ABSTRACT OF THESIS

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Title of Thesis ..... Becoming Technologists: a study of the recruitment and adjustment of graduate scientists and engineers to industrial employment.

During the 1960s there was widespread public concern and controversy in Britain about the flow of graduate scientists and engineers into industrial employment. This thesis summarises some of the major viewpoints in this public debate and examines relevant sociological studies of the occupational socialisation of scientists and engineers. New evidence on the utilisation of recently-qualified scientists and engineers is presented from a case study of new entrants to the electronics industry.

Information for the study of utilisation was collected in a pilot and main study by tape-recorded interviews with ninety industrial managers and tape-recorded interviews supplemented by questionnaires with over two hundred recently-qualified scientists and engineers. The open-ended nature of the interviews facilitated examination of managerial and recruit perspectives on their situation and the factors shaping these perspectives.

Managers were found to advance a variety of rationales for graduate recruitment, some of which were mutually inconsistent. The state of recruitment policy, execution, and appraisal cast doubts on past manpower forecasting methodology.

Graduates were found to view entry to employment as a continuation of their job search in the face of inadequate information. Tentative entry to the labour market and low commitment to the current employer was reinforced by disappointment in early work assignments, realisation that they must undertake responsibility for their own career advancement and beliefs about an expanding labour market. Graduate scientists and engineers tended to claim a distinctive status in the industrial organisation on the basis of educational qualifications and training, but did not attempt to simulate academic employment. Professionalism and technicism appear as temporary bargaining counters in career advancement. This interpretation of graduate scientist and engineering perspectives on employment emphasises satisfactions and dissatisfactions as products of both educational and industrial situations and not educational experiences alone.

Preliminary evidence is found of differences in orientations and perspectives between scientists and engineers in research and development departments which suggest the vulnerability of graduate physicists to disappointment and dissatisfaction.

Suggestions are made for further research into the utilisation of highly qualified manpower and it is concluded that there should be less reliance on the formal educational system for solutions to manpower problems.
BECOMING TECHNOLOGISTS

A study of the recruitment and adjustment of graduate scientists and engineers to industrial employment

BY

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Ph.D
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August 1973
"I know that I myself have contributed handsomely to the notion that education is the best or even the only way to put the world outside to rights. In a report on scientific manpower, which dissected the ills of science and technology, the Committee of which I was Chairman came down unhesitatingly, and with my encouragement and firm approval, in favour of university education as the only practicable way of curing the woes of British industry. Academics did not much like the idea, but not so far as I can make out, because they doubted the power and influence of education. They simply didn't like the implicit criticism of universities.

It is right, of course, that educationists should believe in what they do, and forgivable if they somewhat oversell their wares. But it is a dangerous situation when they acquiesce in an illusion. For it must soon become all too clear that a society where education is doubled and quadrupled does not suddenly become different and better. There are a few signs of such a realisation already."

Professor M.M. Swann (1970)
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Inevitably a study with a lengthy history accumulates many debts to people who have given generously of their time and knowledge. I am heavily indebted to the many anonymous managers, engineers and scientists in industry for cooperation and guidance, for they were the principal sources of my observations as lengthy quotations testify.

I owe much to the intellectual counsel and encouragement of my supervisors, Professor Tom Burns and Miss Rosemary Johnson. Members of the Sociology Department and Science Studies Unit at Edinburgh University and members of the Science Policy Research Unit and Sociology Group at Sussex University have provided many sources of encouragement and criticism.

The gap between research and production is often lengthy, and hazardous, and I owe much to the stylistic improvements of Mrs. Joan Robson who typed the bulk of the manuscript.

The central concepts of the family, as a unit with resources committed to tasks, which features in numerous accounts of socialisation and in this study, has been a vivid experience during the course of the study. To the members of my family I owe an enduring debt.
1. The Origins of the Study

This study was conceived as an examination of how new entrants to some of the new scientific and engineering occupations responded to the demands made on them in their employment and draws on the experiences of recently graduated scientists and engineers and their managers in the British electronics industry. The intention was to use sociological methods in the analysis of phenomena widely believed to present serious social problems. The manner in which these occupations developed and the manner in which recruitment and employment was organised have been widely believed to illustrate both the importance of the relationships between scientific research, advanced technology and higher education in any major industrial country and the particular weaknesses in the British response to the prerequisites for advanced industrialisation.

Among the many analyses and opinions about an appropriate science policy for a country beset by economic difficulties two allegations have been made with considerable frequency. The first claim was that science and engineering graduates were reluctant entrants to British industry, and the second claim was that those graduates were ill-equipped to cope with the demands of their industrial employers. These preferences and skills were often attributed to the 'aristocratic' preoccupations of the educational system, particularly the universities, and formed part of a larger view which attributed British economic malaise to cultural anachronisms, hangovers from a pre-industrial society or at least from an earlier period of industrialisation.
A corollary of this view was that change should be pressed on the educational system as a cure to the problems of highly-qualified manpower and as part of the cure to the wider problems of slow economic growth. The period 1964-1968 was one in which these views were articulated with considerable clarity, passion and frequency. In opposition the Labour Party used the theme of failures in the application of scientific and technological expertise to launch a critique of British institutions and at the General Election of 1964 presented itself as the party which would harness the talents of scientists, engineers and professional managers to 'modernise' Britain. On achieving office, the new Labour Government appointed a new Committee on Manpower Resources for Science and Technology to advise the Minister for Technology and the Minister for Education and Science about the nature of the manpower situation. From 1964-1968 this Committee produced an impressive body of papers which were a cumulative indictment of the educational system and proclamation of a crisis in a national 'shortage and maldistribution of engineers and scientists.\(^{(1)}\)

\(^{(1)}\)The Committee undertook responsibility for the 1965 Triennial Survey and then produced three main reports which analysed the flows of potential scientists and engineers through schools, through universities, and flows out of the national economy. The main reports cited in this study are:

- Enquiry into the Flow of Candidates in Science and Technology London H.M.S.O. 1968, Cmnd 3541 (Chairman Professor Dainton)
- Brain Drain, Report of the Working Group on Manpower for Scientific Growth, London H.M.S.O. 1967, Cmnd 3417 (Chairman Dr. F. E. Jones)
In the context of this debate about the British economy, science policy and manpower resources I was a new voter in 1964, graduated with an economics training in 1966 and decided to employ the research tools developed by sociologists in their studies of socialisation into occupations to illuminate the processes of recruitment and adjustment to industrial employment for graduate scientists and engineers. This decision in 1967 rested on the belief that a sociological analysis could aid in understanding processes which were widely believed to exhibit serious social problems. (2)

Social problems typically attract the attention of commentators of people from a wide variety of social positions and employing a similarly wide variety of perspectives. In the manpower debates of the mid-1960s two particularly influential perspectives were those used by the manpower forecasters and the economists, and these two sets of perspectives offered opposed interpretations of the manpower situation and, to a much lesser extent, opposed policy directives. (3)

(2) My early sociological interests on moving to Edinburgh University in the exercise of managerial authority became focused more closely on the exercise of managerial authority vis a vis expert authority and eventually the processes of making claims to expertise. This change in focus came during a year of course work and further reading and in which the interim reports of the Swann and Dainton Committees appeared and presented their views on the problems of making and securing the expertise of scientists and engineers to promote the British economy.

(3) Indeed later in the study some remarkable similarities will be illustrated in their policy directives despite differences in interpretation, see chapters 4, 5 and 6.
forecasting view was particularly influential and, in the hands of the Committee on Manpower Resources for Science and Technology, the manpower forecasting tools produced a diagnosis broadly in line with that proclaimed by the Labour Party - a national manpower situation of crisis proportions requiring urgent action. In their reports the Committee argued that there was likely to be an overall shortage in the supply of engineers and scientists, that the way in which these engineers and scientists were distributed across sectors of employment was detrimental to the needs of industry and teaching, and that the skills of those entering industry had serious deficiencies. From the pattern of flows into employment the Committee inferred models of choice which corroborated popular opinion about the deficiencies in the educational system. The other allegation, about the deficiencies in attitudes and skills, rendered these graduate employment choices intelligible, even if regarded as undesirable. Few systematic studies were brought to support this latter allegation and it rested for the most part on the complaints voiced by industrial employers in the press, conferences and journals, and ultimately in evidence to Government manpower enquiries. Against the body of conventional wisdom generated by the manpower forecasters, politicians, industrialists and others in the post-war period, the economists raised objections. For the most part these objections were methodological. Economists were dubious of claims of shortage when no evidence was brought of salary movements. 

(4) Since such salary data was scanty the

economists had difficulty on the substantive issues and their criticisms were mainly expressions of agnosticism about shortages. My undergraduate training as an economist inclined me to view this scepticism of economists with sympathy, yet a brief acquaintance with a sociological perspective prompted some doubt about the benefits of a narrowly conceived economics approach, which placed reliance on the efficacy of the market for solutions to manpower allocation problems. (5)

Sociological studies offered sources for both substantive criticisms of the manpower forecasting view and methodological objections to the approaches of manpower forecasters and economists. Some studies suggested that the manpower forecasting should have given priority to studies of utilisation, rather than the

(5) To some extent the selection of manpower forecasters and economists to illustrate the substance of the debate about scientific and technological manpower is an oversimplification of the variety of participants and the variety of views within those groups of people who could be distinguished as manpower forecasters and economists. Manpower forecasting as an area of study attracts those who would call themselves economists but it has tended also to attract large numbers trained in the natural sciences or technologies. It is this group which have tended to be influential in Government advisory bodies with rather simplistic manpower forecasting models. Somewhat more sophisticated models have been used by some of the economists such as Herbert Parnes and the O.E.C.D. Mediterranean Studies. Again there is a variety of paradigms within contemporary economists and the economists who have consistently and critically scrutinised the activities of manpower forecasters tend to be associated with the neo-classical tradition in economic thought. The selection of these two intellectual frameworks, the engineering oriented manpower forecasting and the neo-classical oriented economics, and their respective protagonists can be justified in terms of their coherence as a bodies of opinion which received serious consideration by other participants.
simplistic study of employer demand, likely graduate supply, and projected shortfall. These studies suggested that there might be a sufficiency of scientists and engineers to achieve existing purposes if they were organised in a different manner.

At the societal level these studies drew attention to the distribution of manpower by type of employment, and, more significantly, studies at the industry and company level revealed the persistence of organisational forms ill-suited to the explicitly stated aims of the organisation. (6) Other occupational studies of scientists and engineers reported on the sources of satisfaction and dissatisfaction in industrial work and noted a widespread feeling among industrial scientists and engineers that their talents were underutilised. (7) Both manpower forecasters and economists proceeded by analysing situations in terms of their own imposed concepts and, while such methods have been used by sociologists, a strong sociological tradition emphasises the importance of seeking understanding of social action through study.

(6) See, for example, the comments by Cotgrove about the preoccupations of manpower advisory committees with universities and degree-qualified scientists and engineers compared to the colleges of technology and technician levels of manpower.


of the definitions and meanings which people give to their situation and on which their actions are based. From this basic premise it seemed appropriate to seek insights into the social problems of recruitment and utilisation through the perspectives of those who confronted the tasks of making the transition from university to industry. There appeared to be a case for a study in a science-based industry which asked managers why they recruited graduates and how they were employed and which asked graduates about their experiences of education and employment as a complement to those studies which proceeded to infer models of behaviour from limited kinds of data.

Having undertaken a study of managers and recruits in the electronics industry, the central theme of the thesis is that the issue of utilisation was much the more socially significant issue in the 1960's. It is argued that the relative neglect of this issue in preference to predictions about future supply and demand was symptomatic of the way in which manpower issues were defined as social problems by the manpower forecasters. The approach of the manpower forecasters was one which fostered naive beliefs that

(8) The benefits of this approach became evident during my undergraduate courses in sociology from David Lockwood and John H. Goldthorpe, for they demonstrated the importance of understanding the reactions of car assembly line workers to their work situation through the workers' perspective on that situation rather than through concepts imposed by the researcher. As they stated the position "We reject the idea that workers respond or react in any automatic way to features of their work situation, objectively considered; and we emphasise the extent to which the 'realities' of work are in fact created through workers' own subjective interpretations". J. H. Goldthorpe 'Attitudes and behaviour of car assembly workers' British Journal of Sociology Vol. 17 No. 3 September 1966. The benefits of such a 'social action' approach were strengthened in Edinburgh by Tom Burns and his discussion of the strategies of the various groups in an industrial organisation, see T. Burns and G. M. Stalker op. cit.
increasing the flow of numbers was a major part of the solutions to problems in the employment of scientists and engineers, facilitated employer broadsides against the educational system, presented a view of the educational system as a ready tool of Government policy in the search for remedies, and assumed that graduate complaints about industrial employment would be considerably alleviated when educational changes had been made. (9) As the study proceeded it became evident that the distortions in the analysis of the Committee on Manpower Resources had severe limitations for understanding the recruitment and adjustment of graduate scientists and engineers to industrial employment and that policy proposals based on their analysis were conducive to the kind of disillusionment depicted by Professor Swann in the passage quoted on the fly-leaf.

(9) One example of the employer broadside was the much-quoted address by Paul Chambers, then Chairman of I.C.I. to the National Union on Teachers in the Chuter Ede lecture, 1964. He emphasised industrial requirements for abilities in decision-making and the formation of character, and proceeded to criticise universities as being in the hands of those largely sheltered from the need to take decisions and productive of graduates unable to take decisions. However, this impediment did not deter I.C.I. from being one of the largest employers of scientific and engineering manpower in Britain. 'Education and Industry' Nature No. 4942 July 18th 1964 pp. 227-30. Examples of graduate discontent appeared in numerous letters to journals and press, and even in the advert of one scientific weekly New Scientist entitled 'Graduates misplaced ... send your tales of woe to the Deputy Editor ... '. One recent lengthy account of graduate disenchantment was addressed 'Industry - you are not just making proper use of us' and came from a graduate who turned to lecturing after two years in industry. The burden of his complaint was the lack of opportunity to make decisions. Times March 10th 1969.
At the time of writing up the thesis in 1972 many of the participants to the earlier debates have redefined the social problem of manpower resources for science and technology, many of those who had predicted future 'shortages' in the early 1960's were announcing a 'surplus' of scientists and engineers at the turn of the decade.(10) This has not been without dispute and some have argued that the present situation could be seen as a temporary recession or 'an inability to make an essential investment in the future.(11) Despite controversy about the importance of the first of the two allegations of the 1960's, many commentators still retain their views about the deficiencies of and need for change in the educational system. On these points the thesis has contemporary relevance as a contribution to that re-thinking which Professor Swann thought important and necessary and as a caution against the predilection for seeing the educational system as a ready tool of Government and industrial policy.

2. Outline of the Study

In considering the perspectives of graduates as they move from universities and colleges to industrial employment it is important to know more of the historical context in which this kind of transition has come to be seen as a serious social problem. The public debates themselves have become part of the taken-for-granted assumptions which shaped graduate perspectives. Therefore in Part One, which sets the context for a study of scientist and engineers

(10) See, for example, the change in views of the Secretary of the Manchester University Appointments Service, B. F. Holloway, in two of his articles in the New Scientist, 'The Threat of Manpower Starvation' 12th November 1964 and 'Great Expectations' 20th May 1974.

entering industry, I begin with an account of the development of the debate about scientific and technological manpower in post-war Britain. The purpose of this chapter is to show the way in which issues of science policy were debated in a fragmented manner such that manpower questions could be discussed in a compartmentalised fashion, thus trends in national efforts in 'Big Science' or 'Big Technology' or defence R and D could be largely ignored by the manpower forecasters. (12) This tendency to compartmentalise public debate complemented the tendency of manpower forecasters to neglect study of the demand for and the existing utilisation of scientific and engineering manpower and concentrate attention on the supply side and the educational system. As a contrast to the manpower forecasting approach through inferences from statistical studies it is argued that the manpower issues can be approached through direct recourse to people involved. Indeed when the manpower forecasters used such methods in a study of the 'Brain Drain' they began to enquire directly into the salaries and work experiences of scientists and engineers and their analysis and proposals placed less emphasis on change in the education system and more emphasis on change in industrial employment. (13)

While chapter one outlines the context in which studies of scientists and engineers became of wider social interest, chapter two reviews the then available sociological literature and three outlines the design and conduct of the fieldwork which began

(12) For some comments on the 'fitful' nature of the debate about science policy see L. Gunn "Organising for Science: some relevant questions". Minerva, vol. 5, no. 2, 1967.

(13) See the 'Brain Drain' op. cit.
with a pilot study in the Scottish electronics industry and followed with a main study in electronics companies in the South East of England. Of the contemporary British sociological studies it appeared that they were dominated by research which was either directed to elaborate on concepts developed by American sociologists of science or directed to present descriptive studies with little theoretical framework. In both cases it appeared that these studies had serious limitations in advancing understanding of British manpower problems. While the studies by Professor Cotgrove and his colleagues achieved some important advances they appeared too heavily entangled in imported American concepts to explain the process of adjustment to industrial employment in Britain. (14) The 'anatomical' studies, on the other hand, presented a great deal of descriptive material and then produced interpretations 'from out of the hat'. (15) These interpretations tended to either echo the American sociological commentary that scientists (and engineers to a lesser extent) were committed to values of the scientific community centred on the


university and antithetical to industry or invoked 'conventional wisdom' about the consequences of a British university education.(16) The decision to adopt an alternative theoretical approach was prompted by dissatisfaction with a sociological approach which emphasised the stability of values and commitments, by criticisms of this kind of approach in explanations of scientists and engineers in American industry, and by the explanatory power of a sociological approach which emphasised the susceptibility of values and commitments to situational change and emphasised the importance of family, educational and work experiences in the shaping of

(16) See for example, Rudd and Hatch op cit. p.169-170. Gerstl and Hutton managed to introduce both views, perhaps not surprisingly, for Gerstl was a visiting American sociologist and Hutton was a professor of mechanical engineering and member of the Committee on Manpower Resources for Science and Technology, see Gerstl and Hutton op. cit. p.16 and p. 12.
perspectives and commitments. (17) The steps from this basic theoretical framework to the more detailed formulation of questions and hypotheses in the study and the procedures for contacting twenty-three managers and forty-seven recruits in the pilot study and with fifty-four managers and one hundred and seventy recruits and conducting interviews in the main study are outlined in chapter three.

(17) Some highly pertinent criticisms of the American literature were made by Norman Kaplan in his paper 'Professional Scientists in Industry: an essay review' Social Problems Vol. 13, No. 1, 1965. The sources of an alternative approach lay in the work of Everett Hughes and the Chicago studies of Howard S. Becker, partly because in some of his papers he made direct reference to engineers and partly because he wrote some rather more formal statements of the approach, see his collected papers in Sociological Work London: Allen Lane Press, 1970.
The full design of the main fieldwork was developed during the course of the pilot study whose confirmation of the fruitfulness of the theoretical perspective and illustration of the importance of the utilisation problems are outlined in appendix two.

Part two comprises four chapters addressed to the detailed examination of graduate occupational preferences and the allegations of anti-industry bias leading to shortages of scientists and engineers in industry. This examination is put into the context of a discussion of the various labour market institutions. Chapter four shows the extent to which much of the discussion of 'shortage in the manpower debate was conducted at cross-purposes because of different sets of assumptions held by manpower forecasters and economists about the working of these labour market institutions. The kind of 'evidence' collected to support cases further underlines this point and it is argued that the results of further data collection stimulated by the debate tends to support the scepticism of the economists. Discussion of the nature of the industrial demand for graduate scientists and engineers is continued in chapter five, where it is argued that the variety of rationales and practices in graduate recruitment illustrate the weaknesses of the use made of employer evidence in forecasting studies and point the way to a discussion of utilisation issues. Set against the perspectives of managers on graduate recruitment are the graduate perspectives on entry to an occupation which are introduced in chapter six. In this chapter the models of occupational choice developed by manpower forecasters and economists are examined against the perspectives of graduates and it is argued that both models exhibit
weaknesses, the former in a neglect of the influence of financial factors in occupational choices and the latter in a sole preoccupation with financial factors. In contrast to these approaches it is argued that an adequate theory of occupational choice would incorporate a fuller specification of the resources which individuals bring to the labour market and the financial and non-financial costs and rewards for participation in that market.

Chapter seven begins with an examination of the relationships between advanced industrialisation and education postulated by the Committee on Manpower Resources and their assumptions about the impact of the experience of higher education. The Committee suggest that industrialisation entails an expansion of educational opportunity, and increased vocational content in education, and the extension of educational provision beyond the terminal dates of full-time provision into a life-long experience. By their preoccupation with deficiencies in the second of these developments in Britain I argue that the Committee underestimated the relevance of the other two developments to the manpower debate and once more busied themselves with educational reform to the neglect of change in industry. Examination of the reported experiences of scientific and technological education suggests that the Committee misunderstood the impact of higher education on students.

Part three covers the entry to the world of work and deals with the process of induction into industrial work and the development of commitments, and in this way deals with the substance of allegations about deficiencies in attitudes and skills among graduate entrants to industry.
The development of commitments forms the core of discussion in chapter eight, nine and ten where the suggestion of Burns that individuals bring along a variety of private ends which condition the nature of their availability as resources to organisations is followed up by an examination of the extent to which new recruits developed commitments to meeting the demands of their employers (chapter eight), to meeting the demands of advancing their own careers and status (chapter nine), and to meeting the demands of colleagues and fellow practitioners for standards of professional competence (chapter ten). (18)

The extent of commitments among new entrants to their companies and the achievement of managerial purposes is examined in chapter eight by the use of a social psychological model of influence processes and the conditions under which organisations are likely to be successful in their attempts to secure the commitments of new recruits. Here it is argued that although managerial preferences about appropriate induction procedures closely resembled the strategies indicated in the model, an examination of graduate experiences suggests that industrial practice falls short of these preferences and the graduate perspectives suggest a consequential growth of interest in careerism as a solution to the induction crisis.

The growing interest of industrial companies in career structures and career development can be traced to the growth of large scale organisations with large administrative hierarchies and the different time horizons for the application of mental compared to physical labour. In chapter nine the complaints of

company recruiters about the indifference of interviewees to their 'careers' are explained in terms of the different life cycle positions and perspectives on the labour market of recruiters and potential recruits. The subsequent development of interest in careers is related to the experience of employment and the consequences of this interest for commitments to the company are elaborated.

The extent to which the much reported mis-match between graduate scientists and engineers and their highly qualified employers can be understood in terms of employee efforts to secure conditions of employment described as professional and derived from notions of university practice are examined in chapter ten. From this examination I suggest that industrial scientists and engineers are more likely to use university-derived conceptions, such as those of scientific and engineering creativity, in their efforts to secure greater degrees of control over their work situation rather than as expressions of their desire for university employment per se or any other approximations to basic research.

Finally in Part IV I draw together some conclusions from the study in a chapter which has suggestions for future directions in the study of manpower issues and the sociological study of engineers and scientists.
PART ONE

THE SOCIAL AND SOCIOLOGICAL CONTEXT OF

STUDIES OF ENGINEERS AND SCIENTISTS
1. Introduction

Public enthusiasm and support for science and technology became striking in the advanced industrial countries after the Second World War. Despite some contemporary rumblings of discontent about the fruits of this support and some of the social evils which have accompanied economic growth, the levels of support in the budgets of most advanced industrial nations remain at high levels. The relatively slow rate of economic growth in Britain through the 1950's and 1960's stimulated a great deal of concern about national efforts in the support of scientific and advanced technological research and developments and attempts to secure the benefits of R & D through applications in industry. This context of economic crisis has resulted in the definition of a manpower crisis and provoked the search for readily formulated and administratively simple solutions in the manpower problems. The central argument in this chapter is that this search has resulted during the post-war period in a preoccupation with the supply of manpower and the educational system to the neglect of the manner in which demands for manpower are presented and the utilisation of scientists and engineers in industry.
The political context of the manpower debate is outlined in the first section where it is argued that the decision of the Labour Party to contest the 1964 election on a theme of science and modernisation created a receptive national audience for the alarmist views of the manpower forecasters, moreover the absence of a coherent political analysis permitted an equally myopic analysis of the manpower situation. While the account of events down to 1964 is given more detailed attention in Appendix one, this chapter takes up the critiques made of the manpower forecasters by economists in the 1960s and concludes with a discussion of the utilisation of highly-qualified manpower, and the view that study of these issues might prompt a different emphasis for policy and political action.

2. 1964: Manpower resources as a political issue.

While material and manpower resources had been regarded as significant issues since the Second World War, they took on an added political significance in the years immediately preceding the 1964 general election. The Labour Party took the issue of resources and organisation for civil science and technology as a major point on which to press criticism of the Conservative Government's record. The science and technology platform served important functions for the internal unity of the Labour Party, a unity which could be best furthered by a degree of
vagueness in the policy. The degree of vagueness in policy, the context of political debate and beliefs about economic crisis created a situation in which was a search for dramatic and ready solutions, some of which were forthcoming from the manpower forecasters in the years after 1964.

Most post-war British Governments have issued at least one widely-quoted declaration stressing the importance of encouraging science and technology in an industrial society and aware of some disquieting parallels between British efforts and those of other industrial countries. For example these speeches were made by the post-war Labour Government and continued by the Conservative Administrations.

"...The Government attach the very greatest importance to science. We recognise the contribution which science has made to the prosecution of the War and the achievement of victory, and we are no less desirous that science shall play its part in the constructive tasks of peace and of economic development."(1.)

"The prizes will not go to the countries with the largest population. Those with the best systems of education will win. Science and technical skill give a dozen men the power to do as much as thousands did fifty years ago. Our scientists are doing brilliant work. But if we are to make full use of what we are learning, we shall need many more scientists, engineers and technicians. I am determined that this shortage shall be made good."(2.)

Despite the efforts of various governments in the post-war period, by the early 1960's the Labour Party was agreed in the diagnosis of a scientific, educational and industrial crisis confronting Britain.

(1.) Speech by Herbert Morrison to the House of Commons, November 30th 1945. (cited in N. Vig op. cit. p. 15). Herbert Morrison was Lord President of the Council, the Cabinet Minister with responsibility for Government Civil Science.

(2.) Speech by Sir Anthony Eden, Prime Minister, at Bradford 16th January 1956. The speech was cited in the introduction to the White Paper on "Technical Education", Cmd. 703 p.4.
While the Labour Party was united in its proclamation of a crisis, there was much less clarity in the policy for the post election period. Several commentaries have linked the favourable postures on the Labour Party on science and technology issues to the party's need for an electoral strategy to contrast against the Conservative Party and to unite several different groups in the Party. The modernisation of the economy through the application of scientific and advanced technological knowledge and skill was a convenient banner to hoist against a Government led by an aristocrat. Within the Labour Party there were those, such as Anthony Crosland, who believed that the nature of capitalist industrial society had changed significantly such that a new interpretation of socialism was required, and there were opposed views which saw the essence of capitalism as essentially unchanged. The groups holding these views had been in heated contention during the late 1950's with the 'Revisionist' group wishing to dissociate the party from 'primitive' techniques such as nationalisation and the 'Left-wing' opposed to an attack on the party constitution. The policy document, "Labour and the Scientific Revolution", prepared by the National Executive Committee in 1963 offered the policy to paper over the breaches. To the 'Revisionists' the policy implied greater degrees of sophistication and expertise in the control of the economy, and to 'Left Wingers' the policy implied considerable extensions of the public ownership. While commentators disagree in the degree of emphasis they place on opportunism or traditional concerns as motives in the Labour Party's adoption of the 'Scientific revolution', they are agreed
that the Party had given insufficient attention to the prospective implementation of these plans. (3)

Some of the weaknesses in prior planning became evident in the creation of ministries which lacked a clear brief yet were heralded as administrative innovations to tackle glaring problems. In opposition, Richard Crossman, then Shadow Minister for Education and Science, had proposed 'a real Ministry of Science' with responsibilities for higher education, science research and technology. Eric Robinson, an ardent campaigner for expansion in the non-university institutions of higher education, has linked the switch of Crossman to another responsibility after the Labour victory in the General Election to the successful efforts of an university pressure group on the Labour Party, a pressure group fearful of Crossman's intentions towards the direction of expansion. (4) In office, the Labour Government adopted a single Department of Education and Science, to cover all levels of education and the supervision of the research councils, and a Ministry of Technology, to "guide and

(3) For a writer who tends to emphasise 'opportunism' see N. Vig (Science and Technology in British Politics op. cit.) and for writers who point to the Fabian traditions and policies for national efficiency or the Marxist traditions of 'scientific socialism' see the studies by H. Rose and S. Rose (Science and Society op. cit.) and V. Bogdanor ("The Labour Party in Opposition 1951-1964" in V. Bogdanor and R. Skidelsky ed. The Age of Affluence 1951-64 London: Macmillan 1970).

(4) E. Robinson op. cit. p. 33.
stimulate a major effort to bring advanced technology and new progress into industry." (5) In their commentaries on this period both Vig and the Rosseres conclude that these two Ministries become diverted from their original purposes with regard to the science-technology relationships partly because of inadequate prior preparation of briefs and partly through the pressure of other priorities. They argue that the Ministries for Education and Science became preoccupied with the programme for comprehensive schools and the demands of primary schools. The main speech directed to the manpower issue and the attempt to break from traditional patterns of higher education probably did more to raise anger and dismay than to indicate a direction for educational reform. In a speech delivered amid the euphoric atmosphere of the centenary celebrations of the Woolwich Polytechnic, Mr. Crosland urged attention to the technical colleges rather than universities as more likely sources of industrial manpower. (6) The suggestion that universities were not socially responsive drew the anger of the universities and the suggestion that there was a 'binary system' of higher education in which the 'public sector' (technical and further education colleges) might receive more favoured treatment than the 'autonomous sector' (universities) brought dismay from the former C.A.T.'s who had been transferred from the 'public sector' to the 'autonomous sector'. (7) Subsequently Mr. Crosland


(6) Administrative memorandum No. 7165 (6.5.65: The Role in Higher Education of Regional and other Technical Colleges engaged in advanced work. This was an administrative version of the speech and suggested the policy implications of the Government thought.

(7) P. Venables "Dualism in higher education" Universities Quarterly vol 20 no.1 1965.
attempted to clarify his charge that universities were not socially-responsive and to remove some of the odium in that view in another speech at Lancaster University. (8) Meanwhile the white paper, "A Plan for Polytechnics and other Colleges", approved in the year between the two speeches, was criticised in the Polytechnics as 'ambiguous, uncertain and half-hearted.' (9) On other fronts ministers joined in the campaign to boost the national effort in raising manpower resources for science and technology. They drew attention to the 'wastage' of potential scientific and engineering talent by region, (the North East), and by sex, (able female school-leavers), and they attempted to boost the image and social status of the engineer. (10) The other ministry, the Ministry of Technology, it was alleged, had a poor start because of the poor brief given to its first minister, Frank Cousins. (11) The initial brief consisted largely of sponsorship functions for four industries - computers, machine tools,

(8) A. Crosland 'The structure and development of higher education' 20th January 1967, reprinted as an appendix to the book by E. Robinson (op. cit. pp. 249-56). Mr. Crosland has regretted the Woolwich speech for clumsiness and suggested that was the result of a new minister ill-advised by his department. (See K. Rogan The Politics of Education: Edward Boyle and Anthony Crosland in conversation with Maurice Kogan Harmondsworth: Penguin 1971.

(9) E. Robinson op. cit. p. 13.

(10) Mr. Edward Short, Secretary of State for Education and Science after Mr. Crosland, spoke at Newcastle upon Tyne on the 'national disgrace' of girls shunning engineering, and the high level of engineering work typified by the use of a slide rule rather than spanner among contemporary engineers, (quoted in the Times Educational Supplement 25th March 1969). Similar speeches were made by the Ministers of State for Education, Mrs. Shirley Williams and Mr. Gerald Fowler in 1968.

(11) Vig suggested four factors which resulted in disappointment and criticism of the new Ministry. These were the delays in setting up the Ministry, difficulties in staff recruitment (or new tasks, inadequacy of pre-election plans, and the restriction by the Ministers that their tasks were long term rather than short term. (N. Vig op. cit. p.146). Rose and Rose added that no little criticism was crowned by personal antagonisms against the Minister, a former trade union leader. (N. Rose and S. Rose op. cit. p.114.)
electronics and telecommunications - which was in line with the concept of a Ministry to foster new technology. Another conception of the Ministry gradually took precedence, however, and this was the concept of a Ministry to promote efficiency in existing industry. This trend, apparent under Mr. Cousins, became more apparent under the new Minister, Anthony Wedgewood Benn, and the trend stemmed from both the exigencies which confronted Government in existing industries and the realisation that technology could not be fostered in isolation from existing industries. (12) On the manpower side, the Ministry of Technology

(12) Some reflections made by Wedgewood Benn included the comment that the Ministry was essentially one for industry with a technological flavour. ("Mintech: some key decisions needed", The Times 18th September 1970). The new Conservative Government in 1970 did reorganise ministries and re-named the Ministry of Technology under a Minister of Trade and Industry. Of course most commentators have their own blueprint to offer for the appropriate structure of Government functions and some idea of the many combinations and permutations canvassed during this period can be gauged from yet another variation offered during this time by an industrialist, Dr. F. E. Jones, the managing director of Mullard, a major company in the electronics industry. In a desire to switch more R. & D. from Government labs to industry, Dr. Jones ventured, 'Applied research and development outside these spheres of government should be administered by a 'real Ministry of Technology', that is a Ministry that had an oversight of research, development, production and marketing - which would mean a combination of the present Ministry of Technology, the Department of Employment and Productivity, and the Board of Trade.' The novelty of these remarks lie in the inclusion of the Department of Employment and Productivity and the exclusion of an education department in the manpower side of the equation. The views expressed in a public seminar on science and technology organised by the Conservative Party were quoted in 'Strengthen industry's role in R. & D. says Mullard chief', The Times 13th November 1968.
joined in the efforts to boost the social status of engineers and engineering studies. These efforts included units for "technocentres" as showcases "to make the whole nation more technologically minded", calls for the greater representation of engineers in industrial decision-making and in public life, and publicity of the attractions of a career in engineering, for example, engineering as a step to management. (13)

In many ways the progress of policy formulation with regard to science and technology appears one of fumbling and the gradual realisation that the problems of industrial reorganisation would require long-term solutions. Progress towards those long-term solutions was hampered by the imposition of policies in the short term to check the rate of economic growth and the balance of payments problem which accompanied faster growth.

In such a situation of apparent crisis and considerable frustration for solutions a group which could offer 'ready' and 'practical'

(13) The comments about technocentres came in a report commissioned by the Ministry of Technology from architects and public relations practitioners to think up ways of brightening technology's image. (See Gerald Leach 'Benn plans cathedrals of technology' Observer 27th April 1969). Gerald Fowler, then joint parliamentary secretary at the Ministry of Technology, observed that had the presidents of America's top 500 companies had engineering or other technical degrees, while the comparable figures for other countries were Belgium (50%), France (40%) and Britain (12-20%) (these observations from a lecture to faculty and students of Queen Mary College, London, were quoted in the Guardian November 1968). There was considerably more optimism from the joint survey by the Ministry of Technology and the Council of Engineering Institutions of Professional Engineers which revealed that about 70% of all engineers were under the age of 44 and that over 30% were engaged in senior or top management functions. A graph of responsibility functions against age indicated that 50% of all engineers were engaged in junior and senior management by the age of 33, and 22% were in top executive positions by the age of 47.
solutions was likely to achieve considerable influence over a wide audience. A group was available in one of the Government advisory bodies on manpower, and, using the techniques of short-term manpower forecasting, this group presented a formidably detailed statistical analysis of the problem together with proposed remedies through action on the educational system.

Having set the administrative boundaries with a split between science and technology, the Labour Government sought to ameliorate any potentially damaging affects of this division by cross-membership of Committees. The use of this device was most evident in the creation of a Committee on Manpower Resources for Science and Technology to report to both the Council for Science Policy, (the C.S.P. which in turn reported to the Department of Education and Science), and to the Advisory Council on Technology (the A.C.T.) which in turn reported to the Ministry of Technology. (14)

The Committee on Manpower Resources for Science and Technology set to work with a good deal of vigour to initiate a review paper of the manpower problems, undertake the descriptive and statistical work of the 1965 Triennial Manpower Survey and select problems for investigation in the 'swing away from science' in the schools, the flow of highly qualified manpower overseas in what was termed

(14) The 1947 Advisory Council on Science Policy (ACSP) was decomposed to form the Council for Science Policy (CSP) and the Advisory Council on Technology (ACT), and the Committee on Scientific Manpower dissolved to form the Committee on Manpower Resources for Science and Technology. By 1966 it was felt that another link was needed above the CSP and the ACT and this was forged through the Advisory Council on Science and Technology (ACST). The Committee on Manpower Resources for Science and Technology sat under the overall chairmanship of Lord Jackson, with the various subcommittees under Professor Swann, Professor Dainton and Dr. F. E. Jones.
the 'brain drain' and was a matter of heated political controversy. (15) In one respect the work of the Jackson Committee was incomplete, the Working Group on the Utilisation of Engineers and Scientists in Employment did not publish a report before the disabandonment of the Committee after the 1970 General Election. (16) Some issues on the utilisation of engineers were raised in the Jones Report which tends to give a rather different emphasis in the diagnosis of the problem and set of remedies from those advocated in the Swann Report, although both Committees tended to see their analyses and remedies as complementary to each other. In this section I shall examine two of the available reports of the Jackson Committee and the way in which they defined a crisis situation in manpower resources, and some of the neglected issues of utilisation are taken up in the following section.

(a) The Triennial Manpower Survey 1965.

By comparison with the 1962 Triennial Manpower Survey, the Jackson Committee estimated an increase of 14.6% in the active stock of engineers, technologists and scientists from 273,000 to 313,000 (divided fairly evenly between engineers and scientists),

(15) A Review of the Scope and Problems of Scientific and Technological Manpower Policy Cmd 2800 Committee on Manpower Resources for Science and Technology London; H.M.S.O. 1965. The main reports on which this study draws have been listed already (see Preface, page 2) and for convenience in subsequent pages the various committees will be referred to by the name of the chairman.

(16) This Committee was mentioned in the report of the Swann Committee. (Swann Report Cmd 3760 op. cit. p. 5.)
### TABLE 4

**Actual and Forecast Changes in the Employment of Scientists, Engineers and Technologists during the 1960s**

<table>
<thead>
<tr>
<th></th>
<th>1965</th>
<th>1968 (Forecast)</th>
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<tbody>
<tr>
<td><strong>Education (inc. HM Forces' Schools)</strong></td>
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<td></td>
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<tr>
<td>Universities and other further education establishments</td>
<td>+15</td>
<td>+45</td>
</tr>
<tr>
<td>Schools</td>
<td>-20</td>
<td>+6</td>
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<td><strong>Total Education</strong></td>
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<td><strong>Industry</strong></td>
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<tr>
<td><strong>Sub-total manufacturing industry</strong></td>
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<tr>
<td>Other manufactured man-made fibres</td>
<td>+7</td>
<td>+43</td>
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<tr>
<td>of which - cotton, flax and textiles, clothing etc.</td>
<td>+6</td>
<td>+37</td>
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<tr>
<td>Aircraft</td>
<td>-</td>
<td>-</td>
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<tr>
<td>of which - motor vehicles, etc.</td>
<td>+29</td>
<td>+29</td>
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<tr>
<td><strong>Electrical engineering</strong></td>
<td>+21</td>
<td>+18</td>
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<tr>
<td><strong>Electrical engineering and electronics</strong></td>
<td>-</td>
<td>+30</td>
</tr>
<tr>
<td><strong>Mechanical engineering</strong></td>
<td>+11</td>
<td>+50</td>
</tr>
<tr>
<td>Chemicals and Allied Industries</td>
<td>+10</td>
<td>+17</td>
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<tr>
<td>Food, drink and tobacco</td>
<td>+24</td>
<td>+34</td>
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<tr>
<td><strong>Other manufactures</strong></td>
<td>+49</td>
<td>+20</td>
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<tr>
<td><strong>Total manufacturing industry</strong> (11 or more employees)</td>
<td>+11</td>
<td>+22</td>
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**Note:** The table continues on the right side of the page.
<table>
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<tr>
<th></th>
<th>1965 (Forecast)</th>
<th>1966</th>
<th>% Change in Employment</th>
<th>1968</th>
<th>% Change in Employment</th>
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<td>Construction (larger firms)</td>
<td>2971640</td>
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<td>+12</td>
<td>160608</td>
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<tr>
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<td>11934</td>
<td>2856</td>
<td>+12</td>
<td>118414</td>
<td>+23</td>
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<tr>
<td>Nationalised industries and public corporations</td>
<td>10066</td>
<td>22763</td>
<td>+12</td>
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<td>Government Central Government (excluding HM Forces)</td>
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<td>Atomic energy authority and HM Forces</td>
<td>26213</td>
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<td>+12</td>
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<td>Local authorities and Nationalised industries and Industrial research associations</td>
<td>7887</td>
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and an overall increase in employment of 15% from 183,000 to 211,331, (see table 4). Over the same period, there were sharp contrasts in the extent of growth in different sections. Growth was highest for universities and further education establishments, (18,273 to 24,612, i.e. 35%), and lowest for manufacturing industries (86,221 to 98,540 i.e. 14%), and in schools, (27,443 to 25,939, i.e. 5%). Within the manufacturing sector there were variations from the mechanical engineering sector with the lowest increase (19,282 to 21,278 i.e. 10%) to the electrical and electronic engineering sector with the highest increase (18,054 to 21,048 i.e. 17%) (see table 4).

For the future the Jackson Committee could predict supply with fair accuracy over a three year period by an estimate of numbers on courses started and an allowance based on past 'wastage' rates. Although the Committee felt that the new supply would contribute a relatively small proportion to the total stock, (for example only 18% of the 313,000 qualified scientists and engineers over the period 1962-5), they decided to concentrate on new supply rather than the total stock and efforts at re-training because of 'finite educational resources' (17). Estimates of employer demand were derived from questionnaires to employers similar to those in past triennial manpower surveys. The estimated overall increase in demand of 50,400 (i.e. 24%) engineers, technologists and scientists greatly exceeded the expected rate of growth of stock of 14.6%. Moreover, the Jackson Committee was particularly gloomy when they broke the figures down by sector for the estimated increases for manufacturing

(17) The Triennial Manpower Survey op. cit. p.31.
industry (overall 26%) and schools (21%) seemed unlikely to be fulfilled when viewed against recent growth rates of 14% and 5% respectively, (see table 4). Drawing from the statistics on unfilled vacancies, the Jackson Committee proclaimed,

"A new balance of employment on the lines of employer's demands must be achieved and means devised for attracting and retraining larger numbers of qualified manpower in industry and school teaching." (18)

Several lines of policy and means proposed for further investigation included review of the growth of universities and further education, review of the utilisation of government research establishment personnel with a view to possible transfer to sectors in shortage, review of industrial employers' policies, and for the longer term, investigation of undergraduate courses, retraining facilities and technical employment.

(b) The Reports of the Working Group on Manpower for Scientific Growth

The Swann Committee produced an interim report which gave its terms of reference, ("to discover whether there was any imbalance in the employment of qualified engineering, technological and scientific manpower between universities, research councils, and Government laboratories, and industry and education"), and additional statistical information with which to assist interpretation of the 1965 Triennial Manpower Survey.(19) The task was attacked under the following headings:

(1) the pattern of flows into employment;

(2) the pattern of demand;


First employment of first degree graduates in engineering, technology and science, expressed as percentage of graduates excluding overseas students returning home

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<td>Higher education and research (of which overseas employment):</td>
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<td>Schools, colleges, teacher</td>
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<td>of which research and study</td>
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<td>Higher education and research</td>
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### TABLE 6

First employment of first degree graduates in engineering, technology and science, expressed as percentage of graduates excluding overseas students returning home.
TABLE 6

First employment of first degree graduates, by class of degree; expressed as a percentage of all students in the period 1962-65 (excluding overseas graduates returning home). Total graduates excluding overseas students requiring home (100%)  

<table>
<thead>
<tr>
<th>Sector Employment</th>
<th>Science and Technology</th>
<th>Engineering</th>
<th>Higher Education and Research</th>
<th>Industry</th>
<th>Government</th>
<th>Other</th>
<th>Total Graduates excluding overseas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class of degree</td>
<td>1st Class (honours)</td>
<td>2nd Class (honours)</td>
<td>Other Class (honours)</td>
<td>1st Class (non-honours)</td>
<td>2nd Class (non-honours)</td>
<td>Other Class (non-honours)</td>
<td>1st Class (non-honours)</td>
</tr>
<tr>
<td>1962</td>
<td>63.8%</td>
<td>71.7%</td>
<td>72.7%</td>
<td>52.9%</td>
<td>65.1%</td>
<td>74.8%</td>
<td>47.1%</td>
</tr>
<tr>
<td>1963</td>
<td>66.5%</td>
<td>73.9%</td>
<td>75.3%</td>
<td>55.0%</td>
<td>68.0%</td>
<td>77.5%</td>
<td>50.2%</td>
</tr>
<tr>
<td>1964</td>
<td>69.2%</td>
<td>76.0%</td>
<td>78.2%</td>
<td>57.1%</td>
<td>71.0%</td>
<td>80.4%</td>
<td>53.4%</td>
</tr>
<tr>
<td>1965</td>
<td>71.9%</td>
<td>79.0%</td>
<td>81.3%</td>
<td>59.0%</td>
<td>74.0%</td>
<td>83.2%</td>
<td>55.6%</td>
</tr>
<tr>
<td>1966</td>
<td>74.6%</td>
<td>82.0%</td>
<td>85.2%</td>
<td>61.0%</td>
<td>77.0%</td>
<td>86.2%</td>
<td>57.8%</td>
</tr>
</tbody>
</table>

(3) the influence of existing policies and practices on the pattern of flow involving (a) the growth of science and technology faculties in the universities, (b) the effect of post-graduate awards and research grant policies, and (c) attitudes to industry and teaching.

Among their provisional findings the Committee discerned differences in the flow into employment by discipline (see table 5) and by class of degree (see table 6). Taken together these differences had a compound effect such that the Committee noted that on the whole a higher proportion of the most 'able graduates' compared to 'less able' graduates took courses which led to higher degrees, and thereafter except for chemistry and some engineering schools, the majority remained in higher education or entered Government research and a high proportion went to the U.S.A. The Swann Committee came to a number of tentative conclusions and recommendations in much the same vein as those in the Triennial Manpower Survey, these included revision of the scale and kind of support for post-graduate training, exhortations to industry and schools to attract and retain 'graduates of high quality', and investigation of possible redeployment from other sectors such as Government research establishments.

Some two years later, the Swann Committee announced that 'our new data without doubt reinforce the conclusions that we drew earlier', in particular, 'our two most important findings were that in general the career most sought after by graduates with the highest ability was research, whether in universities, in Government establishments, or abroad; and that the sectors where demand was numerically greatest (industry and schools) did not attract the ablest graduates in proportion to their needs.' (20)

### Table 7

Pupils on 'A' Level Courses in the First Year of the Sixth Form 1962-1971; Number and as a Percentage of Total and of Potential Population - Boys and Girls

<table>
<thead>
<tr>
<th>January of year</th>
<th>Actual</th>
<th>Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science group</td>
<td>32.7</td>
<td>35.9</td>
</tr>
<tr>
<td></td>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>Non-science</td>
<td>36.3</td>
<td>45.3</td>
</tr>
<tr>
<td>group</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>Mixed group</td>
<td>7.8</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>78.8</td>
<td>90.6</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>&amp; as percentage of total in first sixth year (projection 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science group</td>
<td>44.5</td>
<td>39.6</td>
</tr>
<tr>
<td>Non-science</td>
<td>48.6</td>
<td>50.0</td>
</tr>
<tr>
<td>group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed group</td>
<td>9.8</td>
<td>10.4</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>&amp; as percentage of potential population (projection 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science group</td>
<td>4.8</td>
<td>5.0</td>
</tr>
<tr>
<td>Non-science</td>
<td>5.6</td>
<td>6.3</td>
</tr>
<tr>
<td>group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed group</td>
<td>1.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>11.5</td>
<td>12.6</td>
</tr>
</tbody>
</table>

*Excluding pupils in independent schools not recognised as efficient.

Source: Enquiry into the flow of candidates in science and technology into higher educationCmd 3541 p.110.
Indeed such was the confidence that the language of the main report became more colourful as the Committee was 'disturbed' by 'serious imbalances' and a 'positively dangerous situation'.

The Swann Committee was confirmed in its view of impending crisis by the views of the Dainton Committee which examined the flow of candidates in science and technology into higher education. The Committee detected a fall by 1967 of 3,500 pupils on first year science courses in the sixth form compared to the peak year of 1964 with 40,000 (see table 7). The Committee made two projections for the four years down to 1971. The first projection was based on the distribution of sixth formers starting A levels between three groups of subjects - science, non-science and mixed subject courses. The second projection was based on the proportions of the potential population (i.e. those qualified) on all courses in each subject group. The two methods gave different results because of the decreasing size of the underlying potential sixth form population after the passage of the 'bulge' cohorts. The first projection gave a rapidly declining share of first year sixth form placed to science pupils and a drop in absolute numbers, while the second projection, which related the behaviour of sixth formers to the base population, indicated a slight rise in absolute numbers. The Dainton Committee focused attention on the first projection and urged action on the educational system. (21)

In their move to policy proposals the Swann committee distinguished between short term and long term measures and both included recommendations for changes in the educational system and industrial employment. It was the educational system which was singled out for particular emphasis in these recommendations for it was the educational system which was believed to be amenable to policy control, at least more readily capable of registering immediate short-term solutions.

"Our recommendations, aim at an immediate amelioration of present difficulties and at longer term reforms designed to increase the ability of scientists, engineers and technologists to meet the requirements of future employment, some of which are as yet unknown. Since it is the educational system which can most readily respond to change, it will fall mainly to educationalists, particularly those in higher education, to consider what action to take; but industry must also recognise its needs and move accordingly." (22)

The short term measures for education included proposals for slowing down the growth of post graduate places in science and engineering, and changing the balance in postgraduate studies away from research towards taught courses. This latter proposal was related to proposals to encourage collaboration with industry. For industry there were exhortations to conduct 'vigorous recruitment', 'full and effective employment', 'attractive and challenging careers' and 'steady policies for research and development'. The Government was urged not to use the principle of 'fair comparison' for the settlement of public sector salaries to narrow differentials and thereby nullify industrial efforts to recruit vigorously, (due allowance should be paid to the relative lack of freedom and security in industrial employment).

(22) The Flow into Employment of Scientists, Engineers and Technologists Cmd 3760 op. cit. p. vii.
The Government was urged to look at pension rights and their effect on mobility between sectors. Of the five measures proposed for the longer term, four were directed to the educational system and one to Government directly. Universities were urged to make every effort to accommodate students to study undergraduate science, engineering and technology to maintain growth in graduate numbers. Universities were urged to broaden first degree courses in science, engineering and technology to give students some understanding of the working of society and to initiate study of curricula to this end. Study of curricula was recommended too in order to mount post-experience courses. For Government the recommendations were further study and the development of forecasting techniques.

(4) Post-mortems and criticisms.

The work of the Committee on Manpower Resources for Science and Technology lent itself to the kind of headlines which told of impending crisis and called for urgent political action, and sustained the view that such action was possible on the educational system. Although the Dainton Committee did not make projections beyond 1971, others took up their forecasting tools to project the disappearance of sixth form science by 1984 and produce the further coincidence that Orwell's distopia had no word for 'science'. (23)

(23) Dr. H. G. Judge, principal of Banbury School in a speech to the Royal Society of Arts, March 5th 1969. (Cited in the Times Educational Supplement 14.5.69). Even Professor Dainton toyed with the concept of '1984' and projections to that date in a speech to the North of England Education Conference (cited in The Times Educational Supplement 10.1.69). What is most surprising is that he did not believe that the science sixth form would disappear because salaries offered to scientists would be 'too good to miss'. This confidence in the market is surprising in view of the later criticisms of economists that forecasters ignored the functions of salaries in allocating labour.
The work of the Committee was not without contemporary criticisms, however. These criticisms were various in nature, for some related to the analysis of failures in the educational system and some related to the analysis of the labour market and industrial problems. Perhaps the most consistent of these criticisms were those made by the economists who had a relatively coherent analytical framework from which to advance an alternative interpretation of the situation.

In an editorial 'The Times' newspaper detected failures in the educational system on strictly 'educational' grounds but doubted the value of manpower forecasts, so that the Dainton Committee's proposals for greater breadth in curricula could be accepted irrespective of manpower arguments.

"One does not have to be a Powellite to be suspicious of assertions to the effect that momentum can be sustained if forty-five per cent of undergraduates read science and engineering but not if only thirty-eight per cent do so.

"Fortunately the validity of the central recommendations of the Dainton Committee do not depend on the removal of these speculative doubts. For they have strictly educational merits which are independent of argument about manpower needs or the dominant activities of some future society." (24)

In the House of Lords, too, the reports of the Committee on Manpower Resources for Science and Technology received a mixed reception. (25) Lord Wynne Jones, Professor of Chemistry at

(24) "Not so popular science" The Times 1.3.68.
Newcastle University, cautioned that the crisis was not one of supplying university places in science and engineering but of students to fill them and he complained that there was a preoccupation with the few in higher education and a neglect of the many younger age groups, for example, the neglect of science in primary schools. In another criticism of narrow perspectives, Lord King's Norton, Chairman of the Council for National Academic Awards, complained of the Swann Committee preoccupation with universities and neglect of the potential of sandwich and C.N.A.A. courses. Lord Ritchie Calder accepted the relative unpopularity of science and explanation in terms of the inhumanity of some scientific and technological developments advanced by the Dainton but added another contributory factor, an economic factor. He suggested that "science" had been oversold in terms of the pay packet returns to the individual and the limitations of the earning potential of a scientific or engineering training were being realised in schools. In contrast to these comments which concentrated on the supply side and the educational system, whether pointing to primary schools or polytechnics, Lord Byers drew attention to failures in the utilisation of graduates in industry, to failures to provide the attractive challenges and rewards for graduates or even to communicate these opportunities to universities where they exist.

A sharp and serious criticism of the science and engineering lobby and the manpower forecasters for asserting 'shortage' without
adequate knowledge of existing utilisation was launched by
The Economist in 1968. During 1968 representatives of the Royal
Society, the Confederation of British Industry, the Council of
Engineering Institutions, the Institute of Physics and the Physical
Society and the Royal Institute of Chemistry collaborated in a
report Engineers, Technologists and Scientists in the National
Economy, in which they drew attention to national crises and
shortages in a manner similar to that advanced by the Committee
on Manpower Resources for Science and Technology. (26) Under the
heading "Don't they read?", The Economist accused this "roll of
honour of British science" of "trotting out all the familiar
bromides of the last ten years" without reference to all the
available evidence if the O.E.C.D. Secretariat had prepared
background papers for the meeting of Science Ministers for
March after two years' research. (27). A central finding of the
O.E.C.D. Study was that when the qualified manpower of the non-
university institutions was added to the totals of the
university sector Britain turned out more scientifically qualified
men per head of the population than the United States. This
drew from The Economist two comments, firstly, that how this
scientifically qualified manpower was employed was the central
puzzle, and secondly, that the scientific establishment was
insular and out-of-touch. Lord Jackson replied that the latter
comment was impertinence and that it was obvious that the nation
needed greater numbers of people with scientific awareness. (28)

(26) Engineers Technologists and Scientists in the National

(27) "Don't they read?" The Economist 15.6.68 p.68.

(28) Lord Jackson letter to The Economist 29.6.68 p.4.
How to achieve 'scientific awareness' or what degree of 'scientific awareness' dwelt still on the issue of utilisation and substitutions between different kinds of manpower. In its review of the Swann Report, The Economist was prepared to accept some of the Swann Committee complaints about lack of preparation for industry in university first degree courses but suggested that the step which linked British university teaching to the ills of the economy did not necessarily follow. Instead an alternative view was presented which linked American advantages in the application of scientific and engineering knowledge and skills to the availability of a larger number of graduates per 1000 of the working population in the U.S.A. and to a sufficiency of Science in Arts-based degree courses to provide the managers with the scientific awareness which Lord Jackson and others sought.

In 1969 the work of the Committee on Manpower Resources for Science and Technology received two post-mortems. Both emerged from the Higher Education Research Unit (H.E.R.U.) of the London School of Economics. One commentary by Michael Hall was largely in agreement with the analysis of the Swann Report, but chided the Committee for a lack of resolve in pressing changes on the educational system; the other commentary, by Dr. Gannicot and Professor Bla...g, was sharply critical of the lack of intellectual or economic content in the analysis, illustrated the way in which what purported to be evidence of 'shortage' for the Swann Committee could be interpreted as evidence of 'surplus', and cautioned

(29) "Scientists in the Wrong Jobs" The Economist 28.9.68.
against pressing any changes on the educational system on the basis of the Committee's work(30). As economists, Gannicott and Blaug singled out the nature of Committee membership as a science lobby of science and engineering professors committed to advocacy of expansion for science and technology education and critical of social science expansion, and industrialists from the electronics and aerospace industries who blew up the special problems of their industries into a national Brain Drain. In criticising the manpower forecasting frame of reference of the Committee, Gannicott and Blaug stood in a line of economist critics of repeated alarms of shortage made by the manpower forecasters. The economists felt that 'shortage' was an economic concept and that evidence should be sought from the workings of the market by such indicators as salary movements.(31) Although

(30) It may be one of the ironies of a sponsored research that both commentaries stemmed from studies sponsored by the Committee on Manpower Resources for Science and Technology. Michael Hall was the director of a study of manpower utilisation in the electrical engineering industry, to which Mark Blaug was economic consultant. By the time the study had reached the stages of analysis and report, Michael Hall had moved over to establish the Institute of Manpower Studies at Sussex University. The Report itself completed largely by the economists offered little support to the analyses of the Jackson Committees.

the economists were justifiably sceptical of the case presented by the advisory bodies using manpower forecasting techniques, they went further to belabour the advisory bodies as ideologues of science and advanced technology, eager to raise resources and rewards for scientific and technological interests. (32)

By the same token it could be argued that the enthusiasm for markets represented another brand of ideology.

It is interesting to review the way in which the problem, or rather the definition of the problem, of manpower resources for science and technology changed over the years from the Percy and Barlow reports to the Swann report and the manner of changes in their solutions. To the Percy and Barlow Committees there was little distinction between categories of shortage in the sense that there was an overall shortage of scientists, engineers, technologists and technicians. The crisis foreseen by the Jackson Committee in the Dainton and Swann Reports was rather more curious however, for they referred to a potential problem rather than a present problem. Moreover, rather than an overall problem of shortage what the Swann report foresaw was a sectoral problem of shortages in industry and schoolteaching, and what gave greatest concern to the Swann Committee was the relatively low proportion of physics graduates with 'good degrees' who entered industry or schoolteaching. In many respects the narrowing of the scope of the problem could be contributed to large expansions of the educational system and the provision of larger numbers of graduate scientists and engineers to meet employers demands, or perhaps more accurately to meet the demand of school-leavers for education and qualifications believed appropriate to

(32) See especially K. Gannicott and M. Blaug op. cit.
employment. Indeed it might be asked to what extent there was likely to be a problem of the kind envisaged by the Swann Committee since the expansion of postgraduate studies, particularly in technology, were prompted by the concern of the Robbins Committee to strengthen technology, and such expansion would be a problem in the short run but not the long run for industrial recruitment.

In a number of respects the later reports show an increase in sophistication, the many tables of the Swann and Dainton reports contrast sharply with the lack of statistical information available from the early post-war committees. Yet in a number of other respects the Government advisory bodies had made little progress for attention had been concentrated on forecasting employer requirement such that guidance could be given to the educational system. In a sense the manpower committees had advanced very little beyond a passive 'pegs and holes' view of manpower planning. The number and nature of the holes, the likely vacancies in employment, were taken as given by employers in the medium term forecasts. And it is important to note that the medium term (based on employer reports) rather than the longer term forecasts (based on 'independent' judgement) were the more likely source of cries of alarm after the early post-war years. In these medium term forecasts the manpower committees became part of the industrial employers' chorus for the creation of a 'buyers' market' rather than the 'sellers' market' for scientific and technological manpower which had existed in the early post-war years. The Manpower Committees had done very
little to promote what has been termed 'active manpower planning'.

One reason for the persistence with the passive approach to industry on the part of the manpower committee lay in their belief that the educational system could be more readily controlled than the practices of industrial employers. In this area the manpower committees appeared unaware of the ignorance of why students choose education or particular kinds of education and the consequences of particular kinds of education. The Swann Committee had followed the Percy Committee in that both saw failures to gain the farthest possible application of science to industry, and both saw the problem as partly attributable to the educational system, and both set about designing an educational system more responsive to industrial needs. One of the greatest weaknesses of the work of the manpower committees over the intervening twenty years was that they undertook little investigation of those industrial needs. The need for studies of utilisation had been emphasised by Carter and Williams in their lengthy studies of the national deployment of scientific and technical knowledge in the 1950's.


5. The Utilisation of Qualified Scientists and Engineers.

How scientists and engineers are employed in the national economy can be taken up in many ways, for example, an examination could be conducted at different levels of analysis from macrosocial studies of the distribution of scientists and engineers across employment sectors to the more microsocial case studies of employment in particular industries or companies, or even work groups. In their more detailed work, the Jackson Committee concentrated on macrosocial studies of sectoral distribution. The economists have tended to concentrate their attention on aggregate studies since they have had interests in policy relevant studies at the national level. However, both groups did conduct studies at the microscopical level which yield interesting material for the sociological study of utilisation.

Reliance on market evidence to indicate appropriate policy rests on the belief that a market operates and is likely to ensure a relatively efficient distribution of resources. In the manpower forecasting distinction between 'demand' and 'need' lies a fairly pointed criticism of the adequacy of the market. 'Demand' was taken to be something akin to the economists' use of the concept although when employers were asked about employment in three years' time they were told to assume that supply would be available and this use does not involve the employer making any indication of his willingness or ability to bid in the market through operations on his salary-offers. For the manpower forecaster 'need' was defined by reference to 'stated objectives of an organisation or community'.(35) In their usage of the

(35) For definitions of these concepts see The 1965 Triennial Manpower Survey op.cit. p. 17.
concepts the manpower forecasters suggested that 'demand' (what employers wanted) was always less than 'need' (what the nation ought to have) and so planners could not rely on the market to ensure that 'needs' would be met. Perhaps the most lucid and persuasive of critics of the market mechanism in recent years has been Professor J. K. Galbraith and his study of The New Industrial State. He presents an account of the relationship between industry, education and the state in an advanced industrial society. Galbraith pointed to the relationship between production and consumption emerging in the 1930s and the consequent need seen by industrialists to discover new wants by market research, to stimulate demand by advertising, and develop new goods by research and development to encourage demand in new directions. The state must become involved to a significant degree in the case of research and development, he argued, both as guarantor of demand in the product market to support heavy-development costs and as provider of educated manpower in the labour market to support the research and development effort.

In the U.S.A. Galbraith argued that this occurred because it was feasible to support industrial R & D through the defence budget especially in the period since 1945. The appearance of the Russian sputnik in the cold war skies considerably strengthened arguments in favour of the Federal Government's underwriting of the educational supply to industry. Galbraith adopts a somewhat curious stance in his analysis, however, for while he holds to a logic of industrial development and the thesis that industrial societies are becoming alike under the influence

of technological prequisites, he wishes to maintain that in 
capitalist societies the market mechanism has produced a perverse 
mix of 'private affluence and public squalor' which is not 
inevitable and which can be remedied by public choice. It has 
already been indicated that research and development in Britain 
has been heavily weighted to Government and defence purposes. 
That this has been so seems a matter of political will and not of 
technological determinism nor of anonymous market forces. It 
does mean that where the ultimate products for which R & D is 
undertaken are provided out with the market system, as public goods 
in the case of defence, to dismiss the concept of 'need' as 
'metaphysical' is cavalier and to assume that industrial employers 
are both competent in the employment of qualified scientists and 
engineers and are enforced to be competent by market pressures 
requires justification. These are the kinds of justifications 
which might be provided by a study of patterns of utilisation. 

Even from the evidence of their studies, the 'problem' of 
sectoral maldistribution of the graduates presented by the Swann 
Committee appears to have been a disappearing problem. As one 
might have expected from the Galbraith analysis the distribution 
of scientific and engineering manpower in Britain was heavily 
skewed towards Government supported projects which might be 
termed 'Defence', 'Big Technology' and 'Higher Education'. In 
each of these areas the 1965 Triennial Manpower Survey and the 
Swann Report suggested that there was likely to be either a 
static level of demand for the medium term future or a slowing 
down of the rate of increase (for example, in Defence R & D they
pointed out likely redundances in Government military but did not discuss consequential impacts on defence-funded R & D in industry), and the U.G.C. memorandum on guidance for the quinquennium indicated a slowing down of the rate of expansion in post graduate studies. Much of the 'Brain Drain' could be attributed to various Government decisions not to engage in the large commitments of national resources necessary for 'Big Technology'. In this way the recent inability of industry to gain 'fair shares' of 'able graduates' vis à vis Government research and higher education was likely to diminish.

However, the Swann Committee did recognise that competition between sectors (and other countries) for manpower would continue and that industrial employers should consider improvements in employment. Of course this was the point to cite the evidence of utilisation studies and all that the Jackson Committee had undertaken was the collection of impressions from the 'Brain Drainers' and a report on the design of a 'matching section' between academic study and industrial employment for production engineers. (37) The comments of those who had left for employment in the American defence or space industries included reference to the lack of challenge or responsibility in work available to them in British industry and the Jones Committee

laid the balance of recommendations for reform on the industrial rather than the educational system.

From the nature of the earlier debate between manpower forecasters and economists about the evidence of shortage and the nature of the popular complaints against the inadequacies of the educational system in its responses to industrial needs it seemed worthwhile to undertake a study of utilisation and some steps towards advancing our knowledge of the employment of scientists and engineers in industry. Two points in the debates gave an empirical focus for study - these were the notion of 'best practice' industry and the other was the acknowledgement by the Swann Committee of "the often heard comment that the failure of graduates to enter industry was not so much the cause as the result of the present state of much of that industry." (38)

One of the industries most frequently cited as an example of a science-based industry, with large expenditures on R & D and significant proportions of qualified scientists and engineers in its labour force has been the electronics industry. Of the trio of aircraft, chemicals and electronics, the electronics industry has been regarded as a significant portent of the future. Its most famous products, radar and computers, appeared as peculiarly powerful demonstrations of that fusion of scientific knowledge and technical skill in the Second World War, and the industry was a centrepiece for the attention of the newly-created Ministry of Technology in 1964. On the manpower issue it appeared something of a critical case for this industry and the fastest rate of growth of output in the early 1960's and the most pressing

(38) Swann Report Cmnd 3760 op. cit. p.
demand for qualified scientists and engineers. The electronics industry had the greatest shortages of all branches of manufacturing industry when measured by vacancies as a percentage of employment of qualified engineers and scientists in the 1965 Triennial Manpower Survey. (39) From this, one might expect that close attention would be paid to manpower utilisation in this industry. Thus in any attempt to assess the salience of the 'shortage' and 'utilisation' issues and the prospects for stimulating change in industry through operations on the educational system the electronics industry seemed an appropriate starting point.

Once the industry had been selected, the other question of which scientists and engineers to select for study was resolved by the desire to follow up the allegations about preferences and competence. This implied the choice of a sample of graduates as close to the timing of choices as possible and as close to the point of entry to employment as possible. And since the interpretation of reactions to industry was frequently made in terms of the consequences of a science or an engineering education it was desirable to have a sample with opportunities to compare those with a science and those with an engineering background. Examining what happened to new entrants to industry and in what ways they experienced disillusionment and disappointment seemed an appropriate way to approach the Swann Committee comment that current entrants were put off industry by the reported experiences of past generations. If problems were experienced in a 'best practice' industry then their study might be related to other industries.

(39) 1965 Triennial Manpower Survey Cmnd 3103 op. cit. p. 11.
6. The transition to the world of work: a summary of problems related.

So far it has been argued that any discussion of the malaise of the British economy will touch inevitably on the relationships between the educational system, particularly the tertiary stages, research in science and technology, and industrial production. Indeed it has been seen already that these relationships have formed the core of a number of proposed long-term solutions to the problems of the British economy. Those accounts, which can be readily caricatured, would maintain that it is the 'engine room' of a society which affords the standard of living in that society. Moreover, Britain would be characterised as a technological society one in which the critical resources to be utilised are not material but human, in fact the resourcefulness of her skilled manpower. Provision of skilled manpower is made through the educational system, and if society is to be changed through the activities of industry or to fulfill the preconditions of a logic of industrial development then those changes can be brought about through changes in the impact to industry from the educational system. The educational system in this account can be seen as a tool of policy for educationalists, industrialists and government, a means of effecting derived change. It has been seen too that strands of this model are evident in the numerous reports of the Committee on Manpower Resources for Science and Technology, most explicitly in the Swann Report. While difficulties in these relationships between the educational system and industry have become much-discussed social problems, they are relationships which present significant theoretical problems in the social sciences.

Part of the criticism levelled by the economists at the various Committees who have advised Governments on forecasts of
scientific and technological manpower forecasts since 1947 was that their analysis, their cause and effect reasoning, was an indulgence in layman's social science. Yet in one respect both the committees and the economists critics shared a common approach in digging through the statistics to establish and then inferring models of individual and group behaviour compatible with the trends. A central problem in this 'as if' analysis comes in the move from description to prescription when it cannot be assumed that a particular correlation will hold in all circumstances and a knowledge of causal processes becomes important. Despite the considerable importance attached to occupational or career choice, progress towards an adequate, testable theory has remained limited. One of the fruitful efforts has lain in the sociologists' concept of 'socialisation' which has been employed in explanations of 'how individuals are guided toward, trained for, and inducted into certain occupational roles.' Thus the social problems of 'shortage' or 'reluctant entrants' becomes a sociological problem about the conditions under which individuals develop commitments to a particular occupational role. The other social problem about 'ill-prepared industrial recruits' or 'disgruntlement at problems of utilisation' becomes a sociological problem about the kinds of perspectives which recruits develop to deal with the demands of their employers in industrial settings. Both the manpower committees and the economists adopted relatively simple-minded views about the ease with which scientists and engineers were to apply scientific knowledge and technological skills to industry, the manpower committees with an exaggerated optimism in the power of education and the economists content to assume that employers knew what was required and could readily translate these demands to new entrants.
The way in which the utilisation issues were taken up in sociological study is outlined in the two following chapters and appendix two presents some of the data from the pilot study in 1967-8 which suggested that the issue should be pursued further in the main study.
1. Introduction.

In the early post war period the problems of securing scientific and technological manpower for industry were seen as part of the wider natural problem of simply educating, training and using larger numbers of scientists and engineers in the national economy. By the 1960's the problems of industry were seen more distinctly as sectoral problems, (along with schoolteaching), and the problem was defined by the Government advisory bodies as one in which 'academically able' scientists, (and to a lesser extent, engineers), tended neither to choose nor be suitable for industrial employment. This definition of the problem rested on a set of assumptions about values and motivations which were inferred from statistical studies of behaviour, (for example, flows into employment), and the comments of employers. The case for a disaggregated study which enquired directly into the meanings which employers and recruits gave to the transition of graduate scientists and engineers to industrial employment has been argued in Chapter One already. There it was pointed out that the issues of occupational choice were defined as social problems against a background of beliefs about shortages of scientists and engineers. Furthermore it was pointed out that at root the pattern of employment among the 'academically able' physics graduates was given greater prominence by the Swann Committee because they believed that this revealed the pattern of preferences shared by most graduates, in other words they believed that most graduates sought to identify themselves with universities and research.
The starting point for a sociological enquiry is the definition of the research problem and then a refinement such that the problem can be tackled with the resources at hand. Since the resources were heavily constrained by time, I decided that the issues of choice would not receive priority in the research design. Instead I decided that 'unsuitability' should receive priority for investigation, since this appeared a more serious charge and the utilisation issues would remain whatever short run solutions were found to 'numbers' problems. Having decided to concentrate on a case study of the utilisation of recent graduates in science and technology in industrial employment, there were a number of problems about how to contact a suitable industry, set of companies and recruits.

The remainder of this chapter outlines the way in which the social problem of a 'mismatch' between the requirements of industrial employers and their graduate recruits was defined for sociological analysis. In the following section the literature of American sociologists is briefly examined since a number of these writers tended to present a consistent view of a clash between the values of science and industry and suggested that there might be problems for the individual socialised into holding the values of science and who moved into industrial employment. Overall, however, these writers pointed to the development of accommodations which would permit the more effective employment of scientists and engineers in industry. This interpretation of conflict between industrial scientists and engineers and their employers in terms of a value clash became something of an orthodoxy and the way in which it has
influenced British studies of scientists and engineers in industry is taken up in the third section. Explanations of conduct in industry in terms of a value clash had considerable weaknesses both at a theoretical level, because of their presumptions about the relative stability of value orientations, and at an empirical level, because of the development of these approaches in an American context of employment. In the following chapter an alternative conceptual framework which emphasises the susceptibility of value orientations to change as situations change is outlined. This approach is shown to generate a number of questions about the kind of settings in which employers recruit and induct new employees and questions about the resources and strategies available to recruits in coping with their new situation.
2. **Orthodoxies in the study of scientists and engineers in industry.**

Frequent reference to American studies of scientists and engineers in industry is understandable because American industry has employed large numbers of scientists and engineers and because American universities have large departments of sociology, psychology and business who have studied the problems which arise in a novel situation, that of the quite dramatic increases in expenditure on R & D by industry following the second world war. Although the role of research worker engaged in product development first appeared in the laboratory of Thomas Edison and his self-educated inventors, the wartime employment of university-trained scientists on the "Manhattan project" provided a new kind of model for the employment of scientists and engineers in the development of a new technology; scientists and engineers committed to a common purpose could be given considerable autonomy and massive funds to achieve new technological developments. Such a view applied to industry brought some disappointments and over time the prescriptive management literature changed from advocacy of the view that scientists must be accepted on their own terms to the view that scientific research could be managed. (1) During

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(1) Norman Kaplan detected such a shift in the writings of Peter Drucker, a much-respected writer on management, over the decade 1953 to 1963, ("Organisation: will it choke or promote the growth of science" in K. Hill ed. The Management of Scientists Boston: Beacon Press 1964 p. 120 ). In his 1963 paper Drucker wrote of the 'fables of research management' and the lessons which were being learned. Edward Roberts felt that, even at the later date, Drucker's views and those of many managers were devised more from folklore and wisdom than 'a well supported dossier of facts and figures.' ("Facts and Folklore in Research and Development" Industrial Management Review Vol. 8, No. 2, Spring 1967 p. 5.)
the 1950's sociologists studied the extent to which there was
developing a culture of industrial science in which values and
norms defined what could be legitimately expected of scientists
by industrialists and vice versa. In this approach it was
assumed that a moral order was important to regulate the integrity
of technical contributions, and the sociologists attempted to
distinguish the values and norms of science. Empirically the
normative order was associated with the university in which
scientists were trained and the sociologists attempted to assess
the extent to which industrialists were prepared to grant the
degrees of autonomy and conditions of work associated with a
university. If this autonomy and these conditions were not
forthcoming then it was expected that scientists would not be
able to contribute to the development of science. Since
industry was not presumed to be greatly interested in the
advancement of science per se, conflict between scientists and
industrialists was predicted and indications of dissatisfaction
among scientists in industry were interpreted as evidence of a
clash between the values of science and industry.

In the early 1960's three studies appeared which become
the core of a sociological orthodoxy, for, despite different
origins and research strategies, these studies provided a
common account of the scientist in industry and a common inter-
pretation using the concept of a 'value clash'.(2) Marcson,

(2) W. Kornhauser Scientists in Industry Berkeley: University
of California 1960. S. Marcson The Scientist in American
and L. Kainwater The Professional Scientist: a study of the
based in an Industrial Relations department, focussed directly on authority relations in an intensive study by participant observation of one large laboratory in the American West Coast electronics industry. Using very different methods the study by a large team under the direction of Strauss and Rainwater stemmed from a commission from the American Chemical Society for a study of its members. These researchers followed an early qualitative survey with a postal questionnaire to 9,981 members (every ninth member) which yielded 2,789 usable responses across seven categories of membership from academic scientists to chemical engineer. The study by Kornhauser was less closely related to primary materials gathered by the author and attempted a general synthesis of recent researches. (3) From these diverse modes of enquiry emerges a view of the industrial scientists as members of a profession whose relationship with their industrial employers is fraught with the tensions of a clash of values.

Kornhauser identified industrial scientists as members of a profession exhibiting the distinctive traits of a profession and endeavouring to fulfill the functions of a profession in the maintenance of standards.

"A primary function of professionalism is the protection of standards of excellence in the face of pressures for quick and easy solutions. It serves this function by developing expertise, autonomy, commitment and responsibility among the practitioners in significant areas of human endeavour." (4)

(3) An important weakness in the Kornhauser study is the way in which his own research in government, industry and academic laboratories is submerged in the general synthesis without a clear identification of samples and findings.

(4) W. Kornhauser op. cit. p. 1.
The various developments were elaborated further, for example, 'expertise' lay in the growth of specialised knowledge, 'autonomy' was essential to allow those who possessed expertise to exercise free judgement, 'commitment' was developed in the individual during the lengthy training period enquiring expertise and was evident in a lifetime practice where practice was in part its own reward, and finally, 'responsibility' was the quid pro quo offered by practitioners to society as a bargain for the autonomy granted and an assurance that the power conferred by expertise would not be exploited for personal gain. Having set out his ideal type of the professions Korkhauser had to distinguish scientists as members of a profession. This was done in a rather curious manner. Kornhauser acknowledged that scientists in basic science do not have clients since contributions to knowledge are made to fellow practitioners, and he used another sense of professional, that of the contrast between the Eighteenth Century amateur scientist and the full-time salaried (i.e. professional) of the Twentieth Century to put the pure scientists into his category of member of a profession. The normative order which regulated the conduct of pure scientists Kornhauser derived from the work of Robert Merton and his colleagues. Kornhauser wished to exclude applied scientists and engineers from his category of profession since they did not exhibit those characteristics of autonomy and internal democracy in their social control of their professional affairs which Kornhauser believed characterised the pure scientists. However, Kornhauser acknowledged the comments of others that these groups claimed to be members of a profession and at many points in his
subsequent analysis he includes as one homogeneous group, the pure and applied scientists and the engineers. Two important questions about this analysis are, firstly, how could Kornhauser and his fellow writers distinguish a scientific profession out of a seemingly diverse range of educationally and occupationally experienced employees, and secondly, how this group came to follow the normative order of science, that is, basic or pure science.

On the first point Kornhauser was somewhat ambivalent. At some points he quoted from studies which portrayed the engineer with greater feelings of security in industry compared to the scientists and as committed to the performance of a wide range of skills in a particular organisation compared to the narrow specialisms which the scientist sought to practice before an audience beyond his particular organisational boundaries. (5) At other points, however, Kornhauser acknowledged that engineers sometimes claimed to be professionals and in his discussion of professional societies he suggested that the increased relevance of science to engineering and the increased utilisation of science for practical ends has meant that engineering societies have become more intellectual and the scientific societies more pragmatic. (6) At some points then, Kornhauser argued that the differences between engineers and scientists have become those of degree rather than kind. (7) Strauss and Rainwater in their coverage of the American Chemical Society included scientific and engineering qualifications but did not elaborate on the


(6) Kornhauser ibid pp.84-86.

(7) Kornhauser ibid p.16.
consequences of different educational consequences for professional claims and experiences. Marcson included a high proportion of engineers in his sample of scientists but did not find any distinctions sufficiently important to merit comment.(8) In a somewhat earlier paper, another sociologist had argued that engineers did experience conflict with their industrial employers with its origins in a value-clash, but argued as Kornhauser did, in optimistic vain that mutual accommodations were minimizing the extent of conflict.

"In general the marginal man is a man torn between two cultures whose value systems are in some respects incompatible. In this sense the engineer too is marginal. His marginality derives from the peculiarity of his profession; the two cultures to which he is marginal are the scientific cultures and the business culture. The engineers' case is, however, if anything more severe than that of the traditional 'marginal man'. His is more like the marginality of the child of intermarriage where mother has one cultural background, father another...

"As industrial procedures become technically complex, the engineer's organisational role becomes more central. In terms of organisational requirements, therefore, its cultural and psychological marginality are anachronisms. This lag has unfortunate consequences for professional responsibility and satisfaction. And the course of the log must be either in a stereotype of management which presents the sharing of responsibilities and recognition or in professional education which makes the engineer untrustworthy as a responsible member of the organisation."(9)

(8) S. Marcson op. cit. appendix on method.
(9) H. A. Shepherd "Engineers as marginal men" Journal of Engineering Education vol. 47 no. 2 March 1957.
Although defining what is and what is not a profession and then which groups are to be assigned to the category is both a fruitless and presumptuous activity in which many sociologists have engaged, the decision to include scientists and engineers together merits examination.(10)

Although Kornhauser exhibits ambivalence, he manages this uneasy posture with little discussion of the basis of specialised competence, and few questions about how, why, and where it is acquired and legitimated. This ignores the variety of scientific and engineering disciplines and the levels of skill as measured by bachelor and doctorate qualifications and one British study listed no fewer than ninety-four degree titles. (11) More importantly the problem of how boundaries might be drawn by engineers and scientists themselves and how these conceptions enter in the shaping of conduct. How boundaries might be drawn and how unity could be maintained across diversity was seen as a central question by Strauss and his colleagues. (12)

(10) The task is presumptuous because 'profession' is a highly valued status in our society and sociologists are not gatekeepers to privilege, and the more fruitful lines of enquiry lie in asking why some group should claim privileges and why they expect that it should be granted. Everett Hughes stated this belief many years ago. (Men and their Work Glencoe: Free Press 1958 p.44). One of the pitfalls of the structural-functionalist theoretical approach, in which Kornhauser and the other writers work, is a tendency to assume a set of functional prerequisites which are met by a particular group and then accept the ideology of that group about the way in which 'needs' are to be met.


(12) A. L. Strauss and Rainwater op. cit. ch. 2.
the final report suggested that such unity might be mentioned at a symbolic level where the scientist, whatever the humdrum nature of his work, could recall his initiation as a 'believing young man' and identify with the eminent men of science.\(^\text{(13)}\)

The questionnaire material was somewhat inappropriate to elaborate on these points and they remain open for further investigation.

The other question about the 'orthodoxy' of 'value clash' explanations arises in the specification of the values and norms of the profession of science, when and how these were acquired, and the way in which professional practice was organised such that the community of fellow practitioners attempted to sanction deviance.

The much quoted source for these norms was Robert Merton, who, in turn, derived the norms by inference from "countless writings on the scientific spirit" and deep study of the 'Scientific Revolution'.\(^\text{(14)}\)

The four norms identified by Merton - communism, universalism, disinterestedness, and organised scepticism - composed the 'ethos of science'; "that affectively toned complex of values and norms which is held to be binding on the man of science."\(^\text{(15)}\) 'Communism' referred to the common ownership of goods and limited intellectual property rights of the scientist. 'Universalism' demanded that truth claims be subjected to 'preestablished impersonal criteria', in other words, men of

\(^{\text{(13) ibid pp. 190-8.}}\)

\(^{\text{(14) W. Kornhauser op. cit. ch. 1, S. Marcson op. cit. ch. 2.}}\)

\(^{\text{(15) R. K. Merton's paper was originally published in 1942 and reprinted as "Science and Democratic Social Structure" (Social Theory and Social Structure Glencoe: Free Press 2nd ed. 1967.)}}\)

\(^{\text{(15) R. K. Merton op. cit. p. 551.}}\)
science should not recognise 'Aryan Science' or 'Marxist-Leninist Science'. 'Disinterestedness' was an institutional demand that scientists should not achieve personal gain. Finally, 'organised scepticism' required that a scientist should suspend judgement until a 'detached scrutiny of beliefs in terms of empirical and logical criteria' had been completed. Together with technical norms of empirical evidence and logical consistency, Merton believed that a reasonable degree of conformity to the moral norms would lead to the achievement of the institutional goal of science, the extension of certified knowledge. Merton believed that these norms were transmitted by precept and example, and reinforced by sanction such that they were internalised by the scientist. From this analysis it is easy to conclude that such a community of scientists would be in conflict with industry which does not share the goal of the advancement of certified knowledge nor recognise the relevance of norms designed for that purpose. Yet there are some important steps which are required in this extension of the analysis, for example, why should scientists in industry share the goals of academic science and seek to implement these norms.(16) Marcson suggested some sources of committment in

(16) Elsewhere I have argued that observations on these matters were coloured by the sociologist's viewpoint as an academic. There was a tendency to confuse science and scholarship, for example, in the frequent mistranslation of Weber's paper 'Wissenschaft als Beruf' as 'Science as a Vocation' and the assumption that what Weber said about the academic scholar in Nineteenth Century Germany was relevant to the scientist. ("The expert: some comments on the literature on scientists and engineers" Technology and Society Vol. 5 No. 2 1969 p. 77). For some comments in a similar vein, see N. Ellis "The occupation of science" Technology and Society vol. 5 No. 1 1969.
the scientist's graduate training, work involvement, membership in professional societies. (17). The consequences of graduate training were assumed rather than demonstrated, and while Kornhauser thought professional societies important he did not believe that they were essential to the effective functioning of a community of industrial scientists, but he did not examine the ways in which such a community might sanction the behaviour of fellow members such that they behaved in conformity or sought to conform to the Mertonian imperatives. (18)

Kornhauser pointed to four areas in which the industrial scientist was likely to experience difficulty with his industrial employer - the setting of goals, the use of controls and incentives and the degree of influence of scientists. It was argued that the scientists would disagree with management about the criteria for important and worthwhile research, the scientist was likely to emphasise contributions to basic research, and hence engage in disputes about high quality v. low cost research, long term v. short term programmes, and so on. Two patterns of control were outlined and the bureaucratic organisation based on the principle of hierarchy was contrasted against the colleagueship of professional

(17) S. Marcson op. cit. ch. 6 "Professional Needs of Scientists".

(18) Kornhauser provided examples of the way in which professional societies could sanction the scientist's adherence to the normative order of science - "By conducting technical study through publications and meetings, professional associations provide stimulation of the individual's work, recognition of his contributions, and support of his identification with the community." (Kornhauser op. cit. p. 86).
bodies where judgements were vested in a body of peers. Within the community of science, contributions to certified knowledge were held to be rewarded by solicitations for research papers and marks of honour and esteem, whereas the industrial organisation sought new or improved devices and offered rewards of enhanced income, authority and promotion in the hierarchy of offices. Finally there was likely to be conflict of allegation and counter-allegation over the extent to which the research of the scientists could and should influence in company activities. Despite the initial statement of potential for conflict, Kornhauser concluded his study on an optimistic note where recognition of mutual dependence on the part of both scientists and industrial organisations prompted efforts to devise alternative structures which secured the effective contributions of scientists to organisational goals and yet granted some degree of autonomy to the scientists. These accomodations were in the definition of new professional goals which broadened the scope of professional activity, new professional controls, which sought to accomodate professional and organisational goals, new professional careers such as dual career ladders and a broadening of the definitions of professional responsibilities. Marcson was more pessimistic, and suggested that if accomodations took place then most of the shift in outlook was undertaken by the individual scientist or engineer rather than his employing organisation. (19)

(19) Accounts of optimism and pessimism imply, of course, that these writers were committed to the view that scientists ought to be employed in industry and that industry ought to recognise the demands for autonomy as legitimate. Merton argued the case for industrial support of basic research on the grounds of 'potentials of relevance', an argument which justified industrial interest in science but argued that basic research must be accepted on the scientists' terms. ("Basic Research and Potentials of Relevance" American Behavioural Scientist Vol. 6 1963). It should be noted that to some extent differences in pessimism and optimism arose because Kornhauser was writing of classes of employees and the differences between the employment of professional scientists and engineers vis a vis other groups, whereas Marcson was writing of individual new entrants.
There were, however, contemporary studies which gave a different account of the position of engineers and scientists in industry to that offered in 'the orthodoxy', and drew attention to the variety in the conceptions of science. Krohn defined the population of scientists as holders of Phd degrees permanently occupied at least part-time on research, and took a thirty percent random sample from the working scientists spread across academic, industrial and government employment in the twin city area of Minneapolis-St. Paul. (20) In his interviews he included eight attitude scales to examine three main issues: (a) the conception of science (whether there was a change in the conception of research as properly conducted by individuals to the idea that it belongs to large-scale, formally organised research projects); (b) the conception of the scientific role, (whether there was a change from the conception of the scientist as an independent intellectual to the notion of a salaried scientific professional); (c) the conception of the appropriate organisation for scientific research, (whether there was a change from the justification of research by the value of knowledge for its own sake to justification by its utility in the achievement of general human welfare). Krohn found that these conceptions of science, scientific roles and appropriate organisation for science did vary according to the institutional location of the scientist, for example, on all eight scales those scientists in industry had what Krohn termed 'less traditional attitudes'.

(20) R. G. Krohn 'The Institutional Location of the Scientist and his scientific values' IRE Transactions on Engineering Management E M 8 No. 3 September 1961.
Thus the industrial sample identified science with large scale, formally-organised projects, incorporating scientists as professional team members, and directed to utilitarian ends. In another study, West concluded that even academic scientists were very limited advocates of the institutional imperatives identified by Horton and suggested that scientists were developing a conception of the moral order appropriate to the context of Twentieth Century Science. (21) What these studies challenged was the interpretation of conflicts and showed that the scientist leaving university and entering industry need not hold the view that 'science' is to be conducted by individuals for its own sake but could hold other viable conceptions of science. Yet these studies by Krohn and West did not appear in the mainstream of sociological literature and tended to be cited subsequently as supports (rather than criticisms) of the Kornhauser thesis of an 'adjusted' and 'accomodated' world, of a world in which science and business (and scientists and businessmen) were learning to live with each other albeit with tensions. (22)

Other studies of the 1960's attempted to explore the nature of the accomodations. Evan started from the assumption that the scientist has been trained in basic research in the university and on entry to industry will experience role strain (a 'felt difficulty in fulfilling role obligations') but assuming that role obligations will vary across departments he hypothesised that role strain would be least in basic research, greater in

(21) S. S. West 'The ideology of academic scientists' IRE Transactions on engineering management E M 7 1960.

(22) The Studies were reported in Transactions on Engineering Management of the Institute of Radio Engineers.
applied research, and greatest in development. The crucial aspect of obligations was taken to be the extent of 'organisational pressure' indicated by the managerial efforts to achieve company goals. (23) Checking the hypothesis in the three departments (basic, applied and development) of the relatively small research organisation of a large chemical company, Evan found a curvilinear relationship with more role strain in the applied department than in either basic research or development. Instead of interpreting his findings in terms of the disjuncture between aspirations and expectations using the concept of 'relative deprivation', Evan suggested that the contrast between applied research and the other departments could be understood in terms of the ambiguity in the employment relation for applied researchers. This ambiguity in the manager-scientist relation lay in the absence of a set of mutual expectations, the lack of a moral norm of reciprocity. Such norms were available in the model relationships of patron-artist (applicable to basic research) and employer-employee (applicable to development) but the professional-client model was not applicable to the scientist or engineer in the applied research department. La Porte had started his study of a West Coast aerospace industrial complex by hypothenizing seven sources of strain in the relations between managers and scientists but found only two sources evident. (24)

(23) W. M. Evan "Role Strain and the norm of reciprocity in research organisations" American Journal of Sociology Vol. LXVIII No. 3 November 1962.

Indicators of accommodation (the high productivity of research papers, low turnover, favourable company attitudes held by scientists) prompted two revised hypotheses in which recognition of mutual dependence and administrative and managerial structures were thought influential, and La Porte suggested that the separation of major functional roles within the organisation allowed considerable autonomy to the research lab from the control procedures of the production department, for example, in accounting and administrative facilities. Another study by a social psychologist cautioned against assuming 'what people say reflects the actual situation'; Taguiri maintained that the counter images of scientists and manager held by scientists and managers were distorted by the tensions in the relationships. (25) Taguiri saw some structural changes prompting rapprochement, (the development of a science and profession of management using computer technology in decision-making, the acquisition of managerial experience by scientists in non-profit organisations, the increased contact of university scientists with 'outside' organisations), his suggestion seems very close to a suggestion that improved communication would lead to a diminution of conflict without regard to the tensions which led to the use of distorted stereotypes. The tendency of these studies of 'accomodations' was to draw attention to the variety of specific contexts of employment, (non profit organisations other than universities), to the variety of departments within industry, (from basic research

to development) to the variety of arrangements to co-ordinate organisational departments, (from mechanisms for insulation to mechanisms for integrating departments), and by implication the tendency was to limit the relevance of the approach through value-clash.

While one line of refinement to the value clash thesis has been to study more closely the demands of industry, another line of refinement has been to study the process by which these demands were communicated to the new entrant. La Porte and Taguiri drew attention to the similar social and educational backgrounds of recruits to managerial and technical positions and suggested that a homogeneity of outlook would ameliorate tensions. Other researchers had looked at the socialisation process in industry and concluded that whatever his initial orientations towards basic research, the new recruit underwent an enculturation process by which he learnt to temper his technical considerations with economic considerations and then 'sell ideas' to superiors and colleagues.(26)

Despite frequent reference to these studies in sociology texts and the sense in which their interpretations could be cited as orthodox interpretations they appeared a poor starting point for research on the transition to industrial employment in Britain. There were not only doubts about the relevance of the 'value clash' thesis as an explanation of the mis-match between American scientists (and engineers) and their employers, but there

(26) R. Avery "Enculturation in Industrial Research" I.R.E. Transactions on Engineering Management Vol. EM7 No. 1 1960. This was in line with the view of Marcson mentioned earlier.
were a number of additional features about British education and British industry which encouraged caution. In addition to the studies by Krohn and West, considerable scepticism of the Kornhauser-Marcson-Strauss and Rainwater view was expressed by Norman Kaplan. Kaplan doubted the usefulness of the conception of a profession of science, questioned the validity of the assumption that all scientists would prefer to be in basic-research activities, pointed to the vague, blanket use of relationships between autonomy and creativity and the neglect of specification about levels of supervision in the discussion of hierarchical and collegial control. In the British context, postgraduate studies were not so extensively developed as in the United States, so that university trained scientists and engineers entered industry at the bachelor-level of education. Another source of contrast was that American industry supported a greater level of basic research than British industry. This meant that a priori one might expect a number of different effects in Britain. British industry did not purport to offer

(27) Kaplan could comment, therefore, on the unnecessary lengths to which American industrialists attracted scientists, who were not particularly committed to basic research, with the persuasive appeal of the basic research facilities in this organisation and then launch induction programmes and counselling sessions to persuade them to move to applied research or development, (personal communication). It appeared that some American employers believed a version of the Kornhauser/early Drucker thesis. (See Kaplan's published critiques, "Organisation: will it choke or promote the growth of science" op. cit., and "Professional Scientists: an essay review" op. cit.)
basic research and this might be reasonably known and the aspiring basic researchers would seek either academic or Government employment. British scientists and engineers did not tend to have the acquaintance with research gained through post graduate studies and therefore at the bachelor level might be less likely to seek basic research environment compared to American doctorate level manpower, but at the British doctorate level, the lack of breadth resulting from lack of course work and the high prestige of British academic contributions to basic research might be expected to encourage a greater desire for basic research settings among British PhDs compared to American PhDs. Thus while Kornhauser appeared irrelevant at bachelor-level - the level relevant to discussions about the bulk of the entrants to British industry and a university-industry problem of responsiveness - it might have a 'grain of truth' at the PhD level. This point appears to have escaped a number of British sociologists who attempted to test the Kornhauser thesis on samples of undergraduates.

(28) Box and Cotgrove used a sample of third year undergraduate chemistry students to examine degrees of commitment to the 'ethos of science' and mixed up bachelor level and doctorate level manpower in the examination of accommodations in an industrial sample. (S. Box and S. Cotgrove "Scientific Identity, Occupational Selection, and Role Strain" British Journal of Sociology vol. 17 No. 1 March 1966 and S. Cotgrove and S. Box.) Ellis too, makes the leap from an American context to a British context and claims that Kornhauser's work "contains the supposition that industrial scientists have generally internalised the values of 'pure' science during their undergraduate training" ('The Occupation of Science' op. cit. p. 35 my emphasis). In contrast it should be remembered that Krohn explicitly defined a scientist inter alia by his possession of a PhD.
3. The British Context and studies of scientists and engineers.

The American studies which appeared potentially fruitful, because of their location of the mismatch between industrial scientists and industrial employers in student socialisation into a set of values and norms anti-theitical to industrial research, were much less promising on closer examination. The contemporary British studies were somewhat disappointing as a guide to understanding the transition of graduate scientists and engineers to industrial employment for, although these studies provided a good deal of information, they were conducted either in a-theoretical framework or were too closely preoccupied with the American theoretical approaches and problems. Both kinds of study have severe limitations for the sociologist and policy-maker. The a-theoretical studies which had accurate description as a guide to policy as their aim leave the policy maker free to make his own interpretation of the facts, but the researchers tend to import theoretical perspectives on an ad hoc basis when they publish their reports for broader consumption, and the views of Kornhauser and 'value clash' appeared among the imports. On the other hand some contemporary theoretical studies were too closely related to the American studies to distinguish alternative theoretical frameworks which could guide interpretation of their data.(29)

(29) See the comment by Norman Kaplan on the final report of the Cotgrove and Box studies ("Truth and Cliche in the Sociology of Industrial Science" Minerva vol 9 No. 3 July 1971).
Three studies, in the tradition of social accounting by use of social surveys attempted to provide accurate description to guide educational policy. Hutton (a professor of mechanical engineering) and Gerstl (a visiting American sociologist) set out to examine the nature of the mechanical engineer and the main types of work at various stages of his career, prompted by the establishment of a new department of mechanical engineering and the opportunity to reflect on the syllabus. (30) The researchers used interviews to obtain a sample of 977 members of the Institution of Mechanical Engineers in 1962. From the survey Gerstl and Hutton identified four main problems for the mechanical engineering profession in the status of the profession, engineering education, recruitment, and the utilisation of skill. These were the familiar topics in the manpower debates outlined in chapter one. There was the alleged confusion in British society about the occupation of the engineer and identification with low status manual groups, an alleged failure to recruit from the most talented groups, the over-emphasis in engineering education on technical knowledge and skills, and the widespread feeling among professional engineers that their work could have been done by those with less technical training. Because the initial aim was descriptive, the explanations tended to be post hoc and at points referred to the compatibility of their own findings, such as the technical orientations of new entrants, with the

analysis by Kornhauser. Yet it seems paradoxical that the writers should start by defining engineering as a profession, conclude that it was not recognised as such in society and propose renewed efforts by engineers to convince the public of the professional standing of engineers. In seeking common cause with Kornhauser, these writers linked engineers and scientists with a common set of problems. The two other 'fact-finding studies' were utilised by the Swann Committee in their report. The study by Rudd and Hatch was directed to provide information on graduate studies and employment under seven headings - wastage and time taken, employment patterns and changes of employment, emigration, salaries and relationship of studies to work - which were thought of potential use to the researchers' own study, the university appointments boards' secretaries, government departments and other users in industry. The researchers' finding that the graduates in industry (here they did not distinguish between engineers and scientists) were least satisfied with their work was felt to be consistent with Kornhauser's study. Although Rudd and Hatch cautioned that their questionnaire had not explored thoroughly the reasons for the greater discontent of their industrial respondents they felt

(31) Gerstl and Hutton admit their own study started from very modest and pragmatic origins, became much broader, and the study which began in the same year that Kornhauser's work was published was probably influenced more at the stage of interpretation than in design by Kornhauser's work.

that the reasons given for leaving jobs in industry were consistent with the Kornhauser and Merton analysis of professional values of 'autonomy' and 'communism', in conflict with industrial employer demands for specific work and secrecy. (33) In both the Gerstl-Hutton and Rudd-Hatch studies, then, the 'facts' of fact-finding studies were interpreted as consistent with the study of Kornhauser. The other study cited by the Swann Committee was carried out by Kelsall, Pople and Kuhn in the University of Sheffield. While the Rudd-Hatch samples of graduate students were probably more closely comparable to the samples studied in American industry, the Kelsall study dealt with first degree education and employment and was prompted by the desire for information by the University Appointments Boards. (34)

In one sense it is erroneous to see a study as simply 'fact finding' for facts are theory-laden. Data is gathered within a conceptual framework which directs the researcher to ask some questions and not others, to cite some others and not others. Thus the relationship between social researcher and policy maker is becoming of research interest itself as social scientists become increasingly engaged as advisers to policy makers. In the cases quoted, however, the relationships were those between sociological researchers and an advisory body, but they do raise


(34) A preliminary account of the study appeared as Annex G 'The National Survey of 1960 Graduates' in the Swann report (The Flow into Employment of Scientists, Engineers and Technologists op. cit) and the full study appeared as R. K. Kelsall, A. Poole, and A. Kuhn Graduates: the Sociology of an Elite London: Methuen 1972. This study, like that of Rudd and Hatch was financed by grant from the Department of Education and Science.
questions about the intelligibility of schemes of explanation between sociologists and laymen. This becomes most evident in the Kelsall study. Professor Kelsall in a number of earlier studies had used social class as a major independent variable and the 1972 final report placed considerable emphasis on social class in explanations of orientations to education and work. Yet social class does not appear in the material extracted for the Swann Committee. If it had been included it is a matter for conjecture whether the Swann Committee would have approached the issue of shortage through concern about 'wastage' rates in education.

In contrast to these largely a-theoretical studies, two other British studies were more directly linked to the sociological literature on scientists and engineers and were conducted as critiques of the Kornhauser thesis. The study by Box and Cotgrove shifted attention from socialisation within industry to socialisation within the educational system. They set out to examine the relative importance of observance of Merton's norms of science - autonomy and communality - and the extent of a commitment to a career in science by means of a questionnaire sent to two hundred London University third year chemistry students.(35) From the 1966 replies they devised a threefold classification of scientists into: 'public scientists' (to whom all three factors were important), 'private scientists' (to whom autonomy and career commitment were important, but who placed less value on communality), and 'instrumental', (who would use their skill for career advancement, but be prepared to

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(35) S. Box and S. Cotgrove "Scientific Identity, Role Strain and Occupational Choice" op. cit.
abandon a scientific career). Of the 'public scientists' 28% said that they would prefer to work in industry and 72% in an university or government laboratory while in contrast the 'private scientists' opted for industry (46%) and university or government (54%) and the 'instrumental scientists' opted for industry (51%) and university or government (49%). A question about rewards from work revealed beliefs that industry offered better financial, social and technical conditions while universities offered more autonomy and better professional conditions. A parallel study of chemists in employment included an investigation of company recruitment policy and methods and concluded that companies sought potential executive material rather than pure research ability, from this the investigators concluded that industrial selection favoured the 'instrumental' or 'private' scientist. Further Box and Cotgrove concluded that the process of choice (on the part of students) and selection (by companies) would minimise role strain: the frustrated 'public' scientist of the literature was an accident. Some accidents were likely because of the large numbers involved and shortages of industrial recruits, but Box and Cotgrove had drastically revised the relevance of Merton, Barber and Kornhauser for the British context of first degree graduates in industry. The theoretical impasse of the orthodoxy became more apparent in the work of Ellis. (36)

(36) A preliminary account of his study was given by Ellis in a paper to the Science Studies Unit at the University of Edinburgh. In his approach Ellis had been strongly influenced by Cotgrove but the title of his eventual doctoral thesis suggests the extent to which he had moved in his view of the scientist in industry and adopted a perspective in marked contrast to the structural functional approach of other writers. ("The Scientific Worker" unpublished doctoral thesis, University of Leeds, 1969.)
Ellis criticised the Kornhauser approach for its view of science as 'a socially integrated occupation' and preferred a view of science as an 'amalgam of many diverse elements'. Within the amalgam Ellis included applied research and development as well as pure research, and noted that the distinction between 'technologist' and 'scientist' on the basis of degree discipline had little meaning in many labs. For Ellis, the central conclusion from his studies was 'that holistic generalisations of any kind about the nature of the industrial scientist have a limited heuristic value'. Yet Ellis did return to the holistic question, "If the industrial scientist is neither the 'aspiring academic' nor the 'professional' what is he?" His answer, in paraphrase, was to suggest that an industrial scientist is often a frustrated technologist aspiring to management. The frustrations stem from the deceitfulness in the educational system which funnelled him off to pure science, leaving him to compete on unequal terms with the engineering graduate in his eventual occupation and open to doubts about his competence.

There appears a danger from these two British studies of a view in which academic conceptions of science are deemed irrelevant to the industrial scientist. Box and Cotgrove produce an account which is altogether too neat, with conflict the result of faulty socialisation or accident. While they might assume that socialisation processes within industry operate to mitigate the consequence of 'the accident', for example a process of enculturation guiding the 'public' scientist in industry to become a 'private' or 'instrumental' scientist, it is possible to hold that the 'instrumental' scientist could
react to industry by becoming either a 'private' or even a 'public' scientist. Box and Cotgrove assume a stability of orientation which is a misleading oversimplification. It is a misleading oversimplification to assume that the scientist must opt wholly for one orientation or the other, and does not allow that the conception of himself offered may change according to his situation. (37) There is, however, considerable support for the view that the scientist would have considerable difficulty in sustaining this identity in the face of employer opposition. While the

(37) For example in the pilot study, one graduate, who sought to emphasise his analytical skills and expressed some disdain for the empiricism of industrial engineers and declared himself as a professional in terms of his scientific approach to problems, could criticise his friends who remained in university as impractical and irrelevant. His definition of himself as an analytical or empiricist engineer depended on the context of the discussion - industry or university - and where he saw his relative advantage. Some sociologists use the concept of a reference group in altogether too rigid a manner, for example, Bott in a study of families and their social networks noted considerable inconsistencies in the invocation of norms of conduct by use of reference groups and suggested that the vagueness was an asset in permitting flexibility in different circumstances and noted that malleability was possible because the reference groups themselves were frequently absent from the situation in which they were invoked. See E. Bott Family and Social Network London: Tavistock 1957.
Box and Cotgrove study achieved severe weakening of the functionalist interpretation, Ellis seemed prepared to sweep away too much of the orthodoxy in his doubts about the relevance of academic conceptions of science to industrial scientists. He does not allow that they may play an important part in conflicts with industrial management. Ellis saw the conflicts as the familiar ones of all in large-scale organisations subordinate to management, a view which does not admit that some scientists and engineers claim a special position in the organisation nor explain why they expect privilege to be granted. Norman Kaplan, an early critic of the orthodoxy, hinted perceptively at the need for a model of scientists and engineers in industry which incorporated their use of academic conceptions of science as a strategic device in their conflict with industrial management.

"Perhaps they use the values of science and the desire for more autonomy in order to increase their power within the organisation and not at all to become better basic scientists."(38)

There were two earlier British studies which adopted a different approach to the study of scientists and engineers from that of the Kornhauser-Cotgrove studies. Instead of a debate about whether industrial scientists or engineers were members of a profession or professions, Prandy and Burns viewed claims to professional status as claims to a position of relative privilege involving a bargaining relationship with others.

Prandy studied the position of the scientist and engineer

(38) N. Kaplan "Professional Scientists: an essay review" op. cit. p. 97.
in the authority and prestige structure of British industry and whether scientists and engineers espoused either a "class" ideology, (emphasising the conflictual elements in their employment relations), or a 'status' ideology, (emphasising harmonious aspects of the relations and acceptance of the authority structures), in relation to their age, education and conditions of employment.(39) From his postal survey and interviews with members of a professional association (the Institution of Metallurgists), a trade union (the Association of Scientific Workers) and a professional union (The Engineers' Guild), Prandy found support for his main hypothesis that where engineers and scientists either shared directly in the exercise of authority, or where their work situation gave them a feeling of being close to management, they saw themselves as part of a graded hierarchy, espousing a status ideology which tended to find its concrete expression in membership and approval of professional institutions. Where engineers and scientists did not experience these conditions, but experienced work conditions which emphasised their subordination, their attitudes and ideology resembled more closely the class type with the recognition of a conflict of interest with the employer and likely trade union membership. In linking ideologies and positions, Prandy found that the status or harmonious ideology tended to be related to administrative functions, private industry, full-time university education, and older respondents whereas the class or conflictual ideology tended to be related to technical (especially routine such as production rather than R & D) functions, the public or Government sector, part-time

technical college education, and younger respondents. Even where
dissatisfactions and conflict were expressed, discussion of action
to secure better conditions was only half-hearted for the young
graduate engineers and scientists could aspire to the exercise
of power shortly by individualist advance and the only collective
efforts thought necessary were those to publicise and convince
managements, governments, and the general public of the eminence
and distinctions of scientists and engineers. Thus graduate
scientists and engineers might be expected to express dissatisfactions
and be engaged in conflict with their employer over their claims
to a special position in industry, but these conflicts were
unlikely to be of a deep and abiding kind.

A fascinating account of the way in which industrial scientists
cultivated lay conceptions of eccentricity, to the extent that "the
'prima donna' scientist was a much more familiar figure in the
electronics industry than he appeared to be in universities",
was given by Burns and Stalker in their study of the electronics
industry. (40) Many industrial scientists sought to be more
academic than the academics in their efforts to differentiate
themselves from other members of the industrial organisation.
In return many managers accepted this scientific identity for,
while it allowed the scientist a degree of eccentricity and
waywardness to infringe company regulations, it allowed the
manager to exclude the scientist from managerial control on the
grounds of irresponsibility; those who break rules cannot be
allowed to make rules. Burns went on to interpret the position
of the industrial scientist.

"The industrial scientist's special position is due to his semi-detachment from the industrial concern and to his new importance in the whole economic and social system of modern society.

"The industrial scientist is now a member of a distinctive group in the national population, rapidly growing in numbers (which seem nevertheless to remain perpetually short of national needs), accorded to every considerable share of public and political attention, and inevitably conscious of the importance and power attached to the technological contribution. This awareness has its effect on the general demeanour of the industrial scientist, particularly in his dealings with industrial managements, through whom the claimant needs of society for his services are expressed and who are the media by which these highly valued services may be translated into effective action.

"To this general influence on the position and demeanour of the industrial scientist, two other relevant factors can be added. More perhaps in Great Britain, where the initiative in the expansion of technology has lain outside industry, than elsewhere, the industrial scientist conceives himself as a member of a professional group the bounds of which extends over the institutions of higher education and government service as well as of business.

"Secondly, the technology is new, and therefore fairly unfamiliar. In the greater part of industry, which had little direct dealings with new technology and industrial scientists before the war, preconceived notions about the kind of activity and the kind of person typical of the profession are bound to exist, and these have not necessarily been brought into conformity with reality."(41)

In this generic term, 'industrial scientist', Burns links scientists and engineers in research and advanced development functions, and appears to make three points of substance in his analysis: firstly, the industrial scientists do make a claim for a special status in industry; secondly, this special status claim is not to be understood by reference to beliefs that the legitimate tasks of a scientist is with accretions of certified knowledge but the familiarity with other settings in which scientific skills are employed gives the scientist a different

(41) T. Burns and G. M. Stalker op. cit: p 175.
perspective and bargaining position vis a vis his employer compared to other industrial employees; and thirdly, the relations of industrial scientists and their managers must be understood by reference to the context of British industry and not by a-historical and a-cultural analysis. There is one further methodological point here, which is that any investigation of the special position should proceed through the examination of the claims and definitions of the situation advanced by the participants themselves.

In attempting to explain the failure of companies to adopt the appropriate management structure to cope with the exigencies of changing markets and changing technology, Burns saw the problem partly in the failure of some managing directors to interpret correctly their task and organisational needs and partly in their failure to secure the commitment of organisational members to a new pattern of working relations. Frequently organisational members had other preoccupations in advancing their careers or the interests of their department in conflict with other members of the organisation for control of resources. The availability of different schemes of action to the new entrant to industry - for example, to develop commitments to his employer and the working organisation, to develop commitments to his present status and career advancement, to develop commitments to the internal politics of the organisation, to develop commitments in his professional skills and the approval of his fellow-practitioners - point up the importance of investigating the graduate scientists' and engineers' ways of coping with the demands of their situation and the allocation of their resources between commitments.
In this review of earlier studies of scientists and engineers in industry, dissatisfaction has been expressed with these approaches which have sought to explain conflicts between industrial scientists and engineers and their managers by reference to a clash between adherents of different value systems. This thesis was modified by British researchers to the extent where they believed that such conflicts were minimized. Yet conflicts exist if we are to accept the evidence of concern about graduate scientists and engineers in industry described in chapter one, and the social problem was frequently attributed to the university training of the scientists and engineers. In the next chapter a conceptual framework will be presented which offered alternative research strategy to that available in the 'orthodoxy'. This strategy directs attention to the way in which the new recruit develops a perspective to shape his conduct in a new situation and draws attention to the variety of demands as perceived by respondents and the way in which his responses are conditioned in part by past experiences.
CHAPTER THREE

THE DESIGN OF THE STUDY

1. Introduction.

The clearest attempts to understand social interaction through the eyes of the participants have been linked to the Chicago School of Sociology and some of their most important achievements have been in studies of occupational groups. (1) The Chicago sociologists have demarcated a distinctive area of study in the sociology of occupations, drawing attention to the nature of work and the features of the work situation which encourage or discourage interaction, the social problems which arise in occupations and the relation between occupations and the moral order. The concept of 'career' has had a prominent place in their analyses of occupations as they draw attention to the dynamic processes of social change and career structures at the societal level and the typical developments in career lines, career stages and career contingencies at the individual level.

In a study of medical students making-out in their college situation, Becker and his colleagues introduced the concept of 'perspective' to refer to the complex of ideas and actions which were developed to responses to a novel and problematic situation and seemed to guide further participation in the situation.

(1) The underlying theoretical framework of this group of writers owes much to the conception of man and social interaction developed by the philosopher, Mead. (For a review of Mead's work, see Herbert Blumer "Sociological implications of the thought of George Herbert Mead" American Journal of Sociology vol 71 1965-6). In the field of occupational studies the central figure has been Everett Hughes, supported in many studies by Howard S. Becker and Blanche Geer. (Hughes' papers over a number of years were collected in the volume Men and their Work op. cit. and some of the many studies undertaken within this frame of reference are represented in the volume of essays in honour of Hughes by his students, H. S. Becker est. al. ed. Institutions and the Person Chicago: Aldine 1968.)
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Within the perspective, three further elements were singled out for attention. The 'definition of the situation' was a somewhat loose expression but drew attention to the processes by which the individual (or group) explored the possibilities for behaviour in a situation and noted the constraints which faced him, and thereby developed a descriptive account of the character of the situation. In addition to these ideas and dispositions to act in a situation, the perspective referred to 'actions' specified as appropriate to the situation and to 'criteria of judgement' by which responses might be judged. These researchers emphasised the dynamic aspects of behaviour of social behaviour and showed the way in which situations were explored in ideas and actions in the development of a perspective.

"We use the term perspective to refer to a co-ordinated set of ideas and actions a person uses in dealing with some problematic situation, to refer to a person's ordinary way of thinking about and acting in such a situation. These thoughts and actions are co-ordinated in the sense that the actions flow reasonably, from the actor's perspective, from the ideas contained in the perspective. Similarly, the ideas can be seen by an observer to be one of the possible sets of ideas which might form the underlying rationale for the person's actions and are seen by the actor as providing a justification for acting as he does". (2)

This emphasis on process and the relationship between perspectives and situations forms the basis of an approach which is in marked contrast to many of the earlier studies quoted. Instead of a presumption about the stability of value commitments there is an emphasis on change, and instead of the emphasis on detached observation or closed-ended questionnaires there is an emphasis on eliciting the respondent's view of his world in his own terms.

From within this conceptual framework the interest of many groups in control of the educational system is readily understandable for, as Willard Waller observed, education largely consists of the art of imposing definitions of the situation on the young. (3) An interest in the abandonment of perspectives and the development of new perspectives or in efforts to redefine situations for others implies an inquiry into the mechanisms for change and stability in a situation. Becker's concept of 'situational adjustment' draws attention to the expected and unexpected contingencies which prompt an alteration in perspectives. Becker's other concept of 'commitment' draws attention to the continuity in an individual's behaviour despite situational change, and the committed individual is defined as one who opts for consistent lines of activity rather than opting for feasible alternatives. Any explanation of his choice must be in terms of what he holds valuable in the situation.

The questions which are most readily posed on the transition from university to industry within the Becker approach fall into two sets, the first set relate to aspects of the social structure.

and the second to the processes of adult socialisation and the development of perspectives. The questions on social structure ask about the kinds of situations in which socialising institutions (such as universities and industrial companies) place recruits and the kinds of demands made of new entrants as these institutions sought to manage their passage into a different kind of person. Examination of the development of perspectives means an examination of what it is in a situation that requires the individual to act in a certain way and form a particular definition of the situation. In terms of the transition between two situations the questions are about the kinds of things which provoke adjustment or about the kinds of things of sufficient value to encourage consistency and hinder change.

2. The Social Structure of Socialisation Settings.

Dismay at the failure of production departments to maintain their share of employment of the increasing numbers of highly qualified manpower moved the Committee on Manpower Resources for Science and Technology to set up a Working Group on Engineering Training and the Requirements of Industry. The report of this group called for the provision of 'matching sections' to assist the passage of graduates between university and the production departments of industry. (4) While the 'Bosworth Report' urged special attention to the settings for entry to production departments, the 'Jones Report' called for closer attention to induction procedures in all departments employing professional manpower. (5) Studies of the way in which different

(4) Education and Training Requirements for the Electrical and Mechanical Manufacturing Industries op. cit.

(5) Brain Drain op. cit. p. 58.
societies and social groups provide support and share the burden of status transition with the novice have long been studied by social anthropologists. The sociological literature has been more closely related to analysis of the efforts of organisations such as prisons and mental hospitals to change the status of the inmates and draws attention to a number of dimensions along which situations may be compared. (7) (See Table 1.)

One of the most significant dimensions along which settings may vary is the extent to which the organisation defines the new entrant as a learner or a worker. The kind of definition might be gauged from the presence or absence of formal training schemes, and the importance of these definitions would lie in the extent to which they matched the graduate's self-conception, for example, whether or not he saw himself as qualified by his university training alone. From the available literature it was expected that the definition of the learner and the use of formal training schemes would be more likely for the development compared to research labs. However it was expected that the physics graduate would more readily accept the status of learner compared to the engineering graduate. The content of socialisation,


TABLE 1

Some Major Dimensions of Socialisation Settings

1. Whether the balance of emphasis is on learning or working.
2. Whether the socialisation process is considered developmental or requiring resocialisation.
3. Whether the socialisation process is undergone in cohorts or on an individual basis.
4. Whether the socialisation process is serial or disjunctive.
5. Whether the scope of change envisaged in the socialisation process is narrow or broad.
the nature of the 'lessons to be learned' is closely related to
the pattern of relationships in which socialiser and socialisee
are woven. Here, an important dimension is whether the process
of learning is seen as developmental, building on earlier defini-
tions and actions, or as requiring resocialisation following
desocialisation, that is, as requiring some unleashing before
new definitions and actions can be learned. In the managerial
or company literature there was rarely acknowledgement of a
deliberate effort to desocialise the new graduate, to strip away
what was believed by managers to be the appropriate identity
carried by the recruit from his university background, although
claims to do this emerged in interviews. Two other dimensions
referred to the extent to which the recruit could gain the support
of either fellow recruits or past cohorts of recruits. Here it
was expected that the advantage would lie with recruits in
those organisations or departments which recruited in numbers
such that recruits could gain such support, although it did not
appear a priori whether this could aid the organisation in its
efforts to secure loyalty to managerially prescribed goals or
aid the development of a counter-culture. There were no clear
expectations about the scope of socialisation efforts. Some
studies have pointed to the efforts of socialisation agents to
direct not simply role socialisation, (a training for the perform-
ance of a specific task), but a status socialisation, (a broader
pattern of training with its associated life styles), such
examples include the nursing training schools. While such efforts
were conceivable in managerial training schemes they were not
anticipated in induction schemes or the work situation of
scientists and engineers.
3. **Situational Adjustment and Commitment.**

To conceive of the entry of graduates into industry as a 'crisis' might appear overly dramatic and an unwarranted invocation of the imagery of the 'fatal turn' yet there is a lengthy tradition in sociology which used the concept of 'crisis' to simply refer to an occasion calling for the direction of resources to solve a problem, a stimulus to situational adjustment. (8) Recently psychiatrists have broadened the range of variables in their studies (notably in the psycho-social theories of Erikson), and directed their attention to 'normal' events and efforts to provide support services in status transitions. (9)

In the psychiatric literature the concept of 'task' was used to refer to demands which prompt adjustment. (See table 2.)

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E. Silber et. al. "Compétent adolescents coping with college decisions" *Archives of General Psychiatry* vol. 5 1961.

One example of a study by sociologists influenced by these writings is R. Rapoport and R. Rapoport 'Work and Family in the Contemporary United States' *American Sociological Review* 1965.
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<tr>
<td><strong>Central tasks in the critical role transition from university to industry.</strong></td>
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<tr>
<td>1.</td>
<td>Defining the situation.</td>
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<tr>
<td>2.</td>
<td>Developing technical skills to cover the broader range of tasks.</td>
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<td>3.</td>
<td>Developing social skills in conduct with colleagues and peers.</td>
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<td>4.</td>
<td>Searching out opportunities to demonstrate skills and competence.</td>
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<td>5.</td>
<td>Learning the criteria to assess performance.</td>
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<td>6.</td>
<td>Developing accommodations to new authority relations.</td>
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<td>7.</td>
<td>Developing a self-image consistent with the new situation.</td>
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<td>8.</td>
<td>Developing a rhythm of life appropriate to different time horizons.</td>
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<td>9.</td>
<td>Developing leisure pursuits outside work if geographically mobile.</td>
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<tr>
<td>10.</td>
<td>Developing an orientation on the future and careers.</td>
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<tr>
<td>11.</td>
<td>Developing skills to meet the approval of fellow-professionals.</td>
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One way in which a situation might be less problematic for an individual lies in the extent to which it is predictable and appropriate measures can be taken. For example, in all those aspects of the situation which require information it might be expected that some steps to acquire such relevant can be taken if the situation is foreseen. Thus the information about the timing of career choices available in the Swann Report suggests the expectation that engineers have begun to anticipate the termination of studies and to collect information at an earlier date than the physicists.

Whereas the American sociological literature pointed to a growing similarity in the skills and orientations, there was a strong emphasis on the differences between scientists and engineers in the British manpower literature, and, these differences were emphasised often in a linked expression of dismay about the relative rates of expansion of science and technology graduates. Engineers were considered to have a more broadly based education and it might be expected that they would more readily broaden their definition of their tasks, skills and competence than physicists. Whereas there was no a priori reason to suspect that social skills might be differentially acquired as the result of different educational discipline experiences, it was expected that the engineers would experience a greater desire to work in groups and acquire social skills than the physicists. In the case of authority relations it was expected that conflicts might centre on the degree of autonomy granted in carrying out projects rather than in the choice of projects since it was expected that on entry the recruit would accept assignments to be directed to him. While it was expected that a geographically
mobile group might experience shifts in their out-of-work life; these were not expected to be significant issues for the majority of graduates.

In the attempt to take on an organisational role, there appeared to be two potential sources of problems for the recruit. The first source lay in 'role conflict' (10). Such conflicts may be of many kinds, for example, where the individual has two supervisors who make contradictory demands or where one supervisor makes contradictory demands. These problems were minimised in the companies in the pilot study by the assignment to only one supervisor and in some companies by attempts to vet supervisors, again role conflicts created by an individual having more than one role tended to be minimised by giving the newcomer only one assignment. The problems which were evident were those of person-role conflict where some graduates attempted to maintain a definition of themselves and their situation at odds with the role demands of supervisors. The other set of problems can be summed under the heading of 'role ambiguity'. It has already been suggested in the discussion of the development of perspectives that the individual seeks information in his new setting to enable him to participate—information about the character of the situation, what is demanded of him, what kinds of activities would meet those demands, and what would be the consequences of his action for himself and others in the organisation. Ambiguity arises where this information is either non-existent.

or is inadequately communicated, in the latter case this could be a deliberate withholding of information until the newcomer has 'proved' his worth and loyalty. Although analytically distinct, role conflict and role ambiguity may arise together, for example, where conflicts can lead to uncertainty and ambiguity. While the most obvious conflicts seemed to arise in the non-R & D departments, the R & D lab seemed a setting with a large degree of inherent ambiguity. Crossing an organisational threshold as newcomer required a search process by the interviewer, but his search was the more difficult when the manager insisted that in R & D the able entrant must define his own situation and create his role, the very aim of the departments in creativity and innovation implied an ill-defined setting.

In these situations of 'conflict' or 'ambiguity' the next step in the research was to try to examine the strategies which new entrants employed in their attempts to 'cope' or 'make out'.(11) One likely possibility appeared to be to undertake to relate the new situation to past problems and employ the perspectives successful in the past. Of course this strategy could earn the disapproval of managers who saw a failure to make adjustments to the new situation and interpreted the response as a reluctance to leave university specialisms. The potential for change in such a strategy lies in the response to the breakdown of the symbolic relationship and the attempt to work at the metaphor.(12) Another strategy which could be expected in the

(11) 'Coping' is the term used by Kahn and his colleagues (Organisational Stress) for the processes which Becker and his colleagues term 'making out' (Making the Grade New York: Wiley 1968).

assertion of familiarity in the midst of the novel situation would be an emphasis on continuity with the past. Acquiring vacation experience in industry could be another strategy to cope with the move to industry. In this case learning about the organisation in advance and likely tasks in advance could generate confidence in one's ability to cope with industry and be a measure to clarify some of the ambiguity about the situation which might otherwise obtain. Vacation experience was not the only potential source of information about the future, the reported experiences of other students, family members, friends and university teachers could suggest ways in which adjustments would have to be made. Box and Cotgrove emphasised the importance of such 'anticipatory socialisation' in the reduction of role strain in industry. Other studies have suggested that some distinctions ought to be drawn in the kinds of 'definitions of the situation' available before entry to a situation, for example, while students may know that industry has a major goal in the production of goods such that profits accrue to the company they may not know how those high level definitions of industry are translated into the lower level specific role demands or what activities meet these demands.\(^{(13)}\) In all these strategies which attempted to relate the present to the past or to anticipate the future in the present, the general consensus of opinion available in manpower debates tended to

\(^{(13)}\) See the distinction drawn by Israel between technical-instrumental and expressive-ideological expectations concerning roles. ('Problems of Rolelearning' in J. Berger, M. Zelditch and B. Anderson eds. Sociological Theories in Progress Vol. 1 Boston: Houghton Mifflin 1966.)
suggest that the engineer had advantages compared to the scientist in being able to summon resources from his educational experiences more readily relevant to industrial situations. Thus it could be expected that engineers were more likely to have had industrial vacation experiences (a requirement in some courses) and industrially experienced tutors.

From the sociological and psychiatric literature another set of strategies appeared as ways of coping with the novelty evident in a new situation. One possibility was that graduates would selectively perceive favourable elements in the situation, for example, while they might regret the reduced autonomy in their work situation compared to that of the student they might emphasise the benefits of being a wage-earner. With regard to those elements of the situation, two strategies appeared possible, one strategy was to hope that satisfactions might accrue in the future, while the other was to lower the level of aspiration in line with likely satisfaction, what has been termed the growth of 'realism'.

While the analysis of the first set of strategies, (relating the present to the past and anticipating the future), was expected to draw attention to the resources which graduates brought to their work situation, the analysis of the use of the second set of strategies was expected to introduce some discussion of the 'cost' to the individual of effectiveness in meeting situational demands. Here it was hoped to analyse the causes and consequences for the individual and the organisation of the kind of 'disillusionment' and 'disanchantment' reported in the 'Jones Report', popular science journals and newspapers.(14) The discussion of 'costs' was intended to carry

(14) See Chapter One.
the corollary of a discussion of 'benefits' and the development of 'commitments'.

The development of commitments, or consistent lines of activity, was seen as problematic in two ways in the manpower debates. There was firstly, the regret that the more able graduates tended to enter post graduate study, academic or government employment in greater proportion than entered industry, and secondly, there was regret that graduates in industry did not develop commitments to industry and there was some alarm about the numbers who entered the 'braindrain' and left British industry or espoused their disenchantment. One of the major sources of commitment encouraging attempts to stay within the educational system or hindering adjustment to industry was cited by the manpower committees as the knowledge and skills imparted in the educational system. This appeared to be a hypothesis that salary was relatively unimportant in educational and occupational choice. Two central questions for investigation, then, were to what extent salary was not an important factor in educational and occupational choices and to what extent certain kinds of knowledge and skill inhibited adjustments to industrial demands, for example, across a total sample of engineers and scientists and in comparisons of scientists and engineers. Among other factors which have been regarded as important in the development of occupational commitments are job interest and social prestige. (15) Job interest was a factor thought important in the 'Jones Report' with its recommendations to look for 'challenging jobs', but it appeared to

industrialists that what graduates found interesting was unlikely to assist in the completion of projects. The low social prestige of engineering studies and engineering occupations became a point of concern to the manpower committees through the 1960's and a topic for investigation was whether this low social prestige inhibited the adjustment of the graduate scientists to industrial employment and an association with engineering and technology.

One important source of encouragement to the development of a commitment evident in the literature was a successful situational adjustment. While a crisis can be viewed as a threat to the individual, the crisis literature emphasised that a crisis presents an opportunity for enhancement; the mastery of a new and problematic situation can be the opportunity for the development of a new commitment. Berlew and Hall hypothesised that new managers assigned to relatively demanding jobs would perform better, be more successful, than those assigned to less demanding jobs, and found substantial support for their hypothesis in the correlations between degree of challenge in the task and degree of success at the end of first and subsequent years. (16) While this might be suggestive of one line of answer about why 'successful', (that is those marked out as 'academically able'), remain in research in

university, this was not the central concern of the study or sample studies. Where this research appeared relevant was in turning back the issue of the development of commitments to the analysis of situations, particularly socialisation settings and the kinds of tasks presented to new entrants by industrial managers. Exploring what graduates saw as a challenge, whether that challenge could be identified in their work situation seemed to be the point at which sociological analysis begin to probe the issues of utilisation raised in the Jones Report.
4. The Conduct of the Pilot and Main Study.

The intention of undertaking a study of utilisation, in order to probe the difficulties experienced by industrial managements and their recruits, the attempts to introduce educational and organisational solutions by companies and the perspectives developed by graduates recruits, posed a number of problems about the scope of the study and samples to be studied and the techniques of enquiry.

The first decision on scope was to limit the enquiry to a case study of the recruitment and adjustment of graduate scientists and engineers within one advanced industrial sector, rather than to attempt comparisons between industry and government establishments or within industry between branches. With the resources at my disposal I expected that these latter kinds of comparison would yield too many variables and too few cases. The industrial sector sought was one which was an advanced sector which employed large numbers of scientists and engineers where the problems evident in manpower discussions had arisen and where solutions were being attempted, and where both problems and solutions might serve as prototypes for future industrial developments. The electronics industry appeared an admirable case for study, the industry employed significant proportions of scientists and engineers and, as outlined in chapter one, had developed from the movement of university-trained scientists to industrial employment. The levels of employment and expenditure on R & D rendered this industry highly 'research intensive'. (see table 3). The high rate of growth of output (10.0%) was
### TABLE 3

Innovative Effort and Output in British Manufacturing Industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Research Intensiveness</th>
<th>Innovative Effort</th>
<th>Net Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Expenditure (£M)</td>
<td>Qualifed (Q.S.E) Manpower thousands 1965</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R &amp; D 1964-5</td>
<td>Plant and machinery</td>
</tr>
<tr>
<td>Aircraft</td>
<td>39</td>
<td>138 (102)</td>
<td>4.2</td>
</tr>
<tr>
<td>Electronics</td>
<td>14</td>
<td>71 (25)</td>
<td>7.1</td>
</tr>
<tr>
<td>Instruments clocks</td>
<td>6</td>
<td>10 (10)</td>
<td>n.a</td>
</tr>
<tr>
<td>Chemicals</td>
<td>5</td>
<td>55 181</td>
<td>7.2</td>
</tr>
<tr>
<td>Motor Vehicles</td>
<td>4</td>
<td>32 60</td>
<td>0.7</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>4</td>
<td>26 (45)</td>
<td>3.5</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>2</td>
<td>31 (100)</td>
<td>5.2</td>
</tr>
<tr>
<td>Iron and Steel</td>
<td>2</td>
<td>10 70</td>
<td>(1.5)</td>
</tr>
<tr>
<td>Ships</td>
<td>1</td>
<td>3 4</td>
<td>n.a</td>
</tr>
</tbody>
</table>

n.a. = not available.
() = estimated value.
* = an index developed by the Central Advisory Council for Science and Technology.


adapted from Committee on Manpower Resources for Science and Technology Report on the 1963 Triennial Manpower Survey of Engineers, Technologists, Scientists and Technical Supporting Staff Cmnd 3103 1966 p. 60.
accompanied by a high rate of growth of employment of Qualified Scientists and Engineers (Q.S.E.'s) (15%), but the voracious appetite for Q.S.E.'s still left this industry with the highest rate of vacancies for Q.S.E.'s (17%) of any sector of industry as reported in the 1965 Triennial Manpower Survey. This meant that the industry would be a critical case in which to examine the social significance of the 'shortage' and 'utilisation' issues. If it could be found within this industry that there were serious difficulties and unease about the employment of existing graduate manpower then it could be argued more strongly that manpower research, commentary and policy should be addressed more closely to utilisation issues rather than to efforts to create a buyer's market for qualified manpower by crying shortage and urging educational change. However it was expected that the electronics industry would provide examples of efforts to improve the utilisation of qualified scientists and engineers, this expectation derived from my belief that experiences of shortage would encourage 'good housekeeping' and the ethos of the industry as progressive and efficient on all aspects of company policy. Traces of this ethos have been seen in the way the electronics industry is quoted as an example of good relations with universities, for example in the evidence of Advisory Council on Science Policy to the Robbins Committee. A study of attitudes and practices of British management attempted a characterisation of 'thrusters' and 'sleepers' to distinguish those "attitudes and practices which are likely to be associated with a high and sustained growth in firms and thus in industry
The researchers concluded that

"If shipbuilding is outstandingly an industry in which a long and stormy history has left a legacy which makes it hard for new attitudes and practices to take root, electronics is outstandingly the opposite. Here the rate of expansion and the technological progressiveness of the industry provide an atmosphere in which modern practices may be expected to flourish in conjunction with exceptional rates of growth and profitability." (18)

Having decided on an industry the next sample decisions were required to select companies and graduates. The companies were approached as likely employers of scientists and engineers in Scotland and as self-declared employers of large numbers of graduates with sizeable annual intakes in the main study. Companies were then chosen on the basis of the kinds of co-operation offered, and the selection of establishments was largely determined by company convenience. Companies were given an indication of my research interests and a request for interviews with (i) British-born and British-educated (ii) male (iii) bachelor level graduates (iv) in physics or electrical engineering (v) who were in their first job in R & D (vi) within two years of leaving university.

For the pilot study (Autumn 1967-Spring 1968), discussions with the Ministry of Technology (Scotland) and Scottish Council (Development and Industry) yielded a list of potential graduate recruiters in the Scottish electronics industry. Of seventeen


(18) Ibid. p. 226. The study tended to concentrate on small firms, however, and the firms in my own study were in the medium to large range, at least in the main fieldwork.
<table>
<thead>
<tr>
<th>Establishment Activities</th>
<th>Employees in Scotland</th>
<th>Employees in Britain</th>
<th>Total Company Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch establishment of foreign owned company</td>
<td>20,000</td>
<td>6,000</td>
<td>British owned company</td>
</tr>
<tr>
<td>Branch establishment of foreign owned company</td>
<td>6,000</td>
<td>3,000</td>
<td>Branch establishment of foreign owned company</td>
</tr>
<tr>
<td>Branch establishment of foreign owned company</td>
<td>9,000</td>
<td>2,000</td>
<td>Branch establishment of foreign owned company</td>
</tr>
<tr>
<td>Branch establishment of foreign owned company</td>
<td>32,000</td>
<td>1,500</td>
<td>Branch establishment of foreign owned company</td>
</tr>
<tr>
<td>Branch establishment of British parent company</td>
<td>15,000</td>
<td>1,500</td>
<td>British owned company</td>
</tr>
<tr>
<td>Branch establishment of foreign owned company</td>
<td>600</td>
<td>350</td>
<td>Branch establishment of foreign owned company</td>
</tr>
<tr>
<td>H.Q. &amp; main establishment of British owned company</td>
<td>500</td>
<td>300</td>
<td>Branch establishment of foreign owned company</td>
</tr>
<tr>
<td>Branch establishment of foreign owned company</td>
<td>0</td>
<td>0</td>
<td>Branch establishment of foreign owned company</td>
</tr>
</tbody>
</table>

Table 4: Characteristics of Companies in the Pilot Study
<table>
<thead>
<tr>
<th>Company Establishment</th>
<th>Research &amp; Development</th>
<th>Software</th>
<th>Production</th>
<th>Marketing</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(5)</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>3 (10)</td>
</tr>
<tr>
<td>B</td>
<td>(4)</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>1 (1)</td>
</tr>
<tr>
<td>C</td>
<td>(3)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>(1)</td>
<td>2</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>(2)</td>
<td>4</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>F</td>
<td>(3)</td>
<td>4</td>
<td>4</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>G</td>
<td>(2)</td>
<td>4</td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

The location of respondents in the pilot study by establishment and department.

**TABLE 5**
companies contacted, five made no reply, four companies had no recent graduates, three companies had no graduate recruits but offered interviews with personnel, training and technical staff, and seven companies offered interviews with managers and recruits. An outline of the seven companies and establishments visited is given in table 4. The establishments could be distinguished into the larger establishments employing over a thousand staff and hourly paid workers and the smaller establishments with under five hundred employees in their Scottish establishments. All the large establishments were part of companies with readily-recognised household names, and although the two instrument companies might have been little known outside the electronics industry they could claim to be among the largest companies in the world in their specialised field of instrument manufacture. A significant feature of the table is the extent of foreign ownership which is explained by the strenuous efforts to promote electronics in Scotland as part of regional policy. (19) While the initial intention had been to concentrate on R & D labs it became evident that few companies carried out advanced development work in Scotland and fewer still carried out research. Thus the enquiry became broadened by the inclusion of some graduates working outside R & D in production or marketing (i.e. applications engineering which is an advisory service to marketing and includes extensive lab work). The composition of the pilot sample is given in table 5. In some companies "graduates" were sent for interview who did not meet the sample frame specification. Some of these interviews provided additional information and insights.

(19) Some further account is given of these efforts in Appendix Two.
<table>
<thead>
<tr>
<th>Type of Degree</th>
<th>General Science</th>
<th>Maths</th>
<th>Engineering Physics</th>
<th>Mechanical Engineering</th>
<th>Electrical Engineering</th>
<th>Mechanical Engineering</th>
<th>Mechanical Engineering</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Upper Second</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Lower Second</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Third</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Totals</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>35</td>
</tr>
</tbody>
</table>
on the organisation but have been excluded from the direct analysis of graduate experiences. The industrial designer, holding college qualifications could comment on engineers and lab organisation and assist interpretation of the engineers’ responses but his own educational experiences were too dissimilar for inclusion. Where the graduate was in his second job but was within two years of graduation he was included in the analysis for some purposes if he met the other criteria. One source of disappointment in the pilot study was the paucity of physics graduate which limited the possibilities for the comparisons between engineering and physics graduates which were in the forefront of the manpower debate, (table 6).

The pilot study was largely completed by Easter 1968 and the main fieldwork with larger samples was designed to begin in the Autumn of 1968 when the graduate intake would begin employment after the summer vacation.

A list of companies who claimed to recruit large numbers of graduate physicists and electrical/electronics engineers for employment in R & D in the electronics industry was derived from the Cornmarket Directory of Opportunities for Graduates. Of thirteen companies contacted, two made no reply, three made direct refusals because of the threatened disruption of their activities, one made an indirect refusal by the specification of restrictive conditions and another had no central records but the belief that few graduates had been recruited. In all, six companies offered opportunities for interviews with recent recruits and managers at some of their establishments. The next stage of sampling was undertaken by personnel departments
who nominated establishments and graduate recruits within establishments. Some indication of these establishments and activities is given in table 7. One of the problems in this process was that the nature of comparisons which could be drawn from the eventual sample was constrained, for example, one company nominated all 1967 graduates while another had undertaken little recruitment in 1967, and some companies included their research establishments while others did not. Where it was possible I attempted to gather information about the total intake and those presented for interview to assess the extent of representativeness. Thus there were three stages of sampling at which bias could enter - the selection of companies, the selection of establishments, and the selection of graduates. Again the companies were widely acknowledged as leading companies in the electronics' industry and did not appear a-typical of those engaged in the capital goods sector, which has been the sector of the industry which has enjoyed greatest economic significance, growth of output and employment of graduates compared to the consumer goods sector. In one respect the activities of graduates may have been more biased towards military work than was typical of the industry programme by the late 1960's. (20) Personnel managers generally explained the selection of establishments as indicative of company activity with convenient access to numbers of graduates. For the development labs this was probably accurate for the companies and the industry. Since the production departments visited were those of the semi-conductor sector the forms of organisation of mass production of integrated circuits or transistors

(20) More information is given on the industry's growth and various sectors in chapter five.
could be somewhat different from production departments for computer or missile production. Some of the major electronics companies, including two of those in the sample of companies, have established large central research laboratories with five hundred to six hundred employees and organisationally independent of product divisions. No research labs of this size were visited. The other four companies of this sample maintained several research labs which were organisationally linked to product divisions although physically isolated in some cases. In size the research labs, visited at three of these four companies, had sixty to two hundred and fifty employees. The significance of this point about research labs lies in the probability that the large independent labs undertook a greater volume of 'private venture' and fundamental research compared to small labs linked to product divisions and more dependent on internal or external contract research of a directly applied science or advanced development nature. Hence if scholarly orientations to research were to be sustained they would be more likely in the large independent research labs than the small labs of this sample.

The last stage of sample difficulty was in the selection of graduates. In companies A, B, C and D there was little difficulty for interviews were undertaken with the total population available in that establishment. (21) In companies E and F the intention was to limit the enquiry to a few divisions which

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(21) Non-availability arose sometimes because a graduate had left the company, was absent because of illness, a visit to another establishment or company, or attendance at a course. Another source of discrepancy between columns 8 and 9 is my exclusion of unused interviews from column 9.
left a sampling problem. Graduate recruits were selected by departments and the personnel department and it is unclear whether any bias arises in this procedure. (22) Bias could arise from the selection of graduates to impress the interviewer leading to overstatement of able and fully utilised graduates or the selection of these without assignments leading to an overstatement of cases of underutilisation. Since I could not detect such bias it seems reasonable to accept respondents as representative of those entering the companies in those years. The sample of graduates gathered in this way did include sufficient numbers of university educated physicists and engineers to make comparisons between groups on the basis of educational experiences and sufficient numbers of researchers and development engineers to make comparisons possible here. The numbers become very small when broken down by department and educational experience, however. Here again the sample frame became distorted by the inclusion of production and application lab recruits largely at company requests. I was somewhat ambivalent about the distortion since entry to non-R & D was a frequently discussed social issue and seemed valuable for study but the prospect of small numbers was an inevitable disadvantage. Personnel departments tended to classify their personnel into categories such as professional, technician, craft, and so on, rather than

(22) In company E I had interviews with 27 of approximately 140 entrants to the four divisions over the two years 1967-68. In company E it was intended to use 3 divisions with total populations but after the start of interviews a divisional manager objected and a hasty selection was provided from other divisions.
<table>
<thead>
<tr>
<th>Institution</th>
<th>Discipline</th>
<th>Qualification</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Maths</td>
<td>BA/BSc</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>Physics</td>
<td>BA/BSc</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>ExCat. Eng.</td>
<td>BA/BSc</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Physics</td>
<td>DipTech</td>
<td>1</td>
</tr>
<tr>
<td>E</td>
<td>Other</td>
<td>BA/BSc</td>
<td>1</td>
</tr>
<tr>
<td>F</td>
<td>Maths</td>
<td>BA/BSc</td>
<td>3</td>
</tr>
</tbody>
</table>

NB The category 'other' includes three mechanical engineers and one chemist.
### Table 9

(a) Distribution of respondents by educational discipline across functional departments

<table>
<thead>
<tr>
<th>Educational Discipline</th>
<th>Department: Research</th>
<th>Development</th>
<th>Production</th>
<th>Application</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>10</td>
<td>90</td>
<td>4</td>
<td>4</td>
<td>108</td>
</tr>
<tr>
<td>Physics</td>
<td>18</td>
<td>23</td>
<td>8</td>
<td>3</td>
<td>52</td>
</tr>
<tr>
<td>Maths</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td>34</td>
<td>117</td>
<td>12</td>
<td>7</td>
<td>170</td>
</tr>
</tbody>
</table>

(b) Distribution of respondents by education qualification across functional departments

<table>
<thead>
<tr>
<th>Educational Qualification</th>
<th>Department: Research</th>
<th>Development</th>
<th>Production</th>
<th>Application</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>College dip.</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>HND</td>
<td>1</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Dip Tech</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>BA/BSc/Tech</td>
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<td>105</td>
<td>9</td>
<td>7</td>
<td>152</td>
</tr>
<tr>
<td>+postgrad dip</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>+MSc</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>+PhD</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>34</td>
<td>119</td>
<td>12</td>
<td>7</td>
<td>170</td>
</tr>
</tbody>
</table>
by educational qualifications, so that some non-graduates were included in the sample. (Table 8)

It is apparent already that the nature of company co-operation was very important to the study. Some difficulties arose in the pilot study from restrictive conditions on interviewing, for example, interviews at the rate of one per week or in instalments of a half hour per visit. These problems did not arise in the main fieldwork, the companies in the South East of England provided full days of hour long interviews, here the problems were those of crowded rather than empty timetables. One source of difficulty in most companies in both pilot and main studies was the lack of various kinds of statistical information - for example, graduates as a proportion of the labour force, recruitment costs and graduate turnover - in a readily available and usable form. Frequently this was because the information was not collected in appropriate form since it was not seen as relevant to organisational purposes. It would have been available most probably if I had had the resources to collect it. Thus the main sources of information had to be those which were readily available and did not impose search costs on the company or myself, these were the recruits and their managers rather than company records. (23) The state of these manpower statistics in companies tended to reinforce suspicions about the value of employer returns to the manpower forecasting enquiries, given doubts about the accuracy of information about the existing situation then it appeared likely that forecasts were likely to be guesses, ('least cost estimates' in Blaug's terms).

(23) Curiously in some establishments respondents were able to tell me of other recruits who could be called for interview who were not on the personnel or training department lists.
The reliance on interviews as the main method of data collection in the study of the perspectives of managers and recruits has been mentioned already. In the case of managers these were all open ended interviews to cover a short list of topic headings and lasted about an hour, for the graduate recruits the hour-long tape recorded interviews were supplemented by self-administered questionnaires. In the pilot study the interview guide of thirty-seven open ended questions was supplemented by a brief questionnaire which was handed out at the ends of the interview, for the main study the number of questions was increased in both the interview and questionnaire, but the essentially open-ended nature of the interview was retained. The response rate for the questionnaires was high, 152 (90%) of 170 administered, and it was unfortunate that the actual interview and questionnaire instruments were not 'piloted' since the subsequent experience suggested that more extensive use could have been made of the questionnaire. The interview appeared to provide a context, and stimulus, to the completion of the questionnaire.

Attempts to understand the processes by which people attach meaning to the situations which they encounter have been undertaken often in the Chicago tradition by the use of the researcher directly to enter the situation himself in some form of participation and observation. This approach appeared both inappropriate and impractical for my enquiry, participant observation would have meant concentration on fewer companies and establishments and limited the scope for generalisations about a number of companies and the industry, and ultimately about the manpower debate.
Furthermore the frequent reservations about the disruption to company activities caused by Government surveys and university studies cast considerable doubt on the likelihood of securing industrial consent. (24) The essentially open-ended nature of the interviews was directed to obtain the definitions of the situation developed by recruits and to probe for examples of the specifics of situations encountered. This approach rested on the belief that people do not internalise abstract norms but images of themselves in concrete relationships and subsequently abstract principles. (25) Tape recording the interviews was a considerable aid in permitting concentration on the interview and probes to responses without the distraction of recording and gave a verbatim account, although transcription complicated the time scale of data collection. (26)

(24) The desire of some personnel departments to window-dress, for example, by claims that all recruits were busily employed and that interviews must be strictly time-tabled, was understandable in the context of the manpower debate. They were presented with an opportunity to declare that industry was the wealth-creating sector and universities existed on sufferance to someone from a university.

(25) See the discussion by Daniel Miller 'The study of social relationships: situation, identity and social interaction' in S. Koch ed. Psychology: Study of a Science Vol. 5. This approach may be contrasted with that adopted by Cotgrose and Box. They attempted to assess the relevance of some norms governing their respondents' behaviour in some questions about hypothetical situations in their mailed questionnaire. Respondents were asked to consider the behaviour of Smith an industrial research scientist and express their degree of agreement with his conduct by one of the precoded answers. This rather abstract approach appeared quite unsuitable for new entrants. It is not clear that the responses were informative in Box and Cotgrose's analysis in any event. See S. Cotgrose and S. Box Science, Industry and Society op. cit. p. 188.

(26) Obviously some transcription had to be done in the evenings after interviewing to release my stock of tapes for further use, but the bulk of transcription was carried out from January to April 1969 after the 225 interviews carried out from mid-September to the end of December 1968.
Perhaps a central question about the research design remains, this concerns the extent to which dynamic processes can be studied by examinations conducted at a point in time. Ideally the dynamic processes of status transition and occupational socialisation should be studied longitudinally by observations or interviews repeated over time. The benefits of this kind of study can be appreciated in the study by Barnes of a sample of final year science students from Edinburgh University who were followed into employment. (27) This study design enabled Barnes to study situational adjustment and the development of commitments both before and after the situation changed. Yet where Barnes could control for educational experiences he could not control for eventual employment. In my own case I had decided on a critical case study of an industry and it appeared impossible to contact the entrants within university. (28) Given that the sample was contacted in industry the study is open to the charge that this was a study of 'change recollected in tranquility'. This appears less serious when it is remembered that the graduates were within two years of graduates and were still within the process of adjustment and were not seriously troubled by difficulties of memory in recall.

(27) S. B. Barnes 'Making Out in Industrial Research' Science Studies vol 1 no. 2 April 1971.

(28) A priori it might appear possible to ask companies for a list of people to whom employment often had been made in the Spring, interview before finals and then interview in employment in the Autumn. However there was reason to believe that 'late deciders' on employment might include a high proportion of the most reluctant entrants to industry which would distort the sample.
PART TWO

ENTRY TO THE LABOUR MARKET
CHAPTER FOUR

CONTRASTING VIEWS ON THE WORKINGS OF THE LABOUR MARKET

1. Introduction.

In Part I, chapter one outlined the way in which the provision of adequacy in the numbers and quality of scientific and engineering manpower came to be defined as a social problem following the Second World War. It was evident that there were some shifts in the definition of the problem from one of overall shortage to one of sectoral misallocation, and in the 1960's this was expressed as concern that graduate scientists and engineers tended neither to seek nor be suitable for industrial employment. Chapter two took up the discussion of suitability and showed the way in which some sociologists in the U.S.A. and Britain located this problem in the conflicting definitions offered by industrial employers and university-trained scientists and engineers of the appropriate employment relationship for scientists and engineers in industry, and the definitions maintained by scientists and engineers were traced to the conceptions of science and engineering which they acquired in universities. While the American sociologists referred to the development of 'accomodations' in industry which reduce conflicts, the British sociologists held that processes of choice and selection in the labourmarket would minimise the numbers of scientists and engineers in industry who held views in conflict with those of industrial employers. While this solution might minimise conflict it did not solve the manpower problem seen by the Committee on Manpower Resources for Science and Technology since the kind of equilibrium achieved through the choice and selection of suitable candidate
would not satisfy the industrial demand. The solution advanced by the Committee was to secure more candidates who were suitable. The Committee believed that 'shortage' stemmed from the conceptions of scientific and engineering work fostered in the universities, and that many of the employment problems in industry arose when would-be pure researchers became reluctant recruits to industry.

Two other themes in Part I consisted of critiques of the way in which the social problem was defined, for example, in the manpower forecasting view of numbers and the sociological orthodoxy on the formation of preferences. These themes were related because the critique of the 'shortage case' consisted largely of the argument that the utilisation of existing resources should receive prior examination, and this utilisation involves a discussion of suitability which leads to a discussion of the way in which preferences are shaped. The pilot study provided some limited support for the argument that a number of companies in one advanced sector had problems in the utilisation of graduates which appeared more significant than problems of shortage, that the problems were experienced by the graduate recruits as discrepancies between expectations and experiences of work, and finally, that these expectations derived in part from university experiences but were not related to a desire to be academic scientists or engineers.

In some ways it was paradoxical that Box and Cotgrove should have seen the workings of the labour market as a palliative for employment problems when economists were turning to discuss the inadequacies of the labour market, especially the inadequacies in the distribution of formation and foresight on which the Box
and Cotgrove model set such store. (1) Since the perversity of the mis-match between education and industry was expected to emerge in the labour market it could be expected that economists would enter the jousts. When the Committee on Manpower Resources for Science and Technology proclaimed evidence of market 'shortages', economists rushed in, if only to preserve the purity of their concepts. 'Shortage' is a term with a number of different meanings among laymen and economists and its use always holds the possibility of a debate at cross-purposes. The criticisms ventured by Professor Blaug and his colleagues were not simply rebukes about the quantity and quality of evidence, but criticisms of the kind of evidence and the conceptual framework within which it was collected. Blaug expressed the differences most succinctly in his comment that the differences resolved into "nothing less than a totally different view of how economic systems work." (2)

This chapter will discuss some of the various contemporary definitions of 'shortage' and the criteria which would justify usage in such cases. In the third section the uses of the term and supporting evidence offered by the Swann Committee will be examined, followed by a fourth section which checks the Swann Committee evidence against the favoured definitions and criteria of economists. The way in which searches for evidence stemmed from contrasting views of the workings of economic systems will be explored in section five, and a final section will


summarise the policy proposals made by the manpower forecasting Committee and their economist critics.

This chapter serves an introduction to chapters five, (on the company experience of the labour market), six, (on the graduate experience of the labour market), and seven, (on the response of the educational system to industrial demand), dealing with the labour market for graduate engineers and scientists in Part II. Those chapters present material relevant for a check on the assumptions about company market strategies and graduate job seeking behaviour made in the analytical models of forecasters and economists and relevant to speculation about the likely implications of policy proposals.
2. **Definitions and evidence of 'shortage'.**

One economist, Folk, has identified eight different uses for the concept of 'shortage' among economists and laymen.(3)

1. a salary rise shortage
2. a dynamic shortage
3. a controlled price shortage
4. a shortfall in projected supply
5. inadequate number to achieve national goals
6. inelastic supply
7. a limited pool of talent
8. a shortage arising from misallocation or malutilisation.

For the economist this phenomenon would simply represent the working of the labour market as demand increases faster than supply at recent market salaries and the competition between employers leads to a rise in salaries, such an adjustment process is thought to be resolved generally without intervention.

2. **a dynamic shortage.**

For the economist this kind of shortage emerges when salaries are temporarily too low to clear the market as in the case of the salary rise shortage. In asserting a dynamic shortage the economist would look for evidence of the slowness of employer-response, for example, in the unwillingness of employers to engage in wage competition in a labour market marked by digopsany (few buyers). For the policy maker concern might be expressed at the speed of the adjustment process and efforts might be directed to speed up the process.

(3) The very clear and comprehensive account of the U.S. literature and debates in Folk's study have considerably influenced the presentation of this chapter. Chapter one 'The shortage and public policy' in The Demand for Scientists and Engineers Lexington, Conn: Heath 1970.
(3) a controlled price shortage.

There was a belief among some of the engineers quoted in the pilot study that the company work on Government contracts carried the requirement that the company observe with especial stringency the Government incomes policy, such a case could lead to a controlled price shortage with employers unable or willing to pay the market salary and labour going to other employers (e.g. non-Government contractors in industry).

(4) projected supply shortfalls.

These shortages formed the substance of the fears in post-war Britain about the demand and supply of highly-qualified manpower for various surveys showed an arithmetical difference between projected requirements and projected supply.

(5) inadequate numbers to achieve national goals.

Although it is extremely difficult to state the goals of a society, governments make statements of economic objectives, for example, in statements about a desirable rate of economic growth. Such a statement could lead to the comment that society had insufficient numbers of trained engineers and scientists to achieve the desired objectives.(4)

(6) a limited pool of talent.

The critics of the Robbins report mentioned in chapter one raised a frequent slogan that 'more means worse' and a claim that a limited proportion of the population would have the ability to cope and benefit from higher education.(5) This view

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(4) See, for example, the discussion of indicative planning in The National Plan London H.M.S.O. 1965 Cmd 2764 pp.1-21.

(5) See, for example, the correspondence included in The Times Educational Supplement started by Professor Jones, a professor of natural philosophy at Aberdeen University, whose initial article complained of the lowering of the average quality of students by expansion, the starving of industry of potential recruits, and the expansion in 'soft' subjects. 'Where Robbins went wrong' The Times Educational Supplement 27th February 1970.
had its corollary in the view that there would be a limited number able to undertake scientific and engineering occupations.

(7) a shortage arising from misallocation or malutilisation.

An economic definition of shortage arising from misallocation or malutilisation would be where scarce engineers and scientists are "employed in activities that are neither profitable to their employer's nor useful in a wider sense of social utility."(6)

Folk gives four examples of widely-criticised activities among U.S. Federal Government contractors in "gold-plating" (overspecification and search for excellence at any price), "brochuremanship" (the employment of resources in the preparation of contract proposals), "stock-piling" (hoarding teams of scientists and engineers to bid for contracts, and the "duplication of effort" (the prolonging of projects on cost plus contracts). The first and fourth of these criticisms imply that the companies are not in a competitive situation and would call for very different policy approaches from the kind of shortages evident in the working of market adjustments.

The kind of policy proposals made then depend very much, as Blaug suggested, on the view taken on the workings of the labour market and in the next section the beliefs of the Committee on Manpower Resources for Science and Technology will be distilled by an examination of their use of the concept of shortage and the kind of evidence brought to support their argument.

(6) H. Folk op. cit. p. 3.
3. The Swann Committee and evidence of a 'shortage'.

The Swann Committee saw a shortage of scientific and engineering manpower in three of the senses defined. The most obvious sense in which they saw a shortage was the discrepancy between the numbers estimated as required for employment and the number likely to be available for employment, especially in the long term. There was also a shortage defined in terms of difficulties in meeting national goals, for the Committee drew a distinction between the 'needs' of the economy and employer 'demands' and suggested that employer demands understated national need. In their references to the demand and supply for schools the Committee suggested the existence of a controlled price shortage where there was resistance to applying differentials to science teachers vis-à-vis other teachers, and they hypothesised that a similar situation might occur in industry where it was thought that any salary increases by industrial employers would lead to stalemate as universities and Government would apply for increases on a principle of 'fair comparison'.(7)

The techniques for illuminating the existence and extent of a shortage used by manpower forecasters are closely-related to their view of how the labour markets operate. The Committee on Manpower Resources for science and technology made estimates of the future enrollments of schoolchildren in science studies in the Dainton Report and could make estimates of university outputs for three years ahead in the Swann Report.(8)

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(7) The Flow into Employment of Scientists, Engineers and Technologists Cmnd. 3760 op. cit. p. 68 and pp. 82-3.

(8) The substantive results of these projections and shortage have been raised in chapter 1.
to planning, however, the manpower forecasters have concentrated attention on the demand side, using four main techniques to derive estimates of future manpower requirements:

(a) the employers' opinion method;
(b) the incremental labour-output ratio (ILOR) trend method;
(c) the density-ratios method;
(d) the international comparisons method; and
(e) target production forecasts.

Of these techniques, the Committee on Manpower Resources for Science and Technology placed most reliance on the employer opinion method through the questionnaires to employers for the triennial manpower surveys. The substantive evidence derived in this way, of past shortfalls between the numbers employers expected to be in employment and the actual numbers eventually employed and discrepancies between the projected rates of growth of employment and past rates of growth of employment in industry and schools, has been presented in section 3 of chapter one. The criticisms that have been made of this method include doubts about the significance of the responses to employers when medium or long term estimates of labour requirements are requested of them. The absence of detailed personnel records of existing staff prompted Layard and his colleagues to doubt the value of responses which employers might make and the paucity of manpower planning in companies revealed in a Ministry of Labour study strengthened these doubts.\(^9\)

Other doubts about the employer response method arise from the way in which the statistics are aggregated by the Committees. For example where product markets are characterised by oligopoly it is not clear what kinds of assumptions are being made by

employers about their relative market shares and even in competitive markets some indication of estimated production levels would provide a check on the internal consistency of projections.

The Committee supported the evidence gathered by employer questionnaires and discussions with industrialists by evidence gathered by two other techniques, the density ratios method and international comparisons. In a version of the density ratios method, the Committee took the data on the proportions of various categories of manpower across different sectors, for example the proportion of engineers and scientists employed in research and development in manufacturing industry and the proportions employed in more general functions throughout the economy. While it was evident that absolute numbers rose in R & D from 21,700-34,000 over the period 1956-65 the proportion of the total numbers of engineers and scientists employed in R & D manufacturing industry fell from 44.5% to 38.5%.(10)

Moreover the Committee quoted a study of the Electronics industry in which engineers and scientists were expected to become a larger proportion of the managerial and supervisory staffs.(11) On the assumption that this was a best-practice industry, the Committee could forecast similar trends in the ratios of engineers and scientists to other qualified staff being taken up in other industries. The forecasts from best practice had an element of international comparison in the study commissioned by the Committee which enquired into the employment of engineers and scientists in the U.S.A.(12) This latter study made comments

(11) Electronics op. cit.
on shortages in qualitative terms, about deficiencies in education and training, as well as observations on a numbers shortage and these qualitative issues will be taken up more fully in chapter seven in the discussion of the kind of resources which graduates bring to their employment situation. The objections to the density-ratios and international comparisons techniques stem from the assumptions that the ratios are stable functions, for example that from two observations one could draw a straight line, and the assumption/some practices could be singled out as best practices.

Because they use different conceptions of shortage economists tend to look for different kinds of evidence by different techniques in order to evaluate the state of the labour market and their criticisms of manpower forecasting techniques among policy makers have been consistent on methodology since the late 1950's.
4. Economists and the evidence of a 'shortage'.

As Folk observed economists tend to start from an assumption that "a competitive economy allocates resources to their most remunerative uses," and in consequence pay most attention to salary changes as indicators of the efficiency of the market.(13) The senses in which economists tend to see a shortage are the 'salary rise shortage' and 'dynamic shortage' or in those situations where impediments hinder the smooth functioning of the market, such as the 'controlled price shortage', 'inelastic supply' or 'misallocation' problem. An early economist critic of manpower forecasters, Peacock, reviewed the work of Zuckerman's Committee on Scientific Manpower, the predecessor of the Committee on Manpower Resources for Science and Technology, and suggested that an economist looking for evidence of a labour shortage would use three main indicators - salary rises, substitutions of other forms of labour or capital for the scarce labour, and installments of production output.(14) In this section the evidence of the Swann Committee and other commentators will be examined to see how far these criteria were met.

(1) Salary movements.

The Swann Committee was quite candid in their relative unconcern about their state of knowledge of salary movements.

"We have not attempted to examine detailed evidence on the movements of salaries of scientists and technologists in different sectors, or their interaction. Salaries are not, of course, the only consideration in the relative attractiveness of occupations; and, even if they were a major factor, industry must necessarily be under the constraint

(13) H. Folk op cit p. 2-3.

of obtaining an adequate return for outlay. We do not know how flexible industrial salary structures can be, and how readily they can reflect demand, and we think these points should be studied further."

(15) The Committee went on to urge observation of a principle of 'fair comparison' which gave due weight to the non-pecuniary disadvantages of industry vis a vis universities and government. The lack of salary statistics in Britain is well-known but the degree of unconcern was somewhat surprising. The Jones Committee was prompted to explore relative salary levels by the frequent citation of salaries in popular explanations of the 'Brain Drain' and the Jones Committee observed that these were differences in both absolute salaries and salary structures in the U.S.A. and U.K. which were probably a major influence among 'at least half of those who emigrated'.

(16) The Swann Committee collected no similar data on salaries in different sectors in Britain and did not check the workings of the principle of 'fair comparison'. The Kelsall Study gave reported characteristics of their own jobs as seen by scientists and technologists, and on this there was little difference in the scored rating by technologists in universities compared to scientists and technologists in industry although the scientists in universities gave a markedly lower rating to their own salaries. Certainly these reports on job characteristics gave support to the belief that there was wide variety in perceived characteristics of sectors but could not indicate how characteristics were perceived in other sectors and how important characteristics were in job choice. The Swann

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(15) The Flow into Employment of Scientists, Engineers and Technologists Cmnd 3760 op. cit. p. 63.

(16) Brain Drain Cmnd 3417 op. cit. pp. 27-29.
Committee then took the view that other factors were important in occupational choice, (but did not demonstrate the point), and hinted that salary movements would not reveal shortages, (but did not check for evidence).

Some economists did attempt to gather salary data, and claimed evidence of a dynamic shortage. Peck pointed to upward salary movements for engineers and scientists despite market imperfections which would impede market response. (17) Not only were companies likely to perceive shifts in the supply-demand balance slowly and respond with a lag and reluctance to raise salaries to newcomers when equity might enjoin increases to existing staffs, both problems common to all companies, Peck emphasised that the degree of concentration of a few buyers of labour in the manufacturing industry was likely to caution employers against self-defeating salary bidding. (18) Folk found no obvious shortage of scientists (whether measured by salary rise, salary level or job vacancy) but found evidence of persistent shortage of engineers. (19) He found that engineers earned about the same as chemistry and physics graduates, but over the period 1955-64 he detected a more rapid increase in engineers' earnings than among any other group studied which would indicate a shortage.


(18) M. J. Peck ibid Some other researchers found that companies favoured new recruits rather than experienced recruits in part because of equity problems with existing staffs and in any event were reluctant to respond to difficulties in recruitment by salary increases because of the disturbance to existing salary structures. A similar view is in H. Murray and D. Armstrong 'Report of a Pilot Study on the Mobility of Scientists and Technologists' (personal communication).

One of the problems in the collection of salary data is the choice of which data to collect, for example, in the choice between starting salaries, mean or median salaries, or some measure of lifetime earnings. Where new supply accounts for a substantial proportion of annual recruiting and companies are reluctant to engage in competition among experienced staff the movement of starting salaries might be taken as a particularly sensitive indicator of the state of the market. Of course the important point is to examine the starting salaries of those with other qualifications or those in other functions, for example, a student making a choice of university subjects may take account of the starting salaries for engineers and the starting salaries for economists or the graduate engineer may choose between a taxed industrial income or an untaxed research grant. Collection and use of mean salary data is in some ways a poor substitute data since the distribution of earnings across occupations or industries is compounded by age factors, and youthful industries may have younger, inexperienced and relatively more lowly paid employees. Computations of the life-time earnings have received considerable attention from economists in recent years and where age data is available the mean salary data can be used to give an estimate of expected earnings over the lifetime with due allowance for the probability of survival. From this statistic various refinements could take account of the different shapes of time streams by the use of a discount rate (present value of lifetime earnings). Another refinement is to regard the costs of education as negative earnings and then calculate the discount rate which equates the discounted value of the costs of a particular kind or level of education with the discounted value of the future earnings anticipated from it. This latter approach has
been dubbed the 'rate of return' approach by Blaug and it is this measure which Blaug has advanced as a distinctively economic approach to supply and demand questions about highly qualified manpower. Rates of return could be calculated for private decisions (from post-tax earnings and out-of-pocket expenses) and for social decisions (from pre-tax earnings and taking all resource costs into account) as guides to policy decisions.(20)

Despite the limited nature of available statistics, the researches of the Higher Education Research Unit at the L.S.E. have attempted to calculate private and social rates of return. From the data collected in the Industrial Manpower Project on the electrical engineering industry, Maglen and Layard attempted calculations of the social rates of return to the different routes of qualification for employment in the industry on the grounds that the scale of provision for each route "could and should be varied if it were found too low or too high"(21). In order to judge what might be a reasonable return on invested capital the researchers took the ten per cent norm required of nationalised industries, and against this norm Maglen and Layard found little support for the Swann Committee proposals for expansion in undergraduate education, although they could support the concern expressed by the Swann Committee about postgraduate education.

(20) See for example M. Blaug 'Approaches to Educational Planning' op. cit. and the extended discussion in his Introduction to the Economics of Education op. cit. where Blaug advocates the use of a variety of approaches as complementary tools in manpower planning.

### TABLE 1

Present value of lifetime salaries by subject, 1966-69 (to age 18; 10% discount rate)

<table>
<thead>
<tr>
<th>Subject</th>
<th>1966</th>
<th>1967</th>
<th>1968</th>
<th>1969</th>
<th>1966-69 Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td></td>
</tr>
<tr>
<td>8453</td>
<td>9059</td>
<td>9214</td>
<td>9608</td>
<td></td>
<td>113.7</td>
</tr>
<tr>
<td>Metallurgy</td>
<td>8574</td>
<td>9261</td>
<td>9436</td>
<td>9879</td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>8709</td>
<td>9639</td>
<td>10055</td>
<td>10174</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>8802</td>
<td>9684</td>
<td>10355</td>
<td>10378</td>
<td></td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>8370</td>
<td>8915</td>
<td>9324</td>
<td>9792</td>
<td></td>
</tr>
<tr>
<td>Production Engineering</td>
<td>8296</td>
<td>9306</td>
<td>9677</td>
<td>9907</td>
<td></td>
</tr>
<tr>
<td>Aero Engineering</td>
<td>8390</td>
<td>9620</td>
<td>10120</td>
<td>10470</td>
<td></td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>8426</td>
<td>8967</td>
<td>9303</td>
<td>9704</td>
<td></td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>9239</td>
<td>10209</td>
<td>10314</td>
<td>10511</td>
<td></td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>9484</td>
<td>9873</td>
<td>10453</td>
<td>11110</td>
<td></td>
</tr>
</tbody>
</table>

Source: R. Klinov-Malul "Enrolments in Higher Education as Related to Earnings", British Journal of Industrial Relations vol. 9 no. 1 March 1971
In very general terms, the social rates of return to science and engineering education suggest that the expansion of full-time first degree courses has been of about the right magnitude, while post-graduate education has been over-expanded. Part-time education for H.N.C. has at least as high a pay-off as full-time education, and there is no clear case for deliberately discouraging it in favour of the more costly full-time courses". (22)

Klinov-Malul, in an attempt to study the degree of responsiveness of student enrollments in higher education to rates of return, collected salary data from the Cornmarket Careers Centre which throws some doubts on the existence of a shortage in economic terms during the period of the Swann Committee's deliberations. (23)

Although the author was aware of the limitations of her small samples she found a maximum wage differential across the ten science and engineering disciplines covered of only £1,500 on median life-time earnings (i.e. less than £100 per annum even on a 5% interest rate) and this permitted the tentative conclusion that a shortage was not evident.

"... the first conclusion is that, at a ten per cent discount rate there is no evidence of substantial shortages or surpluses in any of the professions covered, since their present (lifetime earnings) values are very similar. Also, since for the last five years no significant change took place in the ranking of subjects by income, a dynamic process of a relative shortages being created cannot be observed." (24)

Moreover the limited evidence which is available on earnings across non-science and engineering courses does not support the Swann Committees' perturbation of the more rapid expansion among social science disciplines foreseen by the U.G.C.,memorandum of general guidance. (25)

(22) L. Maglen and P. R. G. Layard ibid p. 65.


(24) Klinov-Malul ibid. p. 86.

(25) Klinov-Malul cites a study of 4,000 applicants to the Cornmarket Centre during the latter half of the year 1969 in which insignificant differences were found in a cross-sectional analysis of income differentials among graduates in engineering, economics and humanities.
### TABLE 2

Percentage change in earnings revealed by Engineering Professional Institute Surveys compared with figures for all workers.

<table>
<thead>
<tr>
<th>Date</th>
<th>Age</th>
<th>26-30</th>
<th>31-35</th>
<th>36-40</th>
<th>41-45</th>
<th>46-50</th>
<th>51-55</th>
<th>56-60</th>
<th>61-65</th>
<th>DE all worker index</th>
<th>Observations exceeding DE index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966-68</td>
<td>13.7</td>
<td>11.5</td>
<td>13.4</td>
<td>11.1</td>
<td>11.9</td>
<td>8.8</td>
<td>11.6</td>
<td>11.2</td>
<td>11.0</td>
<td>8/9</td>
<td></td>
</tr>
<tr>
<td>1968-71</td>
<td>27.7</td>
<td>25.7</td>
<td>24.4</td>
<td>23.5</td>
<td>20.0</td>
<td>20.5</td>
<td>24.4</td>
<td>16.7</td>
<td>16.7</td>
<td>33.5</td>
<td>0/9</td>
</tr>
</tbody>
</table>


### TABLE 3

Percentage change in earnings revealed in Surveys of Professional Groups compared with figures for all workers.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>Date</th>
<th>(%) earnings change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(a)</td>
<td>(b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of group</td>
<td>in DE index</td>
</tr>
<tr>
<td>Engineers (Engineers Guild)</td>
<td>all</td>
<td>1955-59</td>
<td>33.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1959-62</td>
<td>22.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1962-65</td>
<td>19.1</td>
</tr>
<tr>
<td>Physicists (Fellows of Institute)</td>
<td>all</td>
<td>1951-53</td>
<td>10.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1953-56</td>
<td>25.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1956-60</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1960-64</td>
<td>40.4</td>
</tr>
</tbody>
</table>

Source: E.G. Whybrew 'Recent Trends in the Labour Market for the Highly Qualified'. Bid.
### TABLE 4

**Median Salaries of Physicists (Fellows of the Institute of Physics) by Age in University and Outside**

<table>
<thead>
<tr>
<th></th>
<th>1968</th>
<th>£ p.a.</th>
<th>No. in Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26-30</td>
<td>31-35</td>
<td>36-40</td>
</tr>
<tr>
<td>Physicists</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>(2352)</td>
<td>2735</td>
<td>3303</td>
</tr>
<tr>
<td>University</td>
<td></td>
<td></td>
<td>3470</td>
</tr>
</tbody>
</table>

**Source:** J. Bibby 'Rewards and Careers', *Higher Education Review* vol. 3 no. 1 Autumn 1970

### TABLE 5

**Extent of Secondary Earnings among Physicists, by Class of Employer**

<table>
<thead>
<tr>
<th></th>
<th>1968 (Percentage of employees in range)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Physicists</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>45</td>
</tr>
<tr>
<td>Industry</td>
<td>87</td>
</tr>
</tbody>
</table>

**Source:** J. Bibby 'Rewards and Careers', *Higher Education Review* vol. 3 no. 1 Autumn 1970
The data on salaries in different sectors reveals that the graduate scientists who entered university employment were on the whole in more a favourable salary situation than those graduate scientists who had entered industry. Table 4 was extracted from a study by Bibby and based on the surveys by the Institute of Physics in 1968. Moreover Bibby shows that the salary surveys counter the notion that the top decile salary in industry is higher than that in university, this finding in conjunction with the evidence that salary dispersion associated with universities was lower than elsewhere suggested that the likelihood of a satisfactory salary was higher than elsewhere. A further point in favour of university employment has been the ease of access to the outside earnings and table 5 contrasts this ease of access for supplementary earnings for physicists in university and industry.

Thus the salary data which has been collected following the demise of the Manpower Committees does not suggest a significant shortage of scientists and engineers in the mid 1960's nor indications of a movement towards shortage.

(ii) Substitutions.

Substitutions to alleviate shortages in the case of engineers and scientists are almost wholly concerned with the substitution of different levels and kinds of qualified manpower.(26)

(26) In R & D in general and electronics in particular the opportunities for higher capital investment to free scientists and engineers are few. In some cases it has been argued that capital 'substitutions' would require more qualified manpower in planning, design and production. Some possible areas of substitution do exist, however, such as in computer aided design. Electronics op. cit. p. 34.
Although the Swann Report did not directly comment on evidence of efforts by employers to substitute technicians for professional level engineers and scientists or efforts to redesign jobs to economise on scarce qualified manpower, there were several points at which they were forced to reconsider pertinent topics such as the relation between education and occupation. The confusion experienced by the Committee in approaching the variety of empirically observable relations is understandable. This variety emerged in the Committee's consideration of four issues:

1. Science and engineering qualifications vis a vis other disciplines;
2. Science vis a vis engineering qualifications;
3. full-time vis a vis part-time routes to qualification;
and (4) technician and professional qualifications.

The unease about the larger growth rates forecast for social science university places expressed by the Swann Committee has been mentioned already, yet the Committee noted in their report the numbers of graduate scientists and engineers employed in "managerial and other 'non-specialist' capacities" and the employment of some arts graduates in production functions. (27) The Committee cut through the problems here, however, by proposing that undergraduate courses were too specialised to favour such flexible patterns and proposed more broadly-based ('generalist') courses where the bases were necessarily science disciplines in a 'scientific society'. (28) Again the Committee noted that employers did not categorise their staff in terms of educational qualification, but in terms of functional role. The Committee


(28) ibid pp. 73-75 and p. 111.
went on to observe that these occupational roles tended to be in engineering and technological functions rather than scientific functions which contrasted with rates of growth of numbers qualifying in the recent post. To this the Committee saw a similar solution in broader courses as furnishing the base from which to enter whatever occupational speciality arose. Another manpower forecaster regarded this whole discussion of 'generalism' and 'specialism' as a hedging operation and urged the Committee to see the rather simple relations between education and occupation of rigid coefficients where 'generalism' implied an engineering course and the obvious policy implication was not to dilute science courses but prune science departments and boost engineering departments. (29) The concentration of the Swann Committee on university sources for qualified manpower has been noted already, and it stands as something of an ironic curiosity that a Committee working to ameliorate the separation of the worlds of education and industry should so strikingly reflect the myopia of that separation in a survey of only half the supply of engineering manpower. Already the pilot study and the earlier study by the Ministry of Labour in the electronics industry suggested that in the case of vacancies in some skills and functions industrial employers looked to part-time rather than full-time courses for manpower. (30) Moreover the rates of return study quoted earlier which suggested appreciable returns to part-time question the ready and unthinking approval of a switch in emphasis to full-time study on economic grounds.


The 1965 Triennial Manpower Survey claimed to be breaking new ground in its survey of technician employment, and was a little surprised to estimate that possibly one-tenth of the entire stock of S. E.'s was engaged in technician capacity. (31) The Committee found this statistic difficult to interpret and worthy of further study, especially in the light of the Council of Engineering Institutions' attempts to create an educational caste system, establishing "different educational streams leading on the one hand and on the other to supporting roles." The Committee suggested that these efforts might founder because of difficulties in creating sufficient status and career opportunities for the supporting-roles but supposed that a proportion of the S. E.'s engaged as technicians were as a training role or only recently qualified. While this interpretation may be correct (and later discussion of the field work material offers support for the training hypothesis) it requires some efforts to square with the claim of a shortage. The shortages of manpower experienced in the U.S.A. led to extensive efforts to redesign engineering and scientific work and make greater use of technicians. (32)

Where there was an apparent substitution of S. E.'s for technicians this might suggest that there were more urgent shortages of technicians or 'surpluses' of professional level engineers and scientists or simply that the prevailing assumptions about the relations between education and occupation bore little relation to industrial practice.

(31) The 1965 Triennial Manpower Survey op. cit. p. 29.
(iii) Production Curtailments.

The Swann Committee gave little evidence of downward revisions of production intentions, indeed the Committee indicated that their fears were largely for the future. (33) The Ministry of Labour study indicated little evidence of the shelving of projects, but did suggest that training functions and management development were inhibited. (34) However it could be argued that industrial training has been a Cinderella in industry for quite other reasons than those of a manpower shortage, and this has been supported in the electronics industry by the widespread belief that these training needs among young engineers and scientists should be met by moves of individuals between rather than within companies and by job experience rather than formal courses. (35)

(33) The Flow into Employment of Scientists, Engineers and Technologists Cmd. 3760 p. 2.

(34) Electronics op. cit. p. 32.

(35) The shortages of manpower experienced in the late 1950's and early 1960's may have discouraged retention of the two year graduate apprenticeship schemes and favoured the on-the-job training schemes, although a number of factors appear to have been at work. See the fuller discussion of these issues in chapter seven.
5. 'Contrasting views of the workings of economic systems.'

Sufficient has already been written to indicate that manpower forecasters have been sceptical of the market mechanism and sought direct intervention to cure what they saw as economic ills. In his offer of advice to the Committee on Manpower Resources for Science and Technology one manpower forecaster exclaimed,

"To wait for public consciousness of employment implies an impracticable delay. The individual's knowledge of the education he requires lags considerably behind the education itself. To wait for salary differentials to indicate educational direction, is to wait for eternity. Some mechanistic interference with higher education is in its own long term interests."(36)

Such a 'mechanistic' view might be expected to find particular sympathy as both a congenial conceptual framework and satisfying to vested interests for a Committee composed of seven engineering and science professors and seven senior managers from science based industries.(37)

Implicit in the Swann Report was a model of occupational choice in which the subject choices of schoolboys (and schoolgirls) were made in the main with little reference to eventual occupations. They were seen to be largely the outcome of expressed preferences for activities enjoyed in their own right. Those who were most able in these academic exercises were expected to seek occupations in academic institutions when grants ceased and earnings began, especially when intrinsic research were linked to positive rewards of social prestige and not offset by salaries compensations elsewhere. Further the choices were seen to be structural such that there would be extremely long lags in the supply side

(36) M. Hall op. cit. p. 13.

(37) See N. Blaug An Introduction to the Economics of Education op. cit. p. and K. Gaunicot and N. Blaug op. cit. p. 56.
## TABLE 6
Contrasting views of the workings of the labour market

<table>
<thead>
<tr>
<th>The Man-power forecasting View of the World</th>
<th>The Date of Return View of the World</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Education Market</strong></td>
<td></td>
</tr>
<tr>
<td>1. Students acquire more education for consumption reasons</td>
<td>1. Students acquire more education for investment reasons</td>
</tr>
<tr>
<td>2. Students choose major subjects in ignorance of, or with no regard to, career prospects</td>
<td>2. Students are well-informed and attentive to career prospects</td>
</tr>
<tr>
<td>3. All education is specialised and specialisation starts early</td>
<td>3. All education is general and there is no specialisation at any age</td>
</tr>
<tr>
<td>4. All input-coefficients in schools are fixed; complete indivisibility and specificity of teachers, plant and equipment</td>
<td>4. All input-coefficients in schools are variable; complete divisibility and non-specificity of teachers, plant and equipment</td>
</tr>
<tr>
<td><strong>The Labour Market</strong></td>
<td></td>
</tr>
<tr>
<td>5. The demand curves for different skills shift discretely</td>
<td>5. The demand curves for different skills shift smoothly</td>
</tr>
<tr>
<td>6. Near zero elasticities of substitution between skilled men</td>
<td>6. Almost infinite elasticities of substitution between skilled men</td>
</tr>
<tr>
<td>7. Near zero elasticities of demand for different skills</td>
<td>7. Almost infinite elasticities of demand for different skills</td>
</tr>
</tbody>
</table>

Source: M. Blaug *An Introduction to the Economics of Education* p.216
from the entry of a fourteen year old schoolboy to scientific specialisms in school to the emergence of a graduate engineer or scientist at some eight years later. Of course the cycle could be seen as longer if one took the entry point to secondary school and postgraduate or industrial experience as the entry and closure points, and the degree of specialisation in irrelevance in schools and the necessity for industrial training would incline some to take the longer view.

On the demand side the Swann Committee were inclined to take the view that sustained economic growth would require a related increase in manpower and that this manpower would be largely qualified in engineering and science disciplines with little opportunities for substitution. Moreover the Committee was confirmed in a view that the pace of technological change was increasing such that contemporary full-time education could not be regarded as a durable asset and required attention to continuing education.(38)

Against this manpower forecasting view Blaug has contrasted an alternative conception of the labour market which he sees as a distinctly economic approach and presented both views in tabular form, (see table 5). Admitting the early specialisation in schools and paucity of counselling services in Britain, Blaug contended that schoolboys in making subject and occupational choices do have regard to life-time earnings. In other words whatever the imperfections there were significant features

(38) See Annex D on Technological Innovation of the Swann Committee report where Professor Pippard gave examples of innovation in physics-based industry and Dr. Month selected examples from chemistry-based industry. The Flow into Employment of Scientists, Engineers and Technologists Cmd 3760 op. cit. pp. 100-105.
of a market for analysis to have to take account of the costs of enquiring and providing education and the private and social returns to investment in education. Blaug was careful to point out that these polar cases represented a continuum rather than a dichotomy with the 'real world' somewhere between them and the problem of analysis to form an estimate of this position as a basis for policy.
6. From Analysis to Policy: Manpower Forecasters and Economists

Manpower forecasters sometimes make distinctions between conditional or unconditional forecasts of what will happen and projections of what might happen. The Swann Committee claimed to be making projections but, faute de mieux, came to treat them as forecasts unless preventive measures were taken. (39) Moreover although the Committee admitted areas of ignorance, for example, on salaries as evidence of demand and as activators to employment, the Committee felt that there was a sufficiency of appropriate evidence to guide their policy proposals.

"Our evidence is less complete than we would have wished ... nevertheless the evidence that was available confirmed to us our earlier findings ... and revealed a potentially dangerous imbalance whose redress could not wait upon more refined studies". (40)

Given their agnosticism about shortages and different conceptions of the labour market it is interesting that the long term policy proposals of the Swann Committee and the economists look very similar with their common emphasis on flexibility and counselling. (41) In the following chapters on the labour market and Part III on aspects of utilisation, material from the electronics study will be presented which I shall use to assess these policy proposals in the concluding chapter. (42)

(39) cf. The Flow into Employment of Scientists, Engineers and Technologists, Cmdn 3760, op. cit., p. 10, 15.
(40) ibid., p. 44.
(41) See Chapter One for the outline of the proposals for educational reform.
(42) See Chapter Eleven, section 3.
1. **Introduction**

In this chapter attention is focussed on the way in which industrial needs are articulated into demands in the labour market, and by implication takes up the issues of the manpower forecasting case that the market might inadequately reflect industrial need. While the manpower debate could be said to have marked progress in the disaggregation of the early all embracing manpower categories, there appears to have been little attention paid to studying how companies behave. Although the Swann Committee dealt with the whole economy they observed a need for disaggregation in their attention to best practice industries. The case for selecting the electronics industry for study stemmed in part from its citation in the Swann and similar reports, from the widespread beliefs about the strategic importance of the industry discussed in Chapters One and Two, and the sense in which it should have exhibited some of the features of a critical case. From its rapid growth rate one might have expected indications of 'shortage' for manpower and from its science-basis and origins in the movement of scientists out of university one might expect evidence of the 'best practice' and precedents for others. This last point links to the central theme of this study of utilisation, in that one might have expected from this industry evidence of the market strategies of companies in the face of shortage and the coping strategies of graduates as they moved from university to a science-based industry, reputed to be much closer in sympathies to the university environment than many other industries.

In this chapter, concerned with the market responses of companies, the next section examines how far selection of the electronics industry
provides a study more favourable to either the neoclassical rate of return view or the manpower forecasting view of the economic system. Subsequent sections examine the objectives and behaviour of companies in the labour market in the policies and practices of recruitment, and a final section summarizes company experience.
2. The Growth and Structure of the Electronics Industry

In some respects the electronics industry was a kinder topic to the neoclassical economists than to the forecasters. A relatively new industry born out of war-time radar it exhibited all the characteristics of an industry whose recruits had no obvious specific training but who were culled from a variety of sources. Although there were research methods applied to the exploitation of electrical phenomena towards the end of the nineteenth century, the efforts in the early twentieth century were largely bound up with the radio industry and with the development of television in the 1930's. At this stage the industry was not generally termed electronics but 'wireless techniques'. In tracing the origins of the industry's title one writer has pointed out that the terminology was very much coined by the scientists.

"Before 1939 the adjective 'electronic' was used almost exclusively by physicists and referred to the electron and its properties rather than to electron devices. 'Electronics' came into general use after the Second World War as the name given to the applications, outside the main field of radio, of the electronic devices which had then been produced: thermionic tubes and photocells. The electronics industry, conceived in peacetime research was born in the blast of war and has grown in vigour and size every since." (1)

Thus the term electronics was carried into new usages by the large numbers of physicists who had been mobilised from the universities into government establishments on radar research. (2) Inevitably such new usages were not without dispute, for example, the appropriate use of the term


'electronics' was debated within the Institution of Electrical Engineers, and in the field of radar the British scientists and engineers sought to establish their definitions and usages, for example, they sought to impose their own early term 'radiolocation' and emphasise their contribution to the war effort vis-a-vis the American term 'radar' and American efforts (3). Within the very broad field of electrical engineering it appeared that the electrical engineer was less well equipped than the physicist to cope with the new activity, for example, a speaker to the Institution of Electrical Engineers pointed to the deficiencies in physics and chemistry in the university courses of the electrical engineering departments aimed largely at the electrical engineering industry and suggested that 'one aim in planning education for the higher grades should be to produce physicists with a radio engineering sense'.(4) Not only were there new kinds of specialism and specialists, the organisations in which they were employed were relatively new to the activity. For while a great deal of the research and development had been undertaken in Government laboratories, in part because of the inadequacies of industrial lab standards and facilities, the subsequent exploitation of much of the wartime electronics development was undertaken by the pre-war electrical companies who boosted their efforts on military contracts in the late 1950's.(5) The search for

(3) On the debate over terminology see, for example, the discussion in the Institution of Electrical Engineers, 'Industrial applications of electronic techniques', Journal of the Institution of Electrical Engineers, Vol. 95, Part I General 1948, pp. 301-393. In order to establish the priority claims of the British scientists and engineers and to hasten the flow of information from the secret military research the Institution of Electrical Engineers organised a 'Radiolocation Conference', see the Journal of the Institution of Electrical Engineers, Vol. 92, Part IIIa 'Radiolocation' 1946.


appropriate organisational forms for these new specialisms and specialists formed the substance of the enquiry by Burns and Stalker into the Management of Innovation, now a classic among innovation studies. The adoption of unsuitable organisational structures had a frequent consequence in failure to cope with the technology and market and resulted in company abandonment of their efforts. The penalties of market failure discouraged the retention of hostility to graduates among the large electrical engineering companies and discouraged the refusal to adopt career development policies among companies with traditions as 'jobbing-shops' in radio production. (6) Granted that no one knew what was the best training for an electronics engineer or which firms were the best employers then, according to the neoclassical economic model, the market was the most efficient system designed to use resources when no one individual or small group of individuals knew best. (7) When all the bits of information useful for a solution were widely dispersed then the market was the most efficient means of bringing them together. The market represented the societal analogue in terms of 'openness' to the 'organic' organisation. (8)

In other respects, however, the electronics industry has a suitable case for the manpower forecaster. As an industry it was been somewhat difficult to define in terms of products and has been more readily defined in terms of processes, and it was the diffusion of those processes to other industries which was seen as the industry's major potential


(7) See Grieg's observation in 1945 that the 'incoherent growth and newness' of the radio industry precluded any attempt to establish rigidly defined methods of training and grading, op. cit., p. 259.

(8) Cf. the concepts of 'organic' and 'mechanistic' organisation in T. Burns and G.M. Stalker, op. cit.
A similar view shared by the Working Group on Manpower of the E.D.C. could lead to a Say's Law view of the output of the electronic industry and the assumption that supply would create its own demand, for 'over-production' for the electronics industry proper would simply facilitate the more rapid diffusion of electronic processes to other industries by the diffusion of competent personnel. (10)

During the 1960's the industry enjoyed a very rapid rate of growth in the value of gross output at approximately 10% per annum, yet even this figure was an understatement in real terms because technological (9) The following information on the statistics of the industry has been gathered from a number of sources, notably those of the Economic Development Committee for the electronics industry. Unfortunately much of this statistical work was only available during the course of the study so that although the general characteristics of the industry were known at the outset the detailed statistics were not available and the available statistics were always several years out of date. N.E.D.C., Economic Assessment to 1972: Industrial Report by the Electronics E.D.C., London: H.M.S.O., 1970; E.D.C. for Electronics, Electronics Industry Statistics and Their Sources, London: H.M.S.O., 1968; E.D.C. for Electronics, Annual Statistical Survey of the Electronics Industry, 1968, 1969, London: H.M.S.O., 1969, 1970; E.D.C. for Electronics, Electronics and the Future, London: H.M.S.O., 1966; C. Freeman, "Research and Development in Electronics Capital Goods", National Institute Economic Review, No. 34, November, 1965.


<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of which Civil</td>
<td>240</td>
<td>286</td>
<td>331</td>
<td>394</td>
</tr>
<tr>
<td>Defence</td>
<td>134</td>
<td>124</td>
<td>142</td>
<td>140</td>
</tr>
<tr>
<td><strong>Telecommunications</strong></td>
<td>131</td>
<td>174</td>
<td>192</td>
<td>206</td>
</tr>
<tr>
<td><strong>Consumer goods</strong></td>
<td>79</td>
<td>87</td>
<td>126</td>
<td>119</td>
</tr>
<tr>
<td><strong>Components</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of which Active</td>
<td>79</td>
<td>82</td>
<td>102</td>
<td>118</td>
</tr>
<tr>
<td>Passive</td>
<td>150</td>
<td>131</td>
<td>160</td>
<td>177</td>
</tr>
<tr>
<td><strong>Total Output</strong></td>
<td>673</td>
<td>762</td>
<td>904</td>
<td>991</td>
</tr>
<tr>
<td><strong>Gross Output</strong></td>
<td>813</td>
<td>884</td>
<td>1053</td>
<td>1154</td>
</tr>
</tbody>
</table>

innovation had been combined with falling prices. From the perspectives of the late 1960's this overall rate of growth was expected to continue, especially in the capital goods although even here it was expected that some sectors such as numerical control would expand more rapidly and others such as radar move slowly. The industry is generally distinguished into four broad sectors - capital equipment, telecommunications, consumer goods and components - whose growth of value of output is given in Table 1. Of these sectors, telecommunications and consumer goods received negligible representation in the study. (11) The consumer goods sector is largely covered by domestic radio and television and it has been responsible for a decreasing proportion of the overall electronics output (in 1968 less than one quarter) and has faced a saturated market with only the hope of colour television for increased sales. Telecommunications is increasingly included alongside the statistics of the capital goods electronics industry although the capital investment requirements of the main customer, the Post Office, have been mainly for electro-mechanical equipment. Growth in this sector is largely dependent on the chosen technologies of this main customer. The components sector which has been the subject of considerable enquiry, awe and speculation has the least satisfactory statistics. Components output, which goes mainly to the capital and consumer equipment manufacturers, is distinguished into active components (those devices capable of controlling the flow of electrons in a circuit such as valves and tubes, transistors and integrated circuits) and passive components (all other components incorporated into an electronic circuit such as resistors and capacitors).

(11) Only one graduate in an applications lab did some work in the consumer goods sector and three graduates came from the division of a company which worked in the telecommunications sectors, unfortunately a further eight interviews were cancelled there because of an internal dispute between the divisional manager and the personnel department.

<table>
<thead>
<tr>
<th></th>
<th>Deliveries to the home market</th>
<th>Deliveries for export</th>
<th>Total deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Computers and related equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Communications equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Systems control and instrumentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Other capital goods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Total</td>
<td>288</td>
<td>313</td>
<td>416/440</td>
</tr>
</tbody>
</table>

Source: Economic Assessment to 1972: Industrial report by the Electronics EDC.

Note: (1) Other capital goods includes a variety of miscellaneous products, a large proportion of which are in the educational and medical fields.

(2) The figures for 1972 were estimates.
A great deal of fascination has been created by the integrated circuits, the miniature active components, stimulated by military and space effort demands for light, portable and reliable components. (12) Lacking the stimulus of a large military demand and Vietnam or space exploration programme the British manufacturers have been largely dependent on the other rapid growth sector of computers, another sector which has received specific government assistance. (13) The capital goods sectors contain some of the older and best documented sectors of the industry. Radio communications and broadcasting equipment under the name of 'wireless techniques' are over 50 years old and radar has been established for 30 years. For long the mainstays of the industry, these sectors have been declining in relative importance. As mature sectors they do not have the growth of newer sectors and their markets are largely in the public sector, dependent on Government (British and foreign) capital investment programmes in defence, transport, and communications. The newer sectors of computers and data processing, numerical control and instrumentation were those on which the Labour Party set great store in plans to 'modernise the means of production'. The major factors in this subsector were the level of industrial and commercial investment, the extent of government support in its role as the biggest purchaser (taking about 14% of the home market) and sustainer of the research and development programme, and the share of home and overseas markets which could be achieved in the face of the massive sway held by American producers, in fact by one American company I.B.M. which held a near monopoly. One continuing tendency in the capital goods sector has been the switch from

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(12) They are widely photographed in prestige and recruiting literature against ladybirds, ants, stamps, and small coins.

(13) In this way the economic fortunes of these two advanced industrial technologies were closely linked and dependent on government goodwill.
military to civil markets. Table 1 showed that despite an absolute increase there has been a relative decline in the importance of the defence markets. (14) The defence forces have remained the largest single customer, but the greatest impact of military expenditure has been in support of the industry's research and development programme. (15) In recent years the research and development programme has risen to over £100 million per annum, and although the 1968 position might be nearer 30%, the military portion was estimated at around 60 - 70% in 1964. (16) Although the military element has been declining, the electronics E.D.C. has repeatedly sought assurances about government support for civil R & D, and it has already been seen that in telecommunications and computers, the government was a significant customer. The situation drew the following comment from the electronics E.D.C. in 1966:

"The Government is inescapably involved in the future of the capital goods sector: it does a substantial amount of research into electronics itself and directly finances research in universities; it pays for about 60 per cent of the development carried out by the capital goods sector and accounts for about 40 per cent of its turnover (including R & D); its negotiations with other governments can determine the British share in cooperative military and civil ventures, it influences the demand for electronic equipment by its promotion of general technical advance and by its policies for public sector agencies; it affects the supply of manpower both in the short term as a large employer and in the long term through its educational policies." (17)

The nature of government involvement could encourage the view that this

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(14) The implications of this change were matters of concern to the various representatives of the industry, for example, in those documents already quoted of the Economic Development Committee. These industry representatives who sought ways in which defence requirements could be linked to civil markets and extensions of the defence market by relaxation of embargoes on sales to the Eastern bloc or South Africa. See, for example, the annual report of the Electronic Engineering Association cited in The Times, 5.4.68.

(15) See the comments of industry representatives in an early 1960's study on the likely consequences of disarmament reported in the study by the Economist Intelligence Unit, The Economic Effects of Disarmament, London: The Economist Intelligence Unit, 1963.

(16) The 1964 figures come from Harlow (op. cit.) and the 1968 figures I have estimated from the O.E.C.D. statistics.

industry corresponds more closely to the world of the manpower forecaster and that a manpower forecaster armed with a knowledge of the government utility function would be favoured indeed!

A priori, the structure of the industry would appear to favour the manpower forecaster's view. Output was highly concentrated (i.e. 1968) with six companies responsible for 60% of the total output. It was estimated (i.e. 1967) that 250,000 of the total 350,000 were employed in ten major companies each employing over 10,000 employees. (18) In addition to these factors the degree of geographical concentration with nearly 60% of the labour force employed in the South East and East Anglia region could encourage the view that companies would be reluctant to engage in price competition for labour, given that the costs of movement to a nearby company might be low. The total number of qualified scientists and engineers (Q.S.E.'s) in electronics reached almost 17,000 in 1968, representing approximately 15% of all Q.S.E.'s employed in manufacturing industry, and during the 1960's the growth to this level had been achieved by the fastest rate of growth of Q.S.E. manpower for any industry. While absolute numbers have increased in all employment functions, the percentage of Q.S.E.'s employed on R & D has fallen from 68.5% in 1959 to 49.4% in 1968. This rise in employment in management functions, in production and marketing departments was another factor which could support a Say's Law view that an increased supply of Q.S.E.'s would facilitate the movement of people with 'science mindedness' into non-technical employment.

It is difficult to conclude from this review of the growth and structure of the electronics industry that a study of the operations of the labour market for graduate scientists and engineers among companies in the industry markedly favours either the manpower forecasters or the rate of return economists. While the heavy involvement of government as customer and provider of funds for R & D and the degree of concentration in industrial structure might suggest that the price mechanism has not been central in the allocation of resources, the importance of the defence work has been diminishing and the companies have been very much aware of the high degree of international competition, indeed it could be argued that the development of a high degree of concentration in the industry had been hastened by government but brought about ultimately through the operation of market forces.


3. **Company Recruitment Policy and Strategy**

It has been suggested that there are four ingredients in a successful recruitment policy, and these have been spelt out as:

"(1) a clear conception of the kind of work for which candidates are to be chosen, together with the qualities and qualifications needed to carry it out;
(2) knowledge of where to look for possible recruits;
(3) knowledge of how to look for them; and
(4) means of recognising and assessing, in the candidates presenting themselves, the qualities and qualifications". (19)

What emerges from the accounts given by company personnel of graduate recruitment is not a commonly held clear conception at all, but a variety of reasons, some of which are mutually inconsistent. On the first two ingredients, for example, there are various kinds of work for which graduates are recruited, sometimes these are readily identifiable jobs and in other cases simply as a 'good man' who might find his own niche, and moreover universities are not the only source of recruits for any of these jobs. Any large scale organisation will be concerned to fill the positions in the organisational structure in terms of various functional activities, for example, research, development, production, test, marketing, sales, and so on, and also in terms of the hierarchical ordering of occupational activities such as craft, technician, professional technical and managerial levels. These positions require incumbents not only at a point of time but for any large-scale organisation there will be an eye to the long-run. Policy in its long-run aspects must make assessments of future production and the pattern of production, staff turnover, education and training and so on. The elaboration of this variety - from recruitment for different functional areas, at different levels, and over different time

horizons - will be organised in this section under the headings of our policy ingredients.

(a) Why graduates are recruited

Shortly before undertaking the main study, one reason for recruiting graduates in the electrical and electronic industries was explained to me by a senior personnel manager. His explanation was in the form of a fable which began with an employer's need for a window-cleaner. An educational institution eager to mount courses, watched the movements of the window-cleaner and organised courses in upward arm circling and knees bend to develop appropriate muscles. After a few years the education institution became renowned for the large number of Olympic athletes among its graduates, but these athletes tended to scorn the occupation of window-cleaner or emerged convinced that the possession of educational qualifications was the key to a successful career as a window-cleaner. Even this latter group found considerable difficulty in relating their education and training to the occupation. The employer recruited at the gates of the college still, largely because he felt that a successful confidence trick had been played on the athletes. They had been convinced of the need for even higher standards of fitness and if the employer wanted to recruit what he considered, in some pristine sense, 'bright people' then he must wait patiently for them to emerge from the educational system. Moreover he must organise his recruitment around the decision of educationists about the appropriate time to release athletes and employment categories, for example, the fifteen year olds, the sixteen year olds, and so on, with more recently the twenty-five year olds. The moral of the story was to underline the differing standards of excellence in the academic institutions and the world of industry, and to point up the existence of educational provision at best irrelevant or at worst productive of harmful attitudes. It was at best irrelevant because the employer wanted 'bright people' and 'bright people' tended to be sucked
into the educational system, hopefully with their original brightness undimmed. It suggests that the development of higher education should not be seen as in response to the increased knowledge and skill requirements for occupations, the growth of the educational system is much more the kind of tertiary activity permissible with increasing affluence. Whilst there might not be whole-hearted support for this pointed critique of the educational system among other industrialists, many do draw attention to the way in which industry is being shaped by the termination dates of schooling. They claim that the bright boys who entered at fifteen and who were subsequently groomed within the organisation now emerge from the educational system at a later stage. (20) Now if the relationship between education and industry ever corresponded to the initial state implicit in the story above and if the expansion of educational opportunity has been as great as is implied then it might have been expected that the discussion about industrial manpower would include the whole range of industrial functions and the sources of recruits. Some recent developments in across-the-board training following the Industrial Training Act of 1964 indicate both a reluctance to rely on employer wisdom about training and efforts to go beyond elitist preoccupations. (21)

Despite the changes in employment trends noted earlier the majority of graduates are still recruited for R & D functions. Universities as institutions most centrally concerned with basic research are expected to provide engineers and scientists capable of coping with change. After all there is a little challenged view frequently propounded by academics

(20) See the comments made by the industrial representatives at the various conferences of the Committee of Vice-Chancellors and Principals, especially the Home Universities Conference 1962 (printed London 1963) and "Industry and the Universities - aspects of interdependence", 1965 (printed London 1966).

(21) This preoccupation with highly qualified manpower was criticised by Stephen Cotgrove, Technical Education and Social Change, London, Allen and Unwin, 1958.
that to be a good teacher the scientist must undertake research or stagnate.

One training officer having explained the problems of change confronting his organisation, saw the solution as stocking up with 'brainpower' and wondered where that could be found in the event of university inability to supply the requirement.

"In this industry the case for recruiting graduates is pretty clear-cut, and it is important to say this industry. All new development and the science behind this engineering activity is moving so fast that the set of rules, laws and equations used last year is obsolete next year. The state of the art is changing so fast that the engineer has to have a good brain. In some areas the changes are faster than in others, in mechanical engineering things change more slowly and you can gently lead a person of lower intelligence to employ the principles of ten years ago to build another bridge. This is not true of transmitters where each year the solid state devices go higher and higher on the power and frequency scale and you get more and more problems, new problems. So in electronics we need more brainpower than, say, in mechanical engineering, with electrical power in the middle. And we would like to try to identify the high flyers as soon as possible because they are the future of the industry."

In a sense this was a vote of confidence in the accuracy of the educational system as a selection and filter process and an acknowledgement of a pyramid of prestige among educational institutions with universities at the peak. The themes, of recruitment for future purposes rather than immediate tasks and the qualities of 'bright people' with a training in coping with change, were repeated several times, not only in R & D, but in production and applications departments too.

"Because we work in a field where what we do today is out of date tomorrow, we need people with the imagination and breadth of training to be able to grasp ideas in one area and transfer them to another. It is no good having a lab full of people with H.N.C. who know in great detail what we did this year and five years before but haven't the basis to strike out to do what might be done. Also we haven't much research backing in our area so that we have to do a lot of our own original thinking. This is where the graduate makes the difference. He has been made aware of a wider knowledge in his course, so that he is probably able to tackle new problems, and new concepts. The H.N.C. might be a little cross that they
are not on the monthly staff whereas graduates are,
I try to explain that graduates are not rewarded for
the present but for their potential." (Development
lab manager)

"It's not so much their state at the time but the
minds that come along. They tend to be more flexible
and adaptable." (Group leader, application lab)

"I've got a number of people who come off the bench.
About them lots of things are very good, their
experience in industry, what they've done and seen.
But they haven't got the questioning mind that I
expect from graduates. For a new process the graduate
decides from first principles, often the man from the
bench will get these in the end but he makes a lot
of booms doing it. Graduates I expect to get there
faster." (Production manager, semiconductors).

These comments about 'brainpower' and coping with change were repeated
several times over and suggest a world where technological change is not
only rapid but jerky and dramatic in the manner of the manpower forecasting
model. However there is considerable debate about this topic. It
should be remembered that the applications and production departments
were for semiconductors technology which has had appreciable technological
change in recent years, a development engineer in his mid-thirties will
have experienced changes from valve to transistor and to integrated
circuit technology. Within this area of quite appreciable change there
was still controversy about the ease of coping with change, for example,
in one company a development manager boasted of the ease of switching
an establishment (all departments from development to production) from
production of transistors to production of integrated circuits in two
years with negligible redundancies, and, on the other hand, the training
officer of another establishment talked of his therapeutic sessions among
graduate production engineers depressed about their technical futures.
The Ministry of Labour study found that one manufacturer employed graduates
in line supervision because of production complexities but this was less
common now that "technology had 'settled down'". (22) Among the capital

(22) Electronics, op. cit. p. 11.
equipment manufacturers integrated circuits were expected to lead to a shift in required skills from circuit design to systems design. (23) Yet there were sharply differing implications drawn from these changes reported in the Ministry of Labour study from those who saw possibilities to retrain circuit engineers into systems engineers to those who wished to start afresh from a different multi-disciplinary base. (24) There have been numerous doubts about the likelihood of graduates coping with study change, for example, the criticisms in the pilot/about closed-ended problems and written exams implied a rote learner overidentified with narrow disciplines. However, in terms of the manpower forecaster versus rate of return debate even in this most volatile of technologies it appears that the rate of change has been sufficiently smooth for adjustments to be managed although the present balance of full-time versus post-experience education could be altered to ease such adjustments.

The suggestion that graduates are the ones most likely to cope with change in the long-run and one employed for their potential raises questions about their assignments in the short-run and the whole question of the fixed technical coefficients and inelasticities of substitution between different kinds of manpower assumed by the manpower forecasters. In line with the general trend in manufacturing industry, most of the

(23) Whereas in the past the development engineer needed the analytical ability to handle solutions and turn them into practical terms, which involved designing circuits which put a lot of discrete components (i.e. transistors) together to form a particular function, a company can buy often a complete package, an integrated circuit, which does the function to a known specification. This has the implication that the circuit design is transferred to the component manufacturer and links to the work of chemists and physicists, while the equipment manufacturer has less need of the circuit designers' analytical skills and looks for a wide-ranging and broad knowledge of manufacturing processes and philosophies in his engineers.

companies visited had abandoned the formal two-year graduate apprenticeship and placed greater emphasis on on-the-job training, often following a few weeks induction. About jobs the Jackson Committee was somewhat perplexed at the number of graduates, or rather the estimated one-tenth of the total stock of Q.S.E.'s who were reported in technician roles in the 1965 Triennial Manpower Survey. The Committee sought comfort in the explanation that these Q.S.E.'s were young graduates in training. In view of the acclaimed shortages of scientists and engineers the pattern was puzzling. Among the several possible explanations were (1) the training conclusion, (2) the possibility that the technical content of technician roles had become so complex that the 'brainpower' associated with graduates had become necessary, (3) that university expansion had involved lowering standards ('more has meant worse') and so contemporary pass/ordinary degree graduates were appropriate for technician roles, or (4) given a shortage of technicians, employers had substituted Q.S.E.'s for technicians in the sense that this group, defined by qualifications, had not been associated with this role, defined by activities. There were also several admissions from managers that minimal formal training schemes did allow the possibility that Q.S.E.'s, especially recent graduates, were employed by technicians 'willy-nilly'.

"There may be something in graduate complaints about doing non-graduate work, and they may be justified to a certain extent. We don't have many lab assistants. We could be criticised in that we take on new graduates and we use them as lab assistants, but it's our way of training them. It's O.K. provided that we are careful that the work is there when they are capable. Otherwise there is a danger." (Research lab manager)

While a through-put of graduates in training might release some of the shortages of supporting staff and provide valuable training experience, in so far as it does represent training there is a requirement for training supervision as well as job instruction from senior engineers. Attempts
to relieve this pressure have included a search for graduates with experience. The latter solution was evident in warm praises for sandwich course students and higher starting salaries offered for 'thin' sandwich course over full-time course students, and a small premium on the starting salary to those with "relevant vacation experience" compared to those without. Again some of the disquiet about physicists appears to come from the belief that the physicist is less industrially experienced and his course less industrially relevant than for the graduate engineer so that he requires more "fitting out" in lengthier and more costly induction and training courses. One reason for recruiting physicists, then, is similar to the need for 'brightness' theme in our moral tale in that it is believed that "bright children" or "children with high I.Q.'s" enter the most prestigious subjects and industry needs their brightness not their subject specialism. Similarly some companies recruit among Arts graduates with Science G.C.E. A levels for conversion to production engineering and production management in the belief that the 'bright' are now going into Arts and Social Science specialisms. However the requirement for Science G.C.E. A levels suggests a threshold of background and competence in scientific disciplines is thought a necessary condition for even the 'bright'. Some recruiters would go further, however, and suggest that in the research areas the physicist has a superior training and has more relevant skills in technologies such as microelectronics. It could be argued that the increasing demand for computing skills, maths and logic might make the physicist a more attractive employee. The two manpower enquiries, by the Electronics E.D.C. Working Group and the Oatley Committee, reported the opinions of employers that they were finding more physicists and fewer electronics/electrical engineers available than they would wish to employ. (25) The Oatley Committee noted a change in the balance of

<table>
<thead>
<tr>
<th>Source: The Relations between Universities and Industry in Electronics, p. 44.</th>
<th>1959</th>
<th>1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics Engineers</td>
<td>3400</td>
<td>7950</td>
</tr>
<tr>
<td>Physicists</td>
<td>1600</td>
<td>2665</td>
</tr>
</tbody>
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electrical engineers and physicists in the direction of increased proportions of electrical engineers (from rates of approximately 2:1 to 3:1 over a decade). For these reasons the working parties suggested more career advice in schools and universities and greater opportunities to switch courses such that industry might avoid some of the conversion costs for those 'physicists' who become 'electronics engineers' in the industry. Another factor which weighed with these observers was the Swann Report observation that through the 1960's the physicist was more likely to seek academic or government employment in preference to industry than the engineer. The Oatley Committee, however, noted that the statistics of this period were unrepresentative and drawn from a period when the expansion of university departments of physics and of electrical engineering was at its height. A further point of interest which emerged from the studies by Hutchings was that some electrical engineering departments selected physicists in preference to electrical engineers because it was believed that an undergraduate physics education was a better preparation for research than the undergraduate engineering education. (26)

While the balance of scientists and engineers in research and development against other departments has been changing, recently qualified graduates were recruited for the most part directly to research and development departments. (27) From here their future was envisaged as likely to be in one of three main directions, a wholly technical career, a movement into technical management, or a move into management in other departments such as production or marketing (28) F.E. Jones, the managing director of Mullard and a member of the Committee on Manpower Resources

(26) The discussion of occupational choice in the following chapter will take up the point that the manpower forecasters discuss preferences as though they exist independently of structures of opportunity. D. Hutchings, (personal communication).
(27) cf. Electronics, op. cit.
(28) Conceptions of careers among graduates are discussed in Chapter Eight.
for Science and Technology, has claimed that some of the Mullard research expenditure was justified in that it brought researchers to Mullard who could be tempted to other departments. (29) One of the companies visited included a similar view of the research lab as an internal recruiting ground in its recruiting literature and added that turnover through the lab would allow recruitment of 'a new generation with new ideas and enthusiasm'. These kinds of recruiting policies have drawn a number of criticisms. Thomason has observed that labs used for internal recruitment may engender low morale among researchers on unessential research and Box and Cotgrove have discerned an overreadiness to subscribe to the belief that researchers' productivity declines as a simple function of age. (30) Thus while the appeal to the young may be flattering, the debilitating effects on older researchers may encourage the aura of the cul-de-sac about industrial research. (31) This policy effort to transfer personnel out of technical functions in R & D to managerial functions raises more questions about substitution, because graduate scientists and engineers are competitors for managerial positions with both non-graduate scientists and engineers and graduates from other disciplines. Salary and activity surveys suggest that graduate scientists and engineers proceed more readily to managerial positions than those qualified through the part-time HNC and professional institution route. In R & D management

(29) See the reported speech and interview with Dr. F.E. Jones, *The Observer*, 17.11.68. One careers writer has claimed that some larger firms will employ 10 to 20 per cent more engineers than they actually need as provision for long-term succession, Mark Byron, *Sunday Times*, 17th August, 1969.


(31) See also the comments of Gerstl and Hutton about short technical career ladders among mechanical engineers, J. Gerstl and S.P. Hutton, *op. cit.*, p. 89.
there may be little scope for the substitution of graduate economists or other social science graduates yet these possibilities exist in other functions. Many criticisms have been voiced in recent years about scientists and engineers in technical project management from the criticisms about their abilities in project management to the doubts about the relevance of their skills to some of the major industrial problems.

"The success of science in industry has much to commend the scientist, but the arrogance which this apparently induces in scientists outside their scientific expertise is to be condemned. Modern industry is a complicated integration of various disciplines, scientific and non-scientific, involving personal and impersonal qualities which are capable of adopting scientific or logical analysis to cater for situations but requiring judgement for others. In an integrated commercial enterprise of which our major companies constitute good examples, it requires little call on the scientist to fight his way into the organisation to establish his right to be there. The problem is rather to find the right place for the scientist in the company team, a place which may not be uniquely determining or important in all matters affecting the viability and working of the industrial company.... Today, probably the major problems exercising management are the provision of managers, labour relations and scales; for none of these is science qualified to play the leading role." (32)

These comments go further than those which suggest scientists were sought for high I.Q.'s which might be found in other groups and hint at some of the disillusionment with scientists whose skills did not offer universal panaceas but who tended to cast themselves as paragons. The Swann Committee itself recommended that economics, sociology and so on, should be included in what were termed 'generalist' courses. In one sense the whole discussion of 'specialist' versus 'generalist' courses was a bet-hedging exercise which retained all the assumptions of a close identification of science or engineering education with industrial employment and yet attempted to

introduce a degree of flexibility to cope with the range of substitutions possible. (33)

High company turnover seems difficult to reconcile with policies of recruitment for the future. Inevitably questions are raised about the interests of companies retaining recruits. Management views of a desirable length of stay were often expressed as at least five years, but the experience was that considerable numbers left after two years.

'Considerable' was the impressionistic phrase usually employed by respondents, for at establishment level ignorance of precise turnover figures was evident in the collection of discrepant figures in different departments or the collection of manpower statistics in an unusable form. It has been estimated that the average mean period of employment for new graduates in the electronics industry during the 1960's has been two years. (34)

The apparent contradiction of long-term recruitment set against short-term retention could be resolved if the companies regarded the early employment period as a continuation of the search process and sifted recruits such

(33) In contrast to the Swann and McCarthy reports which advocated a science-based 'generalist' course one technological university decided to call its graduates from a newly-designed course 'technological economists'. Professor Bradbury speaking about the Stirling University course in a radio discussion saw the dilemma of titles - "We had to decide whether we were going to make a scientist who knew some economics or an economist who knew a vocabulary of science, and we settled for the second of these two." Gerald Leach, "Tomorrow's Engineers", Third Programme Broadcast, 3rd March 1969, B.B.C. Tape No. TIN 10 T4875. Ironically enough, McCarthy, a science graduate, was joint author with another member of the Committee on Manpower Resources for Science and Technology of a book on technological economics, D.S. Davies and M.C. McCarthy, Technological Economics.

that it retained those judged to have relevant abilities. The rather tentative introduction of staff development officers and the then haphazard appraisal procedures implied that this could not be assumed to be standard policy or practice. Another interpretation of turnover is that, given the lack of consensus about desirable skills in the electronics industry, the graduate should move between companies to acquire a variety of role and skill definitions. A philosophical conclusion might be drawn that 'the industry must be in some sort of balance because we pinch theirs and they pinch ours', and the losses to an individual company represent an increment to the industry's stock of experienced engineers and scientists. The importance of such moves to further training was strongly emphasised by a group leader from a development lab.

"In three years a man has gained a lot of experience and then he develops at a steady rate, so that unless he is promoted I wouldn't expect him to stay. I did stay, but I wouldn't expect anyone else to stay longer. It's a bit strange to say this, but I think that someone should have three years here and then three years in a similar allied company, and he will have doubled his experience. To stay six years within this company will give only the equivalent of four or five years' experience. I have found a move within divisions in this company a considerable change in approaches. You find in these people who have moved around companies, it need only be once or twice, a much broader outlook. They know that there is more than one way of tackling a problem."

This comment came in a company where turnover figures were on the 'secret list' and determined efforts were being launched from the personnel director to retain a higher proportion of recent recruits. The most usual lesson which appeared to be derived from the experience of higher turnover appeared to be a recipe to exacerbate turnover, for managers assumed a high turnover and took on more graduates than could be accommodated.

In these large organisations the mixture of policy aims, a short-run policy which characteristically leaves the long-run to take care of itself with a rationale that turnover adds to the industry's stock of experience and a long-run policy of stocking up with 'brainpower' and
potential entrants to the higher echelons of the company, was only just beginning to summon attempts at resolution in the form of staff development policies. Any resolution would be the outcome of a debate between the various interests of the organisation, the technical and personnel, the establishments and head office. The 1968 situation favoured the short-run interests of the establishments. The notion that companies have simple production functions which employ inputs in fixed ratios is something that may appeal to the linear programmer or the manpower forecaster but has little correspondence to method or outcomes in these political processes.

(b) and (c) Where and how graduates are recruited

While graduates are recruited for their native wit, exposure to courses encouraging problem-solving, believed malleability to company purposes and lack of complications for the company structure compared to experienced recruits, an additional reason for graduate recruitment is that there were more channels of recruitment by which companies can contact the potential employee as a student than as an experienced graduate. While all the large organisations engaged in prestige adverts in the daily and technical press to project a distinctive image of the company, more specifically in recruiting campaigns in the national and technical press, technical and recruitment contacts with universities, it was the contact with undergraduates through the university and college appointment boards which provides an institutional contact unparalleled for experienced engineers or technicians. (35)

(35) As an example of prestige advertising two of the large electronics companies have mounted national press adverts which announce "Ferranti - First in Advanced Technology" and "Marconi is Advanced Technology".
In all of the companies studied university recruitment was centrally coordinated. In response to an enquiry from a central personnel department bids for staff would be made in November. The central personnel department could provide a check on the figure by totting up bids and comparing this figure with past totals and past intakes. In one company, the personnel department made an estimate of 'true demand'. This figure emerged after recruiting fewer than the November establishment bids total on the suggestion of the Personnel Director, a count of the unfilled vacancies in the following October was added to the total intake, and it was found that initial bids overestimated 'true demand' by nearly twenty-five per cent. Another possible check on departmental bids was the request for a job description with a comment on career potential for recruitment interviews. The first kind of check may lead simply to exercises in 'making allowances' for personnel director cuts in initial bids and the second check may mean only that 'errors' become 'plausible errors'. There were peculiarities to the nature of manpower utilisation in the capital goods sector of the electronics industry stemming from the defence portion of R & D work. One tendency among defence contractors is to hoard labour between contracts to keep teams together and to take on labour in other cases in order to win contracts, so that graduates may be recruited for a contract which does not materialize. Another effort of the lab manager is to include as many as possible of his staff on the ministry-funded contracts but have senior engineers on more than one project and attempt to maximise the numbers on private venture work. Since the juggling of men and man-hours is the task of the department manager much of the initiative on manning issues must rest with lab managers at the establishment level. While the company may achieve some overall balance between estimates and eventual employment the pattern of employment may bear little relation to department bids. Table 4 gives some indication of the variations between
sixteen departments on one establishment recruiting electrical engineers, physicists and mathematicians, while the majority of departments recruited fewer than estimated some recruited over their bid and may be the result of a last decision to take on potentially very able candidates and in the hope of finding a vacancy later. The 'offers' and 'accepted' columns indicate another source of discrepancy for companies calculate this ratio and send out offers on the basis of past ratios. Since the ratio is not an immutable statistical law companies can be embarrassed by too few or too many acceptances. (36) Another study of a technologically advanced company found errors of up to 20% in management forward estimates of manpower required against outcomes on a two year basis, again errors were in both positive and negative directions. (37) Errors of this kind on very short term estimates of one year and two years throws more doubts on the employer returns to the triennial surveys and suggests that manpower forecasters should undertake more studies of the manner in which estimates are made and the kind of variables which determine different patterns in different industries. (38) Obviously some important source of differences

(36) One motor vehicle manufacturer was embarrassed because their offers were based on estimates of turnover based on past experience and between department bids and offers the company raised engineering salaries which cut turnover. The company embarrassed by acceptance of non-vacancies then began to withdraw offers and acquired an odious reputation around appointment boards. Other companies cope with their over-estimates by funding suitable college courses or 'making work' to avoid damage to their recruitment reputations.

(37) I.M. Gascoigne, "Manpower Forecasting at the Enterprise Level", British Journal of Industrial Relations, vol. 6, part 1, 1968.

(38) It must be borne in mind that 91 of the 170 interviewed were employed on defence related work which appears to be a disproportionate sample of the electronics industry and increasingly so if a shift away from defence support continues. However, similar problems may occur on the government civil contracts too, so these practices may continue.
TABLE 4. The pattern of vacancies, interview offers and acceptances across departments in one company.

<table>
<thead>
<tr>
<th>Department</th>
<th>Vacancies</th>
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Totals     | 149       | 1671       | 430    | 131      | - 18   |
between and within industries is the company structure and the extent of discretion granted to either establishments and departments against head office and centralised personnel departments. While the personnel manager of one company could claim a large share of the responsibility for doubling the intake of graduates over the previous year's total in order 'to liven up the company and set enthusiastic graduates snapping at management's heels in five year's time', in most of the companies visited initiative lay with the short-run requirements of departments or divisions. This was especially true in those companies where graduates entered directly on to employment and the departmental budget rather than on to the personnel or training department payroll.

During January to April, representatives from the personnel departments visit universities and colleges across the British Isles. Considerable disquiet has been increased in recent years over these initial visits to universities and colleges, and they have earned the somewhat disparaging title of the 'milk run' or 'the circus', and some technical interviewers despise the process as a 'rat race'. The administrative burdens of the exercise are appreciable and one company visited 43 universities and 30 colleges in an initial sift of 2,000 candidates for 100 vacancies, from Table 4 the administrative tasks of a company at the company second interview are appreciable as 640 candidates required 1671 interviews with the various departments. Some companies, in an attempt to reduce the administrative burden of what may be several thousand interviews, have considered the use of pre-selection forms. (39) This has been much to the disquiet of Appointments Board officers who feared a raw deal for some graduates in pre-selection. There may be drawbacks

(39) This has been particularly favoured among the large oil companies, see the reported discussion among members of the Standing Conference of Employers of Graduates (S.C.O.E.G.) reported in The Times, 25.9.69.
even to the companies, however, as one personnel officer noted, "We had wondered if we could eliminate some of the interviewing by some form of pre-selection at university, but it's very difficult because on the circus or milk-round many have got no idea what they want. They soon learn - maybe they just learn answers and it's a game. In any event it's possibly easier for us to choose than for them to choose because of our knowledge of the jobs and post graduates."

These difficulties of ill-informed candidates become compounded when it is felt that the final year allows little time for candidates to become knowledgeable and companies try to avoid second interviews beyond the Easter vacation. Another attempted solution is to create more information by encouraging Appointment Board's officers and students to visit companies earlier and arrange Christmas vacation interviews, thus bringing forward points of choice into less crowded timetables.

Criticisms are sometimes made of the 'milk round' as inadequate for information purposes, cumbersome in administration, and expensive in costs. Occupational psychologists may have just cause in their points about information and canvass various selection instruments for employer use and a strengthening of the counselling services of the University Appointment Boards, but the points about costs are less easy to substantiate. (40) Employers do not pay the full economic costs of recruitment in that they do not pay for the distribution of information and interview facilities made available at the university by the Appointments Board. One of the major objections to pre-selection forms by employers was that these forms would lead to increased administrative costs being placed on the Boards and when the Sussex University Appointments Board attempted to impose charges on visiting employers it was forced to back down by a threatened employer boycott and lack of support among the other Vice Chancellors and

(40) R. Williams, "Industry as a Career: What Students Think", New Society, 26.3.70.
Principals. Calculations of costs of company second interviews usually include hotel and rail expenses on company visits, personnel visits to universities, graduate travel expenses, even flowers and cigarettes, but rarely the cost of managers' time on second interviews at company interviews. The general impression given by one personnel officer was that graduate recruitment when compared to other forms of recruitment was not expensive, and 'expensive' is surely a term implying a comparison of alternatives.

"We really don't know the costs of recruitment per man, we had an accounting error so that we ended up holding a finger to the air and finding a figure. I would say it's an inexpensive way of recruiting. Our labour pools are in the colleges and we visit them there, we ought to see quite a number of people in one visit. We then get a number to the company in the Easter vacation, again there is a concentration of the market to the company. And over a period of six weeks or so we have a pretty intensive time, after the first week we have a pretty well-organised system, to cope with events. Compared to normal recruiting methods, by, say, advertising or paying agencies fees for the man they put forward, we do pretty well out of it. It's not strictly comparable. On the one hand you've got experienced people, and on the other inexperienced people. But any firm that is alive and is going to remain so is going to take on graduates, and they will become increasingly important to it." (Personnel Officer)

If we examine the alternative ways of contacting recruits contacting school leavers has the disadvantage that the labour pools are scattered in many schools and schoolchildren are believed to be enmeshed within the educational system till graduation. Sponsored school leavers on university courses is attempted but only in a relatively small way by a number of companies. (41) Again recruitment during the undergraduate career has limited potential because it is realised that vacation employment is often a deterrent to employment and some companies limit numbers in

attempts to give worthwhile experience. The recruitment of experienced engineers has no institutionalised market, the professional institutions have been loathe to enter too readily into placement functions and their conferences serve this purpose in only a limited way. (42) There has been a considerable growth of management selection consultants, advertising agencies and employment agencies from the setting up of Management Selection Ltd. (M.S.L.) in 1955 to the 123 similar services in the Directory of British Recruitment Services in 1969. The services tend to specialise in different ways - the management selection consultants have tended to specialise in personnel earning above £2,000 per annum (i.e. at late 1960's rates) and charged between 10 - 15% of the recruited manager's salary, registers, dealing in the salary ranges £2,000 - £3,000 per annum and charging about £50, gave access to a particular category on the register, and finally the advertising agencies were generally employed to place a volume of advertising equivalent to 10% of the recruited personnel's salary. Insofar as it is possible to make comparisons between costs of recruiting relatively inexperienced and experienced personnel (bearing in mind the earlier points about training costs and that advantages of malleability), the general impression is/recruiting graduates direct from university is less costly than recruitment at a later point in time. (43) There was, however, a more interesting comparison drawn in interviews with managers about the costs of recruitment and this was a comparison between the costs of recruiting technicians and graduates,

(42) A small service was set up by the professional institutions to cope with post-war resettlement but it was not considered a proper function for full development. The Department of Employment Scientific and Technical Register has had a patchy record and is undergoing reorganisation.

where the assumption is that non-graduates are the main sources of technician employment. One lab manager commented on the lack of an institutionalised labour market for technicians and a major problem in the unpredictability about supply.

"The ways of getting graduates are more well-defined. We have a thorough campaign each year and our lab has a good reputation for getting graduates in, or so I am told. The lab assistants just turn up and are not the sort you get by adverts in the national press. Also we are not sure when they are going to come, whereas with graduates we know we are going to get a certain allocation." (Research lab manager)

While some writers have referred to the abundance of anecdotal evidence that graduate scientists and engineers are recruited for prestige reasons and then employed on routine work and seen this as irrational behaviour on the part of the company, the nature of the labour market suggests that there may be a simple economic rationale in recruiting graduates for technician work. Although many managers emphasised that the graduate was recruited for his potential contribution in the long run, the manner in which the exercise was costed and regarded as inexpensive and the availability of familiar routine demands of recruitment suggested important short run implications too. It meant that the technical department in making up its bid for manpower to the central personnel department could rely on an input from the annual recruitment campaign and need not conduct a thorough scrutiny of its needs in terms of categories of manpower distinguishing technician and professional. The work load need not be scrutinised and then manpower sought accordingly, the situation more closely resembled one in which staff were sought and the tasks allocated.

(c) Selection criteria in recruitment

The final aspect of recruitment policy to be considered is the means used by company representatives to recognise and assess the qualities and qualifications in candidates relevant to company purposes. Discussion
of these points in interviews with managers suggested a number of different perspectives on recruitment and the analysis of these perspectives put into sharp relief the potential sources of confusions and crossed purposes in manpower debates. Technical staff involved in interviewing often made remarks about their search for "first class men", "the cream" or "the self-starter". It was not clear how far performance on these criteria related to academic brilliance. It was not clear how far industrial complaints about a shortage of "good graduates" related to the Swann Report findings about the reluctance of "the more able graduates", although the Swann Committee had little difficulty in juggling from statements about "the highest academic attainments" to the ambiguous phase "best graduates" in their interim report. (44) Putting these ambiguities forward forces attention on the central question of the relationship between educational experiences, educational qualifications and occupational competence as seen by company recruiters.

For the manpower forecaster there appeared to be a simple set of positive correlations between length and level of education and occupational competence, and, academic competence attested by academic qualifications and occupational competence, all of which were confirmed by employer demands. The manpower forecaster admitted some doubt about the relationships when they were critical of educational courses and echoed the criticisms of employers, however, while they made proposals for reform their use of the concept of 'need' suggested that employers were not always aware of the benefits which could be gained from the employment of highly qualified manpower. For the economist there has been evidence in numerous studies of a positive association between levels of education and earnings, and if

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labour markets could be assumed to be competitive than earnings could be taken as satisfactory measures of productivity. (45) These latter studies have usually been of levels of education, for example, primary v. secondary or subdegree v. degree level studies and and not within the degree category, for example, by class of degree. However, there is some evidence that in periods of labour market contraction those with a higher class of degree find less difficulty in obtaining employment than those with lower class degrees and this indicates a similar trend of employer preferences. (46)

The problems which remain in the economic analysis are an explanation of the link between education and productivity, of how educated manpower contributes to an organisation, and some justification for the assumption that labour markets are competitive. (47)

Explaining the link between education and productivity tends to fall outside the scope of economic analysis but sociological studies of university groups and non-university educated have offered two lines of linkage, one through the formally prescribed courses offered by teachers and the other link through the development of competence in coping with the informal organisation of college life. The first line of argument contends that courses develop skills relevant to the occupation and could cite the similar arguments of the managers in the earlier section of this chapter, for example, that the development of analytical skills in universities facilitated a competence in coping with novel situations

(45) A review of this literature is available in M. Blaug, An Introduction to the Economics of Education, op. cit., pp. 23-27.

(46) E.G. Whybrew, op. cit.

(47) A very forthright paper addressed to these issues and the topic of this section is that by M. Blaug, "The correlation between education and earnings what does it signify?", Higher Education, vol. 1, no. 1, February 1972.
compared to the greater emphasis on rote-learning and mastery of existing techniques for standard situations in the H.N.C. course. Moreover the facility for learning makes the graduate a more versatile employee. (48) The other line of argument is that students acquire skills and abilities relevant to middle class occupations from aspects of college life not conventionally regarded as part of the curriculum. (49) One important skill comes in the organisation of resources to meet competing demands from teaching staff and other personal interests and another in planning on longer time horizons than were familiar in schools, for example, by terms and vacations. These qualities, the ability to organise and discipline oneself to work independently over a longer time period, were among the qualities claimed by the engineers as benefits of college experience in the pilot study. One skill not mentioned in the Scottish pilot study, but mentioned frequently in the English study, was that of making friends. In the English study many of the graduates referred to the move from school to university as the occasion of their first move away from home into a world of similarly situated people where friendships were not 'givens' of family or neighbourhood but developed with the fashioning of social poise and confidence, in contrast the bulk of the Scottish respondents had lived at home during their university years. (50)

(48) Some engineering and training staff in the British Thomson Houston Company studied the progress of 200 entrants to the company design department and concluded that honours graduates developed more rapidly and more favourably compared to the H.N.C. qualified. W.J. Gibbs et al., "Postgraduate activities in electrical engineering", Institution of Electrical Engineering, Proceedings Part I, 1952, p. 206.


While the American studies have laid some emphasis on the acquisition of managerial skills, such as dealing with ambiguity and compromise, in student organisations, this kind of experience was little mentioned in either of the Scottish or English studies and this infrequency may be attributable to cultural differences or the tendency for the American studies refer to all students and my sample of engineers and physicists may have had lower propensities to participate in other than specifically engineering or scientific societies compared to students of other disciplines. That non-graduates do rise to positions of seniority in industrial organisations suggests that if it is important to experience independence from parents, to develop persistence, ambition, abilities to budget time and energies, and skills in manipulating people and bureaucratic rules, then these skills can be acquired outside college. However the substantial point remains that the opportunities to acquire the relevant skills and experience are more readily available to university students than their non-university contemporaries. (51) Certainly the criticisms advanced by managers in the pilot study indicate that a college education was not an unmixed blessing and that the postulated link between education and productivity was complex and not without critics who would argue that university experiences inculcated skills not readily applicable to industrial problems. The problem then is why are graduates recruited and is the labour market not competitive and are there other explanations of the positive correlation between earnings and education.

(51) Some direct comparisons between universities and trade schools have been made by Becker (Non College Youth, op. cit.) but a more interesting comparison for our purposes is that of the Colleges of Advanced Technology (C.A.T.s) and universities, as the former underwent development from Colleges of Technology to C.A.T.s and then to Technological Universities. The C.A.T. student had less independence in the organisation of his timetable and a much more circumscribed social life compared to the university student. (See M. Jahoda, The Education of Technologists, London: Social Science Paperbacks, 1967 (original edition 1963) and P. Morris, The Experience of Higher Education, London: Routledge and Kegan Paul, 1964). These topics are taken up again in the following chapter.
Testing whether labour markets are competitive has been approached through two main methods, by observation, that is by testing the predictions of labour market behaviour from competitive theory, and on the demand side by interviews with employers to question their motives particularly the assumption about profit maximisation. The results of testing are mixed but a tentative conclusion appears to be that competitive theory is successful in predicting long run changes in occupational wage differentials.

(52) In exploring employer behaviour I was interested to know how managers treated educational qualifications and other criteria from interviews. Some support for the view that academic abilities and other desirable qualities came in one company report on recruitment. Interviewers had been asked to give a composite letter grade (on a six point scale A to C) on the ability, personality and potential of the candidates, and the report noted that interviewers had tended to make offers to B+ candidates but had been more successful with B candidates. Since the report mentioned that the numbers of 'good honours degree' graduates had been "a fair proportion" (i.e. 37%) of candidates but many had declined often these might be assumed to feature B+ candidates. Unfortunately, the latter grades included an allowance for ability and it is difficult to sort out weightings. Although technical interviewers asked questions about project work and university courses, many felt content to regard the university or college degree (or more accurately attendance at a university or college and the prospect of a degree since interviews preceded finals), as an indicator of acceptable levels of skill. They were interested in the degree of commitment to these skills, asking at what age the candidate became interested in engineering as an occupation, and whether his studies

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were supplemented by engineering hobby interests or reading, all of which were taken as indicators of ambition and attitude. The important function of the degree result (or grade on internal university exams) was that it provided an objective measure among all the subjective ratings, and as the ultimate touchstone of 'hard data' it was the basis of salary scales. Only one company attempted to incorporate in a formal way the interviewer assessments into salary offers. (53) While personnel departments in some years write to all those who declined offers and seek responses to a checklist of reasons for refusal to gain information about salaries and recruitment procedure, it is a very limited check on company selection. In order to form a more complete view of company selection it would be important to follow the careers of both those who declined offers and those who were refused offers.

There is a strong likelihood too that if reports are correct in that industry does not attract the 'more able' graduate, and by definition takes the 'less able' graduate, then even graduate interviewers will play down the importance of academic ability and emphasise those personality and attitudinal criteria which have, they may feel, been important in their own success. It was a view heavily underlined by a department head.

"I am greatly disappointed in the graduates we recruit, not in their technical ability, there's nothing wrong with their technical ability. We've never had a problem to my knowledge that couldn't be solved. By and large the people here are clever people and I think that graduates are clever people. What I regret is the total lack of ambition and drive, about one in twenty is interested in making something and interested with some ambition. They want to be led ... I've never been trained to interview but I interview vast

(53) Salary offers were greater by degree class (1st class honours - £1225, 2nd class honours - £1200 and 3rd class honours or ordinary degrees - £1175) and candidates were graded on interview (A-£75, B-£50, C-£25), such that C grade 1st class honours and an A grade ordinary degree graduate could be on the same salary level - £1250.
numbers, and I always get the people I go for. I look for a genuine enthusiasm - I hate the cliches but that's what I look for. I tell them what we do - I can't explain everything in ten minutes so I expect lots of questions, drive, aggression maybe. If they are determined then they can do the job, nothing is so difficult ...

... I'm a bit cynical about graduates at the moment. I don't think they are as good as I was - if you want the straight answer. I got a lousy degree, a pass degree in physics. I never did my work at university, had a fabulous time of it and thoroughly enjoyed myself. I crammed in the last two weeks and got through by the skin of my teeth. But that doesn't seem to matter - it's the attitude that counts." (Development lab manager)

'Attitudes' are undoubtedly important factors in occupational and organisational success, but one might wonder how far a shortage defined by this manager as a shortage of 'ambitious' graduates could be alleviated by an increase in the supply of 'more able' graduates. This point about interviewing practices reinforces the earlier point that there is some danger in regarding the industrial company as having a unity of purpose, just as there were potential differences of interest between head office and establishments, there was a potential difference between the senior management policy in graduate recruitment and practice when policy was interpreted by interviews. For example, one H.N.C. qualified recruiter complained that graduates, especially those with higher degrees, were 'too clever' and looked for design faults when testing or using equipment and overlooked simple construction errors and his preference was for 'practical people' rather than 'highly academically qualified'.

"When it comes to industry, to electronics in particular, it's a practical business and there is something to sell at the end of it. You have to be able to go out on site at all hours of day and night, get your soldering iron out, look at wiring schedules and modify them. It doesn't matter whether you are a Ph.D or not you have to be able to do it. On TSR-2 I had a quarter of a million pounds to spend and graduates under me, the difference between them and me was that I had experience and they hadn't. I was
willing to attend to trivialities, elementary things like earthing impedance, lengths of earth wire, and so on, the graduates were looking for logical errors or programming faults or some major environmental error, they couldn't screw themselves down to basics.

I advocate that if they are going to get anywhere they have got to go through the basics. You should put them on problems likely to throw these problems up, let them burn their fingers, help them over this, and then you've got the best men you can have.

Among graduates I like the six months sandwich type. When it comes to doing a job, getting products through the door to everyone's satisfaction then he is a damn sight better at it than the full-timer. He is not so technical, and he doesn't have this false impression that the qualification is the thing that matters and he's got his qualification with experience.

I'm a bit of a rebel here, but I've seen both sides of the coin. I know the people I prefer to have here. A lot of managers and other engineers think that people are N.B.C. unless they've got a degree, but on the practical side of the industry I think the reverse is true."

There is, however, in the last comment the germ of an explanation for graduate recruitment which runs counter to the competitive explanation. The tendency for recruiters to select in their own image can be linked to those theories of organisation which suggest a high degree of discretionary behaviour available to managers in modern corporations and suggest that some graduate recruitment is undertaken for prestige reasons; within the organisations graduates like large desks and pretty secretaries are a perk to the department head and to the company they add an aura to prestige adverts and rivalry with competitors. (54) While the argument suggests that education is relevant to occupational performance, another explanation agrees that there is a positive correlation between possession of educational qualifications and occupational performance but that it

is a spurious correlation for it is 'brightness' which is really measured. The essence of the window cleaner story in the earlier part of this chapter was that employers were right to recruit highly qualified people because the capacities of intelligence, independence and persistence which had brought educational success were capacities important for occupational success and which had been available to employers among schoolleavers in a more restricted educational system. In other words, the capacities were measured by, but not created by, more educational courses, and as Dore put it, these higher earnings of graduates represent 'not the earnings of capital, but a form of differential rent.' (55) There is much stronger support for the view that the educational system acts as a very expensive ritualistic testing system in the developing countries than in the advanced industrial countries. (56) While there was certainly evidence that educational qualifications were used as a form of skill labelling few of the managers were as extreme as to believe that the content of schooling was wholly irrelevant. And while degrees were used as "hard data" (against subjective interviews) and "rule of thumb" guides there was evidence that companies did change salaries in response to new educational developments and the attempt to match up honours degree graduates with R & D and ordinary degree graduates indicated some consideration of course relevance. Such conventional hiring practices as ways of reducing the search costs for labour were evident in the earlier comments about the visibility of universities and the graduate labour market too, and remained a source of constraint on the range of manpower substitutions.

considered even though it did not approach the degree of miseducation and malutilization apparent in the ritualistic education and testing of the developing countries. (57)

(57) In Blaug's attempt to explain the correlation between education and earnings he proposed three possible lines of explanation — (1) the 'economic', broadly the competitive market view, (2) the 'psychological', broadly the educational system as a ritualistic device which merely confirmed native abilities, and (3) the 'sociological', which has two variants, one that length of schooling is correlated with social class origins and the other is that education imparts social values which are rewarded by the ruling elite. Blaug's view is that the less the market approximates competitive conditions the greater the validity for the other two interpretations, and of course, as this study suggests, various imperfections in the labour market admit a grain of truth in all three arguments. Since this chapter has concentrated on employer behaviour I have said little about the supply side and social class. In passing it should be noted that Blaug's labels of 'economic', 'psychological' and 'sociological' are arbitrary and he 'has' to invent the latter two arguments because psychologists and sociologists have not argued them, whereas a familiarity with the literature of these disciplines reveals that their practitioners have at some point argued all three cases, for example, the Davis and Moore explanation of inequality in society was a rather simple-minded 'economic' account. K. Davis and W. Moore, "Some principles of stratification", American Sociological Review, vol. 10, no. 2, 1945.
4. The Experience of Recruitment

For those companies in the Autumn of 1968 there appeared no outstanding shortages in the overall number of graduates recruited. As other studies noted there were shortages of graduates in particular disciplines and shortages of 'good graduates'. (58) Several companies have noted that there are difficulties where graduates are either in short supply vis-a-vis the many demands for them or where those available are unaware of the employment opportunities open, for example, the electronics industry has increasing demands for mathematicians and still requires mechanical engineers although the latter tend to believe that mechanical engineering problems in the industry are trivial. As already indicated the complaint about the shortage of 'good graduates' is difficult to interpret, at one level it appears, as Carter and Williams observed, as simply a complaint about genetics and the perennial feeling that the world needs more intelligence, (59) Certainly many of the companies had experienced rejection of their offers, and enquiries seeking explanations for refusal found that a significant proportion were from those continuing to postgraduate research, for example, and one company report noted that this factor had been fourth in 1965 but was first in frequency of mentions in 1968. Yet the companies regarded this as a temporary phenomenon of university expansion and another company drew significance in the trend in the ratio of offers to acceptances which had been around 4:1 in the early 1960's but dropped to 2.5:1 in 1968, and was under 2:1 in 1971. Of course, it could be argued that the experience of these companies was atypical of the industry and they may be more successful recruiters of graduates. However since 90% of the total annual

(58) H. Murray and D. Armstrong, op. cit.

### TABLE 5.

Unfilled vacancies for Q.S.E. and technicians as a percentage of total employment of Q.S.E. and technicians.

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<th>Electronics 1968</th>
<th>All Manufacturing 1965</th>
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<td>Q.S.E.</td>
<td>17.5</td>
<td>10.7</td>
<td>9.2</td>
<td>6.2</td>
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<tr>
<td>Technicians</td>
<td>5.4</td>
<td>5.8</td>
<td>4.4</td>
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recruitment of technologists to the engineering industry was generally to the larger firms with over 1,000 employees and given the degree of concentration of output in the industry it seems reasonable to take their experience as representative. (60) Moreover, the Electronics E.D.C. concluded that the industry's overall demand for Q.S.E. level manpower was being satisfied by the late 1960's, although they had reservations that 'needs' might be higher than 'demand'. (61) The elimination of shortage, attributed partly to the slowing down of growth in postgraduate studies and employment in the education sector and partly to the rise in the output of graduates, was traced by the E.D.C. Committee in the decline in unfilled vacancies in the industry (see Table 5). However the significant factor which made the electronics industry different from most industries considered in the manpower debates was the extent of merger and rationalisation in the 1960's. All of the companies visited had been involved in mergers recently or engaged in large scale rationalisation of activities. The consequence of these changes for recruiters and recruits were frequently unsettling, recruiters in several companies carried a memo from the Personnel Director which advised that only reassurance and no information was available on the merger and in one company recruits offered four different variations for the name of their common employer. (62) Again it should be remembered that while companies might be in balance, individual establishments could experience shortages

(60) The figures on recruitment cover all the branches of engineering sending return to the Engineering Industry Training Board, (Report and Accounts 1968-1969, p. 16).


(62) In one company the memo stated: "The integration process has not gone far enough yet for any valid statements other than that the merger will be to the benefit of all concerned."
and others be overmanned, for example, one company had undertaken internal transfers following the closure of an establishment.

Notwithstanding the uncertainty about manpower requirements engendered by rationalisation in the industry, there appear a number of other sources of difficulty for the manpower forecaster, for example, in the lack of records, the rudimentary state of company manpower planning, and use of conventional 'rules of thumb', and the tendency for the ill-analysed short term interests of establishments to dominate recruitment practice. Set against this examination of recruitment policy and practice, the frequent appeals by manpower forecasters and university professors that 'industry must give clear guidance to educationists on its requirements' appears as both another indication of the typical manpower forecasting optimism about the ease of translation of occupational requirements into educational specifications and naïveté about the complex processes by which recruitment policies are translated into practice.
CHAPTER SIX

GRADUATE PERSPECTIVES ON THE LABOUR MARKET

1. Introduction

In this chapter attention is shifted from the examination of company perspectives to the development of graduate perspectives as they attempted to shape their passage through the labour market and into employment. The central themes of the chapter are a critique of the models of occupational choice used by the manpower forecasters and the neoclassical economists for the narrow range of variables considered in their models, and an exposition of the development of graduate perspectives which prescribe a short-run preoccupation and tentative commitment on entry to jobs.

The models of occupational choice implicit in the Swann Report and explicit in economists' criticisms are outlined in the second section. The third section examines some of the data from the study by Cotgrove and Box of chemists in university and industry and shows the way in which a sociological approach differs from that of the manpower forecasters and the economists and leads to somewhat different policy conclusions. Data from the study of entrants to the electronics industry is presented in the fourth section in an examination of the social context of occupational and educational choices and orientations to work. On the first topic it is argued that the manpower forecasting case understated the importance of influences on choice outside the educational system and on the second topic it is argued that different educational experiences are associated with different orientations to work but that few graduates could be said to be 'frustrated academics'. The importance of the distribution and access to information among graduate decisions-makers in shaping a conditional commitment to occupations and employers is emphasized in the
fifth section and the final section concludes with a review of experiences and hints of disillusionment among graduates about the discrepancies between the 'conventional wisdom' and experience.
2. **Models of Occupational Choice in the Manpower Debate**

Why schoolchildren and students made choices which resulted in the 'swing away from science' and a 'marked preference for postgraduate studies and employment in research in university or government' was a central question in the manpower debate and was largely approached by inferring models of choice which would explain the flows into higher education and into employment. The statistical account of these flows was presented in Chapter One and the very broad schemes of contrasting interpretation of the economic system were discussed in Chapter Four, here I am concerned with the models of occupational choice and the way in which, although aware of a whole complex of factors associated with educational and occupational choices, the models of choice were grossly simplified with emphasis on the shaping of preferences within the educational system for intrinsic rewards and prestige in the manpower forecasting model and the emphasis on financial reward in the economic model.

The Dainton Committee emphasized that choice was a continuous process and outcomes were really the result of a series of choices. This view of choice brought out the significance of early specialisation for it implied a lengthy time lag between stages of choice such that some choices could be made without cognisance of their implications for later choices. (1) Over this time period the Committee identified two main sources of influence on children in their decisions about subject choices, personality variables and various sources of influence in institutional settings. The former were not of particular concern since they were outside the control of the policy-maker, moreover, there appeared to be some evidence that many children were interested in science around 8 or 9 years of age. (2)

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Attention was concentrated, therefore, on the institutional variables since they appeared to be associated with the relevant time period and subject to policy control, and the main culprits for the 'swing away from science' were cited as the schools and universities where schools imposed specialisation to enable able pupils to meet university entrance requirements. Competition for university entrance encouraged the teaching of science largely as an examination subject such that to pupils it was a dull memory slog on out-of-date curricula. (3) Two sets of extrinsic factors were considered in choice - the image of science and career prospects - but the main weight of the argument was on the curriculum as a determinant of educational choices. It was thought possible that the more rapid expansion in social science study was because 'they deal with people and with society' whereas the 'objectivity of science and the purposefulness of technology have become identified, for some, with insensitivity and indifference,' and here the Committee identified 'idealism' as a powerful motivator in the young. (4) Another possibility conveyed was that the study of science had become identified solely with a career as a research scientist such that it was not worthwhile to anyone who had other ambitions or was undecided. (5) However these points about the image of science or careers were not taken as central points because the Committee did not believe there was sufficient information and tended to the view that schoolchildren were ill-informed. Thus the Committee's proposals were for a two part reform, firstly, for a massive public relations exercise to convince pupils of the benefits of science and the variety of careers, to convince employers of the benefit of employing scientists, and secondly, for the

(3) Ibid., paras. 148-150.
(4) Ibid., paras. 151-152.
(5) Ibid., paras. 155-156.
actual reform of curricula such that they are more attractive and for later specialisation such that better informed choices could be made. (6)

The Swann Committee endorsed the Dainton Committee's analysis of early specialisation as a limit on the range of occupational choice to the detriment of the national supply of scientific and technological manpower and in their own analysis of the flow into employment they placed similar stress on the importance of educational institutions. In addition to their work with official statistics, the Committee offered two main pieces of evidence on choices from the Kelsall survey of graduates, the first about the timing of choices and the second on the characteristics of jobs.

Analysis of the changes in job intentions during the undergraduate careers of the Kelsall respondents confirmed the Swann Committee in the belief that education played a special role in shaping performances and choices. It was apparent that a higher proportion of the scientists (47%) than technologists (35%) could recollect entering university with an 'open mind' about future jobs, by graduation the proportions with 'open minds' had fallen to about 10%. Analysis of net changes by discipline and class of degree showed that among both scientists and technologists obtaining first class or upper second class degrees, the increases were in the proportions intending to take up university teaching and research compared to other occupations. (7)

In their comments on the Kelsall data on characteristics of their own jobs as seen by scientists and technologists, the Swann Committee noted

(6) Ibid., paras 162-171.
(7) Since the Kelsall data came from a study six years after graduation, students were recalling events after ten years in some cases. The other interesting point is that the timing of change came before final degree results so that if academic ability is influential it stems from prior exams, coursework, and so on, on which the student assesses his likely abilities.
that no sector was unattractive on salary (that is, no sector had a negative score), although schools appeared relatively poor by comparison to the other sectors. The Committee noted favourable university views of the congeniality of colleagues and working conditions, the opportunities for intellectual development and increasing one's specialised knowledge, and the scope for initiative and freedom to develop one's own ideas. On salaries technologists in universities gave a net score comparable to that of the scientists and technologists in industry, although scientists in universities recorded a lower score. Again on novelty and variety in employment a relatively low score from scientists in universities contrasted with the higher net scores from scientists and technologists in industry and the even higher net score of technologists in universities. An obvious limitation of the data is that it does not give respondents' assessments of other sectors on these same items nor had the Committee collected salary data, yet there was sufficient pattern for the Swann Committee to find broad accord with the patterns of employment and evidence of 'the marked attractions of a job in a university and the lesser attractiveness of industry'. (8) Again this was a matter of inference since the data did not give an amount of instructions or reasons for occupational choice and the Committee inferred that the salient characteristics in choice were the nonfinancial factors.

The Swann Report spelt out the mechanisms by which the educational system had shaped these preferences, and, although the Committee urged industry to bid for the attentions of graduates, a change in the direction of choices was seen to imply a change in the mechanisms of influence. At root the educational system shaped skills and the conception of the way

(8) The Flow into Employment of Scientists, Engineers and Technologists, Cmnd 3760, op. cit.; p. 88.
skills could be employed, and this occurred because there was an encouragement to look for intrinsic rewards in work, a lack of encouragement for other sectors, and the espousal of a scale of prestige in university which was inimical to industry. Again specialisation was the bogey, which encouraged particular skills and narrowed occupational horizons.

"From the age of about 15 or thereabouts these students receive little formal education outside their specialities, and it is hardly surprising that they may emerge with little knowledge of, or interest in the problems of the society of which they are to become responsible members. They may see little place for themselves except in the specialities in which they have been trained. Are they to be blamed for preferring the academic world here or abroad (even without a permanent post) to industry or school teaching in this country?" (9)

Whether consciously or not university teachers were seen to influence students in their choice of occupations by precept and example.

"We believe that a new and enlightened attitude to industrial problems will not be achieved unless a significant part of the teaching of these courses is given by men currently engaged in industry and seconded to universities part-time for this purpose. There must be day-to-day contact between teachers and students if the ethos of industry is to be conveyed with the same impact that university teachers unconsciously achieve in imparting their own attitudes." (10)

Through their design of courses, example in teaching and research, and relative lack of contact with industry, the university teachers added weight to what was a widespread view of the relative prestige of occupations which attached greatest merit to university research.

"It is of great importance to change a widespread belief that academic research is the only respectable outcome of a scientific education." (11)

(9) Ibid., p. 75-6
(10) Ibid., p. 65.
Perhaps one of the grosser leaps in imaginative reconstruction for a model of choice underlying the pattern of flow appeared in the Interim Report where it was suggested that the factors so far discussed in choice did not apply only to those who entered university employment but were motivators for the majority of graduates.

"The trend away from industry is most marked in those with the highest academic attainments, and least apparent amongst those with the lower class of honours degrees or ordinary degrees. Nevertheless such trends amongst the best graduates inevitably suggest the patterns of first choice and ambition amongst the majority." (12)

This assertion about choice and ambition was neither inevitable nor supported by any further investigations of samples of scientists and engineers. In their subsequent investigations and recommendations the Committee did not investigate why there were differences between disciplines in the pattern of flows or the timing of job intentions. Such investigations which might have revealed differences in motivations were largely bypassed in favour of concentration on analysis by class of degree. As argued already this approach concentrated attention on the able physics graduates and then proceeded by generalisation to all graduates. The policy conclusions of this analysis were similar to those of Dainton, that educational and occupational choices were largely determined within the educational system (courses and teachers), at least to the extent that there was a social problem, and that those lay within policy control.

The starting point for the economist was altogether different from that of the manpower forecaster, Gannicot and Blaug held that financial costs and benefits were important to pupils and students.

"We assumed that pupils and students were acting as if they were making perfectly rational decisions in a world where they are well informed and whose demand for educational manpower is transmitted smoothly through the price mechanism." (13)

From these assumptions the 'swing away from science' could be interpreted as the response of students who recognised that the yield on their academic training in science was no longer attractive, in other words, the phenomena were compatible with a relatively low or declining rate of return.

Similarly the entry of increasing proportions of the academically able to further education and training could be interpreted as students' 'perception that they will now have to undergo a lengthier training period than colleagues in relatively scarcer disciplines in order to achieve equally remunerative employment." (14) Gannicot and Blaug relaxed some of these assumptions, they allowed that there could be impediments to the rapid market clearance on the demand side (external economies may not be perceived by employers), and in Britain they admitted impediments on the supply side (the long lead time in an educational system with early specialisation). However one assumption which they did not relax was the central assumption that the student planning calculus dealt wholly with financial factors, despite denials to the contrary.

"This is not an oversimple rejection of all non-economic factors: the assumption is simply that, on the margin, students implicitly calculate the net financial advantage of choosing one career rather than another." (15)

If non-financial factors were to be acknowledged the assumption should have been that students calculate the sum of financial advantages and disadvantages and non-financial advantages and disadvantages. The non-financial

(13) Gannicot and Blaug, op. cit., p. 72.
(14) Gannicot and Blaug, op. cit., p. 71.
(15) Gannicot and Blaug, op. cit., p. 71.
factors could be ignored if it could be assumed that they were unimportant in job choices or that net financial and non-financial rewards were positively correlated. In their polemic on the manpower forecasters Gannicot and Blaug made no such case and their own argument is open to a charge of special pleading for the importance of economic analysis. A more limited case for the importance, if not dominance, of economic factors advanced by Blaug was that parents were interested in their children's financial well-being and saw education as a means to this end. Against possible objections that there is inadequate information for precise calculation of rates of return by economists and still less for school-children and parents, the Blaug notion of planning assumes only that students can realistically estimate two points on their lifetime earnings profile. Those points are the starting salary and a salary at an age comparable to that of parents, typically in the mid-forties. While refining the case on economic factors these proposals still omit non-financial factors in choice, and still leave open a number of questions about the financial factors, for example, do parents seek more educational qualifications for their children in terms of very broad classes of jobs or are they attentive to differences in disciplines and do they attempt to match disciplines and qualifications to particular occupations? Another question is whether different factors have different weights at different times, do economic considerations become more important as students approach entry to the labour market? Whilst various sources may offer information about average salaries, the individual may have to make some estimate of his own abilities vis-à-vis the average student, and the likelihood of gaining entry. The reforms of Gannicot and Blaug were directed to improve the responsiveness of the labour market in particular the flows of information on which decisions were to be made, for example,
they proposed less specialisation in courses to broaden the array of potential occupations and introduce flexibility on the supply side, occupational choice delayed to a point nearer to occupational entry, vocational counselling to improve information about job opportunities, loans rather than grants to prompt consideration of economic returns and scholarships to attract to particular disciplines. One point which becomes apparent in examining the reforms is that the models of choice were mixed with considerations of how claims are made and ought to be made.

In terms of the continuum of manpower forecasting and neoclassical views of the economic system presented in Chapter Four, Blaug saw educational reform consisted of shifting the system to the right, towards greater reliance on the market to guide the allocation of educational provision and manpower.
3. Occupational Choice, Social Origins and Occupational Socialisation

As Blaug has observed economists and sociologists have tended to be interested in different aspects of the education-occupation linkages, where economists take tastes and the preference hierarchy for education and occupations as given and proceed to use partial equilibrium analysis to investigate the consequences of a change in one or other factor in the market, the sociologists take the tastes and preference orderings as the subject of their enquiry. The sociologist goes further, however, and holds that the socialisation processes by which tastes and preferences are developed are distinguishable from choice processes only in an analytical sense for choices within the context of sequences of choices with potential for broadening and narrowing which date back to birth and early childhood experiences. The sociological approach to manpower questions then has been distinguished by studies of the social origins of members of specific occupations and studies of socialisation processes for entry to particular occupations. The first approach shifts the emphasis away from the individual decision-maker and examines the extent to which the members of a specific occupation are drawn from distinctive social groups. This approach relates closely to the second approach of studying socialisation processes since the discovery of a distinctive social background among occupational recruits would prompt questions as to whether some social groups provide particularly distinctive learning environments, in terms of the available knowledge, skills, values, and attitudes relevant to that occupation. Both kinds of study, studies of social origins and studies of socialisation processes, serve to examine the constraints on mobility in labour markets and impediments to reliance on market mechanisms for the efficient allocation of resources.

Box and Cotgrove made a heroic attempt to follow the analytical distinction between occupational choice and occupational socialisation in
<table>
<thead>
<tr>
<th>Type of Scientist</th>
<th>Favourable employment conditions</th>
<th>Expected degree result</th>
<th>Future Employment preference</th>
<th>University</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>Better professional freedom in university</td>
<td>High</td>
<td>80</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>7</td>
<td>93</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Professional freedoms</td>
<td>High</td>
<td>67</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>more or less equal</td>
<td>Low</td>
<td>20</td>
<td>80</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46</td>
<td>54</td>
</tr>
<tr>
<td>Private</td>
<td>Better professional freedom in university</td>
<td>High</td>
<td>26</td>
<td>74</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>17</td>
<td>83</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Professional freedoms</td>
<td>High</td>
<td>22</td>
<td>78</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>more or less equal</td>
<td>Low</td>
<td>30</td>
<td>70</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>Instrumental</td>
<td>Extrinsic research</td>
<td>High</td>
<td>25</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>more or less equal</td>
<td>Low</td>
<td>25</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Extrinsic rewards</td>
<td>High</td>
<td>22</td>
<td>73</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>better in industry</td>
<td>Low</td>
<td>12</td>
<td>88</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>82</td>
</tr>
</tbody>
</table>


Note: High means First or Upper Second, Low means any other response.
their study. (16) Assuming the background of characteristics at the point of career choice, Cotgrove and Box gave prominence to efforts to implement a particular self-concept. This meant a central place to the values students held and the way in which occupational settings matched those values, and the students' estimates of their chances of achieving their preferred employment. This model of occupational choice could be expressed in two propositions:

1. "In choosing between alternative occupations, a person will rank the occupations in terms of the relation between his values and the perceived characteristics of the occupation; the higher the coincidence between the characteristics and his values the higher the rank."

2. "The higher a person perceives the probability that he will obtain employment in the higher-ranked occupation, the more likely he is to choose that occupation." (17)

The scientific identities distinguished by Box and Cotgrove were outlined in Chapter Three, and it will be recalled that 86% of their sample of 372 London University chemistry students were distinguished into "public scientist", "private scientist" and "instrumental scientist". Table 1 from the Cotgrove and Box study shows some support for their model with its three main types of scientific identity, perception and evaluation of job conditions, and expected academic achievement. Those who identify with what Cotgrove and Box term "public science" (viz., hold a more favourable view of university employment on opportunities for public and professional freedom), and expect a "good degree result" (i.e. first or upper second class honours), are likely to opt for University employment and conversely those who see scientific skills as largely a means of securing an income, perceive higher extrinsic rewards in industry, and do not expect a "good


(17) S.Cotgrove and S. Box, ibid., p. 70.
"degree" will opt for industry. (18) In their explanation of how these preferences are shaped Cotgrove and Box leave a number of open questions, however.

One of the central questions which Cotgrove and Box admit is the direction of influence in the relationship between preference for academic careers and espousals for a particular set of "value orientations". Box and Cotgrove admit that expected class of degree is associated with preferences for academic career and preference for academic career is associated with an identity as a "public scientist". Instead of the stress laid on prior value orientations as determinants of occupational reliance favoured by Cotgrove and Box, it is possible to argue that students with the expectation of a "good degree" realised that an academic career was within reach, and projected themselves into a possible occupation and all its consequential activities, such as publication, to produce the kind of questionnaire response found by Cotgrove and Box. (19)

Unfortunately when Cotgrove and Box examined socialisation processes in order to understand why students came to hold one or other of these distinctive orientations to science, the researchers concentrated their attention wholly on the "public scientist". (20) Their study of "public scientists" was relevant to the manpower debate, in the sense that the correlations between academic achievement and scientific identity suggests that this group of public scientists contained some of those "able

(18) Cotgrove and Box, ibid., pp. 69-85. Between the 1966 paper and the book in 1970 the authors changed "instrumental" to "organisational" to avoid pejorative overtones.

(19) The desire to publish may simply represent recognition that publications are important to career advancement in academic settings rather a subscription to a set of values and norms which enjoin free access to knowledge.

(20) Their preoccupation with this problem was understandable given the sociological standpoint of Cotgrove and Box, their emphasis on the role of values in social action, and their starting point as a critique of American sociological studies of scientists, (see the discussion of Chapter Two).
scientists' reluctant to enter industry about whom the Swann Committee expressed concern. Identification of the variables influential in shaping the preferences of those reluctant to enter industry would interest the manpower forecaster and policy-maker anxious to operate on variables amenable to control by public policy to move "good degree" entrants to industry (or schoolteaching). Yet equally, however, the manpower forecaster and policy maker should be interested in the variables which shape/"private" or an "instrumental" orientation, particularly if this is associated with entry to industry, and the policy-maker might seek to operate on these variables to encourage greater numbers to enter industry (albeit with "good degrees"). A considerable number of variables were found to be influential in the shaping of a "public scientist" from the influences of university, both staff and peer groups, to the individual's experiences of family social class, birth-order and religious beliefs. The variables were combined in a theory in which scientific identity was a coping response to experienced social marginality. The position of the working class student was defined as marginal in "the university which is dominantly middle class". Whether the situation was experienced as marginal would depend on the nature of the student's links with his home background and his resources of social skills to negotiate his passage through the middle-class milieu, on this latter point biographical features such as birth order and childhood isolation were seen as important influences in the development of these social skills. The role of "dedicated scientist" was seen as potentially attractive to the working class student - a classless image, a premium set on dealing with things rather than people, and a high visibility of the role for students. The biographical factors of childhood isolation or birth order could, of course, operate for some middle-class children and leave them relatively disadvantaged in social skills. Box and Cotgrove found support for both sets of hypotheses: firstly, working-class students who experienced marginality (and, additionally
were first-born and experienced childhood isolation, were non-religious, and identified with public scientists or university) were more likely to be classified as public scientists, and secondly, those middle-class students who were classified as public scientists were more likely to have experienced childhood isolation and lacked social skills. The central conclusion was that, "if we control for other socialising factors, working-class students are more likely to become committed to public science." (21)

The policy proposals which Cotgrove and Box make from studies of scientists based on their model of occupational choice have some interesting differences and similarities to those of the manpower forecasters and the economists. In the first place they identified differences in preferences among students with some placing greater emphasis on non-economic rewards and others placing greater emphasis on the economic rewards of a scientific occupation: the "public scientist" is defined as one who places greater emphasis on the prestige and honorific rewards from colleagues and the personal and intrinsic rewards of crying "eureka", for the "private scientist" the intrinsic rewards were more salient than colleague approval, while the "organisational scientist" was one who saw his scientific skills as resources to secure extrinsic rewards mostly of a material kind. (23)

Clearly industry can attract the organisational scientist, but what of the public scientist or private scientist. Cotgrove and Box with their beliefs in the stability of orientations feel that industry must

(22) Cotgrove and Box, ibid., p. 62.

(23) Of the public scientist, Cotgrove and Box write, "The public scientist is one who is developing his skills as a scientist and making a public contribution to a body of knowledge ... the public scientist is also characterised by a disinterestedness, in other rewards, which takes the form of a deep 'commitment' to science." (Ibid., p. 28).
accept them on their own terms, that is, industry must offer facilities for fundamental research and opportunities for publication, and they observe that British industry is less forward-looking than American industry in this respect. This proposal can be compared to the Jones proposal that industry should offer research and then attempt to convert the scientist to other activities. Their proposals differed from the Swann Committee proposals in a direct criticism of industry and an advocacy of changing industry to meet the needs of students. In another respect Cotgrove and Box give similar stress on the importance of the university and its amenability to policy change. While the policy-maker could do little directly to alter the social class, birth order, degree of childhood isolation, or religious beliefs in a simple and direct manner, Cotgrove and Box saw the university experience as subject to policy control. Educationists could reduce the relative visibility and attractiveness of the role of 'public scientist' and 'pure science' activity vis-a-vis an industrial career and applied science, and by provision of new kinds of institutions and courses, the technological universities and sandwich courses or more industrially relevant three year courses, the universities could change the kind of skills and perspectives with which graduates emerged. The researchers saw the scope for change as being limited but since universities were influential to some extent and the aim was not to convert all scientists but only a proportion they were optimistic. Their findings support the view of Blaug that some students may view their educational decisions as investment decisions and cast doubt on the Swann Committee inference that all students seek research, indeed any employer who tempted 'organisational scientists' with fundamental research and then attempted to convert them to other functional areas would perpetrate an unnecessary and expensive conversion.

A later paper by Cotgrove reveals an interesting shift of position.
on the assumption about the influence of educational experiences and hence about their amenability to policy control. (24) Starting from within the same theoretical framework of values, as determinants of career choice and the university as a major source of exposure to values, Cotgrove and Fuller attempted to study differential socialization on 'full time' and 'sandwich' courses and drew on samples of chemistry and engineering students. (25) Since a higher proportion of sandwich course students compared with full time students in both first and final years were intending careers in industry, the authors concluded that the influence of courses on occupational socialisation and occupational choice was small, and they suggested that questions should be directed to what participants seek from the educational system rather than making the assumption that the educational system can readily shape taste and choice. (26) While one might have wished that the authors had retained an analysis across courses and disciplines instead of a concentration on courses, the more limited role ascribed to educational institutions modifies the views of the earlier Cotgrove and Box study.


(25) The students were drawn from three technological universities and three technical colleges, one civic university provided supplementary chemistry students. The effects of this kind of sample are not clear, for example, whether there are differences in the orientations to industry of civic university chemistry students and those of technological institutions on full time courses in any event. A much more critical question mark against the study is the lack of explanation about the extension of the Cotgrove and Box typology of scientists to engineers. The nomenclature has changed slightly and the 'public' has become 'academic', perhaps this was thought more readily applicable to engineers but it is not clear whether the authors are making a further break with the Martinian approach which identified a value complex distinctive of the institution of science rather than a value complex associated with scholarship.

(26) While Cotgrove and Box might have reached similar conclusions by examination of the 'private' and 'organisational' scientists, the same point should have been apparent to the Swann Committee from the evidence of differences in the timing of occupational choice in the Kelsall survey.
### TABLE 2.

(a) Faculty distribution of home undergraduate entrants in 1955 (excluding medical students: by social class G.B.)

<table>
<thead>
<tr>
<th>Father's occupation</th>
<th>Arts</th>
<th>Science</th>
<th>Technology</th>
<th>Arts, science and technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-manual</td>
<td>56</td>
<td>28</td>
<td>14</td>
<td>100</td>
</tr>
<tr>
<td>Manual</td>
<td>49</td>
<td>33</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>


(b) Subjects studied by inter-generationally mobile and stable graduates (Men only).

<table>
<thead>
<tr>
<th></th>
<th>Stable</th>
<th>Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arts</strong></td>
<td>27</td>
<td>29</td>
</tr>
<tr>
<td><strong>Social Science</strong></td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td><strong>Science</strong></td>
<td>26</td>
<td>33</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>All subjects</strong></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>


### TABLE 3.

Motives of inter-generationally mobile and stable graduates wanting higher education

<table>
<thead>
<tr>
<th>Motive</th>
<th>Stable graduates</th>
<th>Mobile graduates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instrumental</strong></td>
<td>28</td>
<td>33</td>
</tr>
<tr>
<td><strong>Expressive</strong></td>
<td>49</td>
<td>45</td>
</tr>
<tr>
<td><strong>Both types</strong></td>
<td>77</td>
<td>78</td>
</tr>
</tbody>
</table>

No. keen to go to university: (5005) (2539)

Note: Instrumental: To qualify for a career, for a better chance to get on, to better myself, etc.

Expressive: To broaden my education, pursue my subject, develop academically, for family reasons (e.g. tradition), for the fun of university life, etc.

Studies of the social origins of students in different faculties revealed quite marked differences as early as the Robbins study of the 1955 entrants to universities which reported a higher proportion of male students with fathers in manual occupations in faculties of science and technology (see Table 2). The Kelsall study of entrants to university in 1960 revealed a similar pattern of more graduates from working class homes (i.e. where fathers had had manual jobs) among science faculties than among graduates from other faculties (see Table 2). Commenting on the attraction of science and technology faculties for students from working class backgrounds, Kelsall and his colleagues observed, "More men from manual backgrounds who graduated in 1960 took a degree in Science or Technology than did those whose fathers had white collar jobs. Technology seemed to appeal equally to men with upper or lower social origins, than those whose fathers had white collar jobs. Technology seemed to appeal equally to men with upper or lower social origins, while those from the lower middle (other non-manual) class studied science in preference to technology. One explanation for this comes to mind. Sons of higher white collar workers, of whom about a quarter studied technology, possibly saw their study as the key to high managerial positions in industry, while those with manual backgrounds probably recognised its similarity to the kinds of work their fathers, uncles and others they knew were doing. For the middle group neither of these factors operated. Science, though was less attractive to some of the upper class than it was to those with working or lower middle class origins." (27)

This suggests that students from different social backgrounds bring to the educational system different resources of skill and knowledge of occupational opportunities which shape, in part at least, their motives for entry to the educational system and the kind of demands which they make on it. Responses to the question about motives for entry to university were coded by Kelsall and his colleagues into several categories, two of

which were 'instrumental', (for example, as a career qualification or for social advancement), and 'expressive', (for example, to broaden one's education or the fun of university life), and the distribution of responses showed a greater propensity to instrumental rather than expressive motives among the upwardly mobile compared to the non-mobile graduates (see Table 3). (28)

The studies of the Robbins report and Kelsall dealt with university graduates only, other studies of the post-Robbins institutions, the technological universities, report that engineering departments enrol greater proportions of students from working class backgrounds than the departments of pure science, and both engineering and science departments have greater proportions of these students than do the arts or social science departments.

(28) The authors observe that the non-mobile may simply assume the existence of material rewards and so concentrate responses on the expressive motives. R.K. Kelsall, A. Poole, and A. Kulin, op. cit., pp. 55-56.
4. **Entrants to the Electronics Industry**

In this section the experiences of my sample of entrants to the electronics industry provide the data for an analysis of two major assumptions in the Swann Report. The first assumption was that the educational system was the crucial source of influence in decisions about educational courses and occupations and the second assumption was that those university-influenced preferences among all graduates were for academic research. In examining the first assumption the analysis continues the main point of the last section in showing the relationship between social background and education as determinants of entry to an occupation. Examination of the orientations to work among these entrants to the electronics industry reveals gross over-simplification in the charge that many of the entrants to industry were 'frustrated academic researchers' although it can be seen that experience of higher education is associated with orientations to work which were likely to be frustrated.

(i) **The social context of occupational and educational choices**

In attempting to date their first thoughts on following engineering as an occupational activity those who had engineering qualification were more likely to cite an earlier period in their academic career than those with a physics qualification (see Table 4, columns 19, 20). The overwhelming majority of the engineering graduates had decided on an engineering occupation before university. For some, these considerations were dated in the early 'teens while a slightly larger number pointed to their period in the sixth form especially the period about G.C.E. 'A' level examinations. In contrast, the occupational considerations were largely dated in their first year in university, in many respects their comments gave the impression of thought prompted by the realisation that the termination of the three year course was close.
TABLE 4. The timing and factors recalled in occupational choice by university-educated engineering and physics graduates.

<table>
<thead>
<tr>
<th>Timing</th>
<th>Age</th>
<th>Events</th>
<th>Discipline</th>
<th>Factors Recalled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14/15</td>
<td>16</td>
<td>17/18</td>
<td>1st/2nd year university</td>
</tr>
<tr>
<td></td>
<td>Column</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>P</td>
<td>E</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Totals</td>
<td>19</td>
<td>4</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>
Turning to the comments about factors involved in the choice of occupation some further interesting patterns emerged. Three graduate engineers who reported 'early choices' were more likely to refer to 'being mechanically-minded' or to hobby interests such as building crystal sets and radios than to their academic aptitudes such as 'being good at physics'; (see Table 4, columns 9, 11). In other words it appears that the 'early choosers' tended to cite resources from outside the formal educational system, and the 'late choosers' tended to cite their resources developed and confirmed within the formal educational system. (29) Again by contrast the physics graduates rarely cited hobby interests or 'practical orientations' in their considerations but emphasised skills developed within the educational system, (see Table 4, columns 9, 11 v 10, 12). The sense in which the educational system provided resources to overcome problems which were posed in an orderly chronological sequence was well-expressed by a physics graduate, who was somewhat unusual among the physics graduates in that he did have a hobby interest in electronics.

"It was three months before finals when I became interested in microelectronics, before that I was interested in electronics, I enjoyed model-making, and I liked working with small units, but the thought of engineering just never occurred. You tend to get into a pipeline at school and the subjects you do best you go on to do at university. In my case this was physics and chemistry so I wound up doing a general degree at university, that's fair enough, that's what I liked doing. Then I found I liked doing electronics, although the amount of electronics in the undergraduate course was negligible, so I did an M.Sc course at (another university). I had hoped to go on and do the Ph.D course but the exam results were not so good, so I didn't go on beyond the M.Sc."

The point about the hobby interests was that they did not appear to take

(29) Included under 'academic aptitudes' for engineers are those which referred to being not 'good enough' at maths or physics, whereas the physicist comments were almost wholly comments about arts v. science distractions and abilities.
TABLE 5. Direct and indirect occupational recruitment among a sample of entrants to the electronics industry.

<table>
<thead>
<tr>
<th></th>
<th>University</th>
<th>Ex-Cat</th>
<th>Technical College</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father qualified scientist</td>
<td>2 1 -</td>
<td>- - -</td>
<td>- - -</td>
</tr>
<tr>
<td>Father professional engineer</td>
<td>3 2 -</td>
<td>1 1 1</td>
<td>1 1 1</td>
</tr>
<tr>
<td>Direct</td>
<td>11 3 -</td>
<td>1 1 1</td>
<td>1 1 1</td>
</tr>
<tr>
<td>Father science teacher</td>
<td>2 1</td>
<td>- - -</td>
<td>- - -</td>
</tr>
<tr>
<td>Father non-professional engineer</td>
<td>16 9 2</td>
<td>1 1 2</td>
<td>- -</td>
</tr>
<tr>
<td>Indirect</td>
<td>18 10 2</td>
<td>1 1 2</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>29 13 2</td>
<td>2 2 3</td>
<td>1 1</td>
</tr>
<tr>
<td>Respondents</td>
<td>85 44</td>
<td>7 5 16</td>
<td>3</td>
</tr>
<tr>
<td>Registrar General's Social Class Groupings</td>
<td>Educational Institution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>University</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex-Cat</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technical College</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I Professional</td>
<td>Discipline <img src="Eng.%25" alt="" /></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phys. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eng. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phys. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II Intermediate</td>
<td>19 (22.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 (18.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIIa Non-Manual: other non-manual</td>
<td>2 (28.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 (25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIIb Manual: Skilled manual</td>
<td>24 (28.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 (31.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV Semi-skilled manual</td>
<td>2 (2.35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (6.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V Unskilled manual</td>
<td>2 (2.35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Manual</td>
<td>28 (33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17 (38.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td>1</td>
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</tr>
<tr>
<td></td>
<td>6</td>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Forces</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don't know</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No answer</td>
<td>3 (3.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 (2.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All respondents</td>
<td>85 (100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>44 (100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>170</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
on significance for educational and occupational choices until a wholly academic frame of reference had to be abandoned and then industry and engineering became possibilities.

The more ready reference to parental influences and contacts with engineering among engineering graduates compared to physics graduates cannot be explained by a higher degree of occupational self-recruitment or different social class backgrounds among the sample, since these were broadly comparable (see Tables 5 and 6). There does appear a slight difference in the social class backgrounds of university-educated scientists and engineers, for, although 60% of both groups came from non-manual backgrounds, within the non-manual groups a higher proportion of the engineers had fathers in the professional and intermediate categories and the physicists had a somewhat higher proportion in the lower 'non-manual category', (i.e. inspectoral, supervisory, and routine non-manual occupations). (30).

So far it appears that some different patterns of choice emerge with distinctions between 'early choosers' and 'late choosers' and distinctive frames of reference associated with the timing of choice, furthermore these patterns of choice appear related to study in engineering and physics. Some writers have criticised the whole rate of return approach to education on the grounds that students do not make choices to acquire education but simply carry on to acquire it. An examination of the language and imagery used by my sample of respondents to characterise their move from school to university gave some impressive support for this passage as 'non-decision'.

(30) Their distribution across social backgrounds is roughly comparable to that in the Kelsall survey although non-responses in a postal survey made comparison difficult. The Gerstl and Hutton study of mechanical engineers found among their younger graduates (i.e. born post-1928) that 70% came from non-manual homes and 30% from manual homes, more detailed examination of the white collar group is difficult because Gerstl and Hutton use a different occupational classification. (See J. Gerstl and S.P. Hutton, op. cit., p. 27.)
<table>
<thead>
<tr>
<th></th>
<th>University</th>
<th>Ex-Cat</th>
<th>Tech. Coll.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng</td>
<td>Phys</td>
<td>Eng</td>
</tr>
<tr>
<td>(a) Considered alternatives to higher education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>23</td>
<td>43</td>
<td>34</td>
</tr>
<tr>
<td>No</td>
<td>77</td>
<td>57</td>
<td>66</td>
</tr>
<tr>
<td>N =</td>
<td>(74)</td>
<td>(7)</td>
<td>(15)</td>
</tr>
</tbody>
</table>

(b) Alternatives considered

<table>
<thead>
<tr>
<th></th>
<th>University</th>
<th>Ex-Cat</th>
<th>Tech. Coll.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng</td>
<td>Phys</td>
<td>Eng</td>
</tr>
<tr>
<td>Industry</td>
<td>23</td>
<td>43</td>
<td>34</td>
</tr>
<tr>
<td>Armed Forces</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N =</td>
<td>(74)</td>
<td>(7)</td>
<td>(15)</td>
</tr>
</tbody>
</table>

(c) Technical College considered as alternative to university or Ex-Cat.

<table>
<thead>
<tr>
<th></th>
<th>University</th>
<th>Ex-Cat</th>
<th>Tech. Coll.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng</td>
<td>Phys</td>
<td>Eng</td>
</tr>
<tr>
<td>18</td>
<td>14</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>N =</td>
<td>(74)</td>
<td>(7)</td>
<td>(5)</td>
</tr>
</tbody>
</table>
"I never questioned that if I could get to university then I should go." (Graduate engineer)

"No, I didn't really have any ambitions. I followed the trend. I took 'A' levels, got three, found I had the ability to go and so stayed on." (Graduate engineer)

"I was told I had the ability to go and so worked to go. There were no strong alternatives at the time and it seemed natural to go." (Graduate engineer)

"I just followed the system as far as it went - you have the appropriate 'highers' and it just seems to follow." (Graduate physicist)

"Going to university was the easy way out. You've got to do something when you leave school - you've either got to go to work and attend interviews all over the place or go to university which is much easier." (Graduate physicist)

"Although I knew I wanted to do a degree I was not sure what I wanted to do after a degree. It was a case of 'O' levels, 'A' levels, and natural science so I went for a physics degree." (Graduate physicist)

"It was just the case of the path of least resistance - the easiest thing to do. People advising me said go - so I just went." (Graduate physicist)

"I always thought I would go to university. I never thought otherwise, of a job at 'O' or 'A' levels. My attitude was always that when I failed an exam I would stop." (Graduate mathematician)

Here again, however, there was some suggestion of pattern in the use of this imagery of 'decision' and 'non-decision' with just under two-thirds of the university physicists and just over half of the university engineers characterising their passage as 'automatic'. A direct question on alternatives considered before entry to university revealed more extensive searches among the engineers than the physicists. These searches appeared in two ways, firstly, more of the engineers had considered employment as an alternative to higher education, and, secondly, more of the engineers had considered further education or technical colleges as alternatives to university education (see Table 7).

So far it appears that there were two important factors in educational
and occupational choices, social background and academic ability, whose influence was not fully explored in the manpower debate. The patterns of choice among the graduates and the quoted comments are consistent with a view that decisions about education and occupation are 'forced' on pupils or students when they do not have the resources to compete in the academic arena and claim the prizes of academic success, namely the opportunity to stay within the arena and defer choice. Competence depends on the kind of resources which the pupil can bring to the competition and two kinds of competence discussed already in earlier sections are competence in social skills and academic skills, for example, it was suggested by Box and Cotgrove that experience of relative failure in social skills might prompt the able working class student to compete on his relative strengths in numerate skills in science subjects. Doubts about social competence prompted one graduate to have resisted school pressure to seek entry to Oxford or Cambridge.

"If the school had had its way I would have gone to Oxford or Cambridge but I wrenched myself out of it at the last moment because I decided I wouldn't be able to stick the place because I come from a mediocre background. Certainly I've been happy in what I've done, I've always been able to cope with it."
(Graduate engineer - Southampton University).

If the level of competence is in doubt then the individual can engage in a calculation of the costs and benefits from continued participation. Where, however, there were no doubts about either social or academic competence then academic participation could continue 'without decision'.

"I come from what would be called a working class background, my father works manually, so that means I come the hard way. But it's not really the hard way, if you get three 'A' levels and are reasonably competent then you are O.K. It's not difficult if you get into the right stream - class doesn't come into it."
(Graduate physicist - Bristol University)

Data was not collected on academic ability in schools (e.g. 'A' level
TABLE 8. Orientations to work by department of employment (percentages).

<table>
<thead>
<tr>
<th>The importance of different kinds of job opportunities</th>
<th>R &amp; D</th>
<th>Non-R &amp; D</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To grow and learn new knowledge and skills</td>
<td>87</td>
<td>87</td>
<td>80</td>
<td>86</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To work on difficult and challenging problems</td>
<td>84</td>
<td>77</td>
<td>80</td>
<td>86</td>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To have congenial co-workers or colleagues</td>
<td>70</td>
<td>71</td>
<td>50</td>
<td>72</td>
<td>69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To have freedom to carry out my own ideas</td>
<td>67</td>
<td>58</td>
<td>80</td>
<td>86</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To make full use of my present knowledge and skills</td>
<td>57</td>
<td>56</td>
<td>40</td>
<td>72</td>
<td>56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To make a lot of money</td>
<td>70</td>
<td>47</td>
<td>90</td>
<td>57</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To work under chiefs of high technical competence</td>
<td>64</td>
<td>55</td>
<td>40</td>
<td>29</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To build my professional reputation</td>
<td>44</td>
<td>48</td>
<td>50</td>
<td>43</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To work with colleagues of high technical competence</td>
<td>47</td>
<td>43</td>
<td>30</td>
<td>72</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To advance in administrative status and authority</td>
<td>37</td>
<td>40</td>
<td>90</td>
<td>57</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To contribute to broad technical knowledge in my field</td>
<td>44</td>
<td>30</td>
<td>20</td>
<td>29</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To work with people rather than things</td>
<td>20</td>
<td>27</td>
<td>70</td>
<td>29</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To work on problems of value to the nation's wellbeing</td>
<td>27</td>
<td>25</td>
<td>-</td>
<td>15</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To get away from the area in which I grew up</td>
<td>14</td>
<td>15</td>
<td>20</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To associate with top executives in the organisation</td>
<td>14</td>
<td>8</td>
<td>40</td>
<td>-</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To remain in the area in which I grew up</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = (30) (105) (10) (7) (152)
results), so that this model cannot be tested on social background, ability and instrumentalism in decision-making. However, a model of this kind has been developed and substantial support found for it by Andrew McPherson in (31). The central point of the discussion here, and McPherson's study, is the support given for Cotgrove's conclusions from his later study that many of the influences on occupational choice lie outside the control of courses and teachers.

"... the important question may be not 'what does education do to people?' but 'what do people do with education?' And solutions which place over-much reliance on the educational system may fail." (32)

(ii) Orientations to work

The claim of the Swann Committee that all science and engineering graduates would prefer academic research to other occupational activities is difficult to test directly because it is difficult to disentangle 'free' from 'realistic' choice. However, it is possible to examine the orientations to work, the kinds of satisfactions and rewards sought from work, among the sample of entrants to the electronics industry in an attempt to discover whether any of the factors could be said to suggest a desire for academic research.

The most striking feature of Table 8 is the emphasis given to work on difficult and challenging problems, and the definition of themselves as problem-solvers. The next feature of note is that while the use of present knowledge and skills is important, of even greater significance is


(32) S. Cotgrove and M. Fuller, op. cit., p. 68.
learning new knowledge and skills. In that sense these graduates did seek a relationship between their academic training and their employment but claimed to be available to learn the skills relevant to coping in the new situation. Rather more importance was attached to the congeniality of colleagues as distinct from their competence but both items were held important. Indeed it was the competence of the supervisor rather than the competence of colleagues which was sought. This pattern of congeniality and competence may be understandable in terms of what was sought from these relationships if the roles of colleague and supervisor were analogous to the roles of fellow-student and supervisor in college. The supervisor was the essential source of work assignments, advice on lines of attack on problems and assessment for career and salary progress, whilst the colleague was the source of potential friendships. Against the responses about the intrinsic rewards of the jobs, the responses on salary received more guarded enthusiasm, and in organisational status was not regarded as of significant importance by many, and certainly not by association with senior executives. The central conclusions from this pattern of response was that these graduates sought opportunities to make a successful transition to their new industrial work situation but that they did not seek opportunities to develop long-term careers with their present employers. (33)

The assertion that scientists and engineers differ in their orientations to work has considerable support in the social psychological literature. Marquis summarised a number of studies by researchers on populations of undergraduates and graduates at M.I.T. and reported some

(33) There were a number of differences in the rank order if responses were taken only in terms of extreme importance, for example, salary dropped considerably
distinctions found between freshmen scientists and engineers. (34) The scientists scored higher on those tests of theoretical orientation, tolerance of ambiguity, aesthetic interests and desire for autonomy, while engineers scored higher on tests of the desire for economic achievement and power, the need for order and certainty, social extraversion and extent of engagement in organisational activities. By graduation the differences had been maintained or intensified, and while both groups wanted high salaries, good facilities and resources for work, security, and treatment from employers as individuals, there were a number of important differences as scientists placed emphasis on autonomy and professional aspects of their work such as keeping up, publication and earning respect in their field and engineers placed emphasis on organisational advancement and a challenging job solving practical problems.

When attention is turned to studies of scientists in industry, the Cotgrove and Box typification of the 'organisational scientist' seems little removed from the organisationally status-seeking engineer. Yet Cotgrove and Box did not use their typology in their discussions of strategies of adaptation. In his study, Ellis went further to suggest that if comparisons were made of groups in their work setting, then there appears to be little difference between the kinds of work and research sought by engineers and scientists. (35) This finding challenges the notion in the Swann Report of scientists in industry harbouring secret yearnings for the academic life to the consternation of their employers. The Ellis argument that there was little difference between the work preferences of scientists and engineers and only a difference in their


(35) M. Ellis, "The Occupation of Science", op. cit.
skills and ability to secure these ends suggests a weaker relation between preferences and skills than has been argued in this study. The Pelz and Andrews study of American scientists and engineers in a variety of different settings from universities to government and industry found that both engineers and scientists in industry had low scores of indices of 'science orientation' and 'professional orientation' but that engineers had much higher scores on 'status orientation' than the scientists. (36)

In the analysis of the sample of entrants to the electronics industry I have attempted to distinguish between educational experiences (engineers v. physics) and employment settings (research v. development). Unfortunately when only the university educated group is considered the sample is very small, nevertheless examination of the orientations to work suggest some differences which might be substantiated in further research. There is support for the Pelz and Andrews finding in that the engineers in the development labs were those strongly interested in organisational advancement and the enhancement of professional reputations than the physicists in either research or development and the engineers in research.

Again there was a contrast in the style of approach to work and the engineers in the development labs were more interested in 'acceptable results' and more clearly less interested in breadth of work than the engineers in research and the physicists in either research or development. Some further points of difference in styles of approach to work appear between graduates in research labs and graduates in development labs, for example, both engineering and physics graduates in development labs were less interested in working with 'general principles' and 'abstract concepts' than the engineering and physics graduates working in

research labs. These kinds of difference in orientations to work between workers in the research and development labs suggest that it is misleading to lump together all lab workers in industry under the heading of R & D in a discussion of orientations to work.

There are several points at which post-hoc reconciliation of the Ellis study and my own findings might be possible, for example, the nature of industries and populations studied, the laboratories studied, and the age groups of respondents. There are differences in the extent to which industries support research and development and the kinds of research supported, for example the greater importance of development activities in the electronics industry compared to the chemical industry might mean that the Ellis study had more chemical research on electronics research labs than electronics development labs. It has been stated that chemists enter industry more readily than physicists, and may move more readily into organisational careers. (37) Finally the Ellis study contained a much wider age distribution such that some of the scientists might have experienced all those enculturation processes in which scientists redefined their situation and the kind of orientational perspectives which it was feasible to hold. This would have increased the likelihood of different responses to questions about orientation to work in the Ellis sample compared to a sample of recent recruits. Finally it should be noted that Ellis concluded that the scientists were 'frustrated technologists' that is, they were technologists by orientation but insufficiently skilled to meet these role requirements as competently as university trained engineers. I have argued here that the situation is somewhat more complicated than this, that there are some differences in orientations towards work which are distinguishable. Obviously there appears to be

(37) The Flow into Employment of Scientists, Engineers and Technologists, Cmnd 3760, p. 25.
some matching in orientation to work situations by self-selection and
selection by management and a check on whether these orientations are the
product of education or work situation should be done by before-and-after
study, the available analysis of the open-ended interview material after
entry to work suggests that physicists do bring a different orientation and
style of approach to their work in the first year at least but this is not
to be confused with a desire for academic research. (38)

The analysis of this data is taken up in Chapter Nine over the
adjustments to the work situation. A second best to the panel study would
be cross-sectional data from those about to enter and those in employment.
In my own study there were simply too few numbers in the sample for this
kind of analysis and it is second best since different cohorts may have
different experiences which are not controlled in the analysis.
5. **Information in the Labour Market**

The models of occupational choice considered at the beginning of the chapter were all 'rationality models', individuals were construed as making deliberate choices, which were compromises between values or preferences, expectations about feasible jobs on the basis of their knowledge and skills, state of the labour market, and so on. In contrast to this purposive model which portrays the individual decision whittling away alternatives, some writers have proposed a model of choice on which outcomes are the result of chance, situational pressures. While the Blaug (economic) and the Cotgrove and Box (sociological) models were explicit in their assumptions of rationality, the Committee on Manpower Resources manpower forecasting model came closest to proposing the fortuitous, irrational model of choice. In some of their comments about 'choice by schoolboys' they imply that these choices are the result of whim, yet at other points they admit a subjective rationality in that choice is simply the result of ignorance, in other words different choices would have resulted if other information had been available. In all these models the distribution of information was crucial and in policy proposals all the commentators made proposals to change the distribution of information. Yet once the notion of 'bounded rationality' is introduced, once it is admitted that rationality is only to be discussed in relation to a frame of reference which is determined by the limits on the decision-maker's information, then it is important to investigate the sources of these limits in information and the way in which a definition of the situation is shaped. (39)

It is apparent that many of the graduates feel that their passage through the educational system was conducted with little information about

---

Sources of most guidance for subject choice among a sample of schoolchildren

<table>
<thead>
<tr>
<th>Source</th>
<th>Intending university applicants</th>
<th>Lower 6th</th>
<th>Upper 6th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>8.2</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>School Staff</td>
<td>11.7</td>
<td>13.8</td>
<td></td>
</tr>
<tr>
<td>Other people</td>
<td>2.8</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Self</td>
<td>77.3</td>
<td>77.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>(282)</td>
<td>(630)</td>
<td></td>
</tr>
</tbody>
</table>

Source: M. McCreath, "Factors influencing choices of higher education", p. 17.

Sources of serious discussion on what to do after school

<table>
<thead>
<tr>
<th>Source</th>
<th>Intending university applicants</th>
<th>Lower 6th</th>
<th>Upper 6th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>50.4</td>
<td>47.6</td>
<td></td>
</tr>
<tr>
<td>School Staff</td>
<td>18.1</td>
<td>24.8</td>
<td></td>
</tr>
<tr>
<td>YEO or CAO</td>
<td>6.7</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>Other people</td>
<td>4.2</td>
<td>8.9</td>
<td></td>
</tr>
<tr>
<td>No answer</td>
<td>-</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Not yet discussed</td>
<td>20.6</td>
<td>14.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>(282)</td>
<td>(630)</td>
<td></td>
</tr>
</tbody>
</table>

Source: M. McCreath, "Factors influencing choice of higher education", p. 18.
alternative courses and occupations. There were two reactions to this situation, one was the disillusionment evident among some graduates about the press and official statements on the shortage of scientists and engineers and favourable career prospects which contrasted with experiences, and the other reaction, which is discussed in this section, was to take a tentative view of entry to the occupation and conceive of it as part of the search process.

Numerous studies have supported the Dainton Committee view of educational choices made with little guidance by schoolchildren and occupational decisions made largely on the basis of education without 'professional' career guidance. (40) A recent study by McCreath enquired into the sources of guidance for pupils in sixth forms and recorded the opinions of pupils that choices were largely self-determined (see Table 10). A further question on sources for serious discussion on what to do after school - revealed that most discussions occurred within the family, and that school discussions became more important as pupils progressed through the sixth form (see Table 11). The more frequent use of the 'professional' careers advice, the youth employment or careers advisory officer, by the intending entrants to the college of further education compared to the intending university entrants tends to confirm the earlier interpretation of the educational system as an automatic passage for the 'able pupil'. (41)

"In discussions on what to do after school the most useful talk was twice as likely to have been with the family than with the school, though exactly what was meant by 'useful' we cannot tell from the data. Because of the extent to which

(40) See the discussion by the Dainton Committee and their reference to several studies including that sponsored by the Royal Statistical Society. Enquiry into the Flow of Candidates in Science and Technology into Higher Education, Cmd 3541, op. cit., paras. 136-144.

(41) The Robbins Committee had commented on the inadequate knowledge used by students in university applications and the tendency among students to have avoided careers advisors was noted by A.D. Hall, D.C. Larbalestier and L. Massey, "What advice do students get?", New Society, 3.11.64.
the boys and girls said they had not discussed their plans, the inconsistencies about what they said they had done and the general vagueness about what they would do after school, it seems likely that a sizeable proportion of the pupils had been carried along through the system without much thought for the future." (42)

One methodological point about these studies is that they rely entirely on the student as focal person and source of information and it is not clear how far they might be subject to distortion from a cultural bias towards taking individual responsibility and asserting independence from parents, for example, even engineers who could claim descent from a 'line of engineers' stressed their autonomy in choice of occupation.

"There was no pressure on me. I was told to do what I like. All my family are engineers - mechanical engineers - father, brothers, grand-father and back for generations. So the upbringing has been engineering, although it was never thrown at me."

"I was brought up in a family of engineers, my father and brother are both mechanical engineers. But there was never any bias that I must become and engineer."

Only 30 of the 170 entrants to the electronics industry could recollect definite parental preferences for occupations, and with only five exceptions these were all occupations with which one or other parent had had direct contact. (43) Where parental pressure was recalled, it was as encouragement to continue and succeed in the educational system.

"I think I was very fortunate, they (parents) were extremely understanding and never tried to direct me to any job - but they directed me to university. They said that a person of my capabilities would be wasted if I didn't become an expert in a particular field."

(Graduate engineer)


(43) These contacts ranged from fathers who were engineers who preferred engineering for their sons to mothers who were nurses/midwives who preferred medicine for their sons, while those of the five exceptions mentioned parental views of teaching as a 'safe and secure job'.


(43) These contacts ranged from fathers who were engineers who preferred engineering for their sons to mothers who were nurses/midwives who preferred medicine for their sons, while those of the five exceptions mentioned parental views of teaching as a 'safe and secure job'.
"So long as I got to university, it was left to me."
(Graduate physicist)

"My parents are working class and what they wanted for me was a good safe profession. The attitude of my father now, like that of any working class person, is that I work for a company where I get sick pay if I am ill, there's no redundancy or if I got sacked I would just fill in a form and go off to Canada or something like that. There are no worries. There is freedom from fear. As for industrial science, he knows nothing about the job, if they are not scientists then few people do."
(Graduate physicist)

Taken together with the quoted studies these comments suggest that parental aspirations were important in a threshold sense, especially important to encouraging persistence beyond the terminal date for compulsory school at 15 (and beyond 'O' levels at 16). Once the sixth form has been reached students were guided much less by parental aspiration or information. The important point for the parents was that social advancement was achieved or a social position was maintained and educational qualifications were thought the means to that end. Advancing or maintaining a position did not mean a particular occupation but a broad category of occupations, for example, those with security and those without, and those distinctions paralleled closely those between white collar or non-manual and blue collar or manual occupations. Thus while parents influenced demand for education, they appeared less likely to directly influence demand for particular disciplines or choice of particular occupation. In this connection it is interesting that the McCreath study revealed a strong contrast between the extent to which parents were heavily involved in discussions about post-educational careers but little involved in decisions about educational courses (compare Tables 10 and 11). While students from a variety of different social backgrounds emphasised their independence in decision-making, the self-styled working class students were frequently emphatic about parental inability to advise on subject and career choices.
"They thought it was a good thing for me to go to university. They are only working-class type people and didn't really understand, they thought it was like school. They didn't know much about the differences between Science and Arts and Engineering. It was just University to them."
(Graduate engineer)

"I usually find very few people outside physics know what physics is, people outside tend to think of a physicist as a cross between a physiotherapist and a chemist. My parents don't really understand, nor do they understand I've got a job that's nothing to do with it."
(Graduate physicist)

"I think it's the old story of the father being denied education he thought he would give it to his son, but you could say I am a product of the welfare state. Coming from a working-class background one could almost say that everything is against you, there are no books, no technical experience. The only thing you can rely on is the education you receive at school and university and one's own bent. That's the only thing that keeps you going. Parents just let you get on with it. I could have become anything, doctor or teacher, so long as in their eyes it was a respectable profession, so long as it was a recognised profession. I remember being interested in astronomy, and their comment was that no one wanted astronomers."
(Graduate engineer)

Of course this latter comment should alert us to the probability that family influences are exerted in a variety of subtle ways, from the general provision of a rationale for further education and a rationale for the rationality of long-term planning to the fund of myths and stories about the family background in engineering or accounts of how one's bent was apparent in childhood play. (44)

(44) For a theoretical account of the links between parental experiences of the labour market and preferences for children's education, see, M. Lane, "Exploring Educational Choice", Sociology, vol. 6, no. 2, May 1972. B. Jackson and D. Marsdon provide an illuminating account of the incomprehensibility of a working class parent about his child's studies and the embarrassment of a teacher who had never had to make replies to questions such as 'What is Physics?'. B. Jackson and D. Marsdon, Education and the Working Class, Harmondsworth, Penguin Books.
Schools have been heavily criticised by those concerned about the shortage of engineers and scientists. Science teachers have been criticised as instruments of both a conscious and unconscious bias against engineering, sometimes unconscious because of their ignorance of university and industrial engineering. (45) In an earlier period the bias of the Arts dominated schools was criticised for the failure of the technical schools created by the 1944 Education Act. (46) Following the numerous representations made to the Robbins Committee about the ignorance and bias towards technology, further efforts were made to encourage the development of courses in technology in the schools. (47) Where all these exhortations to provide more career advice in schools appear likely to founder is in their underestimation of the commitment of schoolchildren to short term perspectives in coping with their day-to-day school situation and the economy of effort which the use of these same perspectives entails. In this respect the introduction of engineering into the school curriculum might facilitate the same patterns of 'automatic move' from school engineering to university engineering as hold for the able physics student and thus a different kind of solution to manpower problems.

University teachers of physics have earned criticism of conscious and unconscious bias against industry and engineering similar to that launched against their school colleagues. Yet the striking point about the job searches initiated by graduates is their reliance on the formal networks in the labour market, the Appointments Boards, rather than the informal networks, such as lecturers, friends or other students. (48)


<table>
<thead>
<tr>
<th>Table 12. Information channels used in job seeking by educational institution and discipline.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Education</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>University</strong></td>
</tr>
<tr>
<td>1. University/College Appointments Board</td>
</tr>
<tr>
<td>2. Teaching Staff</td>
</tr>
<tr>
<td>3. Adverts in national daily/weekly press</td>
</tr>
<tr>
<td>4. Adverts in technical press</td>
</tr>
<tr>
<td>5. Employer visits to University/College</td>
</tr>
<tr>
<td>6. Vacation employment</td>
</tr>
<tr>
<td>7. Other students</td>
</tr>
<tr>
<td>8. Family and friends</td>
</tr>
<tr>
<td>9. Friend in company</td>
</tr>
<tr>
<td>10. Wrote directly to Company</td>
</tr>
<tr>
<td>11. Government agencies</td>
</tr>
<tr>
<td>12. School</td>
</tr>
<tr>
<td><strong>N</strong></td>
</tr>
</tbody>
</table>
The channels of information as to how he might satisfy his preferences.

The channels of information through which the engineers and physicists from the three types of institutions, the universities, ex-cats and technical colleges, sought information about future employment are given in Table 12. Mention has already been made in company recruitment strategy of the relative ease of recruitment of graduates for professional employment compared with the recruitment of experienced engineers or technicians.

Appropriate to these comments then are the preponderance of references to use of appointments boards and employer visits to universities, whilst these two channels are usually associated they were not always linked by these respondents.

Of the other sources of information used there are contrasts between the university engineers and physicists, with the latter group giving the impression of more readily seeking information about jobs. Some of these contrasts are rather curious, for example, the physicists appeared to seek the comments of their teachers and fellow students more frequently than the engineering graduates. Intuitively one might expect that university engineering staff have more information about industrial employment than physics lecturers, and similarly engineering undergraduates by more frequent vacation employment in industry might be expected to have more information about industrial employment than physics undergraduates. It might be this factor of a relative lack of information which was perceived by the physics undergraduates and prompted them to use as many information channels as possible, even frequently writing to the company directly.

The paucity of references in all cases to other students should not underestimate a student 'grapevine' of information and folklore about companies, since such information may be volunteered rather than sought.

Information was not gathered systematically on the quality of information gathered in each of these channels. The appointments boards
vary across universities in terms of the kind of service which they seek to offer, from the relative emphasis placed on counselling and placement for current undergraduates to the follow-up of past graduates and services to them. The general impression gained was one where the appointments boards were used for their placement services and the undergraduate used interviews to gain information about jobs and companies. (49) The interviews represented an opportunity for both the student and the company to gain information about each other, and the student developed a strategy for both eliciting information and presenting himself as desirable. The student made choices about companies largely on the basis of information which he gathered during interviews about salary, projects currently under way and expected in the near future, and working conditions, and the information which he gathered during his tour. The importance of this form of contact with the company, the personal scrutiny, was further underlined by references by over a third of the respondents to 'a favourable impression of company recruiters' in their reasons for choice of company, in contrast to the paucity of references to personal knowledge of the company, or recommendations from appointments boards or teachers.

The many comments about the lack of information available to students made in official pronouncements and numerous surveys had their counterparts in graduate criticism of the lack of information in school and university and in the development of a perspective on entry to the labour market as a continuation of that search process. The situation was defined as one in which the essential problem was to find out what kinds of demands were

(49) In the past adverse criticism has been made of this ring-holding function of the Appointments Boards (see, for example, one article in career journal, D. Hilton, "Lack of Advice, no enthusiasm: results of university survey", Choosing a Career, November 1965.) A number of the Boards have been attempting to change this situation by giving greater emphasis to their counselling services, see, for example, W.P. Kirkman, "Role of University Boards Changes Emphasis", The Times, 2.10.70.
made in industry and what kinds of activities were feasible (see Table 13). Thus, overall, 113 respondents took the exploratory view and only 38 respondents were confident that they had sufficient information. The educational backgrounds of these respondents provides some further speculative suggestions about information for over half of the satisfied groups came from the Technological institutions (the ex-campus and technical colleges) where the graduates had gained personal knowledge of industry and particular companies. Although a large proportion of the university engineers had had experience of the electronics industry, unlike the Scottish sample, few had returned to companies of which they had had vacation experience. Thus for the bulk of the university engineers and physicists entry to industry was seen as a very tentative commitment.

"I wasn't sure what I was going into - what industry was. I just wanted to make my way as far as I could with the capabilities I had. Thinking about it now, my plans are to stay in this sort of job. It seems unusual that I have found a job I enjoy doing so early on."

(Graduate physicist)

"I wanted to see what industry was like and to make a decision then whether to stay with it for the rest of my life, or whether I might turn to other pastures such as setting up my own concern. I didn't give it much thought really - as long as I get some qualification, I'll see how I go from there."

(Graduate engineer)

There was a commitment in the sense of a lengthy period of academic training which was presumed to hold some relevant knowledge and skills and offer a recognisable role in an organisation, but this was a short-term commitment to the least costly mode of transition, and for the longer-term the graduate could hope to broaden his knowledge and skills such that commitments would be renegotiable. The essential task in the short-term was to gain reassurance that one's knowledge and skills were indeed relevant and that one could cope.
### Table 13. View of Entry to the Labour Market as Continuation of Job Search by Educational Institution and Discipline

#### (a) Adequacy of Information

<table>
<thead>
<tr>
<th>Education</th>
<th>University</th>
<th>Ex-Cat</th>
<th>Tech Coll</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eng Phys</td>
<td>5</td>
<td>4</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>-</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Eng Phys</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

View that sufficient information exists

<table>
<thead>
<tr>
<th>View</th>
<th>57</th>
<th>33</th>
<th>1</th>
<th>132</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonrespondents</td>
<td>18</td>
<td>11</td>
<td>1</td>
<td>37</td>
</tr>
</tbody>
</table>

#### (b) Reactions to Inadequate Information

<table>
<thead>
<tr>
<th>Education</th>
<th>University</th>
<th>Ex-Cat</th>
<th>Tech Coll</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eng Phys</td>
<td>31</td>
<td>13</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Eng Phys</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Totals</td>
<td>63</td>
<td>29</td>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>

No. of multiple responses

| 68 | 29 | 9 | 4 | 2 | 6 | 2 | 120 | 62 | 29 | 8 | 4 | 2 | 6 | 2 | 113 |

(a) first job as opportunity to look round

(b) first job as opportunity to gain experience

(c) Intention to review after 3 years

(d) complaints about lack of information

N 62 29 8 4 2 6 2 113
"I think I would have preferred a social science - economics - and to work for a firm that was really customer oriented like Proctor and Gambol. I'm not unhappy - I don't know that might have been pushing myself beyond the limit. On a technical job you can have confidence from the technical background which you can't get from a non-technical background and a managerial job. I think this technical background gives help because results are more clearly defined."
(Graduate engineer)

Further confirmation of the short-term explanatory perspective dominant among the graduates came from responses to a question about plans and ambitions on leaving college. Responses were coded to the extent that they showed a preoccupation with the 'immediate future' and the first job on leaving university, or considered second and subsequent jobs and indicated thoughts about 'intermediate' stages of the career, or finally, whether the respondent thought in terms of 'peak' or ultimate stages of a career. (50) The results of this examination confirmed a perspective which closed off the future and dealt wholly with the transition and the demonstration of competence in a new work milieu (see Table 13).

(50) This analysis was prompted by a reading of the study by R. Rapoport, E. Lauman and T. Ferdinand, "The Power of Choice: Careerline decisions of Technologists' Class of 1964", (personal communication).
TABLE 14. Types of Employer against whom decisions were made in considering jobs.

<table>
<thead>
<tr>
<th>Education</th>
<th>University</th>
<th>Ex-Cat</th>
<th>Technical College</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not decided</td>
<td>23 (31.5)</td>
<td>9 (22.5)</td>
<td>5</td>
</tr>
<tr>
<td>against any employer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decided against some employer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Public corporation</td>
<td>16 (22)</td>
<td>9 (22.5)</td>
<td>-</td>
</tr>
<tr>
<td>b) Civil service</td>
<td>35 (48)</td>
<td>19 (47.5)</td>
<td>3</td>
</tr>
<tr>
<td>c) Government research</td>
<td>11 (15)</td>
<td>9 (22.5)</td>
<td>3</td>
</tr>
<tr>
<td>d) University</td>
<td>29 (40)</td>
<td>21 (52.5)</td>
<td>3</td>
</tr>
<tr>
<td>e) L.E.A.</td>
<td>34 (46.5)</td>
<td>27 (67.5)</td>
<td>3</td>
</tr>
</tbody>
</table>

N 73 (100) 40 (100) 9 7 5 13 3 1 151 (100)
6. **The Experience of the Labour Market**

Entry to the labour market was the first opportunity for the entrants to the electronics industry to gain personal experience and information about the state of the market which could be set against the dominant folk wisdom that there was a shortage of engineers and scientists. To form some judgement on the state of the labour market numerous cues could be used, the extent of efforts by employers to organisation recruitment campaigns and interview procedures, the number of job offers received against applications made, and the salary offered. Later this information could be supplemented by observation of work organisation, the kinds of job opportunities offered and the availability of complementary manpower, and salary progression. Of course, in forming an impression of the state of the market the salient point for the individual graduate was a view of the market for his personal talents but this was formed against an awareness of the market for graduate scientists and engineers. While there was general satisfaction about their entry to the labour market, there was evidence of disappointment among those who had been in industry for a year and the disappointment centred on both the discrepancy between salaries and what they expected in a situation of market shortage, and discrepancies between job expectations and experiences.

Paradoxically in this sample a higher proportion of the engineers appeared 'open-minded' about jobs in approaching the labour market than among physicists (see Table 14). However this contrast to the Kelsall finding might be attributable to the higher proportion of 'good degree' graduates among the engineers compared to physicists in the electronics sample. Overall one-third of the sample had not made definite decisions against any particular employment sector at the outset of their job search. The most definite of these decisions against an employer, against school teaching and against the civil service, can be interpreted with the
aid of the interview material and earlier descriptions of job opportunities. The civil service was associated with 'red tape' and constraints on freedom and initiative, factors which were not associated so strongly with Government research. Schoolteaching was resisted because it appeared to be an abandonment of skills as a scientist or engineer, and to present a lack of intellectual stimulus for further learning, remarks in this view were summed up in the comment that 'teaching's a job to retire into'.

While opposition to schoolteaching appeared greatest among the physics graduates, the lesser extent of 'decisions against' among engineers may be attributable to a complete lack of consideration about teaching among engineers for few engineers have entered schoolteaching on graduation and engineering is not a 'school subject' in the same way as physics. (51)

Such a degree of antipathy for teaching could not be of comfort in the context of a shortage of science teachers, but although the absence of 'decisions against' among a large minority of the physicists might suggest sufficient numbers available who could be attracted to teaching, the advisory committees were not seeking to make switches between industry and schools (52)

At the time of graduation, 11 of the sample had sought and 9 achieved some form of graduate study. (53) After the experience of industrial employment another 12 were seeking further academic study, of these 5 were seeking Ph.D study, largely to secure some control over the organisation

(51) Statistics on the proportions of physics and electrical engineering graduates entering teacher training and schoolteaching can be found in U.G.C. Reports, published annually since 1963, First Employment of University Graduates, H.M.S.O.

(52) For further comments on the lack of attractions of science teaching for science pupils and students, see the studies by Andrew McPherson, 'The Dainton Report: A Scottish Dissent', Universities Quarterly, June 1968

(53) See the description of the sample in Chapter 2, 3 had undertaken Ph.D study, 3 had been on M.Sc courses, and 3 obtained postgraduate diplomas.
TABLE 15. Reasons for taking their first job by company. (percentages).

<table>
<thead>
<tr>
<th>Reason</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reputation for training</td>
<td></td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>12.5</td>
<td>18</td>
</tr>
<tr>
<td>2. Offer of training</td>
<td></td>
<td>0</td>
<td>18</td>
<td>40</td>
<td>9.1</td>
<td>50</td>
<td>23</td>
</tr>
<tr>
<td>3. Recommended by Appointment Board</td>
<td>18</td>
<td>18</td>
<td>0</td>
<td>9.1</td>
<td>0</td>
<td>13.5</td>
<td>16</td>
</tr>
<tr>
<td>4. Recommended by Teaching Staff</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>9.1</td>
<td>12.5</td>
<td>4.5</td>
<td>5.5</td>
</tr>
<tr>
<td>5. Location of Works</td>
<td>72.5</td>
<td>36.5</td>
<td>50</td>
<td>63.5</td>
<td>58.5</td>
<td>36.5</td>
<td>31.5</td>
</tr>
<tr>
<td>6. Type of Products Made</td>
<td>91</td>
<td>27</td>
<td>40</td>
<td>27</td>
<td>50</td>
<td>91</td>
<td>68.5</td>
</tr>
<tr>
<td>7. Working conditions</td>
<td>82</td>
<td>54.5</td>
<td>10</td>
<td>45.5</td>
<td>41.5</td>
<td>86.5</td>
<td>47.5</td>
</tr>
<tr>
<td>8. Starting Salary</td>
<td>82</td>
<td>72.5</td>
<td>70</td>
<td>72.5</td>
<td>71</td>
<td>72.5</td>
<td>42</td>
</tr>
<tr>
<td>9. Good prospects</td>
<td>91</td>
<td>45.5</td>
<td>80</td>
<td>27</td>
<td>37.5</td>
<td>77.5</td>
<td>47.5</td>
</tr>
<tr>
<td>10. Impression of Recruiters</td>
<td>36.5</td>
<td>27</td>
<td>30</td>
<td>27</td>
<td>33.3</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td>11. Person (e.g., fiance in area)</td>
<td>9.1</td>
<td>36.5</td>
<td>20</td>
<td>0</td>
<td>12.5</td>
<td>0</td>
<td>10.5</td>
</tr>
<tr>
<td>12. Vacation work</td>
<td>9.1</td>
<td>9.1</td>
<td>20</td>
<td>9.1</td>
<td>25</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>13. Personal contact with company</td>
<td>9.1</td>
<td>0</td>
<td>0</td>
<td>9.1</td>
<td>4</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>14. Company ideals</td>
<td>9.1</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15. Industry's future</td>
<td>100</td>
<td>36.5</td>
<td>60</td>
<td>54.5</td>
<td>41.5</td>
<td>95.5</td>
<td>26.5</td>
</tr>
<tr>
<td>16. Company reputation</td>
<td>54.5</td>
<td>63.5</td>
<td>30</td>
<td>27</td>
<td>25</td>
<td>41</td>
<td>26.5</td>
</tr>
<tr>
<td>17. Field of work</td>
<td>18</td>
<td>9.1</td>
<td>10</td>
<td>27</td>
<td>16.5</td>
<td>18</td>
<td>31.5</td>
</tr>
<tr>
<td>18. Other</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

N (11) (11) (10) (11) (24) (22) (19) (23) (23) (154)
of their work and personal life and move into university or technical college teaching and research, and the remainder sought M.Sc courses (h) or postgraduate diplomas, largely to enhance their economic position in industry.

Although a high salary did not feature among the more significant of the aspects of jobs in which graduates were interested, salary appears to take on some significance as a discriminator between companies (see Table 15). The nature of work and relationships to skills and preferences were clearly important for the large numbers who endorsed 'working conditions' and 'type of products', despite the curiously low numbers attaching importance to the 'field of work', Among their reasons for choice of company. Both short term and long term salary factors appeared important in the numbers endorsing the 'starting salary offered' and the 'favourable impressions of the future'. Of companies where starting salary was not so important (D, E, and F), there were some peculiar factors of salary structure in two companies, for example, in company E comparatively low starting salaries were accompanied by guaranteed minimum increments over the first two years, and, in company F, respondents accepted that they bore part of the training costs by accepting lower salaries. Not surprisingly, and yet ironically, the favourable future was associated with the most recent technologies, computers and microelectronics (A, C, and E). The irony has lain in economic vicissitudes which have affected these branches of the industry since 1968. Some of these factors mentioned in choice of company underline earlier points about the nature of information in the labour market available to graduate job hunters, for example, few of the graduates had personal knowledge of companies and relied to a considerable extent on company reputations, which made companies more visible and reduced search costs, and the information and cues which could be picked up from the interviews and company recruiters.
An index of success in the job search proved impossible because job seekers frequently withdrew applications when they had received a satisfactory offer. While other studies have found that students expecting 'poorer degrees' begin to look for jobs earlier than those expecting 'good degrees', it is difficult to assess the consequences of different job strategies. (54) It is evident that physicists were likely to apply for a larger number of jobs than engineers which reflects both the greater anxiety of those expecting poorer degrees and the greater ignorance of physics students. Although a few graduates could claim variations in salary offers of up to £150, the benefits of shopping around did not appear very great in financial terms in the face of standard salary scales based on degree results and the costs of search. (55) For the most part the respondents were satisfied with their current salaries, and some even claimed that they were overpaid in terms of their current productivity. Where dissatisfactions with salary began to appear they did so among those who had been employed for a year and also had either experienced salary increments or discussed increments with fellow recruits or older engineers.

"For what I do, and bearing in mind the cost of living, I am sufficiently well paid. I could do a lot more here but there aren't the opportunities. And if you compare my earnings with the salary of an accountant I am not particularly well paid. The thing that appalls me is the nature of the increments - they give you £50 and think they've done you a favour."

In several companies the graduates received a cost of living increase which had followed a comparable increase secured by the manual workers or


(55) Although some graduates could claim financial gains from multiple interviews with one journey funded by several companies this had to be set against the loss of revision time and risks of detection, for example, one university appointments board invited companies to report on its graduates to prevent 'fraud'. 
<table>
<thead>
<tr>
<th>Satisfaction with current salary</th>
<th>Company</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Yes</td>
<td>97</td>
<td>67</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>Don't Know</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

|                               |         |       |       |       |       |       |       |
|                               | 100     | 100   | 100   | 100   | 100   | 100   | 100   |
| N                               | (31)    | (37)  | (21)  | (21)  | (27)  | (28)  | (165) |

The important point about these interpretations, however, is that they tend to be associated with dissatisfaction with earnings, and underutilization.
draughtsmen through their trade union. These experiences prompted further thoughts about the nature of rewards, and often disgruntlement about relative rewards for manual workers and graduates. One theme which emerged from the entrants of a year's standing was some disappointment that there was a discrepancy between the widely-publicised shortage of engineers and scientists and salaries experienced.

"If it's a capitalist system then it's really a matter of supply and demand. And from what I had read I imagined that the country was short of scientists and engineers, but it can't be true otherwise salaries would be higher."
(Graduate engineer)

"I feel as though I've been cheated because I have been doing a useful job for the community. We've always been told that we are necessary and I feel I should have the regard which this entitles me to."
(Graduate engineer)

The important point about these interpretations, however, was that they tended to be associated with dissatisfaction about work consignments and underutilisation.
1. Introduction

The desire to design a higher educational system that was responsive to the needs of industry has been an important aim of many Government advisers and educational planners since the Second World War. The stated aims of the Advisory Committees and Government spokesmen quoted in Chapter One amply demonstrate this point. Paradoxically, however, as these bodies have seen that an increasingly sophisticated technological society implied an increasing dependence on the educational system for the preparation and selection of its members for occupational roles, they have pointed to an increased difficulty in carrying out this function. The Committees saw that an increasingly sophisticated economy implied a longer period of education and training, a longer gestation period between the commitment of resources and the output of qualified manpower. Thus the educational planner has to commit resources before outcomes can be judged. An added difficulty for the planner has been the lack of detailed knowledge of manifold influences on pupils and students through this lengthy gestation period. It is small wonder that a situation of great uncertainty has generated a great deal of controversy over appropriate educational policy. (1)

(1) This is simply in the area of debate about appropriate ends to agreed ends. In the discussion of educational plans and policy there has been the other major dimension of the debate about desirable ends. References to manpower needs have been defended against a preoccupation with materialistic ambitions and in this context the pleasure of the Dainton Committee that they could reconcile liberal education and manpower needs is readily understandable.
The Committee on Manpower Resources for Science and Technology took as the underlying rationale for their policy proposals a model of the relationship between the educational system and the development of an advanced industrial society which implied a 'logic of industrialism'. To the Committee this model suggested the direction of educational developments and gave some yardstick against which the British educational system could be judged. The efficacy of their proposals for change rested on the assumption that the educational system could be used as an instrument of social policy. When the central features of the model and the extent of educational change are examined then there is a somewhat paradoxical result, because on close examination there are some important points at which the educational system has not been subject to policy control and yet there have been striking changes in the British educational system which could be seen as making closer links between the educational and economic systems. Of the three themes in the development of the educational system in industrial societies - growing links between educational courses and occupations, increasing provision of education and training beyond terminal dates, and increasing educational opportunity - the manpower forecasters were preoccupied with educational courses in criticism of the educational system and neglected industrial response to educational and training developments and the way educational change cannot proceed without broader societal change.
2. Manpower Forecasters and the Educational System

(i) The analysis of trends in the educational system

If there was to be a lengthy gestation period in the education and training of qualified manpower and if employers could not be expected to see too clearly into the future then the manpower forecasters felt that they should undertake to provide an oracular vision. Armed with a model of the relationships between the economy of an advanced industrial society and its educational system, the Committee was able to examine these relationships in Britain compared to other advanced industrial societies. Thus international comparison between educational systems permitted commentary on the British educational system additional to information provided by employer surveys.

The central point in the model was the increasing dependence of a sophisticated technology and complex economy on professional experts and skilled technicians and the increasing importance of the educational system for preparation of highly-qualified manpower. The international comparisons confirmed this view for the Committee.

"It is possible to identify in the experience of countries which give a higher education to a larger proportion of the population than does the United Kingdom a marked shift in the spectrum of employments. Jobs formerly done by craftsmen are done by others more scientifically based and requiring more sophisticated skills and thus appropriate to technicians; and jobs previously done by technicians are replaced by those appropriate to qualified manpower." (2)

Moreover the Committee commissioned an analysis of the relations between occupational requirements and university courses in the USA and UK by M.C. McCarthy. (3) This survey confirmed the Committee view that over and


beyond the requirements for scientifically and technologically qualified people wholly employed in the application of their specialisms there was a need for all members of society to have a scientific or technological background.

".... we see the study of science and technology as a desirable preparation for an increasingly wide spectrum of occupations extending well beyond the traditionally vocational employment in these subjects and into fields outside science and technology as such." (4)

A second development was for educational opportunity to be extended to an increasing proportion of the population.

"The day is past when universities were for the elite only. With a rising proportion of the population entering higher education, employers will increasingly have to seek able new recruits from this source, to fill an ever-widening range of jobs." (5)

The rapid technological change associated with advanced industrialism was linked to shifting the balance of formal provision of education and training from an almost exclusive preoccupation with pre-occupational education prior to some terminal educational age towards the provision of more post experience and part time education and training, towards the conception of life-long education.

"On the one hand the inexorable march of science and technology demands from all qualified people, whatever their subsequent function, a broad grasp of scientific fundamentals. On the other hand, the growth in industry of highly specialised technologies makes the need for specific instruction in these fields, both in educational institutions and in industry, more and more acute. These two requirements will together pose a severe burden on the educational system and it becomes increasingly evident that both requirements cannot be satisfied within an undergraduate education lasting only three years." (6)

(4) The Flow into Employment of Scientists, Engineers and Technologists, Cmd 3760, p.3.
(5) Ibid., p. 3.
(6) Ibid., p.32.
It can be seen that the three trends are closely interrelated, for technological change requires both lengthy training and retraining for larger proportions of the population and the scientific and technological awareness to cope with both societal change and personal development. While employer questionnaire returns could guide forecasts and educational priorities for the short-term, it was believed that this model could be used to predict the general shape of the educational system in the long run, and assess trends in Britain. In this analysis greatest attention was concentrated on the specialised nature of courses. Yet this point of concentration was amongst the most confused and confusing parts of the Report. The degree of ambiguity in the concepts used allowed subsequent commentators to salvage something of note from the report, however, when the forecasts of 'shortage' of QSE's in the future were dismissed after two years. On educational opportunity the Swann Committee looked at the increase in the provision of places and was reasonably satisfied with the extent of increased educational opportunities. The Swann Committee was not tempted by thoughts of 'shortage' to examine 'wastage' from the educational system and the manpower implications of who is to be educated. The central weakness of the Swann Report, however, was the lack of regard for the implications of life-long education and the way in which industrial organisations must conceive of themselves to a much greater extent as part of the educational system if life long education is to be adopted. While the Swann Committee defined these issues as part of the utilisation issue and the work of another committee, it is surprising that more attention was not given to an analysis of the adequacy of industry's response to its own educational and training needs when so much emphasis was put on the importance of general education with supplementary specialist training at a later date. While the Swann Committee appeared aware of the deficiencies in the utilisation of highly qualified manpower
mentioned in the Jones Report, the failure to press the weaknesses in
the industrial response in education and training seems to stem from the
Swann Committee conception of what was politic; namely, that the
educational system could be controlled and directed whereas industry could
not. The counter theme of this chapter is to illustrate the extent to
which the educational system could not be controlled and directed, and
the extent to which industry could be controlled and directed.

(ii) The student experience of higher education

One of the crucial areas of lack of control over the educational
system is the way in which the student's experience of the educational
system is conditioned by factors external to the system and beyond planning
direction. The central points of the Swann Committee view of the student's
experience have been rehearsed already, all that is necessary is the
reminder that they assumed that students' conceptions of themselves and
prospective courses were largely shaped within the educational system by
courses and teachers. (7) The weakness in this analysis was the neglect
of those influences outside the educational system and the presumption
of a harmonious and influential sway of teachers over students.

(7) See Chapter 6, section 2.
3. Vocationalism

The general notion that the educational systems of most industrial nations have undergone considerable transformation during the course of industrialisation has been a popular theme for sociologists, and in expounding this theme a certain issue has been the extent to which older conceptions and traditions in education have been compatible with the requirements of the changing economy. (8) Inevitably a great deal of this literature is both descriptive and normative in its portrayal of educational systems. Burton Clark in an analysis of American and Russian educational systems portrayed developments in the context of the 'cold war' and drew attention to the dilemma of a democratic society in competition with a totalitarian society where education was directed as an instrument of the state, and he commented that in the U.S.S.R., 'the linking of education to the economy is little restrained by traditional conceptions or by commitment to liberal education.' (9) The constraint of a commitment to liberal education in the USA was welcomed by Burton Clark as a necessary handicap and check on 'technical barbarism', the potential for myopia in social affairs, politics, and cultural understanding among men acute in technical judgement only. (10) In contrast to this characterisation of the American and Russian educational systems, Baran and Sweezy conceived of the American system as dominated by the capitalist economic system and lacking the humanistic cultural traditions of Russia. (11) While debates

(8) An early selection of papers which drew attention to these transformations is contained in the collection of essays edited by A.H. Halsey, J.E. Floud in C.A. Anderson, Education, Economy and Society. Later studies have attempted a broader comparative approach and attempt to develop typologies of educational systems. One example of a typology which attaches considerable importance to the dimensions by which response to economic demands can be assessed has been elaborated by Hopper, "A Typology for the classification of educational systems", Sociology, vol. 2, no. 1, 1968.


(10) Ibid., pp. 288-291.

have raged about the USA and USSR, most writers have agreed with Burton Clark on England that 'Cultural tradition restrains the change, since Oxford and Cambridge, national centres of an aristocratic tradition of liberal education, have long dominated English higher education.' (12) The usual discussion of this cultural constraint has been posed as a contrast between the economy's demands for the specialist knowledge of experts and the efforts of educators to promote 'the general powers of the mind' and furnish 'cultivated men and women' with a liberal, broadly-based education.

In this context of sociological and popular discussion, the manpower forecasters have seen it as paradoxical that they, the mediators of industrialists' demands, should announce that British education is too specialised and that employers really support a liberal education through a broad-based general education. (13) The paradox was more apparent than real, however, and owed much to the use of the term 'general' which could evoke many different conceptions for many different commentators.

In one sense the universities have always had a vocational bias, for in the preindustrial period they were linked to the provision of entrants to clerical orders. The universities were important too in the development of 'gentlemen' as future members of the gentry; the curriculum of philosophy and mathematics associated with the shaping of character was thought admirably suited to the development of the gentry for their roles as leaders. (14) Through the eighteenth century and early

(12) Burton Clark, op. cit., p. 57.

(13) See, for example, the rather smug view induced by this line of thought in B.J. Holloway, "Higher Education and Employment: a view from the interface", in P.R. Jevons and H.D. Turner, eds. What Kinds of Graduates Do We Need?, London: Oxford University Press, 1972, pp. 35-7.

nineteenth century considerable criticism was voiced about Oxford and Cambridge, about their closure to non-Anglican groups and the perfunctory attention to research and examinations. Increasingly the attention of critics was turned to developments outside Oxford and Cambridge, to the promotion of research in the Scottish and German Universities and to the scientific research and teaching encouraged in the non-conformist academies. Curiously, however, the very reforms intended to promote competence in the British civil service in the 1860's and 1870's were a stimulus not to the development of a new vocational education but to a revival of interest in classical educational forms and reform of Oxford and Cambridge. The association of these curricula with high status positions confirmed their suitability as educational devices to socialise and select recruits for elite positions on a meritocratic basis. The irony of the situation has been noted by Elliott.

"The non-vocational element was turned into a means of vocational preferment by the form adopted for the competitive systems in the civil and military services, by the prestige accorded to classical education in some of the more traditional professions, such as the Church, and by its general acceptance as a symbol of status and ability. The introduction of competitive examinations, designed to open recruitment into elite positions, had the effect of formalising and institutionalising the connection between the occupational elites and social elites." (15)

Moreover, Elliott gives an account of the way in which the older professions took on the characteristics of the gentry and the 'gentlemanly ideals' and differentiated themselves from those in commercial or industrial careers.

"The ideology of liberal education, public service and gentlemanly professionalism was elaborated in opposition to the growth of industrialism and commercialism." (16)

(16) Ibid., p. 52.
Thus the 'non-vocationalism' of universities appears to have been fostered in the late nineteenth century, to have been part of the development of a new rationale for the universities, to have been defined in part by contrast with industrial vocational training, and to have been so successful among adherents that the self-consciously innovatory efforts of the new provincial universities to provide industrially and commercially oriented education were countermanded. That courses available in universities have not remained the essentially Arts-based general courses associated with most conceptions of liberal education, stands as a reminder that commitment to liberal education has not been the whole story of university development. An important feature of increased specialisation and the apparent preponderance of single honours courses has been the growth of occupational professionalism among university teachers themselves. On the other hand the concept of a 'liberal education' and the 'cultivated man' has been an important feature of the debate about the educational system and the social order, and a general education as part of the effort to 'civilize' technologists appears to have lain behind the somewhat begrudging entry of technological studies to universities in the nineteenth century. (17) More recently considerable controversy was stimulated by the portrayal by C.P. Snow of a society where the social elite no longer enjoyed the 'lingua francæ' of a classical education but were divided by numerous specialist languages. (18)

(17) See Ashby's comments on the influence of Oxford educational thinking on educationists and the reluctance to develop separate institutions for technological studies. E. Ashby, Technology and the Academies, op. cit., p. 63.

(18) Rosinski has argued that Latin Studies were more than 'an expression of mere social snobbery'. He related the structure of the Latin language to the analysis of complex situations and the ready appreciation of their central features and the importance of this common language among statesmen, generals and merchant princes. (See H. Rosinski, Power and Human Destiny, London: Pall Mall Press, 1965, pp. 137-9.)
While 'general education' has been seen by sociologists as part of the conception of 'liberal education' which has served as the hallmark of the social elite in Britain, the use of the terms 'specialist' and 'generalist' have more pedestrian origins in the Swann Report. McCarthy distinguished two kinds of employer needs - one for 'specialist' skills and the other for 'generalist' skills. Both concepts could be defined by either educational or by employment characteristics. In educational terms, the 'specialist' had concentrated in one subject of study largely to the exclusion of others whereas the 'generalist' had studied a variety of subjects. In employment terms, the 'specialist' had studied to the equivalent of graduate level in a narrow range of specified disciplines or undergone lengthy training whereas the 'generalist' occupation could be undertaken after relatively short specialist training by someone of appropriate intellectual powers and personal qualities. McCarthy then attempted to quantify the extent of both types of educational provision and employment opportunities in Britain and America and concluded that under 20% of graduates in Britain emerged from generalist studies in the 1960's compared to the 65-75% of American students who received generalist education. It is important to note that McCarthy set out with the presumption that 'generalist' studies must relate to society, and by a process of presumption and definition considered only 'science-based generalist' education. In considering employment opportunities, McCarthy concluded that science-based specialists were engaged mainly for R & D and in neither country did the proportion of qualified scientists and engineers in manufacturing industry in R & D exceed 4.0%. The Swann Committee seized on the McCarthy report with somewhat incongruous logic. Beset by

(19) M.C. McCarthy, op. cit., p. 3.
a desire to break the presumed automatic link between 'good degree' results in specialist courses and employment in research, especially in universities or government, and promote the prospect of careers in industry, the Swann Committee linked 'generalist' jobs and 'generalist' education in the characteristic fixed input-output coefficients of manpower forecasting. Although McCarthy could only hint at evidence that companies with different educational structures, (i.e. differing proportions of staff with 'specialist' and 'generalist' education) had different degrees of economic success, the whole frame of reference for the Swann and McCarthy discussion of 'generalist' study was the relevant base for subsequent specialisms and contributions to economic productivity, and universities were urged to consider broader first degree courses.

While the status conferring aspects of general education in the nineteenth century considered by sociologists were not discussed in the Swann Report, they emerge more clearly in the discussion of 'specialists' and 'non-specialists' in the Report of the Working Party on the Training and Experience Appropriate for Graduates Entering Industry. (20) The report distinguished the intake from universities to industry into two classes: the 'specialists' ("those who may well pursue their own discipline for the whole of their industrial life"), corresponded closely with McCarthy's 'specialists', and the 'non-specialists' ("those, whether initially specialists or not, who will move towards broader responsibilities in industry") correspond to McCarthy's category of 'generalists'. Although there were promptings to universities to make industrial careers 'visible' by encouragement, to emphasise techniques in the application of knowledge

(20) This cumbersomely titled body was set up by the Confederation of British Industry and the Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom after their joint conference of 1965.
to a greater extent than at present and to encourage teamwork, the report appeared to have reasonable satisfaction with provision for education for specialist employment. Education for non-specialist employment was less clear in conception but took on some of the emphasis on character formation and qualities for leadership associated with older conceptions of 'general' education.

"Industry defined its requirements somewhat broadly - it wanted good all-round men of well-developed critical ability who would have the capability of taking part in the decision-making which management implies. The men must be of good character, disciplined and such presence that they can exert personal influence over their subordinates. The real objective of industry is to get more of the better people. It particularly wants trained intelligence so that the individual has learned how to go on educating himself and is capable, therefore, of being moved rapidly into broader areas ....

For the specialists, fairly precise definition of the work to be undertaken in industry is possible. For the others this is not so. It is not depth of knowledge in a particular subject which is required, but high intellect and, in particular, skill in human relations ....

There is real need for steps to be taken to ensure that a greater number of the best graduates enter industry.

The situation could be improved if undergraduates were made more aware of the meaning, scope, and challenge of industry. This could be brought about by the introduction of studies such as the Role of the Graduate in Society, and continuation of these throughout first degree courses." (21)

However it is interesting that this Working Party made no general presumption that the broad general knowledge and development of intellectual abilities important for non-specialist employment should be on a 'science-
based generalist' course. One of the striking points to have emerged from several studies of managers in British industries is the paucity of qualifications in technical or scientific subjects. (22) The 1956 Acton Society researchers developed a scale for ranking 'advantageous' and 'disadvantageous' factors in promotion, in which 'technical qualifications' ranked bottom and 'arts degree, Oxford or Cambridge' ranked top of the advantageous category. (23) The Swann Committee anticipated criticism of their proposals for further 'generalist' education from those who perceived a conflict between studies in 'breadth' and the qualities of logical and rigorous analysis developed by studies in 'depth'. Such an attack came from two prominent professors of electronic engineering. Professors Sims and Farvis roundly condemned the recommendations for 'generalist' education.

"The'great culture swindle' which suggests that the 'butterfly' mind, fertilised by flitting from one subject to another, is the best kind to have, needs to be countered very firmly - and the sooner the better." (24)

The professors who provided manpower for the industry with one of the largest demands for specialist skills in R & D (albeit with an increasing proportion of Q.S.E.s outside R & D), saw the task of university as that of providing a relevant vocational preparation with 'optimisation' of 'syllabus content' and 'teaching techniques' in response to 'job analysis' and 'job specification'. (25) The Swann Committee version of 'generalist' studies

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(22) For a brief review of these studies, see Theo Nichols, Ownership, Control and Ideology, London: George Allen & Unwin, 1969 (Ch. 7, "Technocracy without Technocrats").

(23) Ibid, p. 83.


(25) Ibid., p. 277. While the language owes much to the audience and occasion, the underlying conception of education-occupation remains heavily coloured by the engineering approach to manpower-forecasting.
was relegated to a minor role 'for those who are unsure of what they want to do'. (26) A manpower planner, Hall, criticised the use of 'generalist' and 'specialist' categories for education as a fudge of the issues, he pointed out that McCarthy and the Swann Committee took two terms with established interpretations in university and industry and gave a third and novel twist. Hall doubted McCarthy's claim that specialisation was even greater in engineering studies than in science courses and contended that 'generalist' in industrial terms implied the engineer rather than scientist, and his conclusion was that when the weight and balance of faculties in universities were restructured away from pure science towards applied science and engineering then the balance of course provision would be corrected. (27) Subsequent study of first degree courses in physics has revealed evidence of a wider variety of course structures than was apparent to the McCarthy study. Although this can be partly attributed to new universities and technological universities not considered by McCarthy, Hutchings found considerable experiment in older physics departments. (28) Perhaps of greater importance was the lack of association between course structures and sector of employment which suggests that these relationships are more complex than formerly recognised. (29)

The search for alternatives to existing courses appears to have been proceeding within the universities prior to 1968, but the Swann Report may come to be remembered as a catalyst in this trend. Part of the success of the Report lies in the ambiguity of the phrase 'generalist

(26) Ibid., p. 278.
(29) The association between industrial employment and sandwich or applied physics courses could be attributed to prior decision by the student rather than the influence of course structure, ibid., p. 345.
education' which could appeal to the industrialist concerned about the pre-
vocational training of a manager or professional administrator and the 
academic anxious to assert the importance of liberal education. When the 
Swann Committee provided examples of 'generalist' courses they included 
at least three different kinds of course which could appeal to very different 
groups. In this category of 'generalist' education, McCarthy included 
the long-standing ordinary degree which offered a conventional curriculum 
in a main field to a sub-professional level. Such courses have tended to 
incure odium as inferior substitutes for the 'real thing', however. (30) 
In the second kind of course, the Swann Committee came close to advocacy 
of the 'specialist' course supplemented by 'tool' subjects, for example, 
social science subjects 'to acquaint the student in some depth with at 
least a few facts of the working of society'. (31) A third variant was 
the specially designed course which attempted to 'interweave several diverse 
disciplines to show their interrelationships and relevance'. (32) Perhaps 
the most radical proposal in the Swann Report was contained in a memorandum 
submitted by a member of the Committee, Professor Pippard, who proposed 
a two year degree course which should be a general course, of a specially-
designed type, whether Arts or Science, which could be followed by more 
specialised courses. (33) Although the Swann Committee found the proposals 
'stimulating and provocative', they did not endorse them in the main body 
of the report because they were 'hardly practicable, requiring too much 
of an upheaval in our accustomed habits to be readily acceptable'. (34)

(30) See, for example, the comments of the Swann Committee on the low 
status of the ordinary degree, The Flow into Employment of Scientists, 
Engineers, and Technologists, p. 78.
(31) Ibid., p. 76. This was akin to the Sims and Farvis recommendations.
(32) Ibid., p. 76.
(33) Ibid., Annexe E.
(34) Ibid., p. 78.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts (including theology, fine art, music, economics, education)</td>
<td>23.8</td>
<td>44.8</td>
<td>38.7</td>
<td>37.2</td>
<td>25.4</td>
<td>16.5</td>
</tr>
<tr>
<td>Social Studies (including social administration, business studies)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11.5</td>
<td>18.3</td>
</tr>
<tr>
<td>Pure Science</td>
<td>19.4</td>
<td>17.1</td>
<td>15.2</td>
<td>21.1</td>
<td>25.5</td>
<td>28.1</td>
</tr>
<tr>
<td>Medicine</td>
<td>33.4</td>
<td>23.3</td>
<td>30.3</td>
<td>21.0</td>
<td>14.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Technology (engineering, applied chemistry, architecture)</td>
<td>21.3</td>
<td>12.5</td>
<td>13.6</td>
<td>15.8</td>
<td>19.5</td>
<td>23.3</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2.0</td>
<td>2.2</td>
<td>2.3</td>
<td>4.9</td>
<td>3.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>(24,768)</td>
<td>(32,682)</td>
<td>(38,368)</td>
<td>(65,831)</td>
<td>(81,330)</td>
<td>(144,956)</td>
</tr>
</tbody>
</table>

Professor Pippard has continued advocacy of his ideas as part of a rationale and moral commitment for universities in an age of mass tertiary education. (35) Proposals for two year degree courses have gained a lobby in recent years on a variety of arguments from the strictly educational to the cost conscious, for Pippard a likely bonus was that science courses would not deter those students who baulked at the specialisation of natural science courses and chose social sciences.

Advisory Committees on scientific manpower and industrialists shared a common uncertainty about the social science faculties. The natural scientists saw them as rival claimants on full-time students and resources but potentially useful adjuncts to natural science courses, while the industrialists suspected that their popularity owed something to their existence as 'soft options' but suspected these faculties that attracted some 'bright students' too. Amid these debates about the vocational relevance of studies and the cultural constraint of older conceptions of education in England on shifts towards a balance of vocational studies, it is instructive to examine the changes in the distribution of students between faculties (Table 1). By 1968 pure science was the most popular grouping of subjects for men, followed by technology and social studies, this compared to the hegemony of medicine, followed by arts and technology in 1920. After the First World War the Arts faculties expanded to take a larger proportion of the male students compared to medicine and applied sciences. This development was attributed by the U.G.C. to the weak economic situation and the security of teaching. However, during the 1930's the trends in proportions were reversed and Arts subjects have taken a declining share of male graduates. The pure science subject group

had a declining share in the inter-war period but re-emerged after the Second World War to become the most popular group in 1968. The Applied Sciences and Technology suffered a comparable decline during the inter-war period and re-emergence in the post-war period. These statistics illustrate the sources of two points of concern, the position of technology vis-a-vis pure science at the beginning of the 1960's and the position of science and technology vis-a-vis social studies at the end of the 1960's. When all first degrees (men and women) in science and technology were considered by the Robbins Committee, the proportion of those in technology was lower in Britain (36%) compared with other advanced countries (Canada 65%, Germany 68%, and USA 49%). (36) By the end of the 1960's the moderately increased shares for pure science, applied science and technology, the latter especially inflated by the ex-Cats, were contrasted against the formidably increased share of students in Social Studies with some unease by the Swann and Dainton Committees. Yet these two sets of judgements on the extent to which the educational system has responded to the manpower requirements of the economy appear distinctly partial. The first neglected the importance of part-time education as part of the educational system and the second neglected the relevance of social studies graduates to staff the bureaucracies of advanced economies. The study by O.E.C.D. statisticians, Gaps in Technology, included qualifications gained by part-time study in the United Kingdom on the grounds that the tendency to regard all post high-school education as university education in the USA concealed the variety which was distinguished by more rigid distinctions in Europe. With this broader classification for comparison the results

(36) There were other factors too (of lower 'A' level qualifications, higher wastage rates and unfilled places mentioned in Chapter One) which perturbed the Committee.
### TABLE 2.

<table>
<thead>
<tr>
<th></th>
<th>Total number University Degrees</th>
<th>Degrees in science and technology $\frac{(2)}{(1)} \times 100$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>5,170</td>
<td>1,106</td>
</tr>
<tr>
<td>E.E.C.</td>
<td>2,175</td>
<td>711</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>662 *</td>
<td>250</td>
</tr>
</tbody>
</table>

Source: OECD, Gaps in Technology: Analytical Report, p. 30

Note: * 75% of persons who finished full-time education aged 20 or over.

### TABLE 3.
Number of first degrees (or degree equivalents) delivered in higher education in U.S.A., E.E.C., and U.K. - 1964

<table>
<thead>
<tr>
<th></th>
<th>Overall Total</th>
<th>Total Science and Technology</th>
<th>Pure Science (2) $\frac{(2)}{(1)} \times 100$</th>
<th>Total Population 20-24</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Science</td>
<td>Technology</td>
<td></td>
</tr>
<tr>
<td>U.S.A.</td>
<td>547.3</td>
<td>110.9</td>
<td>62.5</td>
<td>38.7</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>20.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13,520</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.704</td>
</tr>
<tr>
<td>E.E.C.</td>
<td>148.5</td>
<td>56.2</td>
<td>13.0</td>
<td>39.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>38.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.400</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>74.8</td>
<td>32.6</td>
<td>12.3</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>43.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3,556</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>711</td>
</tr>
</tbody>
</table>

were disturbing for the 'conventional wisdom'. (37) The statistics on
the numbers of persons with university degrees (or equivalents) and the
numbers of these degrees (or equivalents) in science and technology for the
U.S.A., United Kingdom and various E.E.C. countries reveal both the massive
gap between the U.S.A. and other countries in overall numbers of graduates
and the much higher proportion of these degree holders qualified in science
and technology in the United Kingdom compared to the U.S.A. (Table 2).
When the O.E.C.D. team examined the level of effort in the British
educational system in 1964, the year which marked the beginning of the work
of the Committee on Manpower Resources for Science and Technology, there
were some further remarkable comparisons (Table 3). Firstly, there was
greater emphasis on pure science compared to technology in the U.S.A. and
greater emphasis on technology compared to pure science in Britain, and,
secondly, the considerable stress on science and technology qualifications
as a proportion of all qualifications was even more pronounced among the
new cohorts than in the past. Finally, in an examination of enrolment
and graduation rates, the O.E.C.D. team concluded that 'in relation to
the size of its age group the United Kingdom is training 4.0% more
technologists than the United States'. (38)

There is one point remaining in this consideration of vocationalism
and the nature of response in the educational system, the process of
change in the occupational structure itself. Tables 4 and 5 indicate the

1970. It will be recalled that a prepublished version of this paper was
cited by The Economist in its criticism of the alarmist views of various
scientific bodies on the manpower situation. Prepublication copies were
cited by Hall and Blaug in their critiques of the Swann Report too, (see
Chapter One, section 4).

(38) Ibid., p. 37.
### TABLE 4: Occupied Population by Socio-Economic Groups, England and Wales, 1951 - 61.

<table>
<thead>
<tr>
<th>Socio-economic group</th>
<th>1951 Males ('000s)</th>
<th>1961 Males ('000s)</th>
<th>1951 - 1961 average annual compound change. Males %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Agriculture</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Farmers</td>
<td>270</td>
<td>280</td>
<td>0.1</td>
</tr>
<tr>
<td>2. Agricultural workers</td>
<td>690</td>
<td>470</td>
<td>- 3.7</td>
</tr>
<tr>
<td><strong>B. Non-agricultural</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I. Non-manual</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Higher administrative professional and managerial</td>
<td>450</td>
<td>660</td>
<td>3.8</td>
</tr>
<tr>
<td>4. Other administrative</td>
<td>1290</td>
<td>1620</td>
<td>1.2</td>
</tr>
<tr>
<td>5. Shopkeepers</td>
<td>500</td>
<td>580</td>
<td>1.5</td>
</tr>
<tr>
<td>6. Clerical workers</td>
<td>690</td>
<td>810</td>
<td>1.7</td>
</tr>
<tr>
<td>7. Shop assistants</td>
<td>480</td>
<td>570</td>
<td>1.8</td>
</tr>
<tr>
<td>8. Personal Service</td>
<td>310</td>
<td>330</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>II. Manual</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Foremen</td>
<td>470</td>
<td>530</td>
<td>1.2</td>
</tr>
<tr>
<td>10. Skilled workers</td>
<td>5070</td>
<td>5370</td>
<td>0.5</td>
</tr>
<tr>
<td>11. Semi-skilled workers</td>
<td>1580</td>
<td>14,30</td>
<td>- 1.0</td>
</tr>
<tr>
<td>12. Unskilled workers</td>
<td>1780</td>
<td>1740</td>
<td>- 0.2</td>
</tr>
<tr>
<td>13. Armed forces</td>
<td>480</td>
<td>260</td>
<td>- 5.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>14060</td>
<td>14650</td>
<td>0.4</td>
</tr>
</tbody>
</table>

scope of changes in the structure of the occupied population. The overall
trends towards a decrease in the proportion of the labour force in 'blue
collar' occupations and increase in the proportion in 'white collar'
occupations and the pronounced change in the higher administrative,
professional and managerial group are shown in Table 4. The bias towards
the application of scientific and technological skills in occupational
changes can be gauged from the breakdown of professional groups in Table 5,
where the largest increase was among the professional engineers (8.7%).
The more modest increase among scientists (3.0%) was an understatement of
the influence of scientists because it did not include qualified scientists
in 'non-science' occupations. Changes in the lower professions reflect
similar trends towards scientific and technological occupations with a
large increase among lab technicians. While trends are incontestable,
there is controversy about the mechanisms of change. Where the Swann
Committee interpreted the trends as a shift from jobs requiring little to
those requiring more education, (for example, from craftsmen to technicians,
and from technicians to qualified manpower) for the U.S.A. over the period
1940-1960, Folger and Nam estimated that, overall, '.... about 85% of
the rise in educational attainment may be attributed to increased educational
levels within occupations and only 15% to shifts in the occupational
structure from occupations requiring less education to occupations requiring
more ....' (39) Such a conclusion throws open the discussion of causes
of educational expansion, and it seems that employer demand for more
qualified manpower forms only part of the explanation alongside social
demand for education and the leverage gained by the academics and occupational
groups themselves for attempts to raise their social status.

(39) J.K. Folger and C.B. Nam, "Trends in Education in relation to

<table>
<thead>
<tr>
<th>Professions</th>
<th>Numbers ('000s)</th>
<th>1951 - 61 Average annual change %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1951</td>
<td>1961</td>
</tr>
<tr>
<td>Higher Professions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religion</td>
<td>32.5</td>
<td>38.8</td>
</tr>
<tr>
<td>Law</td>
<td>22.8</td>
<td>26.2</td>
</tr>
<tr>
<td>Medicine</td>
<td>35.8</td>
<td>44.0</td>
</tr>
<tr>
<td>Professional Engineers</td>
<td>76.5</td>
<td>175.6</td>
</tr>
<tr>
<td>Surveyors</td>
<td>31.0</td>
<td>42.2</td>
</tr>
<tr>
<td>Scientists</td>
<td>40.8</td>
<td>54.8</td>
</tr>
<tr>
<td>Qualified Accountants</td>
<td>31.8</td>
<td>47.4</td>
</tr>
<tr>
<td>Auditors, Editors, journalists</td>
<td>19.1</td>
<td>50.2</td>
</tr>
<tr>
<td>Lower Professions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trained nurses</td>
<td>19.1</td>
<td>19.3</td>
</tr>
<tr>
<td>Assistant nurses</td>
<td>2.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Student nurses</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Medical auxiliaries</td>
<td>34.1</td>
<td>37.8</td>
</tr>
<tr>
<td>Teachers (including university and music teachers)</td>
<td>122.0</td>
<td>186.6</td>
</tr>
<tr>
<td>Artists, actors and musicians</td>
<td>32.0</td>
<td>27.8</td>
</tr>
<tr>
<td>Laboratory technicians n.e.s.</td>
<td>47.6</td>
<td>104.0</td>
</tr>
</tbody>
</table>

4. **Life-Long Education and Training**

When the Swann and McCarthy Reports pressed for less specialised forms of undergraduate education they saw the corollary as more specialised postgraduate training. The pace of technological change was such that even those with specialised undergraduate courses employed wholly in research would need further training too. Whatever the kind of education or employment, the Swann Committee declared that 'post experience education and training are an essential part of the educational reform we are urging'.

(40) At this point the attempted usurpation of political responsibility by educational reform, a matter of later regret for Professor Swann, becomes especially clear. The Swann Committee decided that educational change was a necessary condition for industrial change and that the educational system could be directed more readily than industry with its multitude of different technologies and companies. (41) In this section I want to argue that industrial education and training, and education could be, and has been, tackled more directly through political measures directed to industry, through the Training Boards.

(a) **Training in the Electronics Industry in 1968.**

The general trend in the industry to abandon graduate apprenticeship schemes has been mentioned already in Chapter Five. At the time of the fieldwork most of the companies were considering change in their induction and training schemes, partly as a consequence of the dissatisfaction with the graduate apprenticeship schemes carried over from company activities in electrical engineering and partly as a response to E.I.T.B. recommendations.

(40) *The Flow into Employment of Scientists, Engineers and Technologists*, p. 80.

Table 6  Proportions experiencing different kinds of training experience (percentages)

<table>
<thead>
<tr>
<th>Training experienced</th>
<th>Company A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Establishment</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Direct Entry only</td>
<td>18 82 40 0</td>
<td>100 33 - - 82 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training Schemes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Training School/College</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Day release</td>
<td>- - - - -</td>
<td>- - 100 - 18 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Less than one month</td>
<td>- - - - -</td>
<td>- - 100 - 18 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Over one month</td>
<td>- - - - -</td>
<td>- - 100 - 18 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Training Project</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Perambulatory Tour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>100 100 100</td>
<td>100 100 100</td>
<td>100 100 100</td>
<td>100 100 100</td>
<td>100 100 100</td>
<td></td>
</tr>
</tbody>
</table>

Note: the various elements in a scheme are not necessarily mutually exclusive.
Graduate apprenticeships had been a recognition that graduates needed further training but tended to be deflected to attempts to impose craft skills rather than an acquaintance with craft skills. Across companies arrangements being tried ranged from direct entry schemes to various shortened forms of perambulatory tour round departments and various kinds and lengths of off-the-job course. Table 6 indicates the proportion of respondents in each establishment who experienced the various elements of training schemes and some companies operated very elaborate schemes, for example, company F had a three-part training scheme of company college, technical college and project which could be taken in whole or part.

Company recruiting literature stressed that the new training schemes were designed with flexibility to meet individual needs and placed emphasis on 'direct entry', that is, assignment to a full-time permanent post in a department rather than entry to a training school or college course or entry to a tour of company departments.

"Every newcomer to the organisation receives training appropriate to the job to which he is assigned .... The company believes in creating the situation in which people can thereafter develop themselves." (A)

"Planned practical experience .... tailored to each graduate's needs .... varying in duration for each individual from one month's induction to a full 24 month's practical training." (B)

"It is frequently found to be in the mutual interests of the company and the graduate recruit, that, instead of joining programmed training schemes, they should enter directly into laboratories or development or engineering departments. There they are able to make immediate use of their scientific or technological qualifications while simultaneously receiving specific training in the work of the department." (E)

The assessment of individual needs included some fairly standard criteria, for example, the sandwich course student was more likely to have direct entry compared to the full time student and the engineer was more likely
to have direct entry compared to the physicists. In addition, on employment criteria, direct entry was favoured for those entering research departments and a full two-year scheme, usually including a tour of departments, was retained for those entering production or commercial departments and some mix of training elements over a shorter period for those entering development departments.

In 'direct entry' schemes, training was largely given in the form of 'job instruction' so that the crucial points for the newcomer were the process of job assignment and supervision. (42) Graduates saw the former as the crucial point and, in contrast to the company claims that it was tailored to individual need, saw the outcome as determined by 'luck'. However, the graduates tended to interpret the possibilities as either 'direct entry' where one could be 'lucky' or graduate apprenticeships where disappointment was likely.

"I took direct entry. It is a matter of luck sometimes; I saw a chap come in the same year, I wouldn't like his job and I don't think he does. He doesn't get enough to do. Graduate apprenticeships, I think in theory are ideal. I tried to get one here but they offered me direct entry, you tend to get thrown in at the deep end. Graduate apprenticeships are ideal, but from what I've heard they are a bit of a let down in practice."

Even among those with favourable experiences of first projects which had drawn on their existing knowledge and skills, unease emerged when it became apparent that there was an element of luck in subsequent assignments which meant that learning became haphazard.

"I would like to have more formal lectures on different topics because at the moment training is haphazard, it depends on you. So far I have not got down to any study since I left university largely because I was fed up of study and didn't

(42) These issues are taken up again in Chapter Eight.
know in which direction to go. I would like to see more planned education for engineers and assistant engineers in industry. I think it's coming. I've been on one or two computer programming courses, but I'd like to know more about the direction of the job."

"I have the nagging feeling that this is all very well and I've been here a year but if I stayed three years I would be chopped and changed about. I could become good at all sorts but not expert at anything. That would be O.K. for a year or two, but if I tried to change jobs then I would have no real experience to offer. I could only take up a similar job."

If direct entry was criticised as haphazard, the same charge could hold for those companies which attempted to supplement training through on-the-job instruction with off-the-job courses. Such off-the-job courses varied considerably from a short 'rapid reading course' to a day-release management course within the company over the first year to a three-month course in production technology. The problem of ad hoc supplements was that they were not necessarily seen as relevant to the newcomer's situation. In a company where an attempt was made in an induction course to give a rationale for the courses this was clearly appreciated.

"I didn't realise I was going to be trained so long. My first idea was that I wanted to get on a job. I had been doing nothing for umpteen years and I wanted to see if I could do something. But looking back I think the lecture courses were a good idea - it was also good that they weren't any longer. I realise what I am doing and why I am doing it. It gives you the basic computer technology and very good programming experience...."

Two companies (A and C) attempted to give the broader view of company activities and extend the period over which the newcomer could choose his preferred area of employment. In these schemes the two or three assignments of three months each were much shorter than the two year tour but still tended to arouse complaints about the passive role to which a newcomer was assigned.
"I've only been in the department three weeks, working for a one-man team. He is very busy at the moment so he's not given me a lot of time. I am just reading up at the moment with no specific problem. This is work on coding systems, pulses to go along telephone lines such that they can be decoded at the other end.... At the moment I am being treated as an errand boy - we want these things duplicated would you go over to stage 2 and get them done. I would prefer to be given a defined project, this would depend on my being in a more permanent group, and I might be asked to find out about codes, then within certain parameters to design a possible error correcting code for so many errors."

"I came with few practical skills, so I plod round, look at the departments and see how they do things. There's very little responsibility given to me because I am just learning. I wish they would give us more freedom, give me a problem rather than just looking over somebody's shoulder. Obviously I couldn't solve a whole problem - I've too little experience. But really I want my own problem rather than somebody else's."

From these comments it might be expected that the extensive use of projects in company F would be welcomed, but it is important to note that these were group 'design and make' projects rather than individual design projects. The projects were recalled as both enjoyable and invaluable devices for learning about company resources and organisation. The reservations which were expressed dwelt on the anti-climax experienced after the project as the trainees entered work departments.

"The project was quite good. It gives you a chance to see round the company and see how it works. I don't think the project is quite the same environment as working in R & D. In the project you have overall responsibility to sell the finished product to the customer, in R & D you are responsible for only a small part."

"I did the project and I enjoyed that. Because I had industrial experience I became one of the influential people in the group. But the project was too good - too interesting. The actual job has been a let-down since, and one also finds that you are not so important and authoritative in groups."
For these projects a company department acted as a customer to a group of
graduate trainees, in turn the trainees were responsible for the allocation
of their £1500 budget, their own internal organisation as a group and the
design and manufacture of a completed device over a four month period. (43)
Approximately half of the 1967 graduate intake to company F undertook at
least one of the three modules of the training programme and approximately
one quarter took all three modules over an eleven month period. The
commitment of resources to this training scheme on a large scale meant that
organisationally significant projects became available in contrast to
those companies where training projects might be designed on an ad hoc
basis for a few entrants.

Collective training schemes were important sources of social contacts
for the newcomers to a company. Evan has suggested that the opportunities
to discuss the transition to a new setting with fellow-newcomers would
not only facilitate role transition, but have a bonus for the company in
low turnover. (44) The study was based on a technology training programme
in an American engineering company. Examination of turnover rates in
company personnel records revealed that the turnover rate declined with
departments where there were three or more new entrants (although turnover
was slightly higher in those departments with two entrants than those with
a single entrant). Admitting the need for a check on the causal
mechanisms of peer group interaction through interview data, Evan felt that

(43) The underlying rationale behind the course closely approximated the
thinking of the 'Bosworth' training schemes, see, Education and Training
Requirements for the Electrical and Mechanical Manufacturing Industries,
op. cit., and Bosworth's comments on "The Education and Training of the
Technologist" in the Gulbenkian Educational Discussion in Universities

(44) W.M. Evan, "Peer Group interaction and organisational socialisation:
a study of employee turnover", American Sociological Review, vol. 128,
no. 3, June 1963.
the statistical data supported his hypothesis of a negative relation between peer group interaction and turnover. (45) While interview data provides evidence of the importance of peer group interaction in facilitating the role transition from student engineer to employed engineer, it does not support the view that this support necessarily encourages commitment to the organisation. Some indication of the importance of peer group support can be gained by quoting comments from the extreme contrasts in socialising among a 'design and make' project group and the lonely situation of an isolated entrant.

"The project in itself provided the group with a bond, this sense of involvement was present from week one, and continued to grow as the project matured. The group activity included a four mile run one evening a week, with a swimming session on another evening. A military discipline being maintained throughout!" (Graduate project report)

This situation contrasts sharply with the comments of a graduate about out-of-work life in a company without a collective training scheme.

"At the moment I spend my time in the evenings, Monday to Friday, doing nothing, except perhaps cooking, washing, living in a bedsitter. This is more or less the suspended state I am living in. It's not permanent. At weekends, I see old university friends, not necessarily friends still at university. I've got half a dozen really close friends who I can go off to see somewhere."

In one company, the lecture on company personnel policy by the personnel director was followed by graduate questions as to why they had to 'clock on', an aspect of employment which was resented as unbecoming for graduates.

(45) Evan examined the possibility of a third variable affecting turnover, for example, the characteristics of departments, the nature of assignments, and scholastic performance. Holding constant peer group interaction, scholastic performance was found to be related to turnover but less important than the peer group variable.
The collective support of fellow graduate trainees focussed considerable hostility on company personnel policy which led on to salary policy and payment where secrecy about salary levels and promotion criteria 'and weekly wage payments were resented. Although a new title of 'junior monthly staff' was created, with monthly salary and a lab arrival book substituted for 'clocking on', the embarrassment to the personnel director led to a reappraisal of the group training scheme, doubts about the desirability of allowing 'inflated aspirations having their collective airing' and some arguments in favour of a 'direct entry' only scheme. Other examples of conflict with a company stimulated by peer group interaction were found in the various folk-tales about careerism which advocated frequent moves.

(b) Criteria for the assessment of training schemes

There are obviously a variety of ways in which training schemes could be assessed from the simple-minded psychological approaches which ask if trainees 'feel more competent' to economic approaches through estimation of financial costs and benefits. Yet another approach is to examine the likelihood that schemes will provide training experiences appropriate to organisational objectives through various principles derived from learning theory. (46)

Earlier discussion of opportunities sought in work revealed an extensive motivation to learn among graduates but reasons for joining companies revealed only two companies distinguished for training schemes. To the graduates the essence of desirable training was for individually-tailored, flexible schemes which involved planned experience. But several

of the schemes failed to give a clear rationale for the various elements of training and failed to provide occasions on which the newcomer could assess his developing competence. Only one company conceived the relationship between the graduate newcomer and supervisor as a tutor-tutee relationship, and since supervisors were largely allocated on the basis of work available the provision of coaching and guidance was very uneven both in quantity, and quality and source. Where trainees were attached to the training department budget then formal responsibility lay with the training department, but at the level of senior engineer, section leader or department head there was considerable latitude for interpretation of relationships with the newcomers from those where the task was seen as simply job supervisor, to those where it was seen as a mentor who guided the newcomer through up-ending experiences and any new learning. (47)

The central criticism of industrial training schemes was that, having abandoned the traditional conceptions of apprenticeships as 'ideal in principle but impossible in practice', companies were tending to allow training to go by default, and justify reliance on 'direct entry' as that combination of what graduates sought and was educationally desirable.

The addition of various ad hoc courses at local colleges unless clearly related to an overall programme could draw cynical comment from trainees.

"I've had one four week course and three lectures and I've been here eighteen months. As far as I know there is no training course. I was told you join as an assistant engineer for two years and have graduate training. I wanted graduate training, I was promised it - not in writing of course, they never put anything in writing."

"I was under the impression I was going to get graduate training. I am told I am getting it, but it really seems to be just a tax fiddle on the part of the company. From what I can see of the direct entry graduates and those on graduate training they are doing exactly the same. There is not really a course of any description."

Given the weak commitment to conceive themselves as part of the educational system with reference to new entrants, industrial demands that universities should produce graduates capable of 'self-development' becomes understandable, along with demands that universities put more emphasis on applied skills and project work. (48)

(c) The Engineering Industry Training Board and industrial training

Rapid technological change, fears of international competition, and studies of training provision in other countries were all stimulants to an interest in industrial training, and the passage of the Industrial Training Act through the House of Commons without a division in 1964 by a Conservative Government signifies the extent of concern. While greatest concern centred on craft apprenticeships, the manpower studies of the A.C.S.P. and the unwillingness of industry to match expansion of 'sandwich courses' in technical colleges with industrial places had drawn attention to technician and technologist training. Thus the Industrial Training Act, which empowered the Minister of Labour to establish a Training Board with wide powers, was a political response to apparent weaknesses in industrial training.

(48) Against these views the Oatley Committee declared that the primary tasks of the university was the teaching of analytical skills and that any project work or practical skills must be seen as secondary and subordinate objectives, The Relations between University and Industry in Electronics, Op. cit., pp. 9-13.
The Engineering Industry Training Board (E.I.T.B.) was among the first of the training boards. As a pioneer the Board attracted the praise and blame of observers and served as a model for subsequent boards. The centre piece of controversy has been the levy-grant system by which the Board raised a 2½% payroll levy (i.e. wages, salaries and directors' fees), the bulk of which was paid back as grants to companies for approved training. Several categories of grants covered the main transferable skills (craft, technician and technologist) with general grants for other kinds of training and supplementary grants to encourage particular kinds of training, for example, to cover shortages such as those of systems analysts. (49)

Since the return of a Conservative Government in 1970 pledged to restore economic vigour through encouraging a competitive marketplace, the Training Boards have faced an uncertain future. The C.B.I. listed four criticisms for discussion before the National Economic Development Council (N.E.D.C.) which included (a) high administrative costs and bureaucratic complexity, (b) inflexibilities and impracticalities in training recommendations, (c) inequities in grant-levy schemes, and (d) the problems of training in small firms. (50) Although there appears little substance in the first charge, the Electronics E.D.C. had criticisms comparable to the remaining charges to make of the E.I.T.B. (51) Because of the scope of E.I.T.B. coverage it was felt that the electronics industry was neglected

(49) The operation of various categories of grant and the desire of the board to encourage particular kinds of training meant that a company could claim grants exceeding its levy contribution. In the case of the E.I.T.B. there was a bar which prevented earnings beyond 150% of the levy. The Board has attempted to avoid 'freezing' company capital by raising the levy and paying the grant in one operation by use of estimates.

(50) Quoted in Rodney Cowton, "Industrial Training Boards under the Microscope", The Times, 7.10.68.

at the expense of mechanical engineering interests, and further that an industry marked by rapid technological change was prone to suffer the Board's bureaucratic inflexibilities. As one example of inflexibility it has been claimed that the Board tended to favour off-the-job training in its weighting of grants to the financial disadvantage of an industry which placed great emphasis in on-the-job training. Moreover the E.D.C. urged that large firms be allowed to operate their own schemes without detailed scrutiny and that the Board concentrate on the less able and less willing. The E.I.T.B. has gone a long way to meet all these criticisms and the rounds of negotiations begun in 1969 have led to a policy of 'disengagement' from the detailed mechanics of the schemes by creating more exemptions in the short term and efforts to develop a long term strategy to influence key decisions, provide relevant facilities on a national scale and advisory services. \(^{(52)}\) The general aim of the E.I.T.B. changes was to seek a compromise which would remove irksome complaints about administrative complication, inflexibility and small firm difficulty. Yet the details of proposals which both remove irritation but retain incentives and sanctions to provide training outcomes seen as desirable from a frame of reference broader than that of the individual employer, have yet to appear.

\(^{(52)}\) The first levy cycle took a 2\(\frac{1}{2}\)% levy from all firms with emoluments above £5,000 and the raising of the exemption level to £25,000 in 1972 removed half the companies from the register. While they did not qualify for general grant these companies could be aided by specific grants. The general policy statements for future strategy were listed, for example, the national activities included training recommendations, a training advisory service, model training schemes, training workshops; the Board saw key areas in the maintenance of supplies of those with transferable skills such as craftsmen, technicians and technologists, increasing supplies to cover temporary shortages such as systems analysts, and encouraging innovatory training especially where company capital costs are high, and assistance in the identification of company needs was seen as possible by the financial incentive or penalty and the provisions of consultancy services. Engineering Industry Training Board, Report and Accounts 1970-71, pp. 29-34.
In 1967 the Board issued recommendations for the training of professional engineers which became mandatory for grant approval in 1969. (53) These proposals form another set of criteria to judge the 1968 situation. In effect the pre-Training Board situation could be judged. The 1969 conditions provided for:

"(a) Appropriate treatment of the elements - induction, engineering practice, design appreciation, work organisation, objective training;

(b) the training facilities and arrangements are adequate to ensure the achievement of the training objectives;

(c) student log books are maintained;

(d) The student engineer has access to a professional engineer who acts as his industrial tutor;

(e) written training programmes exist for the student engineer;

and (f) records of the training conducted are entered in the training register." (54)

In these provisions point (a) referred to the course content and the subsequent points referred to both the kind of support services for student engineers (industrial tutors, written programmes, and general facilities), and the various devices by which the Board could scrutinise training schemes, (log books and training registers). The course content was intended to be flexible and give recognition to the variety of possible combinations of education and training from the three-year full-time university courses through to the various 'sandwich' arrangements, but it was intended that recommended items should be covered at some point. Even if it were assumed that the company would be responsible for only the final element, 'objective

(53) The Board has not yet issued recommendations for scientists or those in research departments, although these have been in preparation.

<table>
<thead>
<tr>
<th>Number of firms reporting employment of scientists and technologists</th>
<th>1966-7</th>
<th>1967-8</th>
<th>1968-9</th>
<th>1969-70</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use of formal selection tests</td>
<td>238</td>
<td>257</td>
<td>331</td>
<td>382</td>
</tr>
<tr>
<td>2. A formal induction course for every new employee</td>
<td>299</td>
<td>336</td>
<td>362</td>
<td>386</td>
</tr>
<tr>
<td>3. Job analysis to derive training programmes</td>
<td>152</td>
<td>173</td>
<td>231</td>
<td>319</td>
</tr>
<tr>
<td>4. A senior manager or technologist responsible for training of technologists</td>
<td>444</td>
<td>466</td>
<td>465</td>
<td>451</td>
</tr>
<tr>
<td>5. Written records for each trainee’s progress</td>
<td>370</td>
<td>394</td>
<td>417</td>
<td>418</td>
</tr>
<tr>
<td>6. Individual counselling by a senior technologist or manager for each technologist</td>
<td>355</td>
<td>435</td>
<td>458</td>
<td>448</td>
</tr>
<tr>
<td>7. Giving training for college based sandwich course students</td>
<td>318</td>
<td>348</td>
<td>351</td>
<td>329</td>
</tr>
<tr>
<td>8. Paid vacation training of at least six weeks per trainee</td>
<td>335</td>
<td>339</td>
<td>336</td>
<td>326</td>
</tr>
</tbody>
</table>

Objective training was preparation 'specifically for an identified first post of responsibility' and involved job description, job analysis, a training specification, and an objective training programme normally controlled and evaluated by the department in which the first appointment was to be made. It was precisely this lack of company commitment to educational or training programmes which was apparent in the 1968 study.

(d) The Impact of the E.I.T.B. and its training recommendations.

The establishment of the Training Boards and levy-grant schemes has changed the relationship between companies and their training departments. From the position of simple overhead costs training departments have become responsible for the management of significant budgets by a Government policy which redistributed resources within the company.

Some estimate of the impact of the E.I.T.B. can be made through examination of changes in training provision in the E.I.T.B. reports. Table 7 reports on training facilities for technologist training in companies claiming grant over the period 1966-1970 in the broadly based engineering industry. The important statistics are those relating to the large companies since they are responsible for 90% of the total annual recruitment of technologists. On the mandatory fulfillment of recommendations for grant there was a fall in the number of trainees as previous schemes were found unsatisfactory, although it was claimed standards for the remainder had risen (55).

Analysis of the various kinds of facilities provided

(55) The numbers of scientists and technologists given training fell from 13,552 (1965-6) to 13,004 (1969-70) despite a rise in employment from 60,450 (1965-6) to 63,973 (1969-70).
shows increases which together with improvement of quality suggest a
twofold improvement. The increases in the number of companies claiming
to base training programmes on job analysis (row 3, from 152 to 319 from
1966/7 to 1969/70), to maintain written records (row 5), to provide
individual counselling for trainees (row 6), and to hold formal induction
courses (row 2), all suggest greater attention to the analysis of training
provision and greater attention to support facilities. In the last resort,
of course, the task of 'policing' company training provision would prove
too daunting for the training board staff and the statutory control of
industrial training does rest on securing considerable industrial goodwill
and cooperation. In their annual reports the E.I.T.B. was aware that
in some companies training efforts were directed to grant recovery rather
than compliance with the spirit of training provision but believed that
the general response was favourable.

Concentration on the new supply of qualified manpower was justified
by the Committee on Manpower Resources on the grounds that the facilities
for retraining the existing stock were sparse. This view about retraining
marks a parallel case on the allocation of responsibilities between education
and industry which has been discussed here in relation to the new supply
only. (56) It marks a reluctance to spell out industrial responsibilities
and an attempt to shift the burden on to the educational system. (57)

(56) 1965 Triennial Manpower Survey, op. cit.
(57) See the discussion of 'Whose Responsibility?' by Lord Jackson of
Burnley, "The Magnitude of Occupational Obsolescence in Engineering and
Sciences" in S.S. Dubin, ed., Professional Obsolescence, London: The
<table>
<thead>
<tr>
<th>Age Group</th>
<th>1870</th>
<th>1902</th>
<th>1938</th>
<th>1962</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 year olds</td>
<td>40</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>12 year olds</td>
<td>2</td>
<td>9</td>
<td>38</td>
<td>100</td>
</tr>
<tr>
<td>17 year olds</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>19 year olds</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>

Source: Committee on Higher Education, p.11.
5. Educational Opportunity

At the end of the Second World War the Barlow Committee on Scientific Manpower was convinced that there were resources of talent not experiencing higher education. At the beginning of the 1960's the Robbins Committee advanced a similar view and deliberately attempted to destroy the notion of a 'limited pool of talent'. Perhaps the experience of the post-Robbins expansion lulled the Swann Committee to neglect 'wastage' from the educational system; the overall expansion in the universities appears to have been taken as adequate and criticism was concentrated on the distribution between courses (Social Studies versus Science and Technology). Yet despite overall expansion in the education system and larger proportions entering higher education than ever before, there remain two important types of wastage of children of high ability, one through sex and the other through social class.

The overall extension of higher education was documented in the Robbins Report (Table 8) where the proportion of nineteen year olds in higher education rose from 1% in 1870 to 7% in 1962. A common presumption accompanying expansion has been that educational opportunity has been extended to children from working class backgrounds, yet the Robbins Report revealed that the same proportion, a quarter of university students, came from homes of manual workers in 1926 and 1961. (58) On the other hand, this cannot be interpreted as a situation of no change, for example, Lacey has documented the consequences of increased vocational interest in education by the middle class in increased competition for grammar school places and the stability of the working class share in one grammar school. (59)

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(58) Higher Education,

Given a potential for the working class share of university places to fall in the face of increased middle class competition it could be argued that the long term stability was a small gain. (60) Yet it must be remembered that changes in the occupational structure have brought a diminution of manual occupations so that the stable share has been maintained from a declining population and thus represents a real gain, although smaller than anticipated. Since the non-university sector has been responsible for a substantial proportion of professional engineers it is important to see what has happened here. Hordley and Lee have argued that the technical colleges and professional institutions have permitted through part-time study a significant opportunity for working class children to proceed through educational qualifications to professional occupations by an 'alternative route'. (61) Although the argument lacks data for conclusive support, these researchers suggest that comparing pre-1945 and post-1945 situations there has been an increase in working class opportunities through technical education. Future prospects are somewhat unclear, however, since the Council of Engineering Institutions (C.E.I.) ceased to recognise the H.N.C. for exemption from Professional Institution membership examinations in 1962. While some have argued that part-time study was unsuitable for advanced courses, others have interpreted the move as an indicator of both the exclusive preoccupation of professional institutions with status claims in a drive for an 'all graduate profession', and the willing compliance of technical colleges eager to slough off part-time studies and ape universities. The status enhancing efforts of professional institutions and technical colleges and the apparent failure to extend


educational facilities more than proportionately to those previously disadvantaged would not matter to manpower requirements or an economic view of the manpower situation if we did not have our earlier evidence of the propensity of distinct social groups to enter scientific and technological higher education. (62) The importance of 'wastage' to manpower issues was heavily underlined by McPherson in his studies,

"The real causes of our shortage of trained manpower lie firstly, and primarily, in the failure of the educational system to retain highly intelligent pupils from homes of lower socio-economic states beyond the minimum school-leaving age." (63)

The other major wastage of able pupils from the educational system has been girls, for example, one study has shown that "in a situation where nearly all the girls who pass two or more A-level science subjects in school wish to go to university, only 40% of them, compared with about 70% of boys with similar qualification are admitted." (64) And a significant point to note about the girls is that they have not made significant use of the "alternative route". (65) This discussion of educational opportunity suggests that when shortages of particular groups of highly qualified manpower are being discussed, the analysis should contain some reference to "who is educated" as well as "how many" if there are distinctive patterns in the social background of recruits.

(62) See Chapter Six, section 3.

(63) A.F. McPherson, "Swings and Roundabouts" (personal communication). In a detailed study of twelve comprehensive schools some researchers have shown that one third of the most able pupils - those who appear in the top fifth of the national distribution of ability - were leaving school at 16. This pattern was despite proportions of those voluntarily staying beyond 16 being above the national average in the nine schools studied. J.E. Ross, et al., A Critical Appraisal of Comprehensive Education, Slough: N.F.E.R. 1972.

(64) C. Davies, Changes in Subject Choice at School and University, London: Weidenfeld and Nicholson, 1969, p. 45.

(65) I. Hordley and D. Lee, op. cit., pp. 24-25.
TABLE 9. Numbers attaching high importance to various goals of college education.

<table>
<thead>
<tr>
<th>University</th>
<th>Eng. %</th>
<th>Phys %</th>
<th>Ex Cat</th>
<th>Eng</th>
<th>Phys</th>
<th>Tech College</th>
<th>Eng</th>
<th>Phys</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Provide vocational training</td>
<td>42 (58)</td>
<td>17 (40)</td>
<td>5</td>
<td>2</td>
<td>9</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Develop social skills</td>
<td>39 (54)</td>
<td>23 (54)</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Provide basic general education</td>
<td>52 (72)</td>
<td>36 (54)</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Develop interest in social problems</td>
<td>21 (29)</td>
<td>14 (33)</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Develop Moral values</td>
<td>12 (17)</td>
<td>8 (19)</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N 72 41 7 5 13 3

TABLE 10. Numbers placing first in rank order various goals of college education.

<table>
<thead>
<tr>
<th>University</th>
<th>Eng. %</th>
<th>Phys %</th>
<th>Ex Cat</th>
<th>Eng</th>
<th>Phys</th>
<th>Tech College</th>
<th>Eng</th>
<th>Phys</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Provide vocational training</td>
<td>26 (36)</td>
<td>9 (22)</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Develop social skills</td>
<td>10 (14)</td>
<td>6 (15)</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Provide basic general education</td>
<td>33 (45)</td>
<td>26 (63)</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Develop interest in social problems</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Develop Moral values</td>
<td>3 (4)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N 72 (100) 41 (100)
6. The Student's Experience of Education

Just as it has been argued in the last section that factors beyond the control of the educational authorities have shaped the development of the educational system, so it can be argued that the wider society conditions the student's participation in and experience of higher education. In presenting this interpretation of the experience of many students I am arguing that academics have a much more circumscribed influence over their student's conduct than is claimed by those who see the answer to social problems in education.

The industrial recruits were asked to indicate what they felt the main purpose of a college education ought to be, and were asked in the first instance to indicate the degree of importance which they would attach to various goals and then were asked to rank order these goals. For present purposes the main contrasts lie in comments about vocational training and general education, where a higher proportion of both engineers and physicists attached high importance to general education rather than to vocational education (table 9). Similarly when it came to rank ordering, a higher proportion of both engineers and physicists put priority on the provision of general education than put priority on vocational training (Table 10). Comparing between disciplines the physicists were more likely to place emphasis on general education compared to vocational training than the engineers on both a scale of importance and a rank order. And this contrast between the former physics students and former engineering students held across institutions, from universities to technical colleges. This emphasis on vocational training among the engineers as the prime aim of college is consistent with our earlier findings that engineers were more likely to have decided on their chosen occupation earlier than the physicists, and most cases this was before university. If we turn to estimates of the importance attached to benefits derived from college attendance and the rank ordering of those benefits then the vocational
TABLE 11. Numbers attaching high importance to various benefits gained from college attendance

<table>
<thead>
<tr>
<th>Benefit Description</th>
<th>University</th>
<th>Ex Cat</th>
<th>Tech College</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng % Phys</td>
<td>Eng % Phys</td>
<td>Eng Phys</td>
</tr>
<tr>
<td>a) Opportunities to study in a particular field</td>
<td>69 (83) 37 (88)</td>
<td>6 3</td>
<td>13 3</td>
</tr>
<tr>
<td>b) Qualifications to ensure a reasonably secure/well paid job</td>
<td>70 (84) 38 (90.5)</td>
<td>6 3</td>
<td>14 3</td>
</tr>
<tr>
<td>c) A broader outlook on life</td>
<td>67 (81) 40 (95)</td>
<td>5 5</td>
<td>3 3</td>
</tr>
<tr>
<td>d) Opportunities to work in a university atmosphere</td>
<td>42 (51) 20 (47.5)</td>
<td>3 3</td>
<td>6 2</td>
</tr>
<tr>
<td>e) Personal freedom and social life</td>
<td>69 (83) 33 (78.5)</td>
<td>4 4</td>
<td>11 1</td>
</tr>
<tr>
<td>f) Training for a particular job</td>
<td>26 (31) 7 (17)</td>
<td>2 1</td>
<td>7 -</td>
</tr>
</tbody>
</table>

N 83 (100) 42 (100) 7 5 16 3

TABLE 12. Numbers attaching primacy in rank order to various benefits gained from college attendance

<table>
<thead>
<tr>
<th>Benefit Description</th>
<th>University</th>
<th>Ex Cat</th>
<th>Tech College</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng % Phys</td>
<td>Eng % Phys</td>
<td>Eng Phys</td>
</tr>
<tr>
<td>a) Opportunities to study in a particular field</td>
<td>22 (24.5) 15 (30.5)</td>
<td>4 1</td>
<td>1 -</td>
</tr>
<tr>
<td>b) Qualifications to ensure a reasonably secure/well paid job</td>
<td>35 (39) 16 (32.5)</td>
<td>4 2</td>
<td>10 2</td>
</tr>
<tr>
<td>c) A broader outlook on life</td>
<td>21 (23) 12 (24.5)</td>
<td>1 1</td>
<td>3 1</td>
</tr>
<tr>
<td>d) Opportunities to work in a university atmosphere</td>
<td>2 (2.2) 4 (8)</td>
<td>- -</td>
<td>- -</td>
</tr>
<tr>
<td>e) Personal freedom and social life</td>
<td>5 (5.5) 2 (4)</td>
<td>- 1</td>
<td>- -</td>
</tr>
<tr>
<td>f) Training for a particular job</td>
<td>5 (5.5) -</td>
<td>- -</td>
<td>2 -</td>
</tr>
</tbody>
</table>

Number of multiple responses 90 (100) 49 (100) 7 5 16 3

N 85 42 7 5 16 3

Note: Multiple responses arose when some respondents ranked some benefits of equivalent importance.
benefits of college attendance emerge as important again for both groups (Tables 11 and 12). Vocationally relevant qualifications emerged as the most important benefits among both engineers (40%) and physicists (34%), but few felt that they had gained training for a particular job as an important benefit (Table 11). Two interesting comparisons between the engineers and physicists were the higher proportions of physicists who saw the benefits of university education in the 'study opportunities in their particular field (29% v. 24%) and the acquisition of 'a broader outlook on life' (27% v. 23%).

All these responses about the nature of college purposes and benefits offer some indirect comments on the earlier 'generalist' versus 'specialist' studies controversy. In the last resort many of the graduates held an instrumental view of their education in the sense that they saw it as providing entry qualifications to work, although they did not see it as granting very specific job relevant skills. Moreover what the graduates (particularly the physics graduates) demanded of their universities was the development of techniques of investigation and analysis which would grant a degree of intellectual autonomy and a capacity for undertaking enquiry in a variety of fields. Yet this kind of demand does not appear to imply a linked demand for 'appreciating one's role in society' and the importance attached to understanding 'social problems' or 'developing moral values' appears negligible in comparison with the other aims of college education (Tables 9 and 10). (66)

If we turn to examine the extent to which university or college education was experienced by the sample as a beneficial preparation for industry then something of the intricacies of the relationships between

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(66) The difficulties and limited success in liberal studies for science students have been reviewed in P. Corbyn and D. Wield, "Science Education in a Social Context", New Scientist, vol. 47, no. 719, 17-9-70.
### TABLE 13. (a) Proximity of university courses to industrial employment by discipline and department (percentages).

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Engineering</th>
<th>Physics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R  D  P</td>
<td>R  D  P</td>
<td>R  D  P</td>
</tr>
<tr>
<td>Much the same</td>
<td>-  7 -</td>
<td>- - -</td>
<td>-  6 -</td>
</tr>
<tr>
<td>Some similarity</td>
<td>37  36 -</td>
<td>50  35  28</td>
<td>46  35  22</td>
</tr>
<tr>
<td>Very little similarity</td>
<td>63  47 100</td>
<td>50  40  57</td>
<td>54  45  67</td>
</tr>
<tr>
<td>None at all</td>
<td>-  10 -</td>
<td>-  25  14</td>
<td>-  14 11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>100 100 100</th>
<th>100 100 100</th>
<th>100 100 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(8) (70) (2)</td>
<td>(14) (20) (7)</td>
<td>(22) (90) (9)</td>
</tr>
</tbody>
</table>

### TABLE 14. (b) Proximity of university/college courses to industrial employment by department.

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R  D  P</td>
<td>R  D  P</td>
<td>R  D  P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Much the same</td>
<td>-  5 -</td>
<td>- - -</td>
<td>-  43 -</td>
<td>-  6 -</td>
<td></td>
</tr>
<tr>
<td>Some similarity</td>
<td>47  34  30</td>
<td>57  36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very little similarity</td>
<td>50  50  60</td>
<td>- -  48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None at all</td>
<td>3  11  10</td>
<td>- -  10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>100 100 100</th>
<th>100 100 100</th>
<th>100 100 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(32) (120) (10)</td>
<td>(7) (159)</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 14. Comments on the adequacy of University as a preparation for industrial employment among university educated engineers and physicists by department.

<table>
<thead>
<tr>
<th>Adequacy</th>
<th>Engineering</th>
<th>Physics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R  D  P</td>
<td>R  D  P</td>
<td>R  D  P</td>
</tr>
<tr>
<td>Favourable</td>
<td>50  60 100</td>
<td>38  62  57</td>
<td>43  60  66</td>
</tr>
<tr>
<td>Unfavourable</td>
<td>50  40 -</td>
<td>62  38  43</td>
<td>57  40  44</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>100 100 100</th>
<th>100 100 100</th>
<th>100 100 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(8) (52) (2)</td>
<td>(13) (16) (7)</td>
<td>(21) (68) (9)</td>
</tr>
</tbody>
</table>
expectations, experiences, and satisfactions in the evaluation of education becomes apparent. While a question about the degree of relationship between university courses and industry produced the expected pattern of decreasing proximity from research to production, a larger proportion of the researchers expressed dissatisfaction compared to the development and production department graduates (see Table 13). Overall the graduate engineers found satisfaction in the theoretical grounding on which to base subsequent training and experience, and in some cases undergraduate projects had developed relevant skills. For the physics graduates satisfaction was drawn from a university training in information sifting and experimental method. For some of the physicists it was accepted that the undergraduate course was not intended as vocational training and should not be criticised on that account. A closer examination of the criticisms of impracticality among some of the engineers revealed that many came from the company with an elaborate training scheme with group projects. But to press for changes in undergraduate education in the direction of more industrial relevance and project work is to raise the earlier mentioned issues of the balance between types of educational institutions and between educational institutions and industry, and the quality of information available to schoolchildren about educational and training provision. To press for projects or an industrial bias in undergraduate courses because the relevance of these skills have been perceived in industrial training is symptomatic of short term preoccupations, whether of managers or graduate trainees, while it must be remembered that students will choose and interpret courses in terms of their assessment of priorities in 'making out'. (67)

(67) One of the problems of liberal or social studies in engineering or science courses has been their apparent irrelevance to 'making out' as a student. See, for example, the comments by Corbyn and Wield, ibid., and L. Davies, Liberal Studies and Higher Technology, Cardiff: University of Wales Press, 1965.
While the 'student unrest' of the late 1960s might have disturbed the view of college as a collective and collaboration learning experience, a great deal of stress was laid on the possibilities for influence on students by college teachers whether through the design of courses or directly through example and precept. This heavy emphasis on the role of the teacher appeared in the Manpower Committee reports and in other discussions of the manpower situation, for example, those of the C.B.I. working parties. Among the sample of graduates in the electronics industry two sets of comments suggested that the scope of teacher influence was likely to be more circumscribed than commonly advanced. Against the view of college as a collaborative pursuit of learning by professors and students, many students saw their situation largely in terms of managing the competing demands of faculty and their own desire for 'free time', and 'good students' were defined in terms of their success in managing 'compromise' or 'balance'. While it was not altogether surprising that many graduates preferred their relations with industrial supervisors because the industrial relationships recognised a substantially advanced degree of competence in the developing technologist, I did not expect the marked antipathy toward university science and engineering faculty which emerged in these responses. While several studies have shown the paucity of contact with faculty outside the curriculum in science and engineering courses and others have shown the heavy emphasis on learning situations, which emphasise the disparity between teachers and students,

for example, lectures and classes rather than tutorials or seminars, few have shown the way in which these situations are interpreted by students as part of a larger context of social stratification with accusations of aloofness and snobbery by students of their teachers. (69)

To recommend an interpretation of the teaching-learning situation as one with inherent conflict is a helpful antidote to the tendency to canvass education as an ever-ready panacea to social ills. Pointing out some of the limitations on educational reform might usefully direct attention away from preoccupation with manpower supply and the educational system to a direct interest in the utilisation of manpower. This topic is explored in Part III through an examination of the responses of the sample of highly qualified manpower to industrial employment and the kinds of commitments which they developed.

ENTRY TO THE WORLD OF WORK
CHAPTER EIGHT

UTILISATION AND THE DEVELOPMENT OF COMMITMENTS

1. Introduction

Some comments on the nature of graduate experiences of industry have been introduced already in Chapter Six, on preliminary impressions in recruitment, salary information, and satisfaction, and in Chapter Seven, on training schemes. In this chapter the experience of employment as a full-time departmental member forms the subject matter of analysis. Exhortations to companies to improve their utilisation of graduates and the admission of the Swann Committee that the present state of industry was a deterrent to academically able graduates did not include any explanation of why this situation obtained nor of the way in which the graduates who joined companies was regarded as an unwilling and incapable entrant.

In tracing some answers to these questions I shall begin with a discussion of the nature of companies as organisations (section 2) and the efforts of managers to shape the conduct of newcomers (section 3). These sections will be followed by a discussion of managerial assignments and graduates in the 'R & D' departments (section 4), and the 'non R & D' departments (section 5). In the final section the relevance of these early assignments and experiences to the failure of companies to develop commitments among new entrants is discussed with some conclusions on the utilisation issue.
2. Companies as Working Organisations

The usual starting point for a discussion of organisations is to define them by reference to an ordered pattern of relations directed to achieve some explicit goal. This kind of approach runs into many problems. Critics argue that there may be a tendency to concentrate on the relations formally prescribed by managers in the organisation manuals and ignore many other relationships into which employers enter which have organisational consequences. (1) Conversely, it has been alleged that some writers concentrate exclusively on the 'informal relations' and neglect managerial directives in the 'formal organisation'. (2) The concept of organisational goal has been challenged because it is alleged that the implied consensus among organisational members can be empirically refuted and because it implies an a-historical 'social contract' view of the formation of organisations. (3) Consequently contemporary thinking about organisations attempts to go beyond the dualisms of 'formal' and 'informal' organisation and also attempts to conceive of organisations as coalitions with a degree of stability but where participation is continually renegotiated. (4)

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(1) This has been the main thrust of a lengthy tradition of Human Relations writing initially launched as a critique of the Classical Administration writers on organisations.

(2) This appears to be a fault in Dainton’s study (Men Who Manage) brought about partly by the covert nature of his work which limited access to official directives. The concepts of 'formal' and 'informal' are extremely ambiguous. At some points 'formal' refers simply to organisations, at others to the Weberian conception of bureaucracy, and at others the 'official' aspects and each of these different conceptions implies a different conception of 'informal organisation'. Unfortunately 'informal organisation' has become used widely as something of a catch-all for all unofficial relations, see J. Litterer, Organisations: Structure and Behaviour, New York, Wiley, 1969, pp. 159-60.

(3) The usual accusation is that the writer accepts as the goals of the organisation those stated by senior management and whether by accident or choice the sociologists becomes a managerial apologist.

While some writers have attempted to incorporate all organisationally relevant relationships within a single analytical scheme to avoid the pitfalls of the dual perspective on organisations, Burns has attempted to develop an analytical scheme which emphasises the variety of frames of reference available to the organisational member. (5) The fruitfulness of this analytical scheme was demonstrated in Burns' explanation of the failure of several Scottish companies to graft electronics on to their existing engineering activities in the 1950's. The starting point was the view that the management system, conferring and defining both rights to control activity and receive information and obligations to accept control and transmit information, was designed to coordinate efforts to meet organisational goals. Having stated the organisational goals, the prime task of senior management was to indicate the appropriate form of management system and set the boundaries of appropriate commitment to the organisation. This management system and the activities directed Burns termed 'the working organisation', and some forms of organisation appeared more appropriate to some tasks than others. A recurring feature of the companies studied was the continual attempt to formalise relationships into a pattern appropriate to conditions of stability, (a 'mechanistic organisation' closely resembling Weber's ideal type of bureaucracy), when the organisation's problems were those of coping with changing markets and technology and would have been more appropriately served by 'organic organisation', (a form of organisation where rights and obligations were less clearly prescribed and circumscribed and subject to 'adjustment and continual redefinition'). (6) While this 'bureaucratic pathology' could


be explained by the ignorance of senior management of problems and solutions or the age of managers educated in the traditions of Classical Administration, Burns showed that the rules of mechanistic organisations were convenient devices by which lower participants could set limits to their commitments to the 'working organisation'. Far from bureaucratic rules being imposed simply from above, they were sought from below too. Rules which set limits to the extent of the cooperation which could be rightly demanded of an organisational member indicated, by implication, his freedom to compete in the career system or 'play politics' in the political system of the organisation. Career advancement and participation in decision-making were morally legitimate and defensible acts within the organisation, indeed organisations frequently advance the view that they must motivate the 'best people' to secure 'the most important posts', but it can be readily seen that demands for both cooperation and competition can pose severe dilemmas for members of organisations in concrete situations and explicit rules can simplify the allocation of effort.

When an organisation is conceived as composed of a variety of social systems built out of commitments at work, each of which may become the dominant frame of reference for the individual, the sense of threat to the organisation faced by the newcomer becomes apparent. He poses a threat in the sense that he may be unaware of organisational role demands, and, while a degree of ambiguity may enable agreement about broad organisational objectives, ambiguity about specific demands is unlikely to elicit satisfactory contributions from newcomers. In any event it is naive to believe that a list of bureaucratic rules would be sufficient guide to the newcomer, for rules require a penumbra of common understandings which guide their interpretation. (7) Even if the newcomer were competent

to meet organisational demands there may remain doubts about his willingness to respond to these demands. By a variety of means organisations attempt to control the conduct of their members to secure satisfactory performance, and some of these important devices have been discussed already. By representations to Governments and educational institutions, industry has attempted to shape the education, training and work preferences of potential employees, and by use of selection companies attempt to recruit only those likely to be willing and able to comply. Even if the educational system has processed its charges such that contemporary organisations have less need for the primitive conformity of past bureaucracies, these organisations still demand a degree of predictability about member behaviour and hold newcomers in some suspicion until their ability and willingness to meet role requirements has been made manifest. Where the last chapter placed the emphasis on company training schemes and efforts to enable the graduate to cope with his new situation, this chapter examines the learning experiences of the graduate as a full-time member of the 'working organisation'. The initial focus is on the efforts of organisations to change newcomers, to change their attitudes and behaviours and to change them into conforming 'organisation men'. The ideology of much of the managerial literature is that 'direct entry' is not only what graduates want, but is the best available learning situation for the development of technologists. The discussion of 'direct entry' schemes in Chapter Seven revealed that they tended to be experienced as somewhat haphazard introductions to work and were criticised against some general principles of learning theory and against the E.I.T.B. recommendations about engineer training. Here the practice of 'direct entry' can be criticised as unlikely to produce the committed 'organisation men' envisaged in the managerial literature.
3. The Making of 'Organisation Men'.

From the manpower debates and interviews with managers it was evident that managers conceived a need to change the customary attitudes and behaviour of graduates developed through university studies. They drew attention to the characteristics of university study: independent work on largely analytical problems with known solutions which could be derived without severe constraints posed by time or cost. In contrast they saw industrial work as largely collaborative team work on practical problems where solutions were not known in advance by supervisors and where the solutions had to be produced within severely contained budgets of time and finance. And underlying these contrasts the managers contrasted the rationale of university education as being largely interpreted by students as being for their own sake, whereas it was emphasised that work in companies had to be seen by employees in terms of contribution to overall company goals. The efforts of managers to produce these changes in the conceptions of work and shape an occupational identity as a professional employee can be understood by reference to a model of influence processes and attitude change.

Schein's model of influence and attitude change views of influence as a process which occurs through time and can be distinguished into three phases - 'unfreezing', 'changing', and 'refreezing'. (8) In the first phase of 'unfreezing' the individual is disturbed such that he becomes available to change either by an increase in the pressures on him to change or by a reduction in factors which might create anxiety about change. The following phase of 'change' involves 'the presentation of a direction of change and the actual process of learning new attitudes'. (9)


(9) ibid., p. 335.
In this phase managers can use two main mechanisms to stimulate change, firstly by presenting a role model with whom the recruit could identify and attempt to emulate ('identification'), and secondly, the managers could attempt to manage the situation and problems confronting such that he will be constrained to discover the prerequisites for coping with his new situation (internalisation). In the final phase of 'refreezing' efforts are made to sustain the changes and while this depends in part on the congruence between the new attitudes and behaviours and other conceptions of himself held by the individual, it is important that there is congruence between the culture of the organisation and changed person. While this model was developed from studies of Chinese techniques of brainwashing, and it may be assumed that the changes envisaged by managers for their recruits are both less intensive and less coercive, when the model is stated in a general way it suggests some of the problems and difficulties which can attend efforts to create 'organisation men' and develop commitments to the 'working organisation' among recruits. For example, it can be seen that changes are less likely to be induced if there is little motivation to change and if there is anxiety about the prospects of change. On the second phase, a general prescription would be that the use of tutor-tutee relationships could be a faster process than the 'discovery' approach but since it involves a more passive role for the learner it might be less effective in developing lasting changes. Finally the 'refreezing' stage draws attention to the importance of congruences between demands, performances and rewards.

When we turn to the management literature to examine their prescriptions for securing the commitment of graduates we find that they bear a striking resemblance to the conclusions drawn by social psychologists. There is considerable emphasis on tasks which are within the newcomer's competence and are organisationally significant, and, above all, there is an emphasis on 'challenge'.
"Industry must pay greater attention to its entrants. Once the graduate is there, the responsibility for him passes firmly to industry. Suitable introductory schemes to engage his mental capacity fully at an early age are needed; so indeed are responsible tasks which are in keeping with his experience, but they must be responsible. Above all he must be kept at full stretch." (10)

While this suggests that industrial companies have not paid attention to the provision of challenging jobs, as the Jones Committee suggested too, the recruiting literature of the electronics companies made claims to offer precisely these conditions. Such work tasks appear remarkably similar to those advocated by Barlow and Hall in their examination of the correlates of successful role transition among beginning managers (11).

If there is a discrepancy between what graduates report and what companies advocate it could arise from different definitions of 'challenge' or from other factors which intervene to frustrate managerial efforts. So far in this treatment of the entry to work both graduates and work situations have been treated as homogeneous and now it is appropriate to drop this assumption. While there is a level at which companies demand expressions of loyalty from all newcomers the demands vary in kind and intensity across departments.

Loyalty in the manager's eyes was indicated by a willingness on the part of the recruit to not only recognise and respond to managerial demands as legitimate but to go further and signify a readiness and sensitivity such that demands were anticipated. Such anticipation could be taken as further affirmation of a commitment to organisational goals and a denial


(11) See the earlier discussion of this study in Section 3 of Chapter Three.
of personal ambitions at odds with the achievement of organisational ends. (12) Where differences emerge between departments are in the degree of explicitness with which demands are made, and by implication the degree to which they may be incompatible with other personal goals and are evidently incompatible. By common consent the sharpest contrasts are drawn usually between research labs and production departments. Since the research department has a raison d'etre in innovation, demands are less clearly specified than in the production department and time scales of work activity are much longer. Treating the industrial organisation as a linguistic community, or rather as a group of linguistic communities, is a useful analogy. (13) By this device the links between research, development, design and production become likened to an interpretative process where the various groups are concerned to translate the information of research into technically and commerically viable products. As the idea conceived in research becomes a design it begins to carry much more imperative demands for work activity, it becomes a definite guide for conduct. At the various stages of this process various groups develop their own specialist languages to describe and further their work but while this specialisation carries all the possibility of incomprehensibility to other groups, the ultimate Babel is constrained by the designation of hand-over points, points at which there are mutual obligations on groups to become intelligible to each other. The newcomer to an electronics


(13) An extended treatment is offered by Burns in T. Burns and G.M. Stalker, op. cit., Ch. 8, "The Laboratory and the Workshop".
company therefore becomes a member of both the department and the wider grouping of the company, where the department tends to carry the main responsibilities for recruitment and training (14). The contrast between research and production in the extent to which there is scope for individual variations in response to manager demands can be illustrated by descriptions from a company recruitment guide.

"The primary aim of the (electronics) research laboratories is to acquire a coherent background of knowledge of the whole range of physical phenomena which may reflect on electronics. This is achieved by adopting a research philosophy comparable to that existing in universities and by studying in depth the theory and properties of materials, devices, circuits and complete systems....

A feature of the laboratory is its flexibility and informal atmosphere. The scientific staff are encouraged to exchange views and contribute to each other's projects as well as being expected to assist in formulating programmes."

"Many graduates are better suited to the faster tempo of factory life where a sense of urgency and constant striving after higher productivity provide the necessary stimulus for personal effort and achievement ....

(a production engineer) must have a thorough knowledge of departmental routine throughout the plant and also of the time required to set in motion the many procedures to be scheduled before production can commence."

The illustrations show two central points of contrast between research and production settings in their impact on new entrants, the first is in the extent to which activities are pre-programmed and the second in the time horizon of demands. The structure of work roles and relationships for the laboratory is characterised as 'flexible' and 'informal' in contrast to the 'routine', many 'procedures' and 'scheduling' which characterise

(14) See the earlier discussion of departmental responsibilities in recruitment in Chapter Five and the discussion of on-the-job training in Chapter Seven.
production departments. The cycles of activity for research are much longer term with the emphasis on study 'in depth' contrasted to the 'faster tempo', 'sense of urgency' and 'constancy' of demands in production.

The implications of these contrasts for the graduate on his entry to a department are twofold, firstly in the managerial efforts to direct his conduct through training and induction, and secondly, in the kinds of difficulties which he is likely to encounter in role-learning. Given the emphasis on originality and informality in the research lab we might expect the managers would favour efforts to control the nature of the task and encourage the newcomer to define his own role as a researcher in the research labs, (in terms of Schein's model they would favour 'internalisation' as the main mechanism for converting the newcomer to departmental purposes) and this is broadly in accord with the emphasis on direct entry for research labs discussed in Chapter Seven and underlined by managers.

"I've resisted a lot of the formal induction schemes because I feel that they are more often suited to the development of production men. They might broaden someone but they are unnecessary for research."  
(Research lab manager)

"We can't have a formal training programme because research is a moving target."  
(Research lab manager).

For the production department we would expect greater reliance on off-the-job instruction or direct instruction by a supervisor in the routines and formal prescriptions for work conduct, and the graduate apprenticeships for entry to production departments broadly correspond to this situation, (and in terms of Schein's model indicate greater reliance on 'identification' as a change technique). Of course these induction techniques are not mutually exclusive, all that is claimed is a difference in emphasis. The different situations and schemes of introduction suggest that newcomers are likely to encounter different kinds of induction problem, in the
research lab where managers are not precise in their demands the newcomer may not know what is expected of him and encounters 'role ambiguity', while in production departments where demands are specified in detail, the graduate is more likely to experience conflicts between his own preferences for his work situation and that prescribed by management, a 'role conflict' which Cyert and MacCrimmon term 'person-role' conflict. (15)

If research and production represent strongly contrasted work settings then it must be remembered that there are intermediary stages in the translation of scientific knowledge into commercial products, and here the development labs appear to suffer popular misunderstanding, pose considerable problems of organisation for managers, and problems of comprehension for new entrants. The sources of popular misunderstanding are laid often at the door of those officials, statisticians, and commentators who use 'R & D' as a convenient short-hand for all innovatory activity. For the manager the organisational problems are those of devising patterns of work organisation to faster innovation, hence 'flexibility', 'informal atmosphere' and encouragement to the exchange of views and mutual support, and yet the development lab manager is concerned to hand over designs to the factory and sales department and resist the 'university philosophy' permissable in research. For the graduate newcomer development is a perplexing point of entry to the organisation because he shares with the layman many of the facile assumptions about 'R & D' as an undifferential activity and about 'creativity' as a diffuse

(15) R.M. Cyert and K.R. MacCrimmon, 'Organisations in G. Lindzey and E. Aronson, eds. Handbook of Social Psychology, vol. 1, Reading, Mass: Addison-Wesley, 1968. Role conflict may be of various kinds, for example, there are the conflicts which arise when two supervisors make separate and contradictory demands or when an individual attempts to meet the demands of two inconsistent roles. These concepts were introduced in Chapter Three, section three.
quality required throughout 'R & D'. (16) Again company recruitment literature can be used to illustrate the nature of work organisation and the implications for the newcomer in development labs.

"One of the industrial functions which is least understood and whose full significance is seldom recognised outside industry is development. Development can be said to bridge the gap between research on the one hand and manufacture on the other, and it stands as an identifiable function in its own right. The uncertainty which surrounds the word development is explained by the loose and often incorrectly used phrase 'research and development' to describe what is often straightforward product development with little or no research ....

(Development) is always directed towards the attainment of a clearly defined objective - usually the design of some product which has to be manufactured and ultimately marketed. Development can therefore be defined as the theoretical, experimental and design effort required to create a new product or system ....

Having differentiated between the function of research and development it is necessary to add that both of these frequently occur concurrently in the same laboratory."

In the following sections the problems of entry to the working organisation as they were experienced by the sample of entrants will be discussed. This discussion will concentrate on two themes of work demands and the extent to which the newcomer is expected to scan his work environment and formulate his own role definitions or is expected to follow the guidance of a supervisor, and the themes are discussed for the research and development departments and the production departments. In what follows it must be remembered that the samples of research and production departments did not include examples of all the variety evident in the electronics industry, for the research labs had limited budgets

which did not permit the extent of private venture projects (and hence 'university philosophies') of some of the industry's labs and the very recent origins of the integrated circuit have prompted some observers to liken these production departments to 'vast laboratories'. (17)

(17) On the nature of samples, see section five of Chapter Three.
4. Entry to Work in the Research and Development Departments

The end products of both research labs and development labs are paperwork, feasibility reports from the research lab and design proposals drafted into working drawings from the development and design lab. The idealised account of relations between research and development presents a smooth translation process. The research project might be distinguished into three typical phases, for example, a first stage of assimilating the problem characterised by a literature survey and proposals for further enquiry, a second stage of implementation of the experimental programme and review of the feasibility of alternative solutions, and a third stage with the construction of a demonstration model and final report with the design parameters for a successful device or system. At this stage the project might be transferred to the development department for engineering to a prototype stage. In development, detailed specifications drawn up by senior engineers may be followed by several stages of prototype building, for example, a stage one model to demonstrate feasibility in a working model may be followed by a stage two model which demonstrates that the model can be built in an acceptable time-scale from working drawings. From this second stage, the design and development engineers can draft the production drawings with the drawing office for despatch to the production departments. There are several points at which the industrial practice diverges from the idealised account. There may be mistakes in the labelling of the project and appropriate hand-over points. As one research manager indicated this error could arise from the desire of development engineers to undertake a research project and managerial policies to use research projects as rewards for their development engineers.

"We don't take the jobs so far and it's better to hand over to development people, we hand over a feasibility report concerned with the principles involved. One of the advantages of having a development unit on the spot is that we can hand over. We have transferred units to development
and five months or so later and they were drafted back. This gives development a flying start. I've drawn a fairly strict line between Research and Development, they have different types of people, different environments, and different backgrounds. Occasionally we get landed with development jobs which we don't like and occasionally they take a research job which we feel they make a mess of. They seem to regard a research job as a reward for their better blokes. They are doing a job at the moment that went to them and they tackled as a development job and landed in a mess with a half-working equipment. Now we are doing a broad study to sort out the mess."

It is in this sense that Allen has characterised a good deal of industrial research as 'gap-filling research', research undertaken into fundamental phenomena an understanding of which is important for the solution of industrial problems but whose study has been by-passed in the development of academic science. (18) The importance of undertaking this research is not always realised until resources have been committed in development stages and the ill-fated TSR.2 project cancelled in 1964 provided some examples of such errors. (19) Other factors complicate the smooth transition account too. While contracts may be placed directly at the development stage or enter research labs, they may be terminated at these stages too. A frequent grumble of managers was directed at the managerial problems which arose from the 'holding periods' on military projects, where expenditure on projects was suspended during a Ministry review at a report stage and left problems of holding teams together and managing

(18) Tom Allen, "Managing the Flow of Scientific and Technical Information", op. cit., Among historians of science and technology, there is a debate about the extent to which the development of scientific and technological information has been and continues to be relatively independent processes, see D.J. de Solla Price, "Is Technology historically independent of Science", Technology and Culture, vol. 6, 1965.

other projects against the vagaries of this contract research. The length of such holding periods could mean that the project team responsible for one stage might have been disbanded by the time of approval for the next stage and a new team had to be assembled.

The importance of these cycles of work activity on projects for new entrants lies in the opportunities and constraints which are created for job opportunities. As projects progress through research and development labs it is evident that they furnish quite different job opportunities, for example, different kinds of 'new knowledge and skill' are demanded, there are variations in the kind and degree of 'difficulty and challenge' posed, and the scope for 'freedom to carry out independent thought and action' changes quite significantly. Once researchers have decided between alternative courses of action, opportunities for independent thought and action are necessarily curtailed and beyond the stage one development model the scope for originality is similarly restricted in development, and in the later project stages a good deal of the work is routine testing. Of course the knowledge and skills associated with test are new to the graduate and valuable as a limited experience but 'challenges' tended to be associated with the preliminary stages of projects, with the assimilation of the problem or the preliminary stages of circuit design, in other words, with points at which analytical skills were most directly relevant and the scope for choice between alternative courses of action was greatest.

Involvement with projects at these early stages was also important because of the difficulties of acquiring information about earlier decisions and their rationale at the later stages and by implication gaining an understanding of one's own work role.

Research managers were unanimous in their preference for taking a new entrant to the lab on to the early stages of a project, for in the early stages the discussion of alternative courses of action among senior engineers was seen as invaluable both as job instruction and training,
the newcomer could be assigned a portion of the project as his own responsibility and could link his own personal development to the success or failure of the project.

"We realise that if someone takes on a job two-thirds of the way through then not only does he not understand it, even if he did understand it, he didn't start it and there's not the same incentive. And there's always the feeling that if anything goes wrong then he can blame it on the first two-thirds. So there are many reasons why we shouldn't start someone late on a project, certainly from an economic point of view we try not to do it. Sometimes the contract runs on several years but someone comes on a new aspect. I would have thought only 20% of our intake came in at the end of a project."
(Research manager)

"We put new people at the beginning of a project because it's inefficient midway through. At the beginning you can run over the project with him. Someone may leave so you have to bring someone new in, if you don't allow for some training in the time scale then someone may be hopelessly out."
(Research manager)

Managers of development labs, however, preferred entry to projects either at the beginning or at the end, on the test stages. At these stages of development projects, managers argued that a supervisor could outline the nature of the project, the function of the device and the rationale behind design decisions and the division of labour on the project. Again it was felt that in intermediary stages project engineers had neither the documentation nor the time to generate information for newcomers.

"The ideal point of entry to a project is either at the beginning or at the end. At the beginning someone can be integrated into the team or at the end, where a great number of mundane tasks remain to be done and a great deal of historical knowledge is not necessary, the path is well-defined. If someone comes into the middle of a project other people know what they are supposed to be doing and where they are going, so it wouldn't be wise unless the team has lost members and has got the time and takes the trouble to make new members of the team."
(Development lab manager)
"Where someone comes in is largely chance. If it is at the beginning then it is at the feasibility stage and it is rather like the deep end. If it is at the end then it is sub-unit testing and this is a good way to find out what the unit produces and it is a good point to come in. You can't always introduce graduates at the test stage. You could give him a piece of paper and say 'go and see if such and such can do that and then come back and ask questions' - that is a good way of learning."

(Development lab manager)

The importance of work cycles had become evident in the pilot study where managers spoke of the difficulties of developing a competence on 'open-ended problems' among graduates trained in universities on 'closed-ended problems'. (20) While managers conceived of the problem as one of broadening the range of variables considered in a problem and saw the ideal point of entry in the early stages of a development project, it was evident that their illustrations and graduate experiences suggested a tendency to put newcomers on to 'safe' projects or into technician roles supporting existing projects. Instead of demonstrating to the newcomer the processes by which designers convert 'open-ended problems' into a 'closed-ended problem' by assigning constraints to the range of potential solutions, managers appeared to select assignments which exacerbated the estrangement of the newcomer rather than facilitated integration. To assess graduate reactions to first assignments in the main fieldwork, responses to a question, 'At what stage did you enter the project on your first assignment?', were coded into simple categories of 'beginning/early', 'middle', 'late', 'test' stages. Clearly independent judgements about stages are difficult since on complex military weapons systems the overall project may be very lengthy but have discrete problems. For example, one project emerged from a Ministry decision to adapt an already developed

(20) See the discussion in Appendix Two, section four.
<table>
<thead>
<tr>
<th>Stage of entry</th>
<th>Research Satisfied</th>
<th>Research Dissatisfied</th>
<th>Development Satisfied</th>
<th>Development Dissatisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry</td>
<td>82</td>
<td>17</td>
<td>66</td>
<td>8</td>
</tr>
<tr>
<td>Middle</td>
<td>6</td>
<td>42</td>
<td>16</td>
<td>44</td>
</tr>
<tr>
<td>Late</td>
<td>12</td>
<td>33</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Test/Commissioning</td>
<td>-</td>
<td>8</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>(16)</td>
<td>(12)</td>
<td>(32)</td>
<td>(60)</td>
</tr>
</tbody>
</table>
missile for helicopter use. To the incoming graduate the specification for a trigger device for use in a slow-moving or stationary helicopter base in contrast to one available for a fast-moving aircraft base was a new project despite a lengthy project history for the original missile. These problems of observer classification, compounded by the juggling of staff between contract and private venture projects, were evaded by adopting the graduate's definition of the stage. The pattern of responses is broadly as expected with greater difficulties and dissatisfactions with first assignments being reported by those who arrived in the middle or late stages of projects, save for those development engineers who found the test or commissioning stages invaluable in experience as an introduction to department work (see Table 1).

A theme underlying the frequent satisfaction with early entry was the satisfaction with greater scope for applying existing skills and for shaping the project and terms of reference under which others worked. As one engineer explained, where knowledge was a highly-prized resource the background information and organisational familiarity acquired by an early assignment gave the newcomer the status of an 'old-timer', very quickly he became someone to be consulted by others.

"When I first came I did odd jobs and then I got on a project for a multiplexor for data transmission and I've been on that for thirteen months. Fortunately I got a fair share of the design of it, I came right in at the beginning and found this a great advantage. Other people, who came in later, didn't get anywhere near as interesting work ....

Coming in early on a project you get more authority than your actual grade merits. Other people came in later with the same qualifications and the same grade and you find you have authority over them because you know more about the project."

(Graduate engineer - development lab)

These comments can be compared to those of the entrant to the middle stages
of a project. Both development engineers dwelt on the importance of knowledge as a resource in the organisation and as a source of power and control over one's own situation and that of others. Lacking a knowledge of project and organisational history the late entrant was continually made aware that he did not share assumptions which others took for granted, that he was still untutored in the use of the organisation, and that he remained a stranger.

"I came in on the middle of a project working on the synthesiser for an aircraft radio. This was under a senior engineer with two assistant engineers, and we produced the synthesiser for several devices. The senior engineer was in charge of our project and several others, and he gave out the parts of projects such as the design of smaller circuits ....

I would have preferred to come in at the beginning of a project when the contract comes in and before they have decided on the overall plan of it. I believe that they have just three or four senior men, they decide everything and they just give out bits to different sections. I think it would be better if they have a big lecture or conference and tell everyone what they have decided and why - before they start giving out the different bits. It tends to be that you get your bit and you have the compass of your bit but you are not quite sure how it fits into the overall section. They are quite willing to tell you if you go and ask them. They are not secretive, it's laziness more than anything. There's no regular way of getting information."

(Graduate engineer - development lab)

These problems of a threat to one's routine work assumptions by manifestations of ignorance and confirmations of one's newcomer status appear more acutely felt in development labs compared to research labs because in the former history tended to be oral history, whereas the various reports demanded of researchers constituted a form of documentary history. Insofar as the research labs approximated to more applied projects or became involved in advanced development they approximated the work habits of development labs.

In the Scottish pilot study one development manager maintained that
### TABLE 2. Patterns of Work Organisation by department of employment (percentages)

<table>
<thead>
<tr>
<th></th>
<th>R &amp; D</th>
<th>Non-R &amp; D</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alone with little</td>
<td>-</td>
<td>1</td>
<td>11</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>consultation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alone with occasional</td>
<td>16</td>
<td>15</td>
<td>22</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>consultation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alone with frequent</td>
<td>58</td>
<td>45</td>
<td>34</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>consultation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close, informal</td>
<td>23</td>
<td>30</td>
<td>22</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>consultation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formal group</td>
<td>3</td>
<td>9</td>
<td>11</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 100 100 100 100

### TABLE 3. Patterns of consultation in Problem Solving (percentages).

<table>
<thead>
<tr>
<th>To whom first approaches are made</th>
<th>R &amp; D</th>
<th>Non R &amp; D</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor</td>
<td>29</td>
<td>45</td>
<td>50</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other than supervisor</td>
<td>18</td>
<td>8</td>
<td>28</td>
<td>28</td>
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<td></td>
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<tr>
<td>Anyone available</td>
<td>53</td>
<td>47</td>
<td>50</td>
<td>28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

N = 100 100 100 100

N = 28 121 10 7
the 'good recruits' did not need a close definition of their work - 'they create an area of work for themselves'. This view puts the emphasis for induction and training on the individual as a scanner of the organisation and provider of his own solutions to role and identity problems rather than a recipient of ready-made directives from supervisors. Yet the supervisor remains a central figure in the work life of the new entrant to a research or development department.

Supervisors tended to be organisationally and geographically little distant from the recruit, typically drawn from the senior engineers or designated section leader (21). The immediate supervisor was responsible for breaking down the project into discrete portions to be carried out by individual engineers. Thus although the research lab work might be organised into teams of engineers by techniques or specialisms and the development lab work organised into project teams, the work of a new graduate was frequently experienced as an isolated and independent 'sub-contract' to the section leader. The essentially dyadic pattern of work relationships was confirmed by graduate reports of their work habits (see Table 2). While there are variations in the degree of consultation with others, the majority of the graduates emphasised that their work was carried out alone, and this pattern was stronger in research

(21) Recent graduates entered as junior or assistant engineer and the typical progression was to 'engineer' after two years, and to senior engineer after a further two - five years. Section leader was usually the next level and might involve responsibility for five to ten engineers and assistant engineers. As the first line supervisor, the section leader was usually regarded as a critical point marking the branching of technical and administrative careers. Few graduates were supervised directly by the departmental head. Project leader was a transitory status during the duration of a project, at the termination of a project the project leader reverted to his title of senior engineer or section leader. Thus the majority of graduates were supervised by someone who was less than ten years older, only two or three levels higher in the hierarchy and worked on a nearby bench in the lab - engineers (8), senior engineers (59), section leaders (56), project leader (36), and departmental head (11).
than in development. Where consultation occurred it was frequently as a reference back to the section leader or senior engineer. Deciding at what point to ask for guidance was one of the central problems for the newcomer, given that he saw his supervisor as someone with responsibility for promotions and increments, a request for guidance, as a confession of ignorance, could carry penalties and the ability to work without supervision carry rewards. Few, however, elected to avoid supervisors and the majority suggested that on encountering a problem they would consult the supervisor in the first instance, or as they became knowledgeable about other lab members they would consult anyone available (see Table 3). Attempting an independent solution was important not so much because supervisors expected it as because feedback on how one was coping in the new situation was highly valued.

"I'm very much on my own after I've been given a problem and a couple of guidelines. Normally I just work away until I come to an impasse. I have to define the problem and if I can't solve it myself I usually ask - who, depends on who comes up first when I'm looking puzzled. That's unfortunate sometimes because I've not defined the problem to myself."
(Research physicist)

"I'm usually given so many days or weeks to do a job and if it's not coming out I get an opinion. I would like to be able to do it myself but I've only been in the job a year and I don't know quite a lot of basic physics. If it's a general question then other people in the lab can give general hints, on more specific things I see the section leader because once a week he has to go to a meeting to report on the project."
(Research physicist)

"It depends on the kind of problem. Some problems are intellectual and it's more satisfying to work it out for yourself, some are very pressing bits of information, like knowing what they are doing in production. Really it's not a question of how difficult the problem is, but how long can you afford to spend on it. Usually the project leader can tell me who has the answer."
(Development engineer)
### TABLE 4. Confidence in Supervisor's job knowledge by department (percentages)

<table>
<thead>
<tr>
<th></th>
<th>R &amp; D Research Development</th>
<th>Non-R &amp; D Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very little</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Not very well</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Fairly well</td>
<td>42</td>
<td>33</td>
</tr>
<tr>
<td>Very well</td>
<td>50</td>
<td>54</td>
</tr>
<tr>
<td>Don't know</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

100 100 100 100

N = (26) (11) (10) (6)

### TABLE 5. Confidence in Supervisor's competence by department (percentages)

<table>
<thead>
<tr>
<th></th>
<th>R &amp; D Research Development</th>
<th>Non-R &amp; D Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor job</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Fair job</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>Good job</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Very good job</td>
<td>42</td>
<td>31</td>
</tr>
<tr>
<td>Excellent job</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Don't know</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

100 100 100 100

N = (26) (11) (10) (6)
### Table 6. Confidence in Supervisor's willingness to help by department (percentages)

<table>
<thead>
<tr>
<th></th>
<th>R &amp; D</th>
<th>Non-R &amp; D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Development</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Production</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Applications</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>R &amp; D</th>
<th>Non-R &amp; D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Very little</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>Somewhat</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>To a considerable extent</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>To a very great extent</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>Don't know</td>
<td>-</td>
<td>10</td>
</tr>
</tbody>
</table>

N = (30) (121) (10) (7)

### Table 7. Confidence in Supervisor's skills in human relations (percentages)

<table>
<thead>
<tr>
<th></th>
<th>R &amp; D</th>
<th>Non-R &amp; D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Development</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Production</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Applications</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skill</th>
<th>R &amp; D</th>
<th>Non-R &amp; D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Not very good</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Does other things better</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>Fairly good</td>
<td>47</td>
<td>20</td>
</tr>
<tr>
<td>Better than most</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Very good</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Don't know</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

N = (27) (111) (10) (7)
The relationship with the supervisor assumed an umbilical character as the supervisor was the source of specifications and work assignments, hints on solutions, guidance on sources of information and facilities, the deliverer of chastisement on delays or mistakes, and ultimately the source of managerial assessment on performance. The relationship was rarely marked by overt conflict, however. Resentments about work assignments or pay increments were directed against 'the company' or 'higher management' rather than supervisors. While the tendency to transfer grievances across hierarchical levels to avoid face-to-face conflict has been evident to other researchers, the tendency to denigrate 'managers' and praise 'supervisors' owed something to the graduate's readiness to accept the 'senior engineer' or 'section leader' as an engineer, someone technically competent to exercise legitimate supervision. (22) Beyond departmental head managers were regarded as ignorant of lab conditions and the sources of the interferences and intrusions which constrained research and development. Supervisors tended to be highly regarded for their competence and willingness to guide the newcomer (see Tables 4, 5, and 6). If the social skills of these supervisors were less highly regarded than their technical skills, it must be remembered that where largely autonomous work situations were sought then technical rather than social skills were sought in supervisors (see Table 7).

Both the jobs themselves and the supervisors were the principle sources of information for the newcomer about organisational role expectations. In addition to telling the newcomer about expected and legitimate behaviour, these sources tell the newcomer about the occupational identity, about the kind of person he is expected to become and the kind of qualities which he should manifest. One of the central points of

interest in the research was the extent to which organisational role demands and the occupational identity thrust on the graduate in industry was compatible with the kind of identity which he sought to sustain. The literature on identities distinguishes several kinds of identity; the 'social identity', the broad social category into which a person may be placed by others; the 'personal identity', the distinctive category which attaches to one individual by virtue of his own unique life-history; and the 'ego identity', which is the individual's subjective conception of himself and his situation. (23)

In our discussion, the relevant 'social identity' is that summarised in the occupational title, and the point at issue is the extent to which the meanings attached to engineering signified by the work situations of recent graduates were welcomed by graduates and compatible with their 'ego identities'. (24) The extent to which conflict existed and the significance of the conflict for organisational and occupational commitments is discussed in the final section of this chapter, for the moment attention is concentrated on the learning of the organisationally-relevant occupational identity. In itself this exercise is interesting because it lends support to the earlier argument about the methodological unsophistication of those studies which lump together research and development labs in their discussion of orientations to work, occupational values, and job satisfaction. (25)

The question 'What do you think makes a good engineer?' was asked on the assumption that answers would give clues to the kind of work problem


(24) Gouldner discusses the issue in terms of the distinction between those identities 'consensually agreed as relevant or legitimate in that setting' (manifest identities) and identities 'defined as irrelevant or inappropriate' (latent identities). See "Organisational Analysis," op. cit, pp. 410-412.

(25) See Chapter Six, section four.
### TABLE 7: Definitions of the 'good engineer' by department (percentages)

<table>
<thead>
<tr>
<th>Desirable qualities</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Enjoyment of engineering</td>
<td>5</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>2. Ability to grasp the problem</td>
<td>22</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>3. Ability to grasp basic principles</td>
<td>22</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>4. Imagination</td>
<td>35</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>5. Intuition/‘feel’ for engineering</td>
<td>9</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>6. Practical outlook and abilities</td>
<td>18</td>
<td>33</td>
<td>18</td>
</tr>
<tr>
<td>7. Logical/methodical approach</td>
<td>5</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>8. Perseverance</td>
<td>9</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>9. Ability to meet time scales</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>10. Skills with people</td>
<td>-</td>
<td>20</td>
<td>64</td>
</tr>
</tbody>
</table>

Total number of multiple responses: 28 102 12

N = (23) (95) (11)
which was central to their situation and the kind of person they had to become in order to overcome them. (26) While it might be possible to derive a composite definition of a paragon of virtue from the responses, as Jahoda did among the students of Brunel University, the variations in response across departments appear more interesting as indicators of different preoccupations in different departments and as confirmation of the research manager's belief that research and development have 'different kinds of people'. (27)

Among the researchers the emphasis was on analytical activities and imaginative or original approaches to problems and solutions, for them the major issue was frequently the definition of the problem and solutions and these were most likely to be generated by someone who could work from 'basic principles' (see Table 8).

"It always seems to depend on basics. If you know how things work from first principles you can work it out from there."

Linked to analytical abilities is the diagnosis of problems the researchers emphasised imaginative and original solutions.

"Our line doesn't seem to be engineering, you've got to think of new ideas and ways of doing things. Engineers are necessary to carry out ideas, but you need something else for the ideas."

"Somebody who is original and can see the wood through the trees."

While some of the development engineers took up these themes, the preponderance of responses emphasised other and sharply contrasted themes.

(26) See the earlier discussion of the rationale for the question 'What makes a good student?' in Chapter Seven, section six.

(27) Jahoda derived the composite definition from first year mechanical engineering students: 'first-class technical education; ability to express oneself concisely in the written and spoken word; an essentially practical outlook; originality of mind; ability to supervise staff and to coordinate the activities of different people or groups of people; enthusiasm and interest for the work in hand'. M. Jahoda, The Education of Technologists: an exploratory study at Brunel, London, Social Science Paperbacks, 1963, p. 35.
Greatest stress was laid on the necessity to be 'practical'. The development engineers emphasised that practicality went beyond technical feasibility to include costs, time scales and commercial viability. Above all this was empirical knowledge and gained by experience.

"You've just got to be very practical in everything you do - you've got to take cost into account. Most of it comes with experience, there are a lot of tricks of the trade."

"A person who knows his job - practical experience keeps coming into it. You come across practical things you never dreamt about."

"My section leader is a very good engineer. I think a good engineer is someone who has got a very complete technical background, it needn't be very deep but solid as it goes. Practical experience is very important, there are a lot of tricks of the trade and ways out of certain situations."

This emphasis on empirical knowledge and skills, on 'tricks of the trade', carried as a corollary a playing down of the importance of analytical skills. Sufficient experience enabled the person to become the 'good engineer' as second nature, the personal identity was overtaken by engineering, and, even if 'made rather than born', 'good engineers' were marked out by 'green fingers'.

"A lot of people I work with seem to have green fingers in the way they put circuits together. I think the section leader's unusually good, he's had ten years' experience. They design systems but they know how to put the boxes together."

"An intuitive feel of what to do, not necessarily good on theory, not very good at all, but good on the practical side."

Among those who had completed a year in industry 'practicality' became linked to the qualities of 'persistence' and 'perseverance'. These were important to the completion of projects, in ensuring that projects went beyond the initial design stages to the routine work in the latter stages.
of projects. Again there is the observation in comments that 'persistence' and 'perseverance' are qualities distinct from 'originality' and not always found in association.

"Someone who can see the job through. Working on problems and it's not coming out you tend to say bugger it. It's difficult to persevere on some problems when it gets boring."

"Someone who is prepared to take the bad along with the good. Someone who's prepared to do the original stuff but doesn't get bored too easily with what follows."

Perhaps the most striking contrast in the pattern of responses between research and development labs lay in the emphasis on the importance of 'social skills', on 'getting on with people', in the development lab compared to the absence of any such references in the research labs. This contrast is consistent with the rather different work habits revealed already, and in their comments the development engineers drew attention to their dependence on fellow engineers within the lab for information and the importance of their contacts with drawing office and production departments.

"I suppose quite a bit depends on getting on with other people because of information and you get to know a lot about what is going on."

"You've got to be able to communicate with people and be tactful. The way you deal with people here is more important than anything else."

What I have presented in this section is an account of industry as a threatening situation for a recent graduate, especially an academically able physics graduate. Through exploring graduate perspective on industrial organisations, asking about their definition of their situation and the kind of person they would have to become to cope with that situation, it is evident that industrial demands challenge the conception of oneself acquired through academic success. Whatever sympathies managers might
have had with graduate preferences to begin assignments in the early stages of a project, whether this occurred was a matter of 'luck'. The first lesson for the graduate was that he had to manage his situation to secure assignments. 'Industry' did not use his skills: the onus was on him to become useful. Outside research, acquiring useful knowledge and skills was a threat because it involved acquiring factual knowledge and local lore, 'tricks of the trade' and 'rule of thumb methods'. These were areas of knowledge and skill which did not distinguish a distinctive graduate contribution, they merely highlighted adequacies compared to older engineers and technicians. The proclivity to define one identity along with a counter-identity was particularly apparent and meaningful in response to the probe question about a 'poor engineer'. Some of the physicists were resentful about being asked for an opinion on engineers and apologised for the company policy which "branded all professionals in R & D as engineers". In their answers, the physicists in research tended to emphasise the benefits of a scientific education, to stress the importance of theoretically-grounded knowledge and hold 'rule of thumb' methods in some contempt. Furthermore they could claim some scope for the expression of themselves as scientific researchers in their research departments.

"I think I am sticking to my training more than to an engineer's approach. From what I could gather their approach to things was more empirical. They fitted their results to an equation, without trying to find out why the results occur. They say this occurred and will occur again without trying to explain why - whereas I am trying to approach it in this way."

"There are a lot of people involved in engineering who more or less quote formulae from books and don't know where they come from or understand them. I don't hold with that - I don't like it."

The definition of the 'poor engineer' among the graduate engineers in the development labs was the antithesis of that offered by the graduate
physicist in research. The same paired contrasts of empirical and theoretical knowledge were evaluated quite differently and the 'poor engineer' was marked out as the 'scientist type' or the 'academic type'.

"Some people ought to be scientists. One chap on our graduate project was a very good Cambridge engineer. He more or less designed our instrument and was technically very good, really inventive. But he couldn't meet deadlines - the rest of us had to make him, lean on him. He had a very good idea which unfortunately would have taken ages, so he went away and came back with something much quicker."

"Some engineers tend to be not very good because they're too academic. They tend to waste a lot of time and not be practical."

"Someone who is too wrapped up in the technical aspects of things, not prepared to get down to it. Someone who shouldn't be in the engineering profession, they'd be better off in research or something like that."

"It's very good to have a brilliant idea but not unless it's practical. We have a saying round here that 'it's a (Johnsonism)' after the chap who was always thinking up brilliant ideas which became difficult to tolerate, that's to say, rather difficult to make work with everyday components. (Johnson) was quite a brilliant theoretician but rather poor on anything practical. Now he's left and gone to another firm."

Other references made an association between academic brilliance and a lack of social skills, and 'ivory tower types' became the butt of further criticism. In this context the suggestion that development engineers should enjoy their work as an important ingredient for success becomes intelligible, because it corroborates the view that either by selection of socialisation certain kinds of person, identifiable by their affinity for an academic scientific training, should be excluded from industry or at least contained within industrial research.

In attempting to establish a successful transition to industry one strategy among the development engineers was to exaggerate the social
distance between university and industry and to compound several role
transitions and link the transition from student engineer to industrial
engineer to the more general processes of maturation from child to adult.

"I would say that conduct here is much more mature. I would say that students are very
much more childish in behaviour and attitudes
to work at times. This element is just not
present when you get into the job. The
sense of humour's changed and the conversation....

In college we might not work one evening, we
might all go into the bar and not do any work
that night. Really it was a waste of time.
At college we were constantly talking -
conversations about women, all sorts. Some
parts of the conversation were quite worth-
while, and it was possible to have a really
serious discussion about politics, but in
general I think people there much more
frivolous. Now it's just not appropriate.
I think it's a case of in a few months growing
up. I don't feel inclined to carry on as a
student any more. I could no more imagine
one of the people from our lab going on a
demonstration than fly."

Perhaps the Autumn of 1968 heightened the consciousness of public debate
about students and legitimate conduct to a degree beyond levels obtaining
in the preceding years or subsequently. Events on the 'Anti-Vietnam
war' demonstration of 28th October became ready examples of conduct in
which some students might indulge, ('Arts students at that'), but which
was out of character for engineers. Even an occasional sympathy for
student grievance was sharply demarcated by disapproval of public
demonstrations and disruptive activities. In politics as in dress, the
engineer was one 'who did not stand out from the crowd', someone who
sought his identity in acceptance of prevailing values and norms, for
established procedures defined the bounds of feasible action without the
anomic confusion risked by challenges to the status quo. In the process
of role transition, the graduates became aware of the gap between that
'ego identity' which they brought to the industrial lab and the kind of
'persona' which they ought to present to supervisors and colleagues as an
acceptable front, a contrived 'self' which manifested the kinds of qualities of character evident in the 'social identity' which supervisors and colleagues sought to impose on newcomers in the lab. (28) An important element of this persona was a demonstration of one's availability for work by taking up a serious demeanour and acknowledging that the social moratoria, which permit student conduct, and sanction the very overt displays of role distance among students, or sanction humour, are suspended. Again the comments of the development engineer emphasise 'practicality' as an essential part of their front in conformity with the identity of the engineer.

"Changing from university to industry you feel you present a more staid outlook on life. You look back at some of the things you did in your university career and you think you were mad at the time. Of course you thoroughly enjoyed it and would have done the same if you had a second chance. The main change is a completely different atmosphere - a change from a largely academic one to a practical one ....

You feel university students tend to be a little boisterous and you feel that in industry you are somewhat less boisterous, there's not the opportunity. You work a 9 - 5 day if you like, in university you don't."

"At university people tend to be apathetic. Here it's a bit more lively and interested, so long as you don't have a sense of humour in your work. If you have a sense of humour in work it goes against you. People tend to think you're not serious. I've seen it happen to people. I've known what I thought of these people and been prepared to laugh jokingly, but I've restrained myself. You are marked out as frivolous. Engineers are very practical people and you have to take work seriously. You have to keep your sense of humour for home."

(28) E. Goffman, Stigma, op. cit.
The existence of an industrial subculture which defines the kind of person and conduct appropriate in industry and, in demeaning analytical knowledge and skills against factual knowledge and skills, attaches meaning to conduct and demarcates the boundaries of industry against universities puts into context the Swann Committee fears that the existing state of industry might deter graduates. This kind of subculture is more likely to be a stronger deterrent among those graduates whose identity has been shaped by success in the academic system, notably the academically-able physicist. Whether it is an effective and overriding deterrent depends on a number of other factors or commitments. The importance of the labour market and the state of the labour market in the 1960's as one set of factors in the flow into employment has been discussed already in Chapter Four, here it can be added that analysis of R & D expenditures by type of expenditure suggests the much greater preponderance of development expenditures against research expenditures and hence the much greater frequency of those settings in which hostility to academic science and physicists could flourish even in science-based industries. And when the electronics industry is put in the context of all manufacturing industry and R & D expenditures then the pattern of flows into employment in a period of increasing employment opportunities in academic settings is also intelligible in terms of the models of choice outlined in Chapter Six. How entrants to industry coped with their situation and the extent to which commitments were encouraged to the working organisation is summarised in the concluding section, which follows a brief comment on non-R & D departments.
5. **Entry to Work in the Non-R & D Departments**

Comments about entry to work in the non-R & D departments on the basis of the 1968 study must be circumspect since the samples were drawn from departments with distinctive characteristics and the numbers of new entrants interviewed were small. Eleven recent entrants were drawn from the production departments of three establishments of one company engaged in the manufacture of semiconductor devices and seven recent entrants were drawn from an applications department of the same company. Despite the small size of samples responses were internally consistent in pointing to different work experiences and problems in the non-R & D departments compared to those found in R & D. These differences served to underline the disjuncture between university and industry and the role expectations held by managers that graduates should not differentiate themselves as a distinctive class of employees by reference to their university-gained resources of analytical knowledge and skill but should concentrate on acquiring technical knowledge and skills of a factual kind through job experiences and didactic contacts with supervisors and should develop those social skills essential to the smooth functioning of a cooperative enterprise.

Recruitment to production departments was regarded by both managers and recruits as a first step towards production management. In two of the establishments recruits entered as trainee production engineers and in the micro-electronics establishment they entered as production trainees into the quality assurance department. Although the company graduate apprenticeship scheme had been abandoned, the production trainees were engaged on a two year training scheme which differed from the older scheme largely by longer periods of assignment to departments and the greater participation of the trainees in the determination of both the choice of department and length of stay. The micro-electronics training
scheme was described as 'informal', it was intended that trainees would
circulate around departments but the number of departments and length of
stay were unspecified in an establishment which had not recruited graduates
for two years and was still drafting training schemes to meet E.I.T.B.
approval. The applications laboratory, although physically located next
to a factory, was part of the commercial marketing organisation, responsible
for the exploration of possible applications for electronics devices, for
the advice on desirable new products to/company, and for advice to the
customers on use of devices. Recruits to applications departments had
opportunities for project work in labs using some of their university
training in the short term, some even called themselves 'development
engineers', and envisaged career paths into managerial posts in either the
technical or commercial field. Thus new recruits to these non-R & D
departments encountered training schemes similar to the R & D departments
in their emphasis on 'on-the-job' training but different in a 'perambulatory
tour' element.

In the production departments first assignments for the production
engineers were usually in the works study project and the quality
assurance trainees were assigned to undertake statistical investigations
of failure rates on the production of batches of devices. As in the R & D
departments the time scale of activities played a significant part in the
nature of assignments. The time scale of projects in production departments
was much shorter than either research, development, or applications
departments, and the constructed time scale associated with production
was compounded by the heavy losses which were being incurred by all British
companies in the micro-electronics sector. (29) One important facet of
assignments in the production departments was that tasks should have low

(29) See Chapter Four.
priority.

"We don't give newcomers work critical to the programme, we only give critical work to those who can bring home the bacon."

From the graduate's viewpoint these low priority projects had their consequence in maintaining the newcomer in a boundary position.

"My feelings vary from day to day but I would like to remove a general feeling that I am playing a game. O.K. it fills in my time but it isn't for real. At the moment I have a work study project. I was quite relieved to get this because it takes away the feeling of being guilty at wandering round with nothing to do. But nobody has looked at this valve type for years and it may be out of business in three to ten months. It's only a small production run anyway and the whole thing is geared to give you the impression that it's a game rather than for real. O.K. it will be good experience and useful but I would prefer to give some useful contribution and not play a game, disturbing a lot of people on the way."

(Production engineer)

Curiously it is the very definition of the situation as one in which work is largely evaluated in terms of its contribution to personal development rather than to some collective goal - 'working for oneself rather than for others' - which gave rise to the graduate's objections in this case. Among the production managers there was an emphasis on giving discrete tasks to newcomers as there was in the research or development labs. When it is found that the task which is devised from this effort to simplify the entry problem is largely a routine exercise, the assignment is justified on the grounds it is another facet of loyalty, of learning to undertake menial jobs willingly.

"To some extent it always works out that we give an individual something fairly specific. The first week or two should be acclimatisation just getting the feel of what we are doing anyway, then we hope for some fairly specific field for him to get his teeth into, to give him some competence. Around that job the specialised information should be vested in
the hands of his boss who should be able to explain. He should be given a fairly clear steer to his job.

He may be given some analytical work at first - data analysis or some physical experimentation. Analysis is frustrating, just sorting sheets, and the graduate may complain we should employ lowly paid clerical operators to do this. He's right of course, we should, but the trouble is we haven't got enough low paid clerical operators and often they've not got quite sufficient technical appreciation of what they are doing to do the simple sorting. Graduates have a tendency to see themselves as though they ought to be doing something more high powered rather than the menial tasks, but we all have to learn to do menial tasks, there are a lot of jobs I don't like doing."

(Production manager)

There are two further important and related points in this production manager's comments on the work situation, the first point is about the level of difficulty in the task and the kind of skill required for its resolution and the second point concerns the nature of the supervisory relationship. Graduates tended to agree that the analysis of rejects was a routine activity and concentrated criticism on the low utilisation of their technical knowledge and skills in work. They tended to see the inter-personal relationships which were affected by routine technical decisions as complications with which they might be better able to cope as experience augmented their personal flair. The wages of the operators, a largely female staff, were influenced by the reject rate and so the decisions of the graduate on a quality control exercise influenced the income and work conditions of operators. In any event the recommended action was rarely given directly by the recent graduate to the operators but referred back through his own supervisor to their foreman. This emphasis on the procedure was prompted by the desire to insulate various relationships and the graduate from the consequences of his political naivete and the insistence of foremen jealous of their position against newcomers. These graduates in production departments were distinctly
conscious of authority relations in their departments and they did not refer to their relationships with supervisors by egalitarian phrases such as 'working with X' as research or development engineers had done in interviews.

The applications engineers faced problems of entry to project cycles too, although these were considerably eased by the shorter project lengths and greater clarity in the definition of problems which came through the marketing organisation. Within the first two years the newcomer tended to be shielded from contacts directly with customers although he might meet with them and his supervisors. In this early employment period work tended to be analytical involving statistical analysis or experimental work, and in some instances, assignments which might include contact with production or research departments in other company establishments, in other words, in situations where conduct could be monitored before exposure to customers and 'outsiders'. The extent to which this early work period was marked by a preoccupation with technical problems can be judged by the traits of 'practicality' and 'intuition' marked out among the characteristics of a 'good engineer', and omission of references to social skills, among the applications engineers.

In their comments on the characteristics of a 'good engineer' the production engineers revealed a preoccupation with problems for which they had little preparation in either their university education or their industrial training. The main resource required in their situation was described as the 'ability to get on with people'. Dressed in their dark ties and dark suits, the production trainees identified themselves with management and presented a very different persona from that associated with the sports jackets and pullovers of the research or development labs. Yet it was a performance which graduates found difficult to stage, for whenever crisis situations arose the policy directives were clearly seen to come from their supervisors. Where factual knowledge of production
processes or company procedures was at a premium then the graduates were clearly disadvantaged compared to operatives and their supervisors. In a situation in which it was difficult to sustain claims to a privileged position on the basis of delegated authority or relevant competence, it was always tempting for the graduate to mount fraudulent claims by 'blinding with science' his onlookers or by emphasising qualifications, which, however dubious as attestations of fitness for his present situation, were nevertheless internationally recognised as meritorious. The way in which curiosity about 'irrelevant' information was sanctioned by disapproval and the assertion of an identity as a graduate as a defensive strategy were well understood by a recent graduate in production.

"The difference between school and university is that in one you are taught and the other you aren't. Here it's similar to school. The information given to me closely approximates to second-form history where everything is given to you in note form, everything is simplified so that you don't get bogged down in detail. And if you want to know the detail then nobody knows the detail anyway. At university it's a matter of getting the barest outlines and it's up to you to get the details, and you are encouraged to get into details. Whereas if you go into detail in industry you tend to get your fingers chopped off. You come up with a piece of information which, quite honestly, it might have taken you a week to get or you come across a blank wall and ask and somebody says, 'I've never known that and I've done the job for thirty years', and you feel you've had your fingers chopped off and you don't bother any more ....

You can get into a situation where you know very little of industry but you know an awful lot about university and your subject and you tend to fall back on this as a confidence booster. After all it's very good to know that although you may be considered a bit of an idiot at this sort of thing, that at something you've made your mark."

(Production engineer)

Falling back on his confidence booster the graduate can readily become the anti-hero of management folk tales about the inflated aspirations
of graduates and the conditional loyalty which binds them tenuously to the company and industry.

...
6. Company 'needs' and graduate 'aspirations'

In this chapter I set out to explore the kinds of demands made by industrial companies of their recently recruited graduate scientists and engineers, and the extent to which new entrants were encouraged to develop commitments to their companies and occupations in meeting these demands. Company demands were derived from official sources, for example, from the statements of industrialists and representative bodies, from evidence to Government enquiries, and from company literature, and from unofficial sources, from the interviews with managers in the electronics industry study. A consistent theme from these sources was that early assignments should be 'challenging' and 'responsible'. These concepts were elaborated in terms of tasks which were of sufficient difficulty to be problematic for graduates but soluble by drawing on his existing knowledge and skills and by extending his competence in areas relevant to company purposes. An essential distinction was that between 'routine' and 'non-routine' work where coping with all the uncertainties of choices of lines of action and task outcomes seemed to be of the essence of the graduate's skills. Contrasted against these tasks, which summoned problem-solving skills, were the routine tasks of drafting wiring schedules, tests and measurements, where choice of action was negligible and the detailed activities of the graduate could be specified in advance. These routine tasks were regarded, especially in the official literature, as inappropriate for newcomers, for they offended both canons of 'challenge' and 'responsibility'. But when principles were compared with practice it was found that 'challenge' and 'responsibility' were frequently withheld. Examination of both the interviews with managers and graduates revealed that first assignments were frequently routine, rather than challenging, and low priority, rather than responsible. Frequently managers admitted that there was a sharp contrast between the attractions and energies advanced in recruitment
campaigns and the mundane and haphazard indifference apparent in assignments. Explanations for these discrepancies indicated a preoccupation with priorities other than training and induction for newcomers and a suspicion of newcomers who had to demonstrate their 'loyalty'. Of course, demands were shown to vary across departments with the greatest propensity for routine work assignments and an obligation that they be undertaken willingly was found in production departments. At this point, it is appropriate to pull together the strands of this discussion to comment on the utilisation issue in the manpower debates.

Economists have long preferred to write of 'wants' rather than 'needs', for the demands for goods and services studied by economists have been seen to vary by culture and climate, and by price, whereas 'need' implied something essential for survival. Furthermore, the economists were wary of making recommendations which might carry value judgements in the prescription of 'need'. With this tradition, the objections of Gannicot and Blaug to the manpower forecaster's view of 'national needs', that these introduced metaphysics to the debate and owed more to values than judgement, were understandable. In another study, however, Blaug and his colleagues attempted to provide some empirical referants for mal-utilisation when they asked job analysts to assess various company positions in terms of requisite formal educational levels. (30) Then the researchers produced a matrix to compare requirements against attainments. Whilst the results provided some evidence of 'underutilisation' (i.e. some people employed in jobs requiring education levels lower than their attainments), the authors were more impressed by the evidence of underqualified people, those whose educational attainment levels did not reach requirement levels.

How far the evidence is a function of a job analysis approach, which specifies prestigious qualifications for prestigious posts or deals simply with formal full-time education to the neglect of experience and part-time education, is not clear. The attempt to provide empirical content for the concepts was interesting but looks suspiciously like an attempt to convert an issue of fact and value into a wholly technical issue of fact. The attempt neglects the moral order which underlies the division of labour. Discussion of the division of labour evokes references to moral precepts and conceptions of fairness because the distribution of work is closely related to the distribution of rewards. (31) The moral aspects of social relationships have been properly understood by the philosopher, Dorothy Emmett, as she points out,

"The notion of a role has built into it a notion of some conduct as appropriate ... The notion of role ... provides a link between factual descriptions of social situations and moral statements about what ought to be done in them. It has, so to speak, a foot in both camps, that of fact and that of values ...." (32)

The importance of this moral discussion to the utilisation issue can be illustrated, indeed becomes most apparent, when we examine satisfactions found in work. For example, in the electronics study questions about satisfactions, dissatisfactions and preferred changes in work were asked in order to elucidate those aspects of their work by which the graduate engineers and scientists sought to identify themselves.

It was found that responses to the question "What aspects of your job do you find most satisfying?" could be coded under four main headings; those referring to technical factors, those referring to self-development,


TABLE 9. Satisfying aspects of jobs by department (percentages).

<table>
<thead>
<tr>
<th>R &amp; D</th>
<th>Non-R &amp; D</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Development</td>
<td>Production</td>
<td>Applications</td>
</tr>
<tr>
<td>Those mentioning satisfactions.</td>
<td>65</td>
<td>93</td>
</tr>
<tr>
<td>Those without satisfactions</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Don't know</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

Sources of Satisfaction

**Technical**
- Solving a challenging problem: 18/24/30/29/23
- Solving a problem: 21/23/30/29/24
- Bench work: 3/6/-/-/-
- Making something that works: 34/34/40/43/35
- Aesthetic work: -/3/-/-/2
- Job variety: 6/3/-/-/3
- Advancing the 'state of the art': -/3/-/-/2
- Putting theory in practice: 6/5/-/-/6

**Self Development**
- Applying university/college training: 3/4/-/-/-
- Learning new skills: 5/9/10/14/9
- Opportunity to prove oneself: 18/19/20/72/21

**Work Relationships**
- Autonomy: 6/5/10/14/6
- Responsibility: 15/4/10/14/8
- Power: 3/2/-/-/2
- Pleasant colleagues: 3/5/10/-/5
- Organisational facilities: -/2/-/-/1

**Extrinsic rewards**
- Social worth of products: -/1/-/-/-

Number of multiple responses: 46/180/16/18/260

N = 33/120/10/7/170

Note: percentages are given from the number in each departmental group who cite an item.
those referring to interpersonal relations in the work situation, and finally, those referring to extrinsic factors such as company location.

Of the 170 relevant interviews, 12 respondents could find no satisfaction in their present job and 3 did not know what aspects of their job gave them satisfaction. Of the remaining 155 respondents, the overwhelming majority, 130, referred to the technical aspects of their work as a major source of satisfaction (see Table 9). Over a third of these references were to craft aspects of engineering, for example, in 'making something that works', and well over half of the references were to 'problem solving', especially on problems that had difficulty and challenge.

"Producing something concrete - something that works".
(Graduate engineer, applications lab)

"I shall find it very satisfying when I've completed my prototype and it works. I find satisfaction when I've completed a stage satisfactorily."
(Graduate physicist, semiconductor production)

"Feeling that you are actually producing something that goes off to manufacture - producing something that has an end result."
(Graduate engineer, development lab)

"When I solve a given problem."
(Graduate engineer, development lab)

The next major heading included references to a situation which marked the move from an educational institution to one of employment in which there was the opportunity to gain self-respect from proving one's ability and also respect from colleagues and supervisors. Some similar elements occurred again in the references which were coded under the heading of working relations. For a few in the production area this was responsibility in the sense of directing the work of others, but the majority of references under this head were to having a portion of a project, the successful completion of which was important to the overall project. Again some of the comments were to the effect that the responsibility was implied by the high degree of autonomy granted by section and project leaders.
TABLE 10. Dissatisfying aspects of jobs (percentages).

<table>
<thead>
<tr>
<th>Sources of Dissatisfaction</th>
<th>R &amp; D Research</th>
<th>Development Production</th>
<th>Applications</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Those mentioning dissatisfaction</td>
<td>94</td>
<td>91</td>
<td>60</td>
<td>85</td>
</tr>
<tr>
<td>Those without dissatisfactions</td>
<td>-</td>
<td>7</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Don't know</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Sources of Dissatisfaction**

**Technical**

- Routine work: 15, 10, 40, 15, 12
- Intellectually undemanding work: 6, 17, 20, 15, 15
- Paperwork: 15, 10, - , 15, 11
- Lack of work: 9, 10, 10, 15, 10
- Personal frustrations: 6, 7, - , 15, 7
- Unoriginal work: 9, 4, - , - , 4
- Other: 6, 5, - , - , 5

**Self-development**

- Cannot apply university training: 6, 4, - , - , 4
- Learning little: 9, 4, - , - , 5
- Lack of opportunity to prove oneself: 6, 8, - , - , 7
- Lack of career prospects: - , 4, 10, - , 3

**Work Relations**

- Lack of autonomy: 9, 9, - , - , 8
- Lack of responsibility: - , 6, - , - , 4
- Poor relations with colleagues: 3, 4, - , - , 3
- Poor relations with supervisors: 6, 7, 20, 15, 8
- Poor company organisation: 15, 18, 30, 15, 18

**Extrinsic rewards**

- Physical conditions of work: - , 4, 10, - , 3
- Engineer's social status: 6, 1, - , - , 2
- Hours of work: 3, 2, - , - , 2
- Other: - , 5, - , - , 4

N = 43, 157, 14, 7, 221

Note: percentages are given from the numbers in each departmental group who cite an item.
"Being left on my own to do my own design work, and having no interference unless I ask for it. I don't have someone breathing down my neck all the time."
(Graduate engineer, development lab)

"I've got a fairly free hand, there's no one standing behind my shoulder saying do this or do that."
(Graduate engineer, development lab)

There were negligible items included in the extrinsic category. This is not to say that these factors were unimportant. Some questionnaire items which included pay and location among possible reasons for taking a job elicited positive responses, the only point here is that in response to an open-ended interview question there were few references to pay. Some studies have suggested that pay is unlikely to appear as a satisfaction factor in jobs but more likely to appear as a dis-satisfier. (33) In any event, it has been seen already that the majority of the respondents were satisfied with their current salaries. (34)

Dissatisfactions again paralleled the satisfactions in that there was a concentration on technical factors. The 96 technical references were to situations where the opportunity for problem solving of a challenging and intellectually demanding nature was absent. Sheer lack of work was of importance among the new entrants, and there were recollections of time spent waiting for work amongst those who had been employed for a year at earlier points in their entry. There were references to intellectually undemanding work, such as doing routine measurements, making out wiring schedules and paper-work. Sometimes they carried the implication that

(33) Herzberg and his colleagues asked a sample of engineers and accountants to recall occasions of particular satisfaction and dissatisfaction. These 'critical incidents' were examined to trace factors influencing these feelings, and Herzberg distinguished 'motivators' related to satisfaction and 'hygiene factors' related to dissatisfaction (F. Herzberg, B. Mausner, and B.B. Snyderman, The Motivation to Work, New York: Wiley, 1959. For a critical assessment of this two-factor theory, see M. Argyle, The Social Psychology of Work, London, Allen Lane Press, 1972.

(34) See Chapter Six, section six.

<table>
<thead>
<tr>
<th>Proposed changes</th>
<th>R &amp; D Research</th>
<th>Development</th>
<th>Non-R &amp; D Production</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Those proposing no change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would not change the job</td>
<td>12</td>
<td>9</td>
<td>10</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Could not change the job</td>
<td>6</td>
<td>18</td>
<td>20</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Not in a position to say</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Those proposing changes</td>
<td>82</td>
<td>71</td>
<td>70</td>
<td>85</td>
<td>74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proposed changes</th>
<th>R &amp; D Research</th>
<th>Development</th>
<th>Non-R &amp; D Production</th>
<th>Application</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Someone to do 'dirty jobs'</td>
<td>9</td>
<td>17</td>
<td>10</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>Clarification of responsibilities</td>
<td>9</td>
<td>20</td>
<td>20</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>Better project planning</td>
<td>12</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Different type of work</td>
<td>21</td>
<td>14</td>
<td>30</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Better facilities</td>
<td>15</td>
<td>7</td>
<td>-</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>More time on projects</td>
<td>3</td>
<td>10</td>
<td>20</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Better supervision</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Different occupation</td>
<td>3</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>More career information</td>
<td>6</td>
<td>7</td>
<td>-</td>
<td>29</td>
<td>7</td>
</tr>
</tbody>
</table>

Number of multiple responses: 22 (33), 116 (120), 9 (10), 6 (7), 146 (170).

Note: Percentages are given from the numbers in each department who cite an item.
this work was also demeaning, particularly on test and measurement work.

"The monotony of some things - testing pieces of equipment I've tested before".
(Graduate engineer, development lab)

"Paperwork. Making out parts lists for each of the boards and checking them."
(Graduate engineer, development lab)

"Sometimes it gets boring, especially the paperwork. I admit it's necessary, it's got to be done. There's nothing the company can do about it, reports have to be written."
(Graduate engineer, research lab)

In expressing dissatisfactions the items under the heading of working relations became more important than in discussing satisfactions, for the organisation or 'the system' was frequently cited as a source of obstructions and delay in progress to solving a problem or having something made. Organisational procedures for making design changes, making drawings, and ordering materials were parts of 'the system' and the lack of information about projects and their inter-relationships received criticism.

A further question 'If you could redesign your job so that it would be more satisfying for you, what would you like to have changed about it?', brought the response from 16 of the sample that they would not change their jobs, and another 26 felt that they could not change their jobs, their jobs had to be accepted in toto, whilst 3 felt that their positions as new entrants limited their ability to talk about changes (see Table 11). The remaining 125 engineers and scientists proposed changes of various kinds which fell roughly into proposals affecting the technical content of their work and those relating to the organisation of their projects and company organisation. There were 26 preferences for a different type of work, usually a preference for an increased technical content in the work, also there were 21 preferences for a technical assistant to take over their job.

"I would leave the routine stuff to other people - we should have a technician on the job."
(Graduate engineer, development lab)
"I wouldn't have myself testing out already developed parts of the receiver. I would have someone else, not a graduate, a technical assistant to do that. If this chap leaves and I take his job then this is what will happen. A technical assistant will do the testing with me looking on."

(Graduate engineer, development lab)

"For the last 15 months I've been a cabbage. I've been a dogsbody till two days ago. I've done nothing at all. Now I've got a job - I don't know if your visit has stimulated them. If they had given it to me 15 months ago it would have been much easier when my academic work was still fresh. I've just been doing odd jobs - bits of metalwork, making printed circuit boards, and so on. They weren't getting their money's worth. The jobs lasted a week or a fortnight, someone had to do the work and as I was the junior it was given to me. Now I've been given some proper work to do, on a project. The trouble is I've only been given a week to do it in. It's a rush job so no one could be found to do it except me ....

There should be a technical assistant and then I would start getting proper work."

(Graduate engineer, development lab)

Those who called for clarification usually did so with a desire to know how the various assignments contributed to an overall project and for a clarification of their responsibilities, and suggestions were usually added about project group or section meetings.

Of course it should be noted that there are variations across companies in the entrants' experience of satisfactions and dissatisfactions. Some of these variations relate directly to explicit company policies. There were frequent references in the company with an elaborate training scheme to the 'company system', the pattern of work organisation held to be peculiar to that company, and susceptibility to these folk beliefs is reflected in the preoccupation with believing that their work could not be organised in any other way or that it could be reorganised and better facilities provided. It is probably not surprising that the greatest degree of dissatisfaction in terms of intellectually undemanding work occurs
in the company from which the lab manager has been quoted as saying that the company policy was to recruit graduates and employ them as technicians during their 'training'.

The references by the last graduate quoted to 'proper work' points up the dilemma of this section in one extreme way. For a non-engineer, or non-job analyst, it cannot be said that the graduate is right. What can be said is that there is a serious discrepancy between the conception of himself as a young professional engineer which he seeks to sustain and the work which he is allocated. All occupations have their 'dirty jobs' which members attempting to raise their prestige will attempt to throw off to another group, the process can be seen in the attempts of the professional engineering institutions to define occupational levels and fix them by educational levels. The task should have been made easier by the claims that there was a shortage of engineers, engineers should have been able to choose their work. Now if double-counting is avoided in adding the references to technician work and the preference for work with more intellectual content, 42 graduates professed that their skills and abilities were being underutilised. These claims that their jobs should be changed probably understates the number whose jobs could be changed if technician manpower were available. (35) Many of those who commented that their jobs 'could not be changed' expressed a wish to hive off some work to others but cautioned that this was 'a counsel of perfection' and that 'all engineers had to take their share of routine jobs'.

While economists have been sceptical, psychologists have taken 'need' as a central concept. With the individual person as the main unit of analysis the psychologists claim that all individuals have needs to be

(35) For some similar comments on utilisation drawn from the sample of older mechanical engineers, see J. Gerstl and S.P. Hutton, op. cit., p. 75.
satisfied and talents to be utilised. From the seminal work of Maslow, who distinguished a hierarchy of needs from low level physiological needs (food, water, clothing, shelter), to high level social needs (belonging and acceptance by peers), and self-actualisation, Argyris has concentrated attention on the form of organisational structure most likely to promote the satisfaction of need and the utilisation of talent. For Argyris, the 'needs' included those to feel a 'sense of competence'; to be 'self-aware', to feel 'self-esteem', and to experience 'confirmation', (to have one's conception of self validated by others). For professional scientists and engineers these needs were spelt out in terms of recognition from fellow professionals, and the most appropriate organisational forms were project-based and flexible and with collegiate rather than hierarchical authority relationships.

While at the individual level, satisfaction of these needs was held to be related to the healthy functioning of the individual. Argyris has claimed that optimal positions can be achieved where 'healthy' individuals contribute to 'organisational' health. This line of reasoning is open to two main criticisms. Beyond physiological needs it becomes difficult to see whether the psychologists maintain that individuals have or ought to have these needs, and so criticisms of non-testability and value judgement can be made. The psychologists have not produced evidence of a link between prescription and measured indicators of organisational performance. It could be argued, for example, that if the complaints of all the graduates in microelectronics development labs about lack of equipment and lack of freedom over choice and direction of projects were met then it would be at the cost of their company's survival in microelectronics production, given the degree of overcapacity in the


(37) C. Argyris, "On the effectiveness of research and development organisations", American Scientists, ed 56, no. 4, 1969
industry. Instead of assuming 'needs', the approach followed in this study has been to explore the definition of the situation advanced by managers and recruits. In this way, instead of organisational 'needs' we have the set of social expectations held by managers, and instead of the needs of professional employees, we have the set of expectations and self-conceptions held by graduates, and, in cases where these sets of expectations were mutually exclusive, we can examine the emerging perspectives of the graduates and the strategies adopted to cope with their situation. In other words, we can examine some of the likely consequences of the pattern of utilisation.

From the manager's perspective the organisation needs were for 'unfrozen' graduates, for graduates who were available for conversion into 'company men'. While a full identification of personal interests and company interests was not expected until the explicit rewards of salary increments and career advancement had been experienced, managers sought some willingness to subordinate personal interests, which could be labelled an academic orientation, and an ability to work with minimal supervision. To some extent graduates were 'unfrozen'. The degree of geographical mobility meant that many were separated from the social support which had sustained former identities and the isolated nature of work assignments limited social supports in work. (38) Moreover orientations to work among the graduates indicated high priority on opportunities to learn new knowledge and skills. Despite these indicators of availability, managers found difficulties in developing an understanding and competence in using organisational processes among graduate recruits.

(38) The extent of geographical mobility is taken up again in Chapter Nine, section four.
"People moving from university tend to exhibit the property that they expect the world to run on a set of simultaneous equations. This man may have done a good design but you can't get it through to him that he's got to check other people. He may lose sight of it - it may go to another factory or the drawing office. He will send it to the drawing office. He'll say 'how long? Six weeks? O.K.' and six weeks later it will come back with a slip; you can't persuade him to go round to check and see it's being done, and, if not, to play hell. The only way to get things done is to be relentless." (Development lab manager).

While one solution to this deficiency might be the inclusion of social science courses in undergraduate science and engineering education, the implications of company reliance on on-the-job trial-and-error learning for teaching the ropes must be seen as a demand for graduates with a capacity for situational learning which might be distinct from academic learning.

From the graduate's perspective needs were seen as opportunities to learn situationally appropriate conduct, to learn what meanings to attach to events and persons, and to gain opportunities to demonstrate in coping with the appropriate technical and social skills. These opportunities may be termed 'good work assignments', and they are linked into something of a 'circle of virtuosity' for gaining them is dependent on demonstrated competence, and in this sense they are both symbols of past achievement and preconditions for further advance. (39) Essentially the problem for the new entrant is to break into this circle of virtuosity. Some further elements of these good work assignments can be summarised for these findings

(39) For a very shrewd analysis of 'good work assignments' and the position of the scientist or engineer in research and development, see F.W. Howton, "Work assignment and interpersonal relations in a research organisation" in C. Orth, Bailey and Woolek, op. cit.
on satisfaction and dissatisfaction. (40) The assignments should be visible in the two senses, that the newcomer's contribution is distinguishable and the sense that the task is organisationally significant and noted as such by others. Another important facet of visibility is that the assignment has definable target points such that he receives feedback on his development from the completion of stages and from his supervisor. In addition to visibility, assignments must qualify as 'good work assignments' on the criteria of being appropriate by level and kind, and in this respect consistent with the kind of self and persona which the newcomer tried fashion as a graduate entrant. Two main sources of offence reported in dissatisfactions and changes were 'trivial work' and 'dirty work'. Trivial work on routine operations offended because it was not demanding and did not engage the analytical and problem-solving skills of the graduate, and 'dirty work' threatened to demean the graduate's status claims. (41)

The implications of a pattern of utilisation which contains a high proportion of 'unsuitable work assignments' for the development of commitments to the working organisation can be seen in relation to the graduate perspectives and strategies of coping. All of the new entrants could emphasise some aspects of their move to industry as favourable, for example, the majority could contrast favourably their supervisory relationships and only a tiny minority of the very disenchanted favoured college supervision. One of the main strategies of response to 'unsuitable work assignments' was to lower aspirations and this was evident in comments that work could not be changed and that initial expectations were 'unrealistic'.

(40) A similar account is offered by Barnes in his study "Making out in industrial research", Science Studies, vol. 1, no. 2, April 1971.

(41) The concept of 'dirty work', which derives from Everett Hughes, indicates work which threatens the status of the individual and in the sense that 'trivial work' is identified with lower status occupations it becomes 'dirty work'. 
"First of all I was starry-eyed. I wanted to be interested in my work. I still do, but not so enthusiastically. I was deadened by working on the tail end of a project for a year. I find everyone else has started new interesting work. I have been tidying up paperwork basically and doing problems that others are not bothered with. That just about deadens you."
(Development engineer)

Perhaps the central process in this strategy was the use of role distance to preserve the self from the threatening situation, in this case reinterpreting the post as a period of 'starry-eyed' immaturity. In addition to the tendency to reduce aspirations, another strategy was to look for the satisfaction of aspirations in the future. Again meeting the formal supervisory expectations to which he is subject, the new entrant holds reservations about his implied identity and the assumptions on which it is based. Coping with whatever work assignments are delegated to him, he looks for ways in which he can change his situation, and he can interpret his present situation as learning and therefore temporary.

"The start was very dissatisfactory. I was thrown in, not at the deep end, but in the middle. Most people knew the basic outlines; nobody knows quite what they want. Everything is in a state of flux, you never know where you are. Although there is the satisfaction that you achieve something in the end; there is nothing much you can do. You just try to grasp what you can and plough on to the end ....

I hoped to be a good engineer to start with and possibly find out what things are like as an engineer. I think most people start as engineers and as you get older you take more responsibility and eventually you are in management. This is the way I suppose I like it. I don't think I'll stay in this company all that long. You've got to have some sort of training just to get out of ... how shall I say it ... you've got to be de-university-ised. Things are not quite as happy and free as they were. It's done bit by bit. At university if you went and asked somebody for something, they would have an answer for you, to go to a library or something. Here the library is nonexistent. There's all the red tape, you realise that people are not quite as readily available as at university, nor are things.
At university you just filled in a form to get something; here they ask is it viable, is it financially possible, is it practical. At university it was just a case of doing it."

(Development engineer)

In essence it emerges that work experiences are unlikely to develop the side-bets which lead to the development of commitments to the Company, nor to engineering as an occupation. Commitments existed already to the extent that a science or engineering education was seen as a marketable skill but these were the temporary commitments discussed in Chapter Six. Work experiences confirmed the wisdom of those short-term exploratory perspectives and encouraged an interest in careers and strategies for moving out of their present positions. The extent to which commitments were developed in the career system forms the focus for enquiry in Chapter Nine.
CHAPTER NINE

THE SHAPING OF CAREERS IN TECHNOLOGY

1. Introduction

When the Minister of Technology promoted the attractions of engineering in a radio interview on the shortage of graduate engineers in 1967, he claimed that many graduate engineers could expect to become managers by the age of 40 and that salaries were rising faster in engineering than in other professions. (1) This kind of promotion brought criticism that industry needed both 'professional' managers (not 'reclassified' engineers), and engineers (not engineers striving to become managers at the age of 40). Moreover it was argued that young graduate entrants to industry needed employment as 'intellectuals' (not as 'tradesmen' with the justification of 'basic training' or 'experience'). (2) Another criticism expressed resentment at the implied subordination of engineers and the advice to abandon engineering ambition by the age of 40. (3) By the turn of the decade the dilemmas of the young engineer in the context of a new imbalance between educational supply and industrial demand were viewed very differently. One manpower forecaster, who had hinted at the evidence of a surplus of engineers and scientists in 1970, commented graphically, 'unlike brussell sprouts, overproduced graduates cannot be turned in'. (4) Meanwhile the President

(1) Remarks by Mr. Wedgewood Benn cited in letters to The Times, 5.10.67, and 11.10.67.

(2) Ibid.

(3) Ibid.

(4) Personal communication from Mrs. Joan Cox.
of the British Association for the Advancement of Science impressed on his 1970 audience dangers of increased personal frustration and political agitation and unrest which could arise from blocked careers in a situation of oversupply of scientists and engineers.

"University education was designed, in each speciality, to offer an intellectual elite the maximum opportunity to develop their intellectual and creative powers....

...If we train too many of the latter (scientists and engineers) then many of them will have to follow the career of technician for which their training was not designed and which they will regard as 'inferior'. The result will be a frustrated white-collar class, with all the dangers to society that such a class implies. This frustrated class is to some extent already with us...." (5)

Thus the resolution of the occupational choice dilemmas and conflicting commitments may be explored from the individual, company, and national perspectives; from the extent of personal anxiety and success to the consequences for company and national manpower resource allocation and utilisation. While the concept of a 'career' has been used by some writers to refer to a variety of aspects of a person's temporal division of labour, it is more usually restricted in usage to a few occupations with a progression through a status hierarchy, as Wilensky maintained,

"A career, viewed structurally, is a succession of related jobs, arranged in a hierarchy of prestige, through which persons move in an ordered, predictable sequence. Corollaries are that the job pattern is instituted (socially recognised and sanctioned within some social unit) and has some stability (the system is maintained over more than one generation of recruits). (6)

(5) Lord Todd, "Should higher education be more vocational?", The Times, 3.9.70. This was an abridged version of the Presidential address to the Durham meeting.

The attractions of the concept are that it is not limited to this structural analysis, however, for it can be examined from both objective and subjective aspects, from the study of ordered sequences of related jobs as career structures to the ways in which the individual defines and judges himself and others in career imageries and a career as a personal experience.

"One value of the concept of career is its two-sidedness. One side is linked to internal matters held clearly and closely, such as image of self and felt identity; the other side concerns official position, juridical relations, and style of life, and in part of a publicly accessible institutional complex. The concept of a career, then, allows one to move back and forth between the personal and the public, between self and significant society ...." (7)

Discussion of graduate perspectives on careers has been introduced already in earlier chapters. The central point which emerged in the examination of occupational and educational choice was the preoccupation with a short-term perspective, with devising ways of coping with the immediate situation. Relative success and relative failure in organising one's resources to meet situational demands encouraged commitments as much by default as by deliberate decision, and relative educational success encouraged commitments to continue in that line of academic activity whereas difficulty in meeting school or college demands prompted a search for alternative routes and prompted some thoughts about longer term situations and career structures. Entry to work was marked by a preoccupation with coping with the immediate job demands and becoming a technologist, and becoming knowledgeable about industrial work and organisation. Again relative failure prompted an interest in careers, this time the relative failure was difficulty in finding job opportunities which supported and

enhanced effort to become a professional engineer or scientist. In this chapter the young technologists' hopes and expectations for the future are the central focus of interest. In particular, I shall attempt to show the way in which the dominant short-term perspective was predicated on a distinctive view of the future and the way that an interest in status advancement influenced the bounds of other commitments notably those to the working organisation.
2. Careers, Career Structures and the Rationality of Individual Planning

It is commonplace to assert that large-scale organisations occupy a significant portion of the life-space of all in advanced industrial societies, from 'womb to tomb' is one popular expression. But just as organisations meet the wants and needs of individuals for goods and services, incomes and identities, so individuals are processed to meet role expectations and service organisations. Two developments underly the efforts of business occupations to shape the lives of employees over their working lives rather than simply at points during their employment. Firstly, there is the scale of activities which include lengthy planning and gestation periods in projects and stimulate an interest in the long-run and the provision of resources to ensure survival in the long-run. (8) The second development is the need for different employment relationships to maximise the amount of knowledge from those which were used to maximise the application of energy in organisations where knowledge has become a major resource. According to Stinchcombe the new relationships are more likely to endure over a career.

"A man's knowledge and intelligence do not vary much from one hour to the next, but vary greatly over his lifetime. Thus, the motivational devices for organising labour have to be directed toward rewarding variation over lifetimes, rather than hours." (9)

As we might expect, the large-scale science-based electronics companies in the sample provided many examples of attempts to attract graduates into long-term career relationships in their recruitment literature.

(8) Growth is frequently cited as among the major company goals in many recent economic models of company behaviour, see, for example, R. Marris, The Economic Theory of Managerial Capitalism, London: Macmillan, 1964.

"(The Company) has a well-defined attitude towards the individual. It makes two basic assumptions. First, that work is the core of existence for the career-minded man and woman. It therefore provides the equipment, the environment, the conditions and the intellectual challenges which enable a man to fulfill himself. Second, that the individual can apply himself whole-heartedly only if he feels secure. Security of employment is testified to by (the Company's) unparalleled record of long-service employees who, upon retirement reap the benefit of an excellent company pension scheme.

For the rest, (the Company) recognises that life means different things to different people, and that the wise firm will provide opportunities and amenities but will leave it to the individual to choose or reject them according to his nature ....

In brief, the Company offers a way of life for the complete man and woman, in whatever direction their interests lie."

(Company F)

"(The Company) attaches great importance to career development and in a company the size of (C), with the whole electronics industry developing rapidly, opportunities for career advancement are many and varied ....

Whatever career path a graduate follows he or she can aim for a management career or that of a specialist in a particular field. Both offer equivalent status and reward. There are no barriers of age or sex."

(Company C)

"The Company believes in creating the situation in which individuals can develop themselves. It is part of this policy that throughout his career each person's progress is periodically reviewed and opportunities made available, either by transfer or attendance at selected courses, to broaden his experience and potential."

(Company A).

These quotations indicate a number of themes common in the sociological literature on organisations: firstly, that companies seek to motivate a long-term commitment to the company and assume that work is a central
life-interest (although not all companies would assume or state that it was "the core of existence" even in the tautologous form here); secondly, that in mapping out a career structure both companies and individuals see dilemmas in alternative career lines in administrative and specialist functions (hence reassurances about the equivalence of rewards in the dual career structure); and thirdly, that companies have formalised a panoply of procedures to shape the conduct of employees through their working lives from recruitment and selection to counselling and assessment. (10)

It is apparent from the earlier discussion of recruitment policies that the companies adopted what might be termed a "course mesh" selection policy, in that relatively large numbers of graduates were selected from an annual recruitment campaign but it was accepted that further selection and self-selection might lead to a high proportion of internal transfers within the company, and even a substantial turnover of those leaving the company. This policy contrasts with that of the Civil Service where an elaborate selection procedure attempted to identify the potentially successful in the long term and concentrate on grooming for posts of responsibility in the early employment period. (11) Although the electronics companies maintained a small arts graduate intake and linked this to general management posts, in one company the commercial entry group were regarded as the 'high flyers' to be selected and groomed for

(10) The theme of organisational loyalty was given wide popularity by W.H. Whyte in his book in which he dealt at some length with the attempts to woo scientists and threats to the flourishing of scientific work, (see The Organisation Man, Harmondsworth: Penguin Books, 1960 (original 1956), especially Chapter 16, "The Fight Against Genius" where Whyte raises his fears about the atrophy among scientific minds when loyalty is the overriding concern of managers.)

management, the technically qualified graduates were regarded as the main sources for future technical specialists and future technical managers, and general management in a science based industry. In most companies salary reviews of new entrants were conducted twice yearly over the first two years and the formal review was accompanied by interview and counselling by the departmental head. Obviously the departmental head was dependent on information supplied by the supervisor and in direct entry all the problems of unsuitable work assignment discussed in the last chapter posed problems for assessment. Even in companies with direct entry, the training officer tended to be nominated for some responsibility to counsel all the new entrants, and adopt a broader perspective to minimise company turnover possibly at the expense of internal transfers. Most training officers, however, confessed that they took little initiative in this area, claiming that training was already burdensome and wishing to avoid possible conflicts with departmental heads. Few companies had formalised the counselling and appraisal procedure to the point of filed documentation and official report forms although personnel departments pressed their anxiety to begin management development on this basis. (12)

Company policy to interpret the early career as an extension of selection in the light of company and graduate ignorance of needs, opportunities, capacities and rewards solved some problems for recruiters in that they could adopt the perspective of their department's short term interests. Where short-term perspectives on careers were adopted by graduates, however, managers appeared somewhat surprised and complained

(12) The development of organisational devices as part of management development has been pursued intensively in military organisations although some critics argue that many assessment exercises function as managerial placebos rather than valid discriminators (see, M. Janowitz, The Professional Soldier, Glencoe, Illinois, Free Press, 1960).
that graduates had not thought about their careers. The complaint was frequently accompanied by the observation that the lack of thought must reflect on the defects of an educational system which did not stimulate such thinking. For company interviewers the graduate perspective presented a problem and frustration in selection interviewees where managers could not talk in a common vocabulary and judge in a common frame of reference. Yet there were two senses in which graduates were ignorant about careers, one sense was the knowledge of feasible moves in a career structure, and the other was the knowledge of a career as a personal experience. Company interviewers, as men in 'mid-career', have acquired such interpretations and conceptions. In short, they have had careers. Interviewees stand on the threshold of careers, and although they might anticipate their future employment and pick up clues from various sources, their understandings are of a different order from those of the interviewer. With respect to individual career planning the graduate new entrant can be said to be in a marginal situation, he lacks a knowledge of the norms which underly conduct in the new situation where the normative understandings relevant to his former situation are no longer guides. In university or college the long-term future was mapped and organised around meeting academic demands for a satisfactory performance on course assessments. The daily problem of meeting academic demands and the desire for a 'private life' and 'free time' was broken down by the allocation of time to lectures, practicals, writing up and 'free time', and these daily cycles, which fitted into the week and weekend, were part of the larger cycles of term, exams and vacations which culminated in final degree examinations. Against this career structure constructed from the academic calendar, the industrial future was relatively unstructured as one newcomer could indicate in his comparison with university.

"There are different attitudes (between university and industry). At the university you are looking for an exam all the time. Here you are looking
### TABLE 1. Extent of knowledge and concern about careers (percentages)

<table>
<thead>
<tr>
<th>Having knowledge of career opportunities</th>
<th>Not bothered about career prospects</th>
<th>Bothered about career prospects</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not bothered about career prospects</td>
<td>11</td>
<td>10</td>
<td>21 (25)</td>
</tr>
<tr>
<td>Bothered about career prospects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of knowledge of career opportunities</td>
<td>52</td>
<td>47</td>
<td>79 (94)</td>
</tr>
<tr>
<td>Totals</td>
<td>43</td>
<td>57</td>
<td>100 (119)</td>
</tr>
<tr>
<td>N</td>
<td>(51)</td>
<td>(68)</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 2. Preferences for future career lines by department (percentages).

<table>
<thead>
<tr>
<th>Preference</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Current Situation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purely technical</td>
<td>94</td>
<td>83</td>
<td>30</td>
<td>100</td>
<td>82</td>
</tr>
<tr>
<td>Purely administrative</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Mixed technical admin.</td>
<td>-</td>
<td>15</td>
<td>70</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Don't know</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100 (164)</td>
</tr>
<tr>
<td>N</td>
<td>(31)</td>
<td>(116)</td>
<td>(10)</td>
<td>(7)</td>
<td></td>
</tr>
</tbody>
</table>

| (b) Future Situation        |          |             |            |              |        |
| Purely technical            | 9        | 10          | -          | 14           | 9      |
| Purely administrative       | 9        | 3           | 20         | -            | 9      |
| Mixed technical admin.      | 66       | 58          | 60         | 71           | 61     |
| Other                       | 3        | 12          | 10         | 15           | 10     |
| Don't know                  | 9        | 12          | 10         | -            | 11     |
| Totals                      | 100      | 100         | 100        | 100          | 100 (168) |
| N                           | (31)     | (120)       | (10)       | (7)          |        |
towards a future that you have to plan, at university it is all planned for you. There's quite a difference there."

While the situation of the new entrant in relation to the distribution of knowledge about career structures could be described as marginal, this situation need not be associated with a subjective experience of marginality and anxiety. While the great majority of respondents could claim that they were not clear about the opportunities for promotion available to them in their companies, a large minority could claim that they were not bothered by this situation (see Table 1). The stressful consequences of the situation were avoided by the adoption of the perspective on careers which emphasised the importance of establishing a competence as an industrial technologist before seeking status advancement in any setting, and so they closed off the future by imposing a short term preoccupation and review period.

While the major source of anxiety about careers stemmed from some area of ignorance, some anxiety arose among those who thought they had a clear idea of possible career lines and were perturbed by the prospect of a lengthy wait before they could move on to the other activities. In this case dismay arose from the feelings of being trapped by past commitments, for example, commitment to technical against administrative activities or to particular kinds of technical activities. In contrast to beliefs about dismal future prospects were the anxieties which arose from ignorance about career structures, or information about the way in which the individual experiences of a career could be related to career structures. While the first kind of ignorance could be remedied to some extent prior to entry, the second kind of ignorance took on deeper significance on joining the organisation when the new entrant was trying to establish the footholds but had to learn about task demands and the criteria for evaluating performance as a preliminary step.
"I'm not sure what opportunities there are. In fact when I came for interview one of the things I was very keen to ask was what proportion of the management came up on the technical side, and whether they came from outside or inside. I was told that most of the managers are technical people and insiders and outsiders are roughly equal. At the time I was satisfied, there seemed to be opportunities for promotion and getting on. But having worked here, having been at the bottom of the scale, it's difficult to see. You can't really correlate the two because there are so many engineers at the bottom of the ladder, all wanting promotion. It's the usual problem I think, at university you can see the path ahead - engineer, senior engineer, project leader, departmental head, divisional head, and so on - but when you join in the 'rat race' you realise that everybody else round you, all these hundreds of engineers, have the same vision of the ladder, and the trouble is that there is only one ladder at the top and so many engineers at the bottom. Let's say I am anxious to get on and I would like to be on the management side, but at the moment it's difficult to see how and when it will come, and that makes me anxious."

"This (being unclear about promotion opportunities) bothers me quite a lot. I know very little about whether the company has a standard career plan. It looks very much like waiting for vacancies to arise. Certainly it's never discussed with me what I might do to make promotion earlier, or whether the manager is satisfied."

Turning to the group who were not troubled by career anxieties, they can be distinguished into those claiming knowledge of and those claiming ignorance of career structures. Yet in both groups the reasons advanced for lack of concern about the future and promotion had a common theme in a preoccupation with the short term and developing a mastery of immediate organisational demands. Even a rudimentary knowledge of company titles and the popularly conceived median time scales of progression through posts could be accepted as an adequate state of information when the main priority was in learning how to cope with the current situation, and, where prospects were evaluated as poor they could
be disregarded when the current situation was interpreted as a temporary learning situation.

"After two years you are considered for a move to engineer, then after that senior engineer, principal engineer, group leader, senior group leader and so on. For the present it doesn't really bother me - I've got a year to go."

"It appears that to stay in engineering is just a dead end, to wait ten years or so to become a section leader. It doesn't look very promising. I suppose it's inevitable in a large firm. Since I only came for training and don't intend staying very long then it doesn't matter very much."

Closing off the future beyond some review point was the same device which permitted some of those ignorant about opportunities for promotion to show unconcern about this uncertain future.

"This (opportunity for promotion or advancement) is not too clear, but then it won't bother me until I've done some worthwhile work. Initially it's a question of proving oneself before going after promotion. Secondly, I want a wider experience of one or two companies before I start settling in and chasing promotion. So the first thing is not so much promotion as doing a worthwhile job so that you can show you are worth what you are being paid."

"I've not really been here all that long to start worrying about promotion. I've got to establish myself in the role I'm playing now as a junior engineer."

In effect just under half the respondents coped with the uncertainty surrounding industrial careers and alleviated the anxieties which could arise in a marginal situation by an explicit recognition of the early employment period as a search period.

The strategy of closing off the future was achieved by imposing boundary markers, for example, by taking a two year period marked out by the second annual salary review. These markers functioned to illuminate and demarcate the "darkness of time" as examinations and terms had defined an academic career.
"At university there tends to be a matter of working hard to get your degree, whereas in industry your objectives aren't very well-defined at all. It's more or less carrying on with the job as it's given to you, and the future prospects are more or less hidden in the darkness of time."

"I had thought of staying three years here and then going to another firm but I've not really thought that out and looked at directions there. I want to see how this job turns out before I plan anything. Three years would be enough time to get enough experience in this job without getting too set in my ways or too settled to the idea of being in this firm, and if I did move I would have experience to offer."

Such boundary markers which absorbed uncertainty could be quoted from career literature, from company advertisements which indicated desirable experience, and from fellow engineers. Three years could even be cited as a convenient planning unit because it had been the length of a sixth-form stay and university degree course. The use of any of these time periods as planning units was a tentative matter until the graduates could check their usefulness against personal experience. (13) The existence of a majority who were concerned about their lack of knowledge of career opportunities suggests a fairly widespread lack of confidence in such standard recipes, however, and in such a situation efforts at long-term detailed planning could be seen as irrational activities rather than as indications of irresponsibility and immaturity.


One of the central points in our definition of a career was that it was conceived as a vertical movement through a status hierarchy. In public and sociological discussion of professional employees in large scale organisations a frequent theme is the extent to which advances in experience and seniority are possible in posts largely concerned with the direct application of professional and technical skills compared to posts largely concerned with organisation and management. From the company viewpoint the central problems are usually seen as those of motivating able technical specialists to seek and be competent in administrative positions. While some of the companies offered the prospect of a 'dual ladder' with some almost wholly technical senior posts with titles such as 'consultant' these were relatively few in number, and the main line of advancement was through the managerial ladder. For the individual the available career lines with changes in the balance of technical and administrative duties pose dilemmas about the desirability and feasibility of switches, points of switching and strategies of career advancement. Horizontal mobility in careers has usually been viewed in discussions of careers as a device of company sponsorship or individual ambition to gain wider experience to augment vertical mobility. Yet where horizontal mobility is closely involved with physical movement and raises questions about the flow of individuals between different organisations and sectors then the issues of technical or administrative career lines and preferred work settings can be seen to be related to the nature of commitments and the graduate's conditional loyalty to his first industrial employer.

(a) Technical and administrative career lines.

Although the general questions about careers produced answers which revealed widespread, self-confessed ignorance about personal abilities
and career opportunities and a short-term future perspective, direct questions about preferences for technical or administrative activities revealed that within companies the new entrants were acquiring information about, and developing evaluations of, possible career lines. The preferences for the current situation were almost overwhelmingly for technical activities and for the future for increased administrative activities (see Table 2).

The preferences for the technical posts in the short term were indicative of the commitments made in the educational system to engineering occupations, and for some engineering graduates these technical skills were not only marketable skills but skills whose exercise had become an ethical obligation.

"I considered I had an engineering degree and thought I would work in the engineering industry. I thought it would be a waste otherwise. I hope it will develop into something broader though I am not quite sure what."

"I was trained as an engineer so I wouldn't like to feel it was wasted."

But just as educational side bets developed skills relevant to making out in industry, educational courses had not developed administrative skills and in some cases graduates were not sure what these skills were.

"For now I would pick pure engineering every time. At the moment I've got no idea of administration whatsoever."

"In my present state I would prefer pure engineering because I am more able to deal with things rather than people, although in future this will change."

"I wasn't really aiming for management, but last year when I was looking for a job, although I preferred research, it seemed that there were few places to do research. Industrial research is just a stepping stone to management: industry can't afford research. So research is just a way of getting established in a firm then moving into management ...."
I realise it's going to take quite a while before I get established. I'll wait another two years before I make up my mind. I've not really thought of management till recently and I can't compare it to anything I've done before."

In asking about preferences for the future there were two interesting points about the nature of the responses compared to those offered about the short term. In the first place many of the respondents eschewed the alternatives of either technical or administrative tasks and stated their preference for a mixture, often the phrase 'technical management' was used. A second point was that the reasons for these preferences tended to deal in rewards rather than resources for making out as the responses on the short term situation had done. In other words in the short term the problems were simply questions about have I the resources to cope, while for the future competence was assumed and the problems were those about where rewards lay, and the rewards of greater income, power and prestige were seen to lie in the managerial ladder.

"I have a dislike of paperwork at the moment. In the future I shall have to resign myself to a certain amount of administration because it is the only way to get anywhere. When I get down to paperwork I'm reasonably good at it."

"I would like to have more responsibility and you can't do that on a technical basis; you've got to get involved in administration."

While many took the dismal view of administration as a necessary evil, implying the loss of intrinsically satisfying technical jobs, to be set against the rewards of income, power and prestige, others took the view that the scale of technical activities implied necessarily some managerial functions and technical management could be viewed as an optimum position combining the intrinsic satisfactions of technical tasks and the rewards associated with management.
"My interest initially is in engineering. After spending three years in particular and twenty in general in engineering then this is the thing. Obviously there comes a point when you are not so interested in the specific details of a particular problem. You are interested in the wider system and coordination of other things and achieving the ends of which the little problems I do are part."

"I'm not interested particularly in paperwork but there's more money in management. You've got to take up some management at a later date but I don't see myself becoming a pure manager, only an engineering executive where you keep in touch with what is going on and still get involved with what your group is doing."

In the short term then, by virtue of the kind of resources which these science and engineering graduates had, they were 'trapped' into largely technical posts. For the longer term when they examined rewards they could be said to be trapped still by their narrow technicist conceptions of management where administration was largely viewed as 'paperwork' which was intellectually dull, or 'politics' which was unscientific, inefficient and morally repugnant. (14) While it could be argued that the narrow conception has been fostered by a predominance of technical specialisms in undergraduate degree courses, there seems little attempt to introduce different conceptions in industrial training or industrial organisation. (15) The domination of industrial training by on-the-job training meant a circumscription of the newcomer's frame of reference to largely technical tasks without that breadth of view once

(14) Engineering conceptions of 'organisational politics' are elaborated and discussed in the next chapter.

(15) The relatively low proportion of an engineer's education on non-vocational courses in Britain has been viewed with disquiet by those seeking a standardisation of professional qualifications within the E.E.C., although it must be remembered that the undergraduate course is generally longer in most European countries without professional institution supervision of industrial experience.
alleged to derive from a company tour or off-the-job courses or projects. Besides, as Peter Duncan has observed, the organisational location of many research and development departments has accentuated a technicist conception of management, for R&D has frequently been isolated from the manufacturing, financial and marketing activities of the organisation, and a traditional 'staff-line' ideology, which conceived of technical 'staff' in an advisory rather than executive role, has been doggedly persistent. (16)

For those who link national and company misfortune to the reluctance of graduate engineers and scientists to advance their careers beyond the research and development departments and technical specialisms, particularly into management in other departments, the implications of these findings are a caution on seeking change wholly, or even mainly, through the educational system. Reform would imply at least comparable scrutiny of industrial training and organisation.

(b) Career lines and work settings

Several researchers have attempted to discern danger in the recruitment policies of industrial companies through an examination of the educational and occupational biographies of different age cohorts of managers. In the late 1950's Clements distinguished five typical patterns: the 'Crown Prince' whose particular pattern owed much to close

(16) P. Duncan, "From Scientist to Manager" in P. Halms, ed., The Sociological Review Monograph No. 18: The Sociology of Science, September 1972, p. 143. In Duncan's study the sample of industrial scientists and engineers divided fairly evenly between approval and regret about the main line of career advancement through management, and as in this study, he found that management was narrowly conceived with a strong preference for technical management.
family links with owners or senior managers; the 'managerial trainee', out
frequently an arts graduate with any strong sense of vocation who went or 'drifted' into the sales or commercial departments; the 'pre-qualified specialists', these were the engineering or science graduate appointed to specific jobs to employ their specific skills but who proceeded through a series of logical steps to promotion within the firm; the 'special entrants' possessed some of the advantages of family or special links enjoyed by the 'Crown Princes' but to a lesser degree and their combination of social ease and rudimentary technical training tended to lead through commercial and sales departments; and finally, the largest group in Clements' study, the 'self-made man', had left school at 15 and undertook a 'long tedious journey' through lower management. (17) Clements suggested an increasing proportion of new managers were being recruited from among the 'pre-qualified specialists', a view supported by Clark who carried out a replication of the Clement's study in the Manchester region. (18) Again a broader national study confirmed an increase in the proportion of technically qualified managers. (19) These trends evident in other industries and national samples have been especially pertinent in the electronics industry where the declining proportion of Q.S.E.s in R & D, despite overall increases in absolute numbers, has been widely interpreted as a reflection of "the growing need for science-based graduate manpower in the management, production and marketing functions". (20) Given the early general shortages of graduate scientists and engineers in the post-war period, industrial companies have advocated

(19) Acton Society Trust, Management Succession, op. cit.
a policy of 'catch them young' supplemented by planned career development.

(21) Such programmes for recruiting and training managers have been termed 'management development' and would include both off-the-job courses and planned promotion and transfers to ensure that requisite experience was acquired at appropriate stages in the manager's career. The design of management development programmes faces considerable problems and it is not clear that many companies have advanced beyond exhortation.

(22) The incipient state of 'management development' in the engineering industry generally and the electronics industry in particular can be gauged from the annual reports of the Engineering Industry Training Board which record 'steady progress' and the Docksey Report which contained evidence of a reluctance to release staff for off-the-job courses.

The stock reason for the neglect of training in the electronics industry was that staff could not be released in a situation of shortage, a view which might appear to be the opposite of those who concluded that training was an integral part of the efficient utilisation of manpower necessary in a situation of shortage. However, two other sources of impediment to the development of extensive career development programmes emerged in the study of the electronics industry. Firstly, there was the perception by the technologist of a market for his training, skills

(21) See, for example, I.A. Millar (Group Education Executive, Elliott Automation), "The Scientist in Industry", New Society, 7.7.66, p. 18. The remarks expressed in this article are similar in spirit to those of the Managing Director of Mullard on using the R & D department for internal recruitment (quoted in Chapter Five).

(22) A brief account of the difficulties in operating a management development programme which arise from the diffuse nature of selection criteria, the lack of universally valid 'leadership' qualities and the rudimentary nature of measures such as appraisals and job descriptions is given by P.B. Smith, "Training and Developing Executives" in D. Pym, ed., Industrial Society: Social Sciences in Management, Harmondsworth, Penguin Books, 1968, pp. 289-291.

### TABLE 3. Anticipated career lines by department of current employment (percentages)

#### (a) Anticipated future with current employer

<table>
<thead>
<tr>
<th>Likely to remain</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>13</td>
<td>10</td>
<td>10</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>No</td>
<td>64</td>
<td>67</td>
<td>50</td>
<td>57</td>
<td>65</td>
</tr>
<tr>
<td>Don't know</td>
<td>23</td>
<td>23</td>
<td>43</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

N = 100 (100) (100) (100) (100)

#### (b) Settings considered as future possible auspices by department of current employment

<table>
<thead>
<tr>
<th>Settings</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Wait and see'</td>
<td>3</td>
<td>24</td>
<td>60</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present employer</td>
<td>17</td>
<td>15</td>
<td>40</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Another company</td>
<td>52</td>
<td>66</td>
<td>40</td>
<td>42</td>
<td>61</td>
</tr>
<tr>
<td>Abroad</td>
<td>7</td>
<td>11</td>
<td>-</td>
<td>23</td>
<td>31</td>
</tr>
<tr>
<td>Own company</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Government research</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>University</td>
<td>21</td>
<td>8</td>
<td>10</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Teaching</td>
<td>-</td>
<td>7</td>
<td>1</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

Numbers of multiple responses N = 30 (29) 163 (119) 19 (10) 10 (7) 222 (169)

#### (c) Reasons for possible move to another industrial company

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To gain experience</td>
<td>33</td>
<td>69</td>
<td>90</td>
<td>33</td>
<td>64</td>
</tr>
<tr>
<td>Blocked promotion</td>
<td>33</td>
<td>20</td>
<td>20</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>To gain promotion</td>
<td>40</td>
<td>32</td>
<td>20</td>
<td>66</td>
<td>34</td>
</tr>
</tbody>
</table>

Numbers of multiple responses N = 16 (15) 95 (78) 6 (4) 3 (3) 120 (100)
and information beyond industry and his particular employer, and
secondly, there was the tradition of the 'self-made man', which placed
the onus for career development on the individual.

Responses to a question, "barring unforeseen development, do you
think you could remain here permanently?", could be answered either in
terms of the feasibility or the desirability of staying. Even where
respondents were alert to this nuance the responses were dominated by
references to desirability and feasibility was assumed. The majority
of responses were for industrial settings and relatively few anticipated
moves into university or government employment, yet within the industrial
sector the majority of respondents anticipated a move to another
industrial employer within the relatively short term (see Table 3).

Despite the preoccupation of the sociological and personnel
management literature with the conception of the graduate as a frustrated
academic, very few of the sample envisaged a return to university
settings. (24) And of these 15 who anticipated a possible return to
university distinctions must be drawn between those who would seek full-
time employment and those who anticipated a return as a short-term measure
to gain further qualifications. Among the former group only two revealed
any similarity to Cotgrove's public scientist or technologist.

"I think I prefer university research to
industrial research. I enjoy it here -
but I think I shall enjoy it more there.
At university you are doing fundamental
research, here they call it research but
it isn't really research in the purest
form, it's design work around new things
that have just come out. Pure is when
you are investigating phenomena, finding
out how everything works. Whereas what

(24) It should be remembered that the table refers to university
graduates only and none of the technical college sample contemplated
a move to university, government or teaching activities.
we are doing is, having been given something made by a manufacturer, a diode, we are building it up into a complete circuit and quite a lot of this is empirical."

"I think sooner or later the academic element will force me back to university or to a government establishment where there is greater freedom of thought. This is almost inevitable."

The point in quoting these views in full is to underline their atypicality, that among the would-be returners there were quite other considerations attached to university employment, for example, teaching and personal autonomy in leisure as much as work.

"I wanted a job in industry to see what it was like, and now that I've seen what it's like I intend to return to university to do a Ph.D and get a job lecturing or teaching at a university or technical college .... I want to do it for the personal freedom. I would get interested in it and not restricted by any time scale save three years. I want freedom to pursue things I'm interested in apart from the job, to plan my life as I want it not as (the Company) want it .... I feel that since university most of my personal life has been robbed."

For the most part, however, further qualifications were sought as part of a short-term return to university and the qualifications were valued as counters in career advance through industry. All of the graduates who envisaged this return to university were encouraged by the ongoing expression of higher education and job opportunities and had the 'good degrees', even some further degrees, which encouraged confidence about getting places, grants and jobs.

The preoccupations with industrial futures among the majority of these technologists and their reticence about futures with their present employers marked a growing preoccupation with status advancement and recognition of a profession of technologists or industrial scientists. The reluctance to anticipate a future with the existing employer owed
much to that tradition of the 'self-made man' where status advancement was the responsibility of the individual. Personnel managers had complained that management development was widely resisted by senior managers who believed that the 'hard way' developed fortitude and independent characters, and the new graduates quickly learned this folklore that the technologist should gain experience of a variety of engineering problems and organisational solutions by initiating moves between companies.

"As far as I can see I could stay here. The only reason I could see for leaving would be the general opinion in this industry that it is better to move around to get on."

"Conceivably I could stay, but it depends on a number of factors. Firstly, that I go in the direction I want, upwards, and, at a reasonable rate and salary. But it's doubtful that I will stay because I don't think that will happen. From what I hear and have seen it's a better idea - at least while at my age - to move around a bit, not every few months but say two years. In any case this is specialising in a particular field and I think I might want to do something different, say computer systems. There's no point in a complete change, but it's useful to change atmosphere. It's also good from a salary point of view .... When I went for interview, they usually sent you round with a couple of graduates and these chaps, who have perhaps been there two years or had other jobs, hold this view. And talking to people who are about 30 here, they seem to hold this view."

During the early 1960's Watson introduced the concept of 'spiralism' to denote "the progressive ascent of .... specialists of different skills through a series of higher positions in one or more hierarchical structures, and the concomitant residential mobility through a number of communities."

(25) The concept seems most clearly relevant to the technologists.

In a comparison of interorganisational mobility rates Gerstl and Hutton observed much higher rates among their sample of mechanical engineers than that reported in other studies of managers. (26) Although neither Gerstl and Hutton nor Pahl found simple relationships between frequency of moves and career success, Shinshoni found evidence of a beneficial relationship between a wide variety of employment experience with interorganisational and successful innovation by technical entrepreneurs in the American electronics industry. (27) Thus there may be some validity in the view that the development of the 'well-rounded' technologist is enhanced by interorganisational moves. For many of the young technologists in the electronics industry acquiring experience and developing knowledge and skills went hand in hand with status advancement for experience was a marketable asset to be sold to the highest bidder in a series of exchanges which marked career advancement. Acquiring experience becomes a side bet which implies only a short run commitment for clearly definable experience, such as that on training schemes, given the freedom to move and hopefully the guarantee that one can avoid the technician grade work of the 'raw graduate'.

"I look at it like this. I'm an 'assistant engineer'. I have just completed the graduate training scheme where if you leave before you are an 'engineer' than you have nothing to show for your experience here. Once you have completed this training scheme you've got to become an 'engineer' whether you like it or not to go anywhere to show them you've got experience. So another year to become an 'engineer' and then I can move."

(26) Among the youngest age group of mechanical engineers, approximately 25 - 35 in age, only one quarter had never changed employer. Gerstl and Hutton employed overall rates with those reported by Clements, the Acton Society Trust and Craig's study of Cambridge graduates, see J. Gerstl and S.P. Hutton, op. cit., p. 95.

**TABLE 4. Anticipated ease of obtaining another job by department of current employment (percentages).**

<table>
<thead>
<tr>
<th>Job Market Ease</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very easy</td>
<td>38</td>
<td>46</td>
<td>56</td>
<td>14</td>
</tr>
<tr>
<td>Fairly easy</td>
<td>50</td>
<td>46</td>
<td>33</td>
<td>72</td>
</tr>
<tr>
<td>Not very easy</td>
<td>9</td>
<td>8</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>Don't know</td>
<td>3</td>
<td>-</td>
<td>11</td>
<td>-</td>
</tr>
</tbody>
</table>

\[ N = \begin{pmatrix} 100 & 100 & 100 & 100 \\ (32) & (108) & (9) & (7) \end{pmatrix} \]

**TABLE 5. Anticipated future demand for own speciality by department of current employment.**

<table>
<thead>
<tr>
<th>Demand for speciality expected to:</th>
<th>Research</th>
<th>Development</th>
<th>Production</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>increase sharply</td>
<td>35</td>
<td>33</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>increase gradually</td>
<td>62</td>
<td>54</td>
<td>56</td>
<td>43</td>
</tr>
<tr>
<td>stay the same</td>
<td>3</td>
<td>11</td>
<td>22</td>
<td>43</td>
</tr>
<tr>
<td>decrease gradually</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>decrease sharply</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

\[ N = \begin{pmatrix} 100 & 100 & 100 & 100 \\ (31) & (106) & (91) & (7) \end{pmatrix} \]

**TABLE 6. Anticipated size of current employer's R & D organisation by company.**

<table>
<thead>
<tr>
<th>R &amp; D Organisation expected to:</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>increase</td>
<td>93</td>
<td>75</td>
<td>65</td>
<td>78</td>
<td>84</td>
<td>87</td>
</tr>
<tr>
<td>stay the same</td>
<td>7</td>
<td>10</td>
<td>35</td>
<td>9</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>decrease</td>
<td>-</td>
<td>12</td>
<td>9</td>
<td>8</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Don't know</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>

\[ N = \begin{pmatrix} 100 & 100 & 100 & 100 & 100 & 100 \\ (13) & (32) & (23) & (22) & (24) & (22) \end{pmatrix} \]
Of course actual moves will be a function of the relative degree of satisfaction with the present situation and the perceived opportunities to move elsewhere. Thus the view that one was responsible for one's own career development and that this was most likely to be promoted through inter-organisational moves rested on an optimistic view of the labour market.

Although interviews revealed some indications of doubt about the future, especially about current employers, the responses to questionnaire items on the economic future were answered with buoyant optimism. It may be some indicator of self-confidence that the responses became progressively more confident of expansion and ease as the focus of the question shifted from the current employer to a particular speciality and the individual's own prospects (compare Tables 4, 5, and 6).

Over half of the technologists expected a gradual increase in the size of the R & D activities of their current employers, and the remainder were evenly divided between the very optimistic and the pessimistic (where stability is taken to imply pessimism, see Table 4). Within this overall optimism there were some patches of doubt, for example, within the company with aerospace activities which had closed down some activities and transferred some newcomers to their present site. Within an electronics development lab the process of reorganisation fostered some disaffection. The interview produced somewhat stronger evidence of doubt about prospects in the current organisation which stemmed from two main sources, one lay in the consequences of recent rapid growth where promotion appeared blocked by the youthfulness of managers and the other lay in the possible ramifications of rationalisation from recent mergers. In one company where three mergers had been entered within the past three years the recent graduate entrants used four different names as the title of their employing company.
Anticipations of the demand for one's own speciality proved extremely optimistic with only two respondents anticipating any decrease in this demand (see Table 5). In their view of their own situation most of the total sample saw a situation of ease in possible future job hunts (if 'hunt' is appropriate to describe this optimistic state). There was a variation, however, in the degree of optimism and the university-trained physicists were noticeably more guarded than the university-trained engineers.

Although I have argued earlier that 'career' is most usefully viewed as a retrospective concept by which people can reinterpret their past, it is evident that a knowledge of 'career structures' can be used to develop a perspective on the future. The Ministry of Labour study reported the common view in the mid-1960's in the electronics industry that shortages had been caused by the rapid expansion of the industry and the movement of engineers and scientists into managerial positions and by the movement of young scientists and engineers between companies. (28) It was this popular view of a benign future and the probable direction of advancement which alleviated many anxieties about the future, and permitted the sealing off of their future beyond a short-term perspective.

(28) Electronics, op. cit.
4. **Work and Non-Work in Career Commitments**

The view, stated in the recruitment literature quoted earlier, that work is the core of existence for the career-minded could be taken as simply tautologous. But taken in the context of the comments about security and the various company welfare provisions the statement signals a view widespread in many companies that work is, or should be, a central life interest for managers and professional staff. (29) While professional staff might be expected to conceive of careers beyond the particular employer, in so far as they sought to enter managerial positions then they would be expected to manifest an interest in career advancement within a particular organisation. Thus 'commitment', 'loyalty' and 'ambition' become the required qualities. Among recently recruited graduates managers saw several impediments to the development of long-term commitments which included academic yearnings or orientations to professional careers beyond the current employer, an 'itchy feet' syndrome which was linked to immaturity, a market shortage for the technically qualified which favoured 'wheeler-dealers', and the trend to professionalise management in the sense that managerial information, knowledge and skills are seen to have a general market value. (30) Such responses become stock explanations of graduate turnover and since many of them could be

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(29) That this view extends into British companies and does not reside purely in the American sphere of organisations and literature has been pointed out by Pahl and Pahl, (see their study *Managers and their Wives*, op. cit., pp. 34-39).

(30) In the U.S.A. where this trend is assumed to have been more pronounced than Britain, Schein and his colleagues found no correlation between orientations to managerial careers and taking the current employing organisation as a principle frame of reference among a sample of scientists and engineers. G.H. Schein et al., "Career Orientations and Perceptions of Rewarded Activity in Research Organisations", *Alfred P. Sloan School of Management Working Paper*, 56-64, Massachusetts Institute of Technology, 1964.
attributed to university experiences, for example, academic ambition and irresponsibility, or university policy, for example, the 'shortage' or 'misallocation', these 'explanations' distracted attention from the importance of the work assignments given to newcomers. Whether or not work was a central life interest it was certainly important to most graduates because they lacked alternative lines of commitment. The majority were unmarried and the incidence of geographical mobility disrupted former friendships and commitments to a private sphere of life, and thus made work an important organising principle for present interests.

A relatively crude approximation to gauge geographical mobility can be made by using the nine standard regions of Britain and noting the extent to which schooling, college or university and work were in the same or different regions. (31) The approach is crude since regions are large and a school education in Reading followed by London University and work on the South Coast could involve marked changes of residence which would be obscured within a region. With this reservation in mind, that the classification understates mobility, it is clear that just over half of the graduates moved into the region after university, (see rows 4 and 5 in Table 7). Almost one-fifth moved back to a region where they completed their schooling after they had been to university (row 3) and the remainder experienced some continuity between university and work (rows 1 and 2). As we might expect the technical colleges were much more local institutions than either the universities or the ex-cats and three-quarters of output in the study experienced between schooling, college and employment. One of the most significant social facts about

(31) These standard regions are South-East, South-West, East Midlands, West Midlands, North West, Humberside, North-East, Wales, Scotland.
universities is their relatively homogenous population by age and social and educational background (and in engineering by sex too). The English universities have been national institutions too, so that although one third of the graduates went to university within their home region only 15% lived at home. The consequences of this pattern of residence and homogeneity of background have been universities which have been noted for 'peer group learning', for the development of collaborative perspectives on common problems. (32) Where the undergraduate life had been 'all of a piece' with few clear boundaries between work and leisure and hence all these problems of 'balance' in the allocation of effort and time, life as an employee was clearly marked out into 'company time' and 'free time'. During a period when 'free time' had to be organised and could be described as being in a state of 'suppression', interesting work could provide some reference points in work time. The disruptions of mobility can be gauged from the difficulties which many faced in nominating friends and social contacts outside work.

"It's a bit difficult to think of friends. I can think of plenty of acquaintances. When you leave university, all the people you know there are friends and would all be engineers. But they leave and go somewhere else. I can't think of any other close friends - acquaintances, yes, and they would certainly be engineers."

"I do have a problem what to do in the evenings after work. I am afraid the answer often is just watch the television in the digs."

"At the moment I spend my evenings, Monday - Friday, doing nothing, except perhaps cooking, washing, and living in a bed-sitter. This is more or less the suspended state I am living in at the moment. It's not permanent."

(32) Burns has commented that the role of student may offer one of the few remaining opportunities for a 'total role' in a society characterised by the high degree of differentiation. See T. Burns, "The Revolt of the Privileged", SSRC Newsletter, no. 4, London: S.S.R.C. 1969.
The geographically mobile graduate without established friendships can find that his bachelor status puts him outside the social circle of married colleagues and that his digs are no stage for his own entertainments and that he must seek commercial entertainment, voluntary associations or accept privatisation.

As a picture of all graduates the above is very much overdrawn, and three alternative situations can be readily seen. There were those who remained near parental homes, or returned to them after college and for them a private sphere could be readily fashioned on old friendships. Most typically this was true of the technical college graduate, and one could indicate the implication of this in the lower expectations for challenging work which he held.

"I appear to be more fortunate than many other graduates in here, because the things I do in my spare time in the (local voluntary association) are more important to me than the things I do in here. To this extent the job becomes less of a worry to me. It satisfactorily fills the time between 9 - 5, it pays me, it puts no great strain on me and it has sufficient challenge to it that it keeps me interested. This is all I ask of it really. It seems to be all that is asked of me and everyone is reasonably contented."

Another possibility was that graduates remained within close proximity to old social contacts at this university. To some extent this can be only a temporary solution, but a temporary solution which affords the establishment of career footholds and a new set of commitments out of work.

Yet a third possibility for the graduate was that he could develop contacts with other recent graduate entrants who shared both his recent experiences and present predicament. This was the point emphasised earlier about the benefits of group training schemes in large companies. Even where a private life was sought apart from work, mobility sometimes imposed a dependence on companies which linked work and leisure.
"Most of my friends have to be engineers from here. I can't get away from it but I've tried. I think it's important to try, conversationwise, because you can't talk about work problems all day and every night. It runs out after a while. I've been to a rifle club, some people from here go too."

"I get my whole personal life from the job. The job introduces me to a lot of people. The other person who shares the flat comes from (this company). They put me in digs at first with eight other people from (this company). I go out with them, get to know them and get to know more of them. This is a new town so the social life tends to be round your work rather than round where you live, usually you don't know your next door neighbour. Your friends tend to come from work."

Company locations in new towns earned the scorn of bachelors for the bleak architecture, shortage of large houses for flat-sharing, the heavily skewed age structure with a high proportion of marrieds, and the lack of social amenities comparable to universities or university towns. When the lack of out of work interests were associated with a lack of challenge in work the newcomer lacked commitment to the organisation which would obviate his search for alternatives, and the coincidence was illustrated by a graduate who was seeking to return to university.

"There seems to be two types of person here. There are ordinary people with a Zephyr or a Consul, live about 300 yards from work, have two children, and go away two weeks a year and have a week at Christmas. The others have a slightly bigger car, live a mile away, and have three children. I find the whole idea pretty depressing. I feel I've got to have a challenge, if I've got an exam then I'll work. At university you could aim at something, the end of term, an exam. If it wasn't an exam it was trying to edit a newspaper or get into the sailing team. Here there is nothing to aim for, except getting a house a mile from work, and I would like to travel, move around and so on."
This reluctance to be identified within the two class model of the organisation and community could be diagnosed as part of the 'itchy-feet syndrome' but to accept its inevitability, or recruit from technical colleges those without such 'broader' horizons, or promote welfare schemes, would neglect the control which could be exercised through job assignments.

How marriage might affect career aspirations can be only partially investigated among husbands or potential husbands. However some preliminary and tentative observations can be made. The first is that the 'near-married', those who mentioned engagement and plans for marriage in the near future, were frequently socially estranged from local communities around their work. Although this was always viewed as a temporary situation these other role transitions could exacerbate the difficulties and frustrations experienced from a lack of challenging work.

"I'm leading a bit of a double life at the moment. I am here during the week and back home at the weekend. It's a bit disheartening from a social point of view because what happens here, happens at the weekend .... I seem to be one step out wherever I go. It's just something I've got to put up with till I get married in July."

"I can't really, at the moment, say I am satisfied with anything, it's partly outside work as well. It all goes with this feeling about responsibility; when it comes am I actually going to have something concrete to meet, that's assigned to me and over which I am responsible. I feel as if I am in a state of suspended animation: I've left university and I can't say I'm settled in fully. Partly also I'm getting married in six weeks' time and I've got money problems as anybody paid a month in arrears would have ....

I'm just waiting for the next ten weeks, for Christmas to roll by when I can settle the personal and money problems. Then once I've got a definite job here I shall be more satisfied."

Both the 'marrieds' and 'near-marrieds' reported on wife or fiancee approval of technological careers as 'secure and reasonably well-paid.' Interests in mortgages might prompt a growing interest in the extrinsic rewards from work but there were two other ways in which marriage could influence career choice. The first was in choice of job, where
several mentioned that shift work or field engineering would not be welcome, and the other was mobility, but here opinion was evenly divided between those who saw marriage as a constraint and those who vouched for a spouse's willing acceptance of moves as part of career advancement. On this point it must be remembered that only one respondent was married with children.
5. Career Structures, Status Advancement and the Work Organisation

The starting point for this chapter was an illustration of the widespread social concern about the careers likely to be experienced by industrial scientists and engineers. In the late 1960's the interests of industrial companies in career structures which stemmed from their survival interests and dependence on scientific and technological knowledge were of wider import because of Government commitments to promote industrial modernisation and Government responsibilities for the educational system. If the provision of educated manpower through the educational system and the availability of career ladders within companies to serve the long-term needs of the company working organisations appear to be readily manageable aspects of a manpower policy, then this facile view can be disturbed by examining how individual commitments to status advancement have implications for the working organisation. This exercise involves drawing together some of the strands of both this and the preceding chapter. While many graduates could close off the future and concerns about careers, it remains the case that the majority were anxious about careers and status advancement. Moreover it was evident from the preceding chapter that an interest in status advancement emerged as a response to early career assignments and a search for an escape from them. Therefore the present focus is on the consequences for conduct in the working organisation when status advancement becomes a major frame of reference.

As Burns observed, organisations elicit both cooperation and competition. (33) The problem for the newcomer is to distinguish the elements of the moral code which prescribes legitimate and illegitimate behaviours. In any particular situation, the pattern of norms,

relationships and acts may be cloaked in ambiguity and the newcomer has to learn to differentiate what might be interpreted as illegitimate 'creeping' from the legitimate cultivation of 'good relations', and to distinguish pressing one's own cause from the denigration of others, where the latter course could rebound as an example of 'pot-stirring' or 'trouble-making'. And as one graduate indicated while these behaviours may feel at odds with private thoughts, they are a pretence which is demanded and whose compliance is sanctioned.

"You've got to fit into the group. If you want to be ambitious within the group and you want to push out - this is what I want - then although you may be pushing for more responsibility, you can't do it in a way which offends other people. I'm not talking about being slimy or underhand, you've just got to oil the process all the time. Everybody is keeping up the facade.

You must make sure everybody knows you are doing a good job. If ever you offer an idea you expect it to be shot to pieces - not just from an engineering point of view. You couldn't tell one person he is in charge of another in my department, the issue is never brought to the fore. You haven't got to think of it in that way. If you don't get on too well then somebody will say you've just got to do what you're told. It's all part of the act. What you've got to do is to come in, do the job, make sure everybody knows you've done the job and don't be frightened to tell everyone you've done a good job. It's just an atmosphere. You get the odd derisory comment when you drop a boob. It's only natural to drop a boob so these are the people who don't fit in, who are deliberately creating friction, who call out in public when other engineers are there."

In probes about the qualities for career advancement, the stress laid on visibility became one of the marks distinguishing the 1967 entrants from the 1968 entrants. The very recent recruits placed stress on technical abilities, on meeting the supervisor's demands as given to them within a given time-scale. For those with a year's experience being visible was an important additional requirement.
"You've got to be willing to push hard. It's noticeable that those who get on have got a different attitude from the rest, they're willing to be noticed."

"My impression - and I was told by people in the lab - is that to get on you've got to make yourself known. You can't be a quiet little worker in the corner, you let them know you're there. You go to the office at least twice a week whether it's anything to do with the job or not doesn't matter. I must say that in the year I've been here it has been borne out. There was a quiet worker type and a bloke who went into the office and had a joke and he was the one who got promoted."

Observations of how it has been done aid the development of strategies for it is important to know by whom, by what means, and for what one should be known. Suspicions about the adequacy of the system of appraisal encourage the belief that it is important to be known directly by the person who makes decisions about promotions, the department head in his 'office' and not just the supervisor. Entree can be made in this direct manner or by securing significant parts of projects, whether significant technically or significant because they involve documentation.

Such a preoccupation with status advancement has its implications in work conduct because it influences preferred projects and conduct on projects, for example, information about forthcoming projects can be solicited and hints dropped about preferred assignments. And the impact of these career strategies can be pointed up most dramatically by looking at the consequences of turnover in the development labs.

Some of the main views on turnover in companies have been raised already in discussions of the labour market. There it was seen that companies were prepared to accept, if begrudgingly, current turnover levels and interorganisational moves as a necessary price to pay for using the early employment period as part of the search process to be
completed by companies and graduates. (34) Before such a conclusion can be accepted with complacency it is necessary to indicate what sort of price is being paid by companies and graduates. Although it is extremely difficult to state these costs in financial terms and a recent study of labour turnover in the electronics industry did not attempt a breakdown by skill categories of disruption costs and was preoccupied by the level of turnover among female labour, it is possible to discern some of the ways in which costs can be incurred. (35)

In the development labs it was evident that both the satisfactions sought and found in work by engineers and the patterns of communication adopted among engineering groups made them peculiarly vulnerable to opportunist career strategies. It will be recalled from the discussion of job satisfaction that the main sources of satisfaction were found in problem-solving, especially at the design stages or in the completion of building preliminary models. Dissatisfaction was found in routine work frequently described as 'paperwork'. Some examples of this antithesis of technical problem-solving and paperwork can be seen in the comments of a research and a development technologist on their satisfactions and dissatisfactions.

"The scientific work as compared to writing memos and reports."

"The sheer engineering, the benchwork: it's paperwork I hate."

The official rewards tend to reinforce the pattern of intrinsic rewards for it would be a foolish engineering organisation which sought a

(34) For a similar view to that expressed in responses to the Ministry of Labour study of the electronics industry, see G.F. Thomason, "The Recruitment and Selection of Scientists", op. cit.

reputation for the preparation of internal memoranda rather than for
the production of physical hardware. Already accounts of work organisation
have distinguished the more specific and local knowledge of the development
engineer compared to the research scientist and the different patterns
of communication with the emphasis on oral communication among the
development engineers. (36)

Both the company recruiters' emphasis on 'personality' and the
development engineers' emphasis on 'communication' among the qualities
of the 'good engineer' serve to underline this point. Thus in the
development labs managers saw the bulk of the early employment period
as a period of becoming knowledgeable about organisational processes,
of developing a conceptual map of communication channels and 'gatekeepers'.
Gatekeepers could be of many kinds, people who had access to knowledge
because they worked on similar problems in the past or access to
materials and services, for example, a 'model shop' which could provide
prototype models more readily than a distant production department.
Thus, while the 'company system' was an omnibus concept and would refer
to ordering procedures or to prescribed drawing procedures, it was used
more frequently by engineers to refer to people who had scarce resources
of information, knowledge and skill and became nodal points in a system
of communication. In problem solving their importance lay often in
their knowledge of the oral history of a project. Company notebooks
and product handbooks recorded decisions and deliberations, and the
source of information for these deliberations was usually the engineer
himself. Where engineers disliked paperwork notebooks were kept in a
very idiosyncratic manner. Supervision of them was almost non-existent

(36) See Chapter Eight, sections three and four.
and although officially company property they tended to become the personal property of the engineer. The way in which turnover becomes a loss in terms of both the oral and written history of a lab because of the pattern of work organisation in the development lab can be illustrated by the comments of a development lab manager.

"If we had a turnover of 30% per annum then our efficiency would drop because part of the efficiency of the organisation lies in knowing your way about. It's such a complex organisation that unless you've had experience of this you just can't get things done. For the first year he doesn't know people, after three years if he left we would only have had one year's effective work. It's not heresy because there are certain parts of the company with 30% turnover - certain laboratories, research labs in particular. Down here people can make a career; at the lab it was accepted but not liked that people move. It's not so catastrophic as it would be here ....

We do issue a standard lab notebook which people should write in, keep up, number them and not destroy them ....

I recently had a very bright young engineer in here who was inventing circuits all the time. He has since left and gone to another company, and I didn't manage to get the reports written on what he had done even though we bullied, badgered and tried."

Where salary scales are not published and the pattern of increments unknown some graduates supplement their knowledge gained through newspaper adverts and professional institution surveys by testing out the market. Such tests can be carried out by applying for jobs in other companies to find out their market valuation or by testing out the market internally. Usually the two applications go together with the rival offer used as a lever against the employer. While proving one's indispensability may be an essential ingredient of all bargaining situations a pattern of work organisation which depends greatly on local organisational knowledge
and stability of personnel enhances the available counters in bargaining. And as another 1967 recruit indicated the significance of the customer on Government military projects and interorganisational familiarity added another counter to the indispensability strategy.

"I think the major thing here as elsewhere is to prove that you are indispensable. One chap did this rather brilliantly by threatening to leave at the 'wrong' moment in a project, and the Ministry said this can't happen he's a marvellous chap, and he was promoted to senior engineer within eighteen months of being made an engineer. He still left the company though: it was too late. This was a monumental bloomer on the part of the company and nobody had any respect for the people involved."

While a loss might be readily seen in the departing member, costs arise to both the organisation and the new recruit from turnover. Indeed the costs to the new recruit may be among the more important and neglected costs, and raise for companies the possibility of a vicious circle in turnover.

The new graduate engineer, who joins the company with the offer of direct entry and the promise that the best way of learning is on the job, is the most likely candidate to take over from the engineer, two or three years his senior, who has left. This is especially the case because other engineers will be already committed or find some commitment to avoid the inheritance. The departed engineer is not available for questions and his notes and reports are terse in explanation. The costs to the newcomer lie in his opportunities for job satisfaction and possibly his development as an engineer. The following comments illustrate both the difficulties and the disgruntlement. The important point in the comments from a lab where a fifth of the new entrants 'inherited' jobs is that the disgruntlement is quite distinct from that in 'trivial work' and 'dirty work'. 
"I would prefer to have started on a new job, not clearing up someone else's mess. I want to be designing, not redesigning."

"They were fairly near to having a trials model when I first came. I found this was all bewildering, some people had left and I had to talk to others who were around on the job."

"The development of the transmitter had been going on in various forms for some time, but the particular form has just been developed. Parts of it had been designed before I came in and it was difficult to follow the thoughts of the engineer. He'd left. Usually there are a few notes and circuit diagrams and that should be all you need anyway, but you can't ask the man where he had difficulties."

"Solving a problem" or "making something that worked" carried the bonus for the newcomer, it marked achievement as a technologist and feedback on making out in a new situation. The denial of this kind of 'baptism' can mean a lengthier probation and less readily developed self-confidence. Whether the new recruit leaves in immediate frustration is dependent on a number of other factors but there is all the potential for a vicious circle of dissatisfactions, of departure and disillusionment.

This is not to suggest that turnover is undesirable. Sufficient studies have been completed already to indicate the importance of the movement of people to the transfer of technology and promotion of innovation. (37) The point made here is that when young engineers begin to 'think of their careers' to the extent that status advancement becomes a major frame of reference then the kinds of commitments which they are

(37) Models of technology transfer in which the movement of people were the crucial variable rather than models involving the transfer of units of disembodied information such as in sophisticated material technologies such as computer stored information retrieval systems appears to have been the main conclusion from the M.I.T. conference on technology transfer. See, H. Gruber and D.A. Marquis, eds., Factors in the Transfer of Technology, Cambridge, Massachusetts: the M.I.T. Press, 1970.
likely to make have consequences for their commitments to the 'working organisation', especially in the development laboratories. Such consequences could be ameliorated by a labour market which reduced the possibilities of movement, by policies which changed the attractiveness of staying or leaving, for example, on work allocation and assignments, by changes in the conduct of engineers, for example, by the development of norms about the state of a project on departure or new patterns of work organisation and communication. Oral communication among engineers is not entirely governed by the nature of the task, it is encouraged by the difficulties which engineers encounter in coping with literature. Any attempt to cope with a high turnover by an insistence on better company documentation practice alone might well founder on the inadequacies of the engineers' prior education and lack of continuing education. What is particularly depressing about the situation is that the problems of social structure and organisation are so frequently seen as psychological problems, as problems of individual personality, and either unalterable or to be changed only through the formal educational system perhaps it is revealing in itself that this can be illustrated in the remarks of a company training officer about engineers and report writing.

"This is a question I think of personality traits. The type of person who makes an engineer is not happy writing, the type of person who makes a solicitor doesn't like to get his hands dirty. I am quite happy to say that there are two distinct types of people, and the engineer is probably less careful in his thoughts, his thoughts move rapidly and outstrip his hands, and he can't get it down. I don't know whether this is true or not, but it satisfies me."

PROFESSIONALISM AND CLAIMS TO POWER AND AUTHORITY

1. Introduction

We have seen that a significant feature of the manpower debate of the late 1960's was the context of economic crisis in which the supply of scientists and engineers for industry was defined as a social problem. Securing greater numbers of better qualified scientists and engineers was part of the broader task of the modernisation of industry and the economy, and this aspect of the broader problem produced calls for more heed to the voice of scientists and engineers in national and industrial affairs. For engineers in particular the essence of the problem was seen in the difficulty of defining a distinctive conception of engineering and engineers which would convey and help establish the claims of engineers to a distinctive competence and right to make authoritative pronouncements. This aspect of the debate went under the heading of the problems of the profession and there has been a long history of attempts to distinguish a professional engineer from a craftsman on the one hand and from a scientist on the other. (1) While efforts to boost the prestige of engineers have been generally applauded by Governments, manpower advisers, and industrialists, the concommitent efforts to develop a community of industrial scientists and engineers and enhance their power and authority at the expense of other groups has been less readily applauded. Such a

(1) The dilemma of theory and empiricism has been discussed by MacFarlane who pointed out the emphasis laid on analytical skills to differentiate the engineer from the craftsman to the public and the emphasis within the occupation on craft aspects of engineering to remind members that they were not scientists. See B. MacFarlane, "The Chartered Engineer", unpublished Ph.D thesis, London University, 1961.
move has been interpreted as the fostering of a potentially disloyal group with a potential to challenge managerial prerogatives.

In the older sociological literature this challenge to management was discussed in terms of staff-line relationships where the staff approximated to a continuous consultant to the organisational doer, the line executive who was typically engaged in production-output activities. This literature has been largely replaced by discussions of professional organisational relationships because experts are rarely employed simply as individual advisers so that the concept of staff has had to be expanded to incorporate functionally distinct activities such as those of the research and development lab. Moreover the marked differences in social and educational background between staff and line are less likely between professionals and their supervisors or other organisational members with whom they interact. (2)

As we saw in Chapter Two a good deal of this sociological literature on profession and organisations has been limited by theoretical weaknesses and a prejudicial view of professions. Handicapped by a theoretical approach which emphasised looking for the 'needs' of a social system a number of sociologists located the professions as those occupational groups with important functions in promoting social cohesion and cited the importance of their service orientations and codes of ethics. This approach was linked to a partiality for a social order which avoided the extremes of laissez-faire capitalism and the dominance of a bureaucratic state and so the professionals became featured as heroes against several

threatening social developments. (3) The corollaries of this approach were that sociologists stood in danger of merely acting as spokesmen to espouse professional claims and acting as doorkeepers to the exclusive 'professional club' attempting to exclude charlatans and rogues. As an alternative to this approach, in Chapter Two, I argued the case for a sociological approach, which viewed the essence of professionalism as an attempt to secure a highly prized and privileged social status and posed the sociological problems as questions about the conditions under which occupational groups claim professional standing and then questions about the consequences of such claims. While this alternative approach had been long advocated in the Chicago tradition of the occupational studies it has been particularly fruitful in the examinations of the conflict of British engineers and scientists and their industrial employers in the studies by Przand and Burns. (4)

In this chapter then, the central issues for examination are the extent to which recent graduate recruits to industry attempted to identify themselves as professionals, the senses in which they would make such claims and their justifications for them, and the extent to which they developed commitments to an occupational community of fellow-professionals which helped sustain an identity and conception of work counter to that of industrial employers. In the following sections it is argued that

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(3) This approach had its origins in the writings of Durkheim,(Professional Ethics and Civic Morals, Glencoe: Free Press, 1958) and is evident in the work of Parsons among current writers ("Professions", International Encyclopaedia of the Social Sciences, New York: Macmillan, 1960). Examples of this approach in relation to scientists are Barber (Science and the Social Order, op. cit.) and Kornhauser (Scientists in Industry, op. cit.) These were discussed in Chapter Two, section two.

although some engineers and scientists in industry did make claims for distinctive treatment as a distinct category of industrial employees the prospects for the collective expression of conflict against industrial employers were weakly developed. One of the central problems in securing the commitment of young engineers and scientists to such an occupational community lay in the difficulties in establishing the cognitive boundaries of engineering and industrial science. For many engineers and scientists their self-identifications as professionals were envisaged as temporary commitments since they aspired to managerial positions. Even within their current positions as 'junior engineers' the graduates recognised the rival conceptions of engineering knowledge advanced in industry which challenged their position and against which they countered their academically-derived conceptions. A professionalism which excluded management and concentrated on the knowledge and skills of the young graduate engineer or scientist was used to define and legitimise the new entrants' competence and rights in the work situation and his position in the wider society. While this was one convenient device to cope with the existing situation of entry it could be pressed only in a 'tongue in cheek' fashion since the graduate aspired to becoming a manager and because it carried the penalty of a technicist conception of management and would hinder both the graduates' organisational learning and career advancement.
### TABLE 1  The Relevance of Professionalism

(a) Self-conception as a professional by education and qualification

<table>
<thead>
<tr>
<th>Self as Professional</th>
<th>University Eng</th>
<th>University Phys</th>
<th>Ex-Cat Eng</th>
<th>Ex-Cat Phys</th>
<th>Tech. College Eng</th>
<th>Tech. College Phys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>58</td>
<td>53</td>
<td>33</td>
<td>80</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>No</td>
<td>42</td>
<td>47</td>
<td>66</td>
<td>20</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>N =</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

N = (84) (41) (5) (5) (15) (3)

(b) Self-conceptions of the University educated engineers and physicists by department.

<table>
<thead>
<tr>
<th>Self as Professional</th>
<th>Research Eng</th>
<th>Research Phys</th>
<th>Development Eng</th>
<th>Development Phys</th>
<th>Production Eng</th>
<th>Production Phys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>78</td>
<td>60</td>
<td>57</td>
<td>53</td>
<td>100</td>
<td>33</td>
</tr>
<tr>
<td>No</td>
<td>22</td>
<td>40</td>
<td>43</td>
<td>47</td>
<td>-</td>
<td>66</td>
</tr>
<tr>
<td>N =</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

N = (9) (15) (70) (17) (2) (6)
2. **The Relevance of Professionalism**

It was the claim of engineers to be recognised as professionals which prompted Kornhauser to revoke his initial impulse to exclude the engineers and applied scientists from his category of professional scientists in industry. (5) It is this dependence on everyday language as a source of sociological concepts which should alert sociologists to the importance of investigating people's own definition of their situation. (6) In the electronics study 'professionalism' was a meaningful concept even for those who would not use it as a relevant category for themselves, and the concept took on meaning for recent graduates as a way of distinguishing a category of employees who had a specialised competence. This competence became the basis for claims to exercise choice over the kinds of works undertaken and to exercise discretion and autonomy in the conduct of work. But the existence of sizeable minorities who did not identify themselves as professionals indicates the extent to which such a professional consciousness was not developed and the hindrances to the development of such a consciousness lay partly in disagreements about relevant knowledge and partly in a view of claims to social prestige in the wider society as irrelevant.

A somewhat higher proportion of the university engineers (approximately 60%) conceived of themselves as professionals compared to the university physicists (50%) (see Table 1). There does not appear to be any greater readiness on the part of those from technological institutions to conceive of themselves as professionals compared to the university graduates.

(5) See Chapter Two, section two.

(6) For one interesting example of this approach among a related occupational group, see P.F. Sheldrake, "Orientations towards Work among Computer Programmers", *Sociology*, vol. 5, no. 2, May 1971.
<table>
<thead>
<tr>
<th>Reasons</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng</td>
</tr>
<tr>
<td>Those holding Professional self-conceptions</td>
<td></td>
</tr>
<tr>
<td>Professional Bodies</td>
<td></td>
</tr>
<tr>
<td>1. Professional Institutions</td>
<td>10</td>
</tr>
<tr>
<td>2. Professional Standards</td>
<td>6</td>
</tr>
<tr>
<td>Training Qualifications</td>
<td></td>
</tr>
<tr>
<td>3. Scarce Skills</td>
<td>4</td>
</tr>
<tr>
<td>4. Training</td>
<td>6</td>
</tr>
<tr>
<td>5. Qualifications</td>
<td>37</td>
</tr>
<tr>
<td>Career</td>
<td></td>
</tr>
<tr>
<td>6. Vocation</td>
<td>34</td>
</tr>
<tr>
<td>Work Organisation</td>
<td></td>
</tr>
<tr>
<td>7. Responsibility</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
</tr>
<tr>
<td>Number of multiple responses</td>
<td>63</td>
</tr>
<tr>
<td>N =</td>
<td>(49) (22)</td>
</tr>
<tr>
<td>Those rejecting professionalism</td>
<td></td>
</tr>
<tr>
<td>Still training</td>
<td>17</td>
</tr>
<tr>
<td>Lack specific skills</td>
<td>14</td>
</tr>
<tr>
<td>Not recognised</td>
<td>11</td>
</tr>
<tr>
<td>Irrelevance of professionalism</td>
<td>54</td>
</tr>
<tr>
<td>Number of multiple responses</td>
<td>35</td>
</tr>
<tr>
<td>N =</td>
<td>(35) (19)</td>
</tr>
</tbody>
</table>
Although this latter finding is at odds with Prandy's study it must be remembered that the technological institution samples were particularly small, and there are the complicating factors in the distribution of qualified personnel across departments which means, for example, that the physicists were more heavily represented in research departments.

For the majority who defined themselves as professionals the defining characteristics lay in a scientific or engineering knowledge and skill which was certified by qualifications, and the important point about the qualification was that it was one granted by an educational institution (see Table 2).

"Yes, I suppose I do (think of myself as a professional) because I have a university degree."

"Yes, in the sense of having a degree."

"Yes, I have a professional degree. With a degree you are entitled to become an associate member of the Institution of Electrical Engineers. If you are in a profession this implies certain skills, a certain intelligence. If you are in another occupation this doesn't immediately follow. If you like that's a faith in the examination system, there may be large numbers of intelligent people not in a profession as such."

Other defining characteristics of professions were in part consequences of the lengthy training which was a prelude to qualification, for example, a number of the new entrants discussed their relationship to technological activities in terms of 'dedication' and 'vocation'. For them it was unlikely that they would undertake frequent and diverse switches in jobs and occupations of the kind which they envisaged in non-professional occupations.

"Yes, in the sense that it is a career that I want to do well at - to become a professional engineer."
"Yes. At the moment I am working in engineering and I regard myself as a professional because I won't skip about from job to job for location reasons but I'll skip about from job to job or change my job if I feel I want to go into a different sort of line."

Again some responses could be grouped together under the heading of autonomy and these were advanced as another consequence of competence. Because the graduate held himself competent by virtue of a lengthy training, a few, notably many fewer than those claiming competence, could distinguish a degree of autonomy in their relations with others because of the difficulties of supervising someone who speaks authoritatively because he knows the task better than anyone else.

"Yes (I think of myself as a professional) in the sense that the job gets done because of my own discipline. There's nobody to tell you what to do. You get times to do a job but it only gets done because you do it not because anybody is telling you to do it. This is my definition of a professional — somebody who does a task which requires a certain amount of skill through his own discipline."

Again a relatively minor theme was a fourth defining characteristic of the professional as a member of an occupational group which defined standards of engineering and conduct comparable to other prestigious occupational groups. Depicting the Professional Institution as the source of these official pronouncements, this theme was a counterpart to autonomy in the sense that the internalisation of standards during occupational socialisation developed that self-discipline which justified autonomy. The main emphasis on the Professional Institution, however, was as a guarantor of a level of competence through qualifications rather than as a policeman of their observance while working.

"Being a professional means that you give a reasonable service."
<table>
<thead>
<tr>
<th>Bases of Professionalism</th>
<th>University</th>
<th>Eng</th>
<th>Phys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Bodies</td>
<td></td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Education and Qualifications</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Scarce skills</td>
<td></td>
<td>4</td>
<td>4</td>
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<tr>
<td>Specialised training</td>
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<td>21</td>
<td>27</td>
</tr>
<tr>
<td>Qualification</td>
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<td>21</td>
<td>9</td>
</tr>
<tr>
<td>Careers and Opportunities</td>
<td></td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Methods of Work</td>
<td></td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>Don't Know</td>
<td></td>
<td>21</td>
<td>13</td>
</tr>
<tr>
<td>Number of multiple responses</td>
<td></td>
<td>96</td>
<td>52</td>
</tr>
<tr>
<td>(N =)</td>
<td></td>
<td>(85)</td>
<td>(44)</td>
</tr>
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</table>
"Yes, (I think of myself as a professional). One has responsibility. We are working on a subject that's very difficult without mathematical expression to ideas but we do tend to use words that are everyday words — machine learning and reproduction — and I feel we shouldn't use these words in public where they might be misunderstood. This is like the doctor who will not talk of his work because he doesn't want to frighten people.

There is a much greater responsibility placed on the professional man compared to the man who is not a professional. The lorry driver has got responsibility for the lorry, the contents and the lives in his hands. But he hasn't got responsibility for the deeper philosophical ideas which occur in his job because there aren't any as far as I can see. But there are very great philosophical ideas which are very significant which arise from the work I'm doing. Responsibility I feel is at the heart of it."

"I think of a profession as one where you train for a particular job and become chartered."

"Yes, I think anyone who belongs to a professional institution is reasonably well-qualified just as much as any professional man."

The lengthy comment above on a broad social responsibility was remarkable for defining responsibility to a group other than employers. Standards of service were almost wholly preoccupied with the relationship to the employer and the Professional Institution qualification as a supplement to academic qualifications as guarantees to potential employers.

If bases of professionalism are sought in responses to a more general question about differences between 'professions' and 'other occupations' then a similar pattern emerges (see Table 3). Professions were distinguished by knowledge and skills which were not widely available, by the specialised training by which the knowledge and skills were obtained, and by the qualifications which labelled and certified competence. And again it was a university or college which was the agent of certification. For some the professions were distinguished by
better career opportunities for advancement and this was seen by contrasting the individual career and individual negotiation of the professional to the collective advancement through trade union action on the part of the manual worker. Again patterns of work organisation involving autonomy for the individual engineer or scientist and a professional institution to promote study and certify knowledge and skills emerged as additional defining characteristics of professions.

Although the university physics graduates appear to cite qualifications among the defining characteristics compared to engineering graduates, and, somewhat surprisingly, those from technicological institutions appeared no more ready than the university graduates to see themselves as professional and do so by their training and qualifications, the central point emerging from the data is the overwhelming emphasis on academic qualifications as a central element of professional claims.

Although legally constituted organisations of professionals with formal codes of behaviour are not necessary either to the making or acceptance of claims to professional standing, professional organisations have important functions in promoting a distinctive conception of the occupation. (7) In Britain, as in the United States, the engineering and scientific professions have concentrated on educational and qualifying functions rather than attempts to define and sanction professional conduct or protect members directly. (8) For the study and qualification

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(7) Ben David suggests that professional organisations have more importance in Britain compared to other industrial countries, see J. Ben David, "Professions in the Class System of Present Day Societies", Current Sociology, vol. 12, no. 3, 1963-4.

functions are emphasised in the aims of both the Institute of Physics and the Physical Society and the Council of Engineering Institutions.

"The objects for which the Institute and Society is established are the advancement and dissemination of a knowledge of physics, pure and applied." (9)

The engineers had regard to the public interest too in the statement of aims in their Royal Charter.

"To promote and coordinate in the public interests the development of the science art and practice of engineering." (10)

Thus the stated aims and activities of Professional Institutions are in broad agreement with the aspirations of the bulk of our sample in the electronics industry. The Institutions support the claims to a distinctive employment status and establish rightful claims by certification of competence, and membership of the Institution takes on importance as an aid to career advancement since technical qualifications and appointments were preliminaries to managerial promotions. Within the first two years after graduation the electronics sample were eligible for only the preliminary stages of Institution membership. At the time of the fieldwork there were three professional grades of membership of the Institute of Physics - graduateship, associateship and fellowship. (11) Eligibility for graduateship was based on academic examinations to honours degree or equivalent level, while associateship required both

(9) Institute of Physics and the Physical Society, General Information, 1960, p. 3.


(11) In 1960 the Institute of Physics, which had catered for the activities of physicists as professionals, and the Physical Society, which had been a learned society "solely for the advancement and discrimination of a knowledge of physics", were amalgamated, but a distinction was retained between membership and fellowship of the Institute and the Society, with less stringent requirements for the non-professional concerns of the Society.
evidence of this standard of knowledge of physics and "satisfactory practical experience" which in conjunction with an honours degree was estimated as "at least three years in such responsible work in physics or its applications as shall satisfy the Council." (12) While regulations laid the broad lines of eligibility, individual applications could be made with various mixes of academic competence and practical experience for review by the Council, and in this way posts of responsibility and strong supporting claims could gain entry to associateship where graduateship might have been denied on academic grounds. A similar pattern of membership grades and titles (graduateship, associateship and membership) had existed in the I.E.E. prior to the renewing of titles in 1966. (13) When the Institute of Physics changed titles in 1971, the two institutions were again in line with associate membership, membership and fellowship as the new common titles. By these titles and qualifications a professional engineer was defined by corporate membership (members and fellows), and the electronics sample were non-corporate members (graduate members or associate members by the old and new titles). In the case of the engineers corporate membership was based on the achievement of a graduate or equivalent level of education, but in this case at pass degree (and not honours degree/ equivalence), approved training and two years' experience in a "responsible position", and again 26 was the expected minimum age at which all requirements would be satisfied.

The definition of a "post of responsibility" has caused considerable anxiety and debate within the Institution and the Council attempts to interpret the regulation in the spirit of the E.U.S.E.C. definition of


### Table 4. Professional Institution Membership by Education

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<tbody>
<tr>
<td>Institution of Electrical Engineers</td>
<td>63</td>
<td>11</td>
<td>57</td>
<td>-</td>
<td>75</td>
<td>-</td>
</tr>
<tr>
<td>Institute of Electronics and Radio Engineers</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Institute of Physics</td>
<td>-</td>
<td>39</td>
<td>-</td>
<td>-</td>
<td>19</td>
<td>66</td>
</tr>
<tr>
<td>Non Members</td>
<td>37</td>
<td>48</td>
<td>43</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| N = | (84) | (44) | (7) | (5) | (16) | (3) |

### Table 5. Perceptions of the Social Status of Engineers held by laymen

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>72</td>
<td>44</td>
<td>40</td>
<td>20</td>
<td>65</td>
<td>33</td>
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<tr>
<td>Medium</td>
<td>17</td>
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<td>20</td>
<td>60</td>
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<td>66</td>
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<tr>
<td>High</td>
<td>6</td>
<td>11</td>
<td>-</td>
<td>20</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Don't Know</td>
<td>5</td>
<td>3</td>
<td>40</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| N = | (78) | (36) | (5) | (5) | (14) | (3) |

### Table 6. Attitudes towards the Low Public Image of the Engineer (University Group Only)

<table>
<thead>
<tr>
<th>Attitudes to low public image</th>
<th>University Eng</th>
<th>University Phys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissatisfied</td>
<td>44</td>
<td>19</td>
</tr>
<tr>
<td>Indifferent</td>
<td>52</td>
<td>81</td>
</tr>
<tr>
<td>Accept as justified</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

| N = | (68) | (16) |
the engineer's duties as involving work "not of a routine mental or physical character but requiring the exercise of original thought and judgement." (14) However there is no specification of the proportion of time spent on this kind of activity, only that it is present at some point. In doubtful cases, approximately one third of all applications, interviews are held at which less than one third of the interviewees are unsuccessful. (15) Somewhat dismayed by their numbers of graduate recruits and fearful lest graduates recognised their first degree as sufficient professional qualification the I.E.E. launched a college recruitment drive and appointed counsellors among engineering faculty in 1966. The numbers of student members rose sharply and it may be no coincidence that three quarters of the I.E.E. members in the electronics study sample had joined as student members.

In assessing the earlier claims to professional standing and the extent and pattern of institutional membership the central points to be borne in mind are the stages to full professional membership as defined by the Institutions. Given the two stages for the physicists of academic qualifications and three years of responsible experience and three stages for engineers of academic qualifications, approved training and responsible experience, new entrants, at most eighteen months from graduation, were far from fully-recognised professionals in the eyes of the Institutions.

Table 4 shows the extent and pattern of professional institution membership among the respondents in the electronics industry sample. This data is only partially helpful in indicating attitudes towards


(15) ibid., p. 392.
institution membership among those with different educational and work experiences. Since one third of the university physics graduates who were non-members were ineligible for graduateship on account of their ordinary degrees, and for others the relevance of the Institute of Physics to the general electronics industry was questionable. However the pattern of membership does suggest the greater interest in professionalism and institutions in research departments. Several studies of engineering professional institution membership yield a common interpretation of motives for joining as the desire to gain qualifications which would support career advancement. For industrial samples approval of responsible experience has been the significant component of membership qualifications in facilitating promotion along managerial career lines. (16) It has been shown that members' participation in the Institution of Mechanical Engineers' activities tended to be least among industrial compared to non-industrial members, and even among industrial members the most active group, the managers, tended to be only superficially involved compared to non-industrial members. (17) Thus among industrial engineers it appears that the qualifying functions of professional bodies are more significant that the study functions. (18)


(17) J. Gerstl and S.P. Hutton, op. cit., p. 130.

(18) Prandy noted the paradox that services directly promoted by the Institution of Metallurgists such as publications were used by an appreciable proportion of members (35%) but were seen as of less significance than the indirect service provided by public relations and efforts to raise the status of members. There have been occasional expressions of dismay about the limited membership of specialist sections of the Institution of Electrical Engineers, for example, only 40% of total membership in 1955 although unfortunately this did not indicate the work sectors of participants, Journal of the Institution of Electrical Engineers, vol. 1 (new series) no. 7, February, 1955.
So far I have argued that the new graduate entrants adopted a very narrow conception of the professional scientist and engineer in industry, narrow in the sense that it emphasised the purely scientific and technical knowledge and skills gained through academic training and certified by academic examination. It is evident that this conception could be challenged, for example, it could be argued that full Professional Institution membership with its requirement and scrutiny of "responsibility" implied an administrative competence. Even the recent entrant definitions of engineering competence discussed in Chapter Eight acknowledged abilities in "dealing with people" and "communications" as important in coping with organisations and any supervisory posts. And it was particularly noteworthy in the context of 'making out' in development labs that purely academic qualifications which testified analytical skills were open to question as indicators of industrial competence. The 'scientist type' especially was a figure for some scorn. These inconsistencies in response reveal the difficulties in advancing a coherent and acceptable professional self-concept. This comparison of responses is revealing not simply of inconsistency, however, the inconsistency is significant in suggesting that the graduates recognise that the conception of the engineer and industrial scientist must be broadened to include administrative roles. But as the graduates recognised in their discussion of careers, administration was something of which they had scant conception, and so the two lines of response to this situation were to emphasise the relevance of academic training, hence the narrow conception of the technologist, and to advocate rationalisation of administration, a technicist conception of administration.

The prevalence of these views and preoccupations with the short term issues of making out in industry by coping with immediate task demands is underlined if we refer to the sizeable minority who did not
conceive of themselves as professionals. Very few took the view that they were not professionals because they were still in training - for this view points up the inadequacy of academic training alone and accepts overtly a subordinate role as apprentice (see Table 2). A more frequent response was a discussion of the nature of engineering and scientific skills in terms of the 'established professions', the doctors and the lawyers. Here two themes were advanced, both were variants of the view that the engineer was not recognised as a professional but in one case it was felt that the industrial engineer and scientist deserved such recognition whereas in the other case it was felt that such recognition was not merited. In both cases the conclusion that the respondent could not claim professional standing was drawn by comparing engineering or industrial science to the highly prestigious medical profession which was widely recognised and provided a set of model characteristics - face to face relations with a client and a service ethic sanctioned by the professional body. By far the largest category of 'non-professional', however, rejected the whole notion of professionalism as irrelevant to their personal situation.

"Profession strikes a cracked bell with me. I regard them with a lot of suspicion, as a lot of petty snobbery."

"I've never really thought about that. I always think that if you're paid for doing a job then that's your profession. The general impression of engineers is not very high as far as I can see, but it doesn't bother me so long as I can do what I want."

"I wouldn't go up to someone and say I'm a professional - I don't know much about that. If you asked me the difference between hourly staff, weekly staff, and monthly staff then you could say that the monthly staff like an interest in their job whereas the weekly staff come through the day and clock off on the hour.

Someone told me that engineers in Germany have a title before their name, something like Dr. I don't know whether that's a good thing or not. I can't imagine myself
with so much status that I can't get on with people making things for me. If I go to the toolmaker I don't want to belittle him. You want him to treat you like a friend and it might be a bit dangerous if he treated you like a doctor."

"It doesn't worry me all this talk about whether engineers are or are not engineers. People who don't know engineers can think an engineer is anyone from a car-mechanic upwards. I think if there was any snobbishness in me it was knocked out of me in vac jobs. It's because I understand the working man."

"Which groups are important to you?"

"Oh the highest - I am a snob there. I want to be accepted by management more than the shop floor. But probably I am more accepted by the shop floor. This is because I talk to anyone from the brush-sweeper upwards - below brush-sweeper I don't bother with them. I think you know what I mean. Some are not like this. Some of the people here make a point of putting their coat on before they walk down the shop."

Comment from three development engineers and one production engineer illustrate the general tenor of responses among the 'non-professionals' and suggest that differences between themselves and the self-styled 'professionals' are more apparent than real. Here professionalism was associated with claims to privilege and a favoured regard, but this social standing in the wider society, in out of work situations, was regarded as irrelevant.

Of central importance to all the new entrants, both 'professionals' and 'non-professionals', was the standing in the industrial company accorded to entrants with academic science and engineering qualifications by managers for this group set the criteria which governed status advancement and the distribution of rewards in organisations. The most
crucial relationship of all for the new entrant, however, was that with the immediate supervisor, for the section leader or project leader was the source of assignments and assessments which guided promotion within the career system of the organisation. As we have already seen this immediate supervisor was generally recognised as technically competent and 'management' was applied to more senior levels. In this way the new entrants sought common cause with technical interests, they sought to advance the conception of the main task of the organisation as technical in which scientific and engineering competence was of paramount importance and they sought a definition of their relationship with their supervisor as 'working with him' rather than 'working for him'. But if the new entrants were to advance in organisational status and authority then they recognised that they must take on an increasing proportion of administrative duties to their work role. In this career structure lies the source of the dilemma for professionalism among industrial scientists and engineers: 'technicism' handicaps efforts to cope with organisations and 'management' offers an escape from a low status profession.
3. **Professionals in Organisations**

"We recommend that industry should do more in this way to create a sense of involvement for young and talented engineers, technologists and scientists through their participating (at appropriate levels) in discussions leading to the formulation of company policy and objectives." (19)

In making these recommendations that there should be an increase in the sense of involvement and participation in company decision-making for the technically-qualified the Jones Committee added their "strong impression that qualified engineers, technologists and scientists do not enjoy an equality of opportunity or of status in industry with their counterparts in, for example, the accountancy or legal professions." (20) Arguments for parity at least with these other professions rested on linking the sources of national wealth to the creative and productive work of industry and the central role in that work of the engineers, technologists and scientists. In the more partisan literature and the more vehement comments of engineers and scientists these other professions, law and accountancy, are presented as the sources of constraints on innovation and productive work because they operate with a conservative outlook, averse to the risk taking of research and developments and the search for technical excellence. At the heart of these claims lie the issues of controls, authority and power.

While the literature on organisations presents the potential for conflict between professionals and organisations in terms of authority and power, the graduates in the electronics study depoliticised the

(19) Brain Drain, op. cit., p. 55.
(20) Ibid., p. 56.
issues. 'Politics' was a term of abuse to describe the pressing of sectional interests whereas the new technical entrants identified the enhancement of their own position with the promotion of overall company welfare. What the new entrant sought was not described in terms of 'power' or 'authority' but 'responsibility'. 'Responsibility' carried the intended implication of work conditions with minimal detailed supervision and the expectation of due reward to those who meet requirements in the performance of a significant task, but it did not suggest claims to exercise power over others in a situation where the gains of some are the losses of others, if anything, responsibility implied acceptance of a subordinate position to those who allocated tasks.

When complaints were made about a lack of involvement in decision-making it was couched in terms of responsibility as, for example, by a research engineer.

X  "I don't have much responsibility, perhaps it will come with time. Certainly I've not yet been presented with a situation where I can make or break a project. I feel rather redundant in a way. I feel I ought to have more responsibility."

McC  "In what sense?"

X  "Having a project of my own and setting my own targets."

In authority relations most of the new entrants to research and development claimed that there were quite clear guides about the extent of their authority in the organisation and suffered little in the way of ambiguity; with emphasis many added that they were the 'lowest of the low'. As newcomers they had little choice over their initial assignments, and, although they might claim to have some choice from among a variety of possible solutions to a given problem, the choice was within several bounds. Those bounds included those of technical compatibility with other parts of a large project (for example, one
engineer might work on the development of a standard transmitter for a range of radios), the bounds of budgets (for example, all staff had to account for their time on time sheets and for their own work 'juniors' could place orders for materials only up to a level of perhaps £20 without a counter-signature), and other boundaries included those set by company procedures for communications (for example, there were the standard drawing procedures required of development labs by drawing offices). These various control procedures, designed to ensure predictable behaviour and smooth coordination, from supervisor reports to project progress meetings, financial and time budgets, and design communication procedures, all produced complaints, especially among those employed for a year in industry, and the theme of complaint was the hindrance to the pursuit of technical objectives.

"It's very frustrating that I'm being asked to do something without the authority to do it, for example, each design specification has to be approved by the Ministry as it is written. I must go through my supervisor although he hasn't got sufficient knowledge and isn't sufficiently specialised actively in that part of the project to do it. Everything goes through him with the signature to the Ministry and back through him, but any questions from the Ministry and he asks me and I dictate the answers to him. Sometimes we do that over the phone. It's protocol I suppose that I've not enough authority to deal with the Ministry."

"To do what you think you could do satisfactorily you need much more time. On the financial side we ought to get rid of the time aspect of the internal budget. It means that though we would be careful about costs we wouldn't worry about time. Being charged on projects is funny because it's all internal money."

"There've been a number of irritating changes recently in drawings and the drawing office has insisted on changes which suit them. Really we should do just rough drawings and concentrate on designing and leave the drawing office to do the detail."
In similar fashion there were objections that originality could not be scheduled so that time charts were meaningless and unjustifiable. The point of sociological interest in these comments is the way in which the new entrants defined their 'proper' role in terms of using their established competence and the way they wanted to hive off or limit the significance of tasks where they were deficient, for example, financial management and routine skills, report writing and procedures for coordination.

In looking at identities and counter-identities in working relationships one of the most interesting boundaries was that drawn between those in 'technical functions' and those in 'management'. 'Engineering' and 'science' were activities distinct from management. Management, especially higher management, was conceived as a preoccupation with 'organisational politics'. By definition and by practice this had the implication that managers were not competent in the particular details of everyday decision-making on a project because they were too far removed from the everyday activity and the specialised knowledge and skill.

X "There are some things which I think are kept deliberately in the dark. I have found quite a lot of it is political. I think that from the project leader I know as much as I would want to know, but when you go from the project leader upwards - tendering for contracts, costs, and so on - this is very political."

McC "Political?"

X "Company political. There will be various fiddles like the tax year is so and so therefore you do this and not that. That of course is way above me - that's what they call higher management. We just say it's political and forget about it."

McC "We say it's political?"

X "From the project leader downwards - the contract we leave up to them."

(Development engineer)
"It's nice to have an idea and act on it. But that just doesn't happen. You have to have an idea and think about it - which is reasonable - and discuss it - which is reasonable - then it has to be discussed at a higher level - which is unreasonable. And the person who decides whether it gets done or not is the person who is most out of touch with it - which is completely unreasonable."

(Development engineer)

Yet the boundary drawn between engineering and science as distinct from management shifted by circumstance. In some situations the group leader was regarded as a technical specialist in a common cause against administrators responsible for project schedules, drawing offices or production departments, but the group leader became a non-engineer when he signed contracts with a customer and defined the task of his development department, for in this case his assistant engineers complained of the manager who agreed to performance specifications without the advice of the specialists, the development engineers, and he became the "man in the office at the end of the lab."

Now it is apparent that there was a paradox in the new entrant's readiness to advocate the central importance of narrowly-defined engineering competence together with a denigration of managers and management as constraints on "the full utilisation of science and technology in the productive efforts of a company and their readiness to conceive of their own career advancement as becoming managers and acquiring managerial skills. If directly considered at all, the paradox was resolved by adopting a technicist conception of the manager and management in which these functions become susceptible to analysis by the concepts of natural science and engineering. The manager was conceived as a human resources engineer skilled in the techniques of manipulation and control and management was conceived as the application of techniques of rational decision-making and control in a human organisation. In this sense these 'engineers
as would-be managers" could still deplore the existing situation for muddle, compromise, pressure groups and lobbying, and the intrusion of emotional and non-technical elements into what should be properly conceived as engineering decisions and they could cast themselves in the role of the 'new men', the 'new breed of technical managers' as several comments illustrate.

"It was summed up very well by the chap I work for, he commented about a fortnight ago it would take about six months to learn the electronics of (this company) but it would take about ten years to learn the politics. It's quite true. There's very strong politics here - what you can mention in front of whom and why, who you are going to be in with." (Development engineer)

"From our level all this fight for space in the establishment is amusing although it's probably not amusing to be involved, and those involved are principal engineer upwards. I suppose it's not amusing to be fighting for space in a lab. But it's amusing that things should be done in this way, that the term 'fighting' should be used when talking about the distribution of available space in a lab. It should be a rational decision that so and so has got so many people and therefore he needs so much area. It doesn't quite work like that - well, it probably works like that in the end but a lot of people get upset and worked up beforehand." (Development engineer)

"I feel that anybody could devise a better system if they would put a little science to it. Business consultants are there to sort these problems out, I'm surprised that they haven't hired their services more." (Development engineer)

"I would like to move into management and apply some science to management perhaps by taking a management science course." (Development engineer)

"For the future I see myself as one of the new breed of technical managers." (Development engineer)
The faith of these technically qualified employees in the ultimate victory of technique oriented approaches to organisational problems summons spectres of management heresies long renounced by social psychologists and sociologists. The "Scientific Management" of F. W. Taylor in American industry in the early 1900's was attacked long ago for its misleading use of 'science' and neglect of social science and for its underlying metaphor of a machine in the conception of the organisation and hence limited conception of efficiency to physical units. (21) Yet the term "Management Sciences", applied to cover a variety of techniques and aids to managerial decision-making from operations research to the information processing techniques associated with computers offers striking parallels to the spirit of Taylorism. (22) While the linking of 'Science' and 'Management' might suggest in a simple-minded way the existence of some transferable skills, the attraction of the motion lay in its linking of scientists and engineers to the contemporary politics of modernisation too, which I have already argued was a curiously depoliticised political slogan of the 1960's. (23)


(22) Some of these parallels have been traced by H.J. Leavitt, "Applied Organisational Change in Industry: Structural, Technological and Humanistic Approaches" in J.G. March, ibid.

(23) See Chapter One for a discussion of the common ground which was achieved between diverse groups in the Labour Party before the 1964 General Election. In the United States in the same period managerial techniques which had a strong technological flavour had a strong popular advocacy and were given prominence by the use of P.E.R.T. (programme evaluation review technique) in the space programmes and P.P.B.S. (planning programming budgeting systems) in Federal Administration. The enthusiasm and euphoria about the utilisation of scientific and technological resources to confront Government problems can be gauged in the rationale offered by a distinguished scientific adviser to the American Government for technological approaches to social problems. Weinberg argued for 'technological fixes' which were bridging solutions to social problems in which the aim was to convince would-be deviants that their 'undesirable behaviour' was 'irrational

(Continued overleaf)
The linking of 'management' and 'science' then has provided another way in which the young engineers and scientists could conceive of management as a natural development in their career since the tasks of management could be conceived as requiring some of the qualities which they have developed as engineers and scientists. (24)

While the corporate bodies of engineers and scientists have been conceived as learned societies with their main rationale in the promotion of a body of knowledge and an important function in granting qualifications there has been little conflict with industrial employers. Recently some senior industrialists have expressed concern about trends in the representation of engineers and scientists and their interests which might pose a challenge to employers. On the one hand there has been the interest in codes of ethics for professional engineers and on the other the interest in trade unions. Both of these developments offer a potential challenge to management for in one case there is an attempt to develop standards of proper conduct distinctive to one group of employees which might be seen as a challenge to managerial prerogatives in defining standards of conduct for all employees, and, in the other case, there are the clear and direct possibilities of threats to withhold services to press claims on employers.

(23) (Continued) behaviour" and so 'blunt the social problem'.
(A. Weinberg, "Social Problems and National Socio-Technical Institutes" in Applied Science and Technological Progress, A Report to the Committee on Science and Astronautics, U.S. House of Representatives by the National Academy of Sciences, Washington, D.C.: U.S. Government Printing Office, June 1967). In much more cautious vein Lord Jackson of Burnley raised the possibility that engineers might list some major social problem and explore the scientific and technological component on which scientists and engineers could advise policy. (Lord Jackson of Burnley, "The future, nationally and internationally" in Engineering Societies in the Life of a Country: A series of lectures commemorating the 150th Anniversary of the Institute of Civil Engineers, London: Institution of Civil Engineers, 1968). In an indirect way these events and ideas operate as part of an intellectual climate which influences the experiences of undergraduate science and engineering education and the conceptions of organisations and politics held by engineers and scientists.

(24) It will be remembered that another mode of reconciliation was to see a career in 'technical management', see Chapter Eight.
Codes of ethics have had more attention among engineers than scientists, but even for engineers they have had limited significance for they have been most clearly relevant to those in independent consultancy where the main aim has been to regulate the nature of economic competition and additionally to advocate the promotion of the good name of engineering. It was precisely because of the much more limited extent of independent consultancy in physics compared to engineering, where even the bulk of engineers are in salaried employment, that Lord Beeching condemned efforts to develop a code of ethics for physicists and warned that it would rebound to the detriment of physicists' participation in industrial organisations, in other words, physicists should identify themselves as loyal employees and forget that they are physicists.

"I deprecate particularly a recent move by the Institute of Physics to establish a code of conduct and practice for professional physicists ....

Very few physicists operate as independent professional men, as do many solicitors, engineers, and architects. Instead, the majority of them are employed in industry, where standards of good conduct on the part of employers and employees are clearly understood, and where it should be unnecessary, and would certainly be objectionable, to have some members of the staff asserting a right to adhere to a different code. Physicists should be able to forget that they are physicists if, by so doing, they become generally useful. They should not appear to assert, or wish to assert, that they are not as other men are. If they do, their assertion may be accepted to their own disadvantage." (25)

Because of the predominance of salaried employment where the higher grades of professional membership rest on sponsorship by existing members, and where, in the case of industry, sponsors are usually engineering

managers, and where expulsion from the institution is not a bar to employment, the effective sanctions on conduct lie with employers rather than professional institutions.

The Professional Institutions as learned societies have been prevented by the terms of their Royal Charter from undertaking any action to further the personal interests of their members so that the protective function in industrial relations has had to be undertaken by other bodies. While no such body was developed for scientists, the engineers have had the Engineers' Guild since 1939. (26) However the protective function of the Guild has been severely restricted by its own Memorandum of Association which prevents the use of funds for trade union objectives, and it has concentrated on a free comprehensive appointments service to individual engineers and efforts to promote the general status of engineers by surveys of salaries and responsibility levels. Membership has been limited to members of one of the fifteen professional engineering institutions and the limited relevance of the Guild in its services as perceived by professional engineers can be gauged from a mere 7,800 membership from the potential 275,000 (160,000 'chartered') engineers affiliated to the Council of Engineering Institutions. Aware of the limited relevance of the Guild and fearful of the rapid growth of white collar unions with interests in the organisation of all levels of engineers and scientists, several professional institutions began to explore the possibilities of professional unionism. To some senior

(26) The Association of Scientific Workers (A.S.W.) which had the support of a number of eminent scientists in the 1930's gradually became a trade union for technicians, some of the steps in this movement can be traced in Prandy's study. Prandy studied both the Engineers' Guild and the Association of Scientific Workers and so provides a direct comparison of these bodies and their membership.
industrialists this interest is a regrettable necessity and largely a
defensive measure against militant trade unions.

"If such development is not encouraged
many young engineers will join unions
whose outlook is not 'professional' and
the results will be unhappy. Although
the trend towards unionisation of
professional engineers is not one that
I welcome, I think that it is wise to
realise how the tide is flowing and not
to try too hard to row against it." (27)

In May 1969 the United Kingdom Association of Professional Engineers
(U.K.A.P.E.) was founded and registered as a trade union to undertake
collective bargaining for chartered engineers with the approval and support
of the C.E.I. (28) A similar protective body was announced for
scientists, the Association of Professional Scientists and Technologists
(APST), in 1971 with the backing of the Council of Science and Technology
Institutes (CSTI) a body with a coordinating function for five science
institutions comparable to that of the C.E.I. for fifteen engineering
institutions. (29) Ironically U.K.A.P.E. has tried to define the

(27) Lord Hinton, Engineers and Engineering, London: Oxford University
Authority, Lord Hinton could speak as a major industrialist and employer
of scientific and technological manpower as well as expressing his
sentiments for an older generation of engineers. Distinguishing employer
and professional interests is another example of the diversity of interests
among engineers and the assumption of their coincidence by some.

(28) While one recent article reports on a study of UKAPE it is mainly
concerned with the proposals for growth rather than some account of its
origins, L. Dickens, "UKAPE: a study of a Professional Union", Industrial
origins I have collected material from interviews with the Secretary of
UKAPE and newspaper articles, among the latter some items were included in
"Gentlemen v. Workers", The Times, 13.1.69, "Militant Hint by Top Engineers",
The Times, 14.7.69, "Trouble about the Ranks", The Times, 8.6.70, "The
'Professionals Only' Union Makes a Bid for Power", The Sunday Times, 16.6.70,
"Hunting White Collars", The Guardian, 6.5.71, and "Engineers in Union Study"
The Times, 16.9.71.

(29) The APST has not restricted membership to members of the Professional
Institutions as in UKAPE.
character of professional unionism by emphasis on the codes of ethics, the very issue neglected by professional institutions, and, while discussion has focused mainly on the subordination of sectional interest to 'national' purpose by avowed interest to avoid use of strikes, engineers have been encouraged to condemn undue industrial secrecy and poor engineering standards. Great store was set for the growth in membership and success of UKAPE on two developments in industrial relations which have occurred since the completion of fieldwork in the electronics study, the growth of unemployment among engineers and scientists and the Industrial Relations Act of 1971. It was expected in the wake of mergers, rationalisations and the generally unfavourable economic climate of the turn of the decade that many more engineers and scientists would seek greater security in a distinctive form of association for professional employees and the coincidental passage of the Industrial Relations Act opened opportunities for UKAPE to be recognised as bargaining agent within the terms of the Act. (30)

While Dickens doubted the likely effectiveness of UKAPE because of employer resistance to fragmented bargaining structures and the opposition of other unions, the orientations to work and careers among the respondents in the electronics industry suggested some limits to the attractions of representative bodies for engineers and scientists. Although they might claim that there was less autonomy than they desired, their jobs gave many

(30) For a review of the efforts of UKAPE to influence the passage of the Bill, to secure a special status for Professionals under the Act, and the possible implications of the Act for UKAPE, see L. Dickens, op. cit. It is an interesting contrast to many sociological studies that the Minister of Employment stated his belief that an adequate definition of professional workers was impossible in his reply to the UKAPE lobby in the House of Commons (see the comments quoted in The Professional Engineer, vol. 16, no. 1, February 1971, p. 4.)
respondents some discretion and responsibility in their work. The widespread interest in career-advancement fostered an identification with the ranks of management into which promotion was seen as likely. Even when account is taken of the diversity of work settings and career orientations, those who had greatest autonomy, those in research labs, could see alternatives to their present employment in other institutions and those who had least autonomy, those in production departments, saw themselves already on the preliminary rungs of management. (31) Of the two objectives, that of securing collective advancement for engineers and scientists as a distinctive group in the power structure of organisations that with greater freedom to organise their work and of securing individual advancement, much the greater priority appears to have been attached by graduates to the latter.

As Prandy observed it would be dangerous to generalise from information about relationships at the workplace to relationships outside and the extent to which work situations determine place and behaviour in the wider society remain topics for further study. (32) For engineers in particular, social imageries and social status have been matters of concern and representative bodies have pressed for change, yet it is evident that in the electronics study these matters were of lesser importance to many graduates because they saw an escape from low social prestige in their work situation through management.

(31) The heterogeneity in motivation to individual and collective advancement among engineers has been cited as a major obstacle in designing objectives for Professional Unions in the U.S.A. See, for example, G. Strauss, "Professional or employee oriented: dilemma for engineering unions", Industrial and Labour Relations Review, vol. 17, no. 4, July 1964, and J. Seldman, "Engineering Unionism", in R. Perrucci and J. Gerstl, The Engineers and the Social System, op. cit.

4. Professionals in Society

A speech by the Minister of Technology expressing the need for more men educated and experienced in the fields of engineering and technology to enter Parliament and to participate more extensively in the conduct of public affairs drew an additional comment from the Chairman of the Committee on Manpower Resources for Science and Technology in the form of a letter to The Times. In his letter Lord Jackson cited, as an illustrative example, the USSR where in contrast to Britain, many Ministers and senior diplomats were qualified engineers and he concluded that in Britain 'we greatly handicap ourselves in our ability to respond to the potentialities and requirements of technological advance'. (33) A reply from an eminent philosopher went further than Lord Jackson in its discovery of engineers or agronomists in the Politburo. But in listing the decisions of this body, including the invasion of Czechoslovakia, writers' trials, the rehabilitation of Stalin and so on, Professor Szamuely concluded that 'we may regard ourselves as positively fortunate not to have our public affairs conducted by engineers and technologists.' (34) Adding salt to the wounds inflicted by such a rebuke, Szamuely hinted at a more than coincidental rumour that the only source of dissension from the Czechoslovakian invasion within the Politburo came from the two Arts educated members.

These two views of engineers and social welfare, one optimistic and the other pessimistic, have been recurring themes during the course of industrial developments.

(33) Letter to The Times, 30.4.69, Jackson of Burnley, Pro-Rector and Professor of Electrical Engineering, Imperial College of Science and Technology.

(34) Letter to The Times, 5.5.69, from Tibor Szamuely, Faculty of Social Sciences, University of Reading.
The optimistic view has parallels with the technocratic vision in which it was believed that the dispassionate, rational mind of the engineer could deploy scientific and technological knowledge to solve the major social problems and promote material welfare, and so the immediate national problem was how to integrate engineers into the political structure of society. Most clearly evident in the writings of Thorsten Vablen, this optimistic view provided an ideological rationale for a political movement which presented engineers as the group most likely to lead the United States out of the Great Depression. (35) Against the view of engineers as virtual monopolists of the knowledge relevant to technological advance, the pessimists argue that there are no purely technical criteria for political and economic decisions and that the social perspectives of engineers are circumscribed by functional specialisation and bureaucratic employment to the point where they have a "trained incapacity for thinking about and dealing with human affairs." (36) On these points I have argued already that the attraction of the terms 'specialist' and 'generalist' for the scientific and engineering manpower lobby in Britain in the 1960's owed much to their sensitivity to criticisms of 'technical barbarism' and the prestige of the 'cultivated man' in British education. (37)

While there has been concern about the participation of scientists in British political life, the case of the engineers has been regarded as


(37) See Chapter Seven, section 3 and Appendix One.
more critical, partly because they have been regarded as the 'men of affairs' more directly linked to the application of scientific and technological knowledge to industrial modernisation and partly because of the lower prestige of the engineer vis-a-vis the scientist in the British educational system. Relatively low social prestige for engineers has been regarded as both a cause and consequence of industrial malaise, a cause in the sense that there has been a poor quality of recruitment and a consequence in that the failures in innovations have been seen as 'engineering failures' while engineers claim that any successes have been wrongly attributed to scientists. Thus many efforts were directed during the 1960's to shaping a distinctive identity for the engineer: Government scientists pressed the contributions of engineers, prominent engineers pointed to the contributions of engineers to the development of science, the mass media tried to distinguish the proper contributions of engineers and scientists, and the engineering institutions abandoned their 'cooperative separation' to establish an overall body, the Council of Engineering Institutions, to speak on behalf of all engineers. (38) The links between low prestige, preferences for entry and the quality of

(38) Seeking the support of more prestigious groups has long been a strategy in the choice for professionalization and the senior Government scientist, Sir Solly Zuckerman responded in a lecture on "The Image of Technology" (Maurice Lubbock Lecture No. 4, 1967). The B.B.C. has attempted in its programmes, such as "Tomorrow's World", to judiciously distinguish and praise both science and technology. All these efforts to promote a conception of 'the engineer' were considerably hampered when engineering was so obviously divided into numerous separate interests in the professional institutions and some of the difficulties in the creation of the C.E.I. can be gauged from the notion of 'cooperative separation' coined by a President of the I.E.E. in his A.G.M. address in 1952 and from the hostility even to discussions about possible amalgamation reported among mechanical engineers, reported by Gerstl and Hutton, op. cit., p. 129.
recruitment are difficult to establish because prestige is difficult to
disentangle from other rewards and because, as we have seen, recruitment
occurs over such a long period that it may have a different significance
for different groups at different points in time. Butcher and Pont's
recent study of high ability Scottish secondary schoolchildren suggests
that boys could distinguish both low prestige and salary for engineers
compared to physicists and lower entrance qualifications but could still
rank engineer higher in terms of interest, social usefulness, and
preference. (39) If we turn our attention to those already employed as
engineers then a similar view of the low social status of engineers is
reported but while nearly a third of the university graduate engineers
found this irksome, a similar proportion were indifferent to this situation
(see Tables 5 and 6). The graduate physicists tended to share this view
of the low social status of the engineer but to a lesser extent and they
expressed indifference to a much greater extent. Thus escape from the
possibly damaging consequences of the stigma attached to an occupation
with a low social status was made by the strategy of re-labelling themselves,
which was that much more possible for physicists, and, by the already-
mentioned strategy of conceiving of their present position as temporary,
and in any event, misunderstood by the public but appreciated by significant
reference groups.

For the university engineers the major problem was seen as the
usurpation of the 'title' of 'engineer' by all manner of groups of skilled
and semi-skilled manual workers from lathe operators and fitters to loco-
men and mechanics, and in this way the analytical knowledge and skills

(39) H.J. Butcher and B. Pont, "Opinions about Careers among Scottish
Secondary Schoolchildren of High Ability", British Journal of Educational
in their own training and employment were obscured by an image of 'the
greasy spanner and overalls'.

"Outside no one knows what you do.
Outside if you say you are an engineer,
people think you are a car mechanic."

"You say you are an engineer and people
say what are you doing in a white shirt."

"It's bloody awful here, in England if
you mention engineer then not many people
appreciate the significance of the word
or the profession. They tend to associate
it with engine drivers or people with spanners,
with technicians as opposed to scientists.
That's not true in Germany or the U.S.A."

Associated with empirical rather than theoretical skills in the public
mind, the graduate engineers saw that the contributions of engineers to
the design, planning and direction of technological innovations and
promotion of material progress were being associated with new knowledge,
with science, and the physicist usurped the engineers' rightful position.
This situation in public debate was another frustration after the elevation
of physics to eminence in schools.

"On a big rocket project the main person
is an engineer not a scientist, but
everyone calls him a scientist. Any
engineer who achieves eminence is called
a scientist not an engineer."

"If you say you are an engineer they think
you are a garage mechanic, if you say you
are a physicist they think you are a Fellow
of the Royal Society."

Some engineers talked of their situation as of middling status and tend
to see their position in terms of their mobility from working class
parents to a middle occupation, and a few referred to the improvements in
status wrought by the advocacy of the professional institutions.

"I think engineers just join the growing
middle mass these days, the sort the tele
 commercials are aimed at."
"Status is fairly good but getting a lot better. People see more technology round them and acknowledge it. It used to be all science - the white-coated scientist - but now people are coming to acknowledge engineers as professionals, and the professional institutions have done a lot on this."

Reactions to this low social status fell roughly into those dissatisfied and those indifferent. Dissatisfactions arose from various social encounters in which occupation occurred or rightful prestige and respect were denied and these ranged from recollections of school to parties and even reported occupations of participants in T.V. quiz games. Such dissatisfactions were usually accompanied by calls for the projection of a better image with the responsibility for this attributed to schools and the professional institutions.

"If you say you work in a laboratory, they tend to give you awed looks. They don't appreciate that the engineer is vital to the production of goods that virtually keep the country going. After all engineering is the prime export of this country and I think that engineers should be recognised for the job they are doing rather than anybody who handles a spanner."

"Status is pretty ropey. It's not as high as you would expect it to be. Judging it from a number of points of view - (1) his contribution to the country's economy; (2) that not everybody could be a good engineer; and (3) it requires as much, if not more, discipline as other disciplines because you've always got to be on the lookout for better ways in the face of a changing technology - I can't understand why it's not the top profession."

For those who were indifferent about this low social status the main sources for this reaction lay in what might be termed their 'private career'.

(40) Dubin drew a distinction between 'public careers', in which work was viewed by the public as following a well-defined career pattern with beginning, developmental stages, and end, and 'private careers', which were specialised to a given company, industry or technology and known primarily to those who follow them and few outsiders. R. Dubin, The World of Work, Englewood Cliffs, New Jersey: Prentice Hall, 1958, pp. 276-278.
The significance of a private career, known only to its practitioners, is that it does not serve to define the general social standing of practitioners and so some engineers 'converted' their occupation into public careers by adding on meaningful qualifying prefixes which denied the relevance of 'spannermen' images and associated the engineer with prestigious symbols and titles, for example, computers, electronics and research.

"Mention that you are an engineer and they look down their noses whereas electronics engineer has a bit more prestige."

"If you say engineer they think of you wielding hammers and spanners, but if you say you are in telecommunications they think twice."

"The term engineering is rather unfortunate, it applies to such a wide range. So when people ask me what I do, instead of saying engineer, I qualify this, I put 'computer design' in front of it."

The physicists could take a more favourable view of their own social standing because they could resist the company title of engineer and identify themselves by their university qualification or area of employment.

"I can choose whether to say research physicist or microwave engineer."

"Generally if I say physicist I notice I'm greeted more warmly than if I say engineer - by relatives or friends of relatives."

"I put research physicist on my passport."

The other significant point about private careers is the tendency for practitioners to identify with and seek the mutual support of an occupational community as a reference group, and in the electronics study, it was apparent that the main sources of reference were other recently recruited graduates and managers within the company.

"Some people frown on engineers, to them engineers are all the same whether computer engineers or railway engineers. It doesn't bother me because most of these people are not informed anyway."
"The engineer comes fairly well down. At times it bothers me because I am an engineer, but if you are ambitious, if you are going to be a manager, then it doesn't matter whether engineers are recognised or not."

Thus engineering was a private career in the sense that practitioners saw reality at odds with erroneous public knowledge and judgements. While there were a number of strategies for coping with this situation, however, the main implication of these strategies was to strengthen an interest in organisational careers and becoming a manager.
5. **Professionalism and Commitments**

In this part of the thesis concerned with entry to the world of work I have examined the extent to which new recruits developed commitments in a number of different directions, principally to meeting the demands of employers, to their own career advancement, and to standards of competence and conduct elaborated by colleagues and fellow practitioners. In each of the areas reviewed earlier, the working organisation and the career system, I argued that the development of commitments in one set of relationships and obligations had implications for the other set, for example, the short term career perspective enjoined concentration on efforts to meet employer demands but since the relationship with the employer was envisaged as short term the career perspective conditioned graduate responses to employer demands with the belief that work demands if irksome were only temporary and the penalties of failure or non-compliance were not irrevocable. It remains only to examine the possible consequences of professionalism for the development of other commitments in this section.

Professionalism has been promoted typically on the grounds that it provides clients with a guarantee of standards of service. It was this sense of occupational professionalism rather than professionalism as a claim and mark of a broader social standing and life-style of a gentleman which found favour with the electronics engineers. Yet it was acknowledged too that corporate clients are in a position to make judgements about occupational competence and so less in need of such guarantees. Moreover there are two ways in which the cultivation of professionalism can have damaging consequences for innovation and the working organisation and thereby provide a poorer service.

Where professional competence is established by academic qualifications, as the electronics engineers tended to assert, there is a danger that
professional development will be hindered by being fixed at this point. I have illustrated the way in which academically-trained competences were used as bargaining counters with managers already, but it must be remembered that the situation has been exacerbated by both the poverty of industrial training programmes which did not clearly establish new competences and the perception of a career into management which involved leaving engineering or science. Thus the professionalism established in academic institutions can single out as relevant knowledge and skills a very narrow conception of the professional identity. Something of this narrow conception has been seen already in the new entrant's conception of organisation and politics, and the possible implications of these views for innovation have been discussed by Donald Schon who writes of the debilitating consequences of the myths of the rational process of innovation. (41) Schon argued that the idealised, after-the-fact view of invention and innovation bolstered a view of invention and innovation as controllable, manageable and justifiable processes where 'success is assured by intelligent effort'. Such a view gives ideological support to the scientist and engineer but is a partial truth in its neglect of emotional and political processes. The other possible source of hindrance to innovation stems from the professional's concern with correct procedure. Although, as McClelland indicates, this emphasis on style and procedure is most evident as a protective device to ensure good service where outcomes are difficult to judge as in medicine, some evidence of a preoccupation with means rather than ends has been cited in studies of engineers and scientists in industry. (42) In the electronics study preoccupation with


Within development labs the means–ends tension was most clearly evident in the tension about analytical and 'rule of thumb' methods and the defensive postures of graduate physicists on theoretical underpinnings supported by proper experimental procedure, and their contempt for these produced results without understanding.

The professionalism cultivated by the professional institutions while it is ostensibly directed to the maintenance of occupational standards has aspects of status professionalism in claims to a privileged social position. While pressing for large numbers of engineers and scientists to meet national manpower needs, the anxiety of the professional institutions to claim and assert the rights of the engineer to a superior social standing above the barber and the brewer resulted in a conservative influence on manpower policy in the 1950's. (43)
The three professional institutions for engineering were supported by the four main science institutions on two other points of difference with the N.A.C.I.E. and the Ministry of Education and these were the call for a limit on the numbers of institutions allowed to develop new advanced courses and a demand that control of the conditions leading to an award should be in the hands of those professionally qualified. (44) Ultimately the case for expansion went ahead and the Institutions pledged cooperation.

In the 1950's and early 1960's the Professional Institutions were in agreement with all those who spoke of 'shortages' and saw educational expansion and status enhancement as complementary development because improved status was thought an essential factor for recruitment of larger numbers. By the late 1960's, however, the professional engineers' union, the U.K.A.F.E., appeared ready to act as a conservative lobby against educational expansion on total numbers as well as types of institutions, for them scarcity rather than expansion appeared the route to status advancement.

"The shortage of chartered engineers, so much publicised in recent years, is not accepted by the Association as a fact. It is disproved by the continuing low salaries and under-utilisation of fully-qualified men. Managements must be taught how to make proper use of the chartered engineers they already have before asking for more.

(45 Continued) "It has been our duty and privilege to point out that the repercussions and implications of sound engineering technology have a much wider range and much deeper impact on the national economy of this country, and indeed throughout the Commonwealth than whether someone's hair is curled vertically or horizontally or whether beer is above or below strength." Presidential address, Journal of the Institution of Electrical Engineers, vol. 1, no. 7, 1955, p. 412.

(44) See the report of the Joint Advisory Committee on Education to the A.G.M. of the Institution of Electrical Engineers (ibid., pp. 413-44). Some of the issues about educational expansion in this period are reviewed in Appendix One, too.
The Association believes that as long as any engineering graduate is free to practice as a qualified engineer the engineering profession should have a say in the quantity and quality of engineering degrees awarded. It will act to avoid inflation of numbers and the collapse of standards and conditions of service. The Association will cooperate with C.E.I. and the Government in exercising proper control." (45)

The cultivation of professionalism then may be a far from unmixed blessing for the members and clients of an occupational group whether viewed at the micro or macro-social level. In any event the massive dominance of technical courses in science and engineering education, post-graduate training largely controlled by employers, and student educational demands hinder socialisation into holding professionalism with a social ethic among scientists and engineers, while functional specialisation, salaried employment and managerial career ladders foster only a limited and defensive strategic professionalism.

PART FOUR

CONCLUSIONS


CONCLUSIONS

1. The Re-Definition of Social Problems

To draw conclusions on the debate about the 'shortage' of scientists and engineers for industry in the 1960's might appear academic in the pejorative sense of a merely theoretic argument without practical relevance when the newspaper headlines and leaders have been concerned with 'graduate unemployment' in the 1970's. (1) Even the related debate about utilisation with its castigation of the educational system for graduates ill-equipped for industrial employment appears to have been stilled. Reports from such eminent bodies, as a joint C.B.I.-Vice Chancellors' Working Party, a Joint Royal Society-Institute of Physics Working Party, and a Royal Institute of Chemistry Committee of Engineering, have tended to concur in the conclusion that 'apart from urging a modest element of flexibility, employers were not calling for substantial changes' in university education. (2) Other observers have reflected that a changed labour market might bring its own discipline to unruly graduate aspirations and shape more modest aspirations. (3) Despite these changes in the terms of debate

(1) See for examples the leader articles, "Graduates for Sale", The Times Higher Education Supplement, 22.10.71 and "Degrees of Unemployment", The Guardian, 7.9.71.


(3) During 1970-1972 the careers columns of the daily and Sunday newspapers have belaboured the disappearance of the 'graduate job' and the importance of a revision of attitudes and aspirations among graduates.
about industrial science and technology and the labour market for qualified scientists and engineers, some important lessons can be learned from a review of the 1960's manpower debates.

Now, just as then, there are alternative criteria by which 'shortage' and 'surplus' might be judged, and now, just as then, there are large gaps in the available statistics which could support either case despite improvement in sources. One of the main problems is to discern the extent to which observed changes in the labour market represent short or long term trends.

The main statistical source for information about graduate unemployment has been U.G.C. statistics on the first employment of university graduates based on returns from University Appointments Boards. The data source means some caution is necessary in interpretation since some graduates do not consult their Boards and some may remain registered although in employment because they hope for a better job. Despite a caution about the absolute levels of unemployment the trends are more reliable in indicating a changed labour market. The proportion of graduates in applied science still seeking permanent employment at December 31st had more than doubled, from 2.9% in 1969-70 to 6.9% in 1970-71. In arts, the increase was from 6% to 7.3%; in social studies from 6.3% to 8.7%; and in pure science from 5.6% to 8%. The very sharp rise reported for applied scientists such that levels of job-seeking were comparable to the other main groups of students has raised some of the sharpest comment because engineers were assumed to have had more obvious and more favourable employment opportunities. (4) The statistics have

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have been supplemented by the annual reports and press conferences of the Appointments Board Officers with information about the stated vacancies of the large recruiting companies and the difficulties of particular students. (5)

While changes in the job seeking behaviour of graduates and changes in the recruiting activities of large companies seem clear, the time scale of changes is not clear. The unemployment figures for graduates must be set against the national unemployment statistics and against the statistics for schoolleavers. In a recession we might expect a short term rise in graduate unemployment. There are reasons for believing that graduates may be disproportionately affected by economic recession since they are employed in the innovatory and administrative departments which are disproportionately cut in a recession. Prospective entry to the European Economic Community has been cited as another source of uncertainty affecting capital investment. If these have been short term factors then it is possible to discern some longer term trends which dampen the demand for graduates too. The consequences of Britain's renunciation of an Imperial role are that she is unlikely to develop a 'military-industrial complex' to defend Imperial interests and the declining proportion of defence research in overall research expenditures when the overall national research and development budget has remained a relatively constant proportion of G.N.P. in recent years suggests that this is unlikely to be a growth point. While the Labour Government emphasised selectivity in Government support of Civil R & D, the Conservative Government adopted

(5) See, for example, P. Scott, "Graduates begin to outnumber jobs", The Times Higher Educational Supplement, 8.5.70; R. Bourne, "Are there the jobs?", The Guardian, 20.11.70; and P. Wilby, "Why the graduate sellers' market has disappeared for ever", The Observer, 9.5.71.
a distinctly cautious attitude to Government support of the 'high technology' industries in its first two years of office. This policy was to the considerable embarrassment of those sectors thought to be growth points by electronics engineers, computers and microelectronics. (6) The rapid expansion of the universities in the 1962-7 quinquennium was envisaged as a once-and-for-all change as the 'bulge' passed and postgraduate studies were thought overexpanded in some cases. Thus two areas of Government influence, R & D for defence and civil purposes and higher education appear unlikely to enjoy the rates of growth of the 1960's. Industry however appears to have had some re-examination of employment policies too. Mr. Heath, who became the first British Prime Minister to warn of the prospects and dangers of producing too many scientists and engineers, suggested that industrial companies were now reaching very different conclusions about the employment of scientists and engineers to those drawn a decade ago. (7) Recently the Gas Council has reported that jobs formerly given to young graduates employed as technical assistants were now given to H.N.C. trained recruits employed as technicians. (8)


(7) The cautions were made by Mr. Heath in a speech to the Parliamentary and Scientific Committee at the Dorchester Hotel, London, 17th April, 1972 (mimeo from the Press Office, 10 Downing Street). When questioned in the House of Commons by Mr. Dalyell and Mr. Wilson, who claimed that graduate unemployment was the result of Government economic policy, Mr. Heath referred to these industrial reviews of recruitment policy, see House of Commons Debates, Official Report 1972, vol. 836, pp. 193-195.

The coincidence of graduate unemployment and vacant student places in science and technology in universities and polytechnics has produced some gloomy comments that higher education has been overexpanded. In response some commentators, such as Lord Todd, have argued that universities recapture that comfortable past of small proportions and assured elites. (9) In these changed circumstances it is possible that some serious issues which underlay manpower utilisation will receive serious thought. In the 1960's the goals of the educational system received little discussion from the Robbins Committee and the utilisation of qualified manpower received scant attention from the Committee on Manpower Resources. Various optimisms and pessimisms left blind spots in the analysis and proposals of these Committees.

Among the economists who debate educational policy and planning considerable attention is being directed currently to the possible discrepancies in outcomes from following different planning criteria. (10) The main discrepancies which could arise from social demand rather than manpower requirements approaches could be quite small if the vocational interests of parents and children could be aided by more information. As yet it is not clear how social demand would be affected if loans rather than grants were used for student finance. Given the severe criticism heaped on the mechanical brands of manpower forecasting, serious attention is being given to the alternative rates of return techniques.

(9) Lord Todd, "Should higher education be more vocational?", op. cit.

Here the difficulties for policy guidance are the interpretation of rates of return in Government sectors and the problems of loads and logs.

In the meantime the overall expansion for the 1970's appears to have been settled on social demand criteria, simply that the demand for more tertiary education is likely to be politically irresistible. Thus it is envisaged that 22% of the eighteen year old age group will be in higher full-time education in 1981 compared to 15% in 1971 and 7% in 1961. (11) Given the decision, the main Government preoccupations have been with the logistics, of dividing the numbers between universities and polytechnics and cost savings to check the financial burdens of the trends towards mass higher education when the student grant system, for example, was designed to assist a few of the able poor to join the university educated few. Yet so far the attempts to provide rationales for this division and allocation have moved little beyond the cumbersome efforts of Mr. Crosland. (12)

Because of their restrictive assumptions numbers rather than goals had preoccupied the Swann Committee. It is unlikely that future educational documents will be able to treat universities in splendid isolation. A number of other assumptions appear less likely to go unchallenged now, for example, the assumption that societal needs include more science and technology, that all talents should be trained with the qualification that the more able should have more training, that the more able should be guided to practice science and technology, and that the highly qualified should have greater rewards. Support for economic growth per se is now much more qualified, and however vague the cant slogans of


'pollution', 'environment' and 'quality of life' it is clear that patterns of national research and development expenditures have been and are likely to change significantly. (13) Realisation that the 'Brain Drain' owed much to U.S. military and space efforts weakens the resolve to emulate these prodigal pyramids. In Britain much acclaimed technological triumphs have failed to materialise or have involved such cost escalations to completion that the optimisms of scientists and engineers are more likely to be greeted with greater public caution in future. (14) If greater public accountability is one likely source of checks to the drive for technical excellence per se then the demands for autonomy and participation must be set against the demands of other groups of employees in industrial organisations in a society where debate about relative incomes and rewards has become increasingly heated and bitter. Even the long standing assumption that all available talent should be educated and trained has been challenged by those who argue that the labour market could not absorb it, (of Lord Todd) and those who argue that absorption could only be at the expense of existing public (vide vested) interests, (of UKAPE).

At present then it appears difficult to disentangle the short run and longer run changes in patterns of demand for scientific and engineering manpower, and their implications for prospective supply. It is possible, as Professor R.V. Jones warned the Standing Conference of Universities Appointments' Services, that alarmist fears about unemployment and disillusion with science and technology following the post-war over-optimism


(14) See the comments of Shirley Williams, a former Labour Minister, on disappointments ("The Responsibility of Science", The Times, 27.2.71.) and of Professor Wolfe on cost escalations ("Cost escalation in research and development activities" in D.O. Edge and M. Wolfe, Meaning and Control, London: Tavistock, 1973).
could depress numbers currently entering scientific and technological studies to produce scientific and manpower shortages in ten to fifteen years' time. (15) Speculation about such possible cobweb cycles has been one of the main rationales for manpower forecasting and intervention in labour markets. Yet given the difficulties of affecting changes through the educational system it is surprising that manpower forecasting committees in Britain have not given more thought to supply adjustments outside the formal educational system.

Although the issues which lead to agitation among commentators on the university-industry interface in 1973 appear different from those of 1968, the "surplus" of present concern may turn out to be as elusive and ephemeral as the "shortage" of the earlier debate. One of the major lessons of this study is the importance of understanding how an issue becomes defined as a social problem, in this case, the political context of educational and occupational choice and selection, and policy-making. Fortunately we appear to have moved beyond the 'salvation by science' recipes for economic ills offered in the Swann Report and unlikely to seek salvation in the simple-minded markets of neoclassical economics.

(15) See the remarks quoted in "Limited pool of talent for science", The Guardian, 1.9.71.
2. Labour Markets, Manpower Utilisation and Research Methodology

Inevitably there may be some reservations about the extent to which substantive points emerging from a case study can be generalised across companies and industries to throw light on the national utilisation of qualified manpower. There was, however, another important aspect emerging from the study and this lay in the support given to the methodological claims for the direction of occupational choice and utilisation studies at the outset of the research.

Emphasising a broad view of the resources and goals which individuals bring to education and labour markets and taking direct recourse to recent recruits highlighted the difficulty of taking tastes as 'given'. Goals crystallised during searches which continued often into employment as further information about abilities and feasible goals was gained. The central point about the variables identified as costs and benefits in occupational choice is that they range beyond simple financial factors; as Becker observed 'the trick in understanding commitment is to grasp the full range of things that have sufficient value to be included in the calculation'. (16)

Blaug offered two cogent arguments against the usefulness of attitude studies and direct enquiry into motives, and hence in favour of reliance on inferred models. He argued, firstly, that there may be a gap between expressed intention and behaviour, and secondly, that the important point for policy is the nature of intramarginal choices.

The concept of 'cognitive dissonance', bet hedging by lowering aspirations to what are recognised as feasible levels, means that choices conditional on uncertain outcomes may lead to pre-choice statements of the

fall-back position rather than the preferred outcome. For example, Barnes found, by use of a panel study, that some students stated 'industry' but on achieving a 'good degree' opted for postgraduate study. (17) This suggests that Blaug's criticisms do not apply to attitude surveys themselves but to some forms of their administration.

The policy maker is interested in the cost in terms of a total salary bill of producing a given increase in the supply of engineers and scientists, that is in the responsiveness to salary changes of a proportion of scientists and engineers. To Blaug, attitude surveys reveal only marginal statements of the kind that most engineers work for technical challenge rather than statements about the number of engineers who would be prepared to sacrifice some degree of intrinsic job satisfaction for a specified salary increase. To this criticism of attitude studies there are two main responses, the first is that the policy maker's desired information is unlikely to be available from any study technique, and secondly, that attitude studies do have a useful, if limited, guide to policy.

Changes in rates of return and concurrent or lagged shifts in employment require interpretation in the light of assumptions about non-financial rewards and preference patterns. It may appear reasonable to assume that non-financial rewards change slowly but changes in salaries are usually introduced along with a package of changes in working conditions too, so that past rates of return require cautious interpretation.

Attitude studies serve as cautions on the current forms of simple-minded rate of return calculations, for analysis which proceeds on the assumption that graduates behave 'as if' they were making capital investment decisions appear as doubtful exercises if only one-fifth of a sample of

(17) S.B. Barnes, "Occupational choice and scientific values", op. cit.
research students entered graduate education because they thought a Ph.D would lead to a higher salary. (18) Bibby maintained that the model of 'homo economicus' was consistent with the behaviour of 'homo academicas'. (19) To this view the attitude studies suggest at least two kinds of modification, firstly that labour markets may be organised into non-competing groups, and secondly, that job opportunities rather than high salaries were the main attractions to academic research and university employment. Bibby's salary data on employment sectors was at odds with the common impressions revealed in attitude studies that industry was the sector with relatively high salaries and that universities were associated with non-economic rewards. (20) It could be argued that those who entered academic employment were better informed about salaries, for example, the academics found employment from professors and teachers whereas industrial recruits went through the 'milk run', in other words, they had different sources of information. (21) In addition it could be argued that those with prospective 'good degrees' will have more favourable access to professors and information. The Cotgrove and Box study suggested that images of work conditions did not vary significantly according to future career intentions. (22) Differential access to information might affect choice in another way, however. If graduates were interested in job opportunities as distinct

(18) See, for example, E. Rudd ("Rates of return to Ph.D.", Higher Education Review, vol. 4, no. 1, Autumn 1970) who distinguishes 20% of decisions as vocational, 16% as drifters, and 43% academic among a sample of science and technology postgraduates.


(20) Compare Bibby's study of earnings with the impressions of earnings in the studies by Box and Cotgrove, Kesall and Sheppard. These studies were discussed in Chapters Four and Six.

(21) Such differences in job finding were reported in Sheppard's study, Scientists and Engineers and their Choice of Jobs 1956-52, op. cit., p. 37.

(22) S. Cotgrove and S. Box, op. cit., p. 72.
from salaries than professors were in a favoured position to advise students about the job opportunities arising in the most rapidly expanding sector in the 1960's higher education. (23) In terms of information networks the 'good students' were the 'marginal ones'.

These qualifications do not present insuperable problems for economic theory, for example, having regard to job opportunities means that supply can still be seen as a function of expected earnings but 'that some consideration be given to changing the traditional emphasis from variations in earnings to variations in expectations'. (24) Psychic returns, the formation of preferences, the nature of expectations, the nature of decision-making, especially in relation to families, structures of choice, and access to information, do mean that economic models must have more regard to a broader form of explanation than those presented as alternatives to the admittedly inadequate implicit theorising of the manpower forecasters.

Recourse to scientists and engineers themselves for views on their situation as supplementary information to that available in the manpower debates proved most useful in the discussion of utilisation. The attitudes and behaviour of graduate scientists and engineers, condemned by industrial employers as products of university education and antithetical to industrial employment, came to be seen in a different light. The short term and technicist emphasis in graduate perspectives on employment emerges as a reasonable response to the way the electronics industry recruits, trains and employs its graduates. Locating the responsibility for 'mismatch' and the possibilities for reform almost wholly within the educational

(23) For a study which illustrates the explanatory power of the job opportunities hypothesis, see the study by Burnes of the flow of engineers into employment in the U.S.A. over the period 1950-1965, "Engineering Occupational Choice, 1950-1965", Industrial Relations, vol. 9, no. 2, February 1970.

system became for employers an opportunity to evade their own liabilities in shaping those perspectives and an opportunity for conservative academics to find yet another ill-consequence of educational expansion, especially of post-graduate study.

In earlier chapters I have outlined the central features of graduate perspectives on entry to employment in the electronics industry. The situation was defined as one where information was lacking about what goals were feasible, what were the available means to achieve them and whether the individual had the necessary resources. This period of early employment became defined as exploratory, a period in which to acquire information. Where information was available it suggested that movement along a managerial ladder was the most likely direction of career advancement, but the means and resources were less readily defined than the general goals. Definitions of 'good work assignments' were closely related to information seeking. 'Good work assignments' were those which demonstrated competence and furnished the basis for further learning, hence the importance of playing to existing skills, having rapid feedback, and visibility. 'Good supervisors' were those who were technically competent and permitted claims by new entrants to an egalitarian 'professional' relationship. Yet the companies became described as organisations where learning was largely a matter of luck and career advancement suffered the vagaries of fortune too. In this situation it appeared sensible to accept an informally prescribed two year learning period but to initiate search procedures for information and for situations which marked out the newcomer for his distinctive contribution and avoided damaging comparisons with technicians. Re-entry to the labour market to discover alternative employment opportunities and market values, re-entry to the educational system for further attestations of knowledge and skill, spotting out
forthcoming jobs with a high analytical content and avoiding 'dirty' and 'trivial' work became standard devices to search out and manifest the distinctive position of the university-educated graduate scientist and engineer. In the short term standards of judgement to assess one's individual performance were derived mainly from the nature of the assignment, for example, whether the solution came readily and satisfactorily, and the comments of the supervisor, but the main standards were accepted as those of the annual salary review. If salary did not feature prominently in first job considerations it appeared likely to gain significance if only because it became a standard unit for assessing career progress. Judgements about colleagues, supervisors and organisations could be made against standards derived from universities, vacation employments and comments of peers who were in the same process of transition from education to employment. In terms of the ease or difficulty of achieving work goals the extent of individual work assignments made colleagues of lesser and supervisors of greater importance than peers and supervisors in university or college. Work colleagues were frequently judged to the extent that they assisted in social adjustments ranging from lunchtime pub gatherings to flat-sharing and here the large establishments with a large annual graduate intake had obvious advantages. Industrial supervisors suffered little from the comparison with university supervisors save in those situations where the recent entrant was on the point of leaving and included supervision in his range of grievances or where an Oxbridge graduate had enjoyed the intimacy of tutorial contacts, compared to the limited contacts of most other graduates, and regretted the lack of intellectual stimulus in relationships with industrial supervisors. When the graduate came to assess the company as an organisation his university experiences left him rather naive and hesitant about judgements, particularly, as one graduate saw, in regard to organisational politics.
"One thing I would like to mention is organisational politics in industry. I don't know if it's different in university, having only been on one side of the fence as a student. In industry there are a lot of levels of management, in some of them you get a lot of petty politics. You see people half the day looking after their own interests rather than doing the job."

Perhaps some of the trends towards greater participation by students in the decision-making of universities will deepen an understanding of types of organisation and organisational membership. In the absence of such understandings many graduates appeared ripe for disillusionment as they carried machine metaphors of organisation and asserted their technicist a conception of proper work role against the haphazard training and induction procedures which did little to shape any alternative view. Military technology with cost-plus contracts negotiated directly with organisationally-isolated research and development establishments has had its impact too in supporting and sustaining these defensive postures of scientists and engineers for these have created protected markets in which technical excellence has been at a premium.

Thus a perspective, which emphasised the early employment period as a continuation of labour market searches and short-term commitments to a particular industrial employer and emphasised the importance of seeking out opportunities which acknowledged and confirmed the graduate scientist or engineer as a member of a special category of employees, seemed a reasonable response to the way the electronics industry conducted its recruitment, training and employment. Such a perspective might suggest something of the conditional loyalty of the professional employee apparent in other literature on scientists and engineers in industry. The important point to note, however, is that I have associated 'professionalism' with a bargaining position vis-a-vis the organisation and hence implicated the employer in the shaping of professionalism whereas many studies assume that
professionalism is the product of socialisation during university or college education.

An 'orientation' differs from a 'perspective' in the sense that an orientation covers an expression of attitudes to work which may not be expressed in action whereas the perspective is derived from study of conduct in the organisation. The study of the various orientations to work revealed little of the 'frustrated academic' in the sense of the graduate who would have preferred university employment. Even the Cotgrove and Box study identified only 17% of their sample of industrial chemists as 'public' or 'academic' scientists and indicated serious utilisation problems among other scientific types, who could hardly qualify as 'frustrated academics'.

Just as there are apparent variations in orientations to work, ranging from the long range managerial career planners who entered production departments to the short-term essentially technically-oriented researchers, there were variations in perspectives too. The definitions of qualities required for success in different departments revealed the vulnerability of able physicists in development departments. Anticipation of this state may have considerable bearing on the relative unattractiveness of industry vis-a-vis the then rapidly expanding universities since development forms the major part of industrial R & D and doubts about 'making out' involve expectations about both financial and psychic rewards.

(25) S. Cotgrove and S. Box, op. cit., p. 33.

(26) In the Cotgrove and Box study, development (39%) was the dominant type of research activity among the industrial sample compared to basic research (5%) and applied research (28%) despite the author's preoccupations with 'public scientists' and 'research'. See Cotgrove and Box, op. cit., p. 20.
With the benefit of hindsight there do appear a number of gaps in the data collected which could be exploited in further studies to throw more light on the problems of occupational choice and manpower utilisation.

1. The response of the educational system. There has been a growth of interest in comparative study of educational systems but there is still a lack of sociological studies of the development of the various institutions of the British educational system from universities to technical colleges and schools, the influence on education policy of various advisory bodies from the U.G.C. to professional institutions, and detailed studies of curriculum change.

2. Industrial demand and utilisation. More studies could be undertaken of the methods of recruitment, career development and training in different industries, companies and departments, for example, in some of the less science-intensive industries. More detailed comparisons could be undertaken of policy-making and execution of policy with attention to the locus of authority and decision-making and to changes in job descriptions and work organisation in the light of technological change, educational development and training legislation.

3. Occupational choice and career development. The relationship between subject choice and choice structure requires further attention in the light of changes in choice structures and the emergence of new occupations. Career development within occupations and switches of occupation requires investigation in the light of changing patterns of utilisation of highly-qualified manpower. Longitudinal studies offer considerable advantages for the study of change over cross-sectional studies, for example,
the dependence of career views in the electronics study on optimistic views of the labour market would alert us to look for different views among new cohorts and re-interpretations among the sample five years on.
3. Manpower Studies and Manpower Policy

Having reviewed the diagnosis of scientific and engineering manpower problems current in the late 1960's, two important questions must be to what extent have the views of various protagonists had any influence on policy and what are the likely outcomes of policies proposed.

Reports of Royal Commissions and Government advisory groups frequently arouse a good deal of publicity and highlight the nature of deficiencies perceived in and solutions currently canvassed for public policies, yet their impact on actual policy is more difficult to determine. Since the solutions proposed are already matters of debate among policy-makers perhaps the main function of reports is to rationalise policies and summon public support. Thus the expansion of undergraduate and postgraduate studies proposed by the Robbins Committee and the checks to the expansion of postgraduate studies and educational innovations for undergraduate studies proposed by the Swann Committee had been clearly initiated by the U.G.C. before the appearance of the reports. Although this suggests that policy determination may lie with other bodies, the lines of influence through cross-committee memberships and the support for policies generated through public platforms may be matters of considerable importance. If the manpower-forecasters appear to have been unsuccessful in pressing the use of manpower forecasts as a basis of educational planning for overall numbers, the ratio of science and technology to arts and social studies places provided in the 1950's and 1960's owed much to the influence of the reports of shortage on U.G.C. thinking.

Since 1970 there has been something of an interregnum in officially-sponsored manpower studies. The manpower forecasters had their influence through the eminent academic and industrial scientists and engineers on the Committee on Manpower Resources for Science and Technology which reported to the Department of Education and Science and the Ministry of
Technology. The Committee looked for broader studies of all highly qualified manpower and the shaping of a national manpower policy after the completion of their own studies, but the new Conservative Government did not establish any such broad manpower committee with the re-organisation of ministries in 1970. Initiatives in manpower studies appear to have passed to the Department of Employment and its Unit for Research on Qualified Manpower staffed by economists. Thus economic approaches, with emphasis on salary data, salary movements, life-time earnings and rates of return and consideration of the whole spectrum of manpower skills and levels of skills, may come to have more bearing on educational and industrial policy than 'scientific lobbies' and physical manpower forecasting approaches. This kind of approach is likely to gain more favour when the system of educational finance is likely to be a major feature of educational debate in the next decade. (27)

In the 1960's the proposals of the Committee on Manpower Resources for Science and Technology were made to correct deficiencies in the educational system revealed by their 'evidence' of shortage. Gannicot and Blaug, sceptical of this evidence and agnostic about the shortage, took the view that all the reported phenomena could indicate a market clearance of a 'surplus' of engineers and scientists. Since in Britain these market clearances could occur only slowly, Blaug made a number of proposals for educational reform. Beyond the obvious and arresting assertion and counter-assertion of 'shortage' and 'surplus', the policy recommendations of the manpower forecasters and the economists look remarkably similar.

The Swann Committee had two sets of recommendations, the first set concentrated on physical manipulation to cut back the number of postgraduate research places in science and engineering to avert short-term crisis. The second set of proposals for the longer term proposed a broadening of curricula following the Dainton and McCarthy reports. Broadening of curricula served several purposes. It was intended that schoolchildren would be permitted to take later, and presumably more mature, choices, and it was assumed that maturity implied a pro-science choice. It was also intended to reduce the extent of student identification with disciplines and hence academic. Two further benefits for industry lay in the belief that a broad pattern of studies was more relevant to the solution of industrial problems which required multi-disciplinary approaches and the belief that a broad-based education would ease adaptation to technological and occupational changes. The proposals to follow American patterns could well meet with educational objections from those who applauded a former British Minister of Science in his claim that the 'Brain Drain' was an indication of American employers' preferences for superior British education and specialisation. Some educationists have associated analytical rigour with specialised study of a major discipline. It is not clear that a reduction of course specialisation will reduce preferences for academic employment for one consequence of such educational reform might be a reduction in the identification of university teaching and teachers with disciplines. A more serious criticism of the proposals, however, is that they ignore relationships between timing of specialisation and choice of specialism, for example, from several studies it appears that those who have continued in science have been 'early choosers' and those who have chosen arts and
social studies have been 'late choosers'. (28) Changing the structure of choice in these circumstances could increase the number opting away from science and technology. An additional criticism of the proposals is that they reflect a presumption that courses are among the major determinants of occupational choice and that tinkering with the educational system can readily redirect manpower flows. Although critical of the Dainton Report in other respects Blaug was pleased to accept the attack on specialisation as excellent analysis and note that broader curricula would introduce potential flexibility in labour market responses. The proposals for broader curricula appeared an agreeable coincidence of liberal education, manpower forecasting and neo-classical economics arguments.

The Committee on Manpower Resources favoured an extension of occupational counselling services especially as a potential counterweight to the prejudiced advice of physics teachers, but Blaug was even more forceful in his eulogy of the American pattern of counselling and claimed that superior wisdom would result from the individual efforts of students and counsellors rather than from the collective efforts of any group of manpower forecasters. Examination of that American pattern discourages ready optimism for the approaches of counsellors reveal a plethora of psychologistic concepts and lasting techniques to solve pegs and holes dalemmas with an all too frequent result in the cooling-out of the aspirations of disadvantaged groups. (29)


(29) See, for example, A.V. Cicourel and J.I. Kitsuse, The Educational Decision-makers, New York: Bobbs Merrill, 1963, (especially Ch. 4).
Of course, the picture might be different if counsellors were trained in neo-classical economics and encouraged students to consider prospective rates of return, but even there the benefits are not abundantly obvious. Under the promptings of company interviewers, students readily developed a patter of salary and career and attempted to simulate 'drive' and 'ambition' but the 'futures' and 'careers' remained a peculiarly foreign concept to those without experience of them.

Blaug was an advocate of another proposal to make the market impinge on student educational and occupational choice by favouring the substitution of loans for grants as a form of student finance. In addition to easing the burden of state finance loans would encourage thoughts about rates of return. However, if critics of loan schemes are correct in their belief that loans would discourage working class students then the consequences for engineering and scientific occupations can be seen quite readily. Already several studies have been cited which noted the disproportionate recruitment into scientific and technological occupations from working class backgrounds. (30) Thus a substitution of loans for grants would appear to discriminate not only against certain students but against certain disciplines and occupations. On the first point Blaug claimed that a graduate tax would not have the deterrent effects of personal debt, while tied loans and scholarships could discriminate in favour of particular occupations. The incentive and disincentive effects of taxation remain largely unexplored areas but there is some available American research which suggests that discriminatory scholarship schemes have not been successful. (31)


If the general message from a good deal of recent research in the sociology of education cautions against the conception of the educational system as a readily available tool of public policy then the importance of more direct approaches to manpower problems becomes more pressing. It is evident from the electronics industry study that even in a highly prestigious and highly regarded industry there were serious problems of utilisation the resolution of which could be attempted by changes in industrial policy and organisation. It is evident too that the resolution of such problems will require from companies a new conception of their relationships to the educational system. For the future we require more research into the capacity of industrial companies to undertake that revision and more evidence of their willingness to move beyond exhortation and scapegoating of the educational system.
APPENDICES

APPENDIX ONE

THE INFLUENCE OF THE MOST LATE REVOLUTION ON A.M. 1962-1964

1. A LEVEL STUDY PLAN FOR INCREASED RESEARCH AND TECHNOCAL
   DEVELOPMENT TRENDS.
   
   After the Second World War, concerted efforts in the
   computer field, aimed for greater attention to the provision
   of increased numbers of scientists and engineers for industry
   was traced back to the Nineteenth Century in Britain. In that
   century, French efforts to 'catch up' with continental
   neighbours were undertaken in a determined fashion and
   systematically shaped through the educational system. (1)

   Alarm in Britain at the apparent success of these French
   measures revealed in 1907. Paris exhibition prompted
   considerable study of French education, and this influence
   was seen in the development of London University and the large
   provincial universities. (2) The emphasis in French science
   and education was linked to wider social developments in the
   rise of German nationalism, and there is evidence that as this
   nationalism brought conflict between Germany and Britain, the
   attractions of the German model of education for British observers
   sharply waned. (3) The search began for other patterns of

   (1) See, for example, the essay by M. C. Henderson, 'Peter Booth
   and the rise of Canadian industry, 1810-1840' in T. F.
   Hughes ed. The Development of Western Technology since

   (2) The major source for the development in British science
   in the 19th century is England in W. B. Corden, The
   Organization of Science in England: A Retrospect
   London: Allen and Unwin 1974. Some other writings which drew
   attention to the German influences on English education
   are those of W. H. G. Sewge in The Civil Universities

   (3) This reversal in the admiration and affection felt for the
   German pattern of scientific and technical endeavors can
   be seen clearly in the contributions of Dr. Bucky, the
   influential editor of 'Nature'. See H. Meichen 'The
1. A long standing plea for increased scientific and technological manpower resources.

While the Second World War stimulated concerted efforts in the manpower field, clamour for greater attention to the provision of increased numbers of scientists and engineers for industry can be traced back to the Nineteenth Century in Britain. In that century, Prussian efforts to 'catch up' with continental neighbours were undertaken in a determined fashion and consciously shaped through the educational system.(1)

Alarm in Britain at the apparent success of these Prussian measures revealed in the 1867 Paris exhibition prompted considerable study of Prussian education, and this influence was seen in the development of London University and the large provincial universities.(2) Developments in Prussian science and education were linked to wider social developments in the rise of German nationalism, and there is evidence that as this nationalism brought conflict between Germany and Britain, the attractions of the German model of education for British observers sharply waned.(3) The search began for other patterns of

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(1) See, for example, the essay by W. O. Henderson 'Peter Leuth and the rise of Prussian industry 1810-1845' in T. P. Hughes ed. The Development of Western Technology Since 1500 New York: Macmillan 1964.


(3) This reversal in the admiration and affection felt for the German pattern of scientific and technical endeavours can be seen clearly in the editorials of Norman Lockyer, the influential editor of 'Nature'. See R. MacLeod 'The Social Framework of Nature in its First Fifty Years' Nature, vol. 224, No. 5218, November 1969.
education which British higher education could be modelled on. (4) Whatever the particular model mooted for development, the concern that these universities should provide graduate manpower for industry continued. Thus a somewhat surprising feature of the flow of graduates from these civic universities was that by and large they entered the teaching profession. It could be argued that any expansion of the educational system will require more teachers in the first instance and that such a pattern of flow might be expected as a short run phenomenon. One important distinction drawn between the German and British educational systems by D. S. L. Cardwell was that in Britain there was a

(4) Given that the fashionable model was discredited, it is tempting to suggest that educationists reverted to the former English model of university organisation, that of Oxford and Cambridge in terms of residential provision, which is taken as indicative of that conception of a university. (See G. L. Payne Britain's Scientific and Technological Manpower London: Oxford University Press 1960.) Moreover, Keele, the institution seen by Payne as the culmination of this trend, had a considerable influence in shaping the new English universities which appeared after the publication of Payne's book. Whether this influence was direct or indirect, and whether it still holds today are matters of debate, some research has been undertaken into the formation of these universities and suggests an indirect influence through the U.G.C. (See M. Cross and R. Jobling 'The New English Universities - a preliminary enquiry', Universities Quarterly, Spring 1969.) To advance any simple relationships about university development in the present state of knowledge may be tempting but foolhardy, for they would need to be examined against the influences of the American land grant and liberal arts colleges, and, the Scottish universities.
concentration on the output of a small scientific elite in contrast to a German output of many researchers of the second-run. In this sense it was less likely that the build up in Britain would be achieved sufficiently rapidly to satisfy educational and industrial needs. Yet if there were problems on the supply side in elitism and the tendency to satisfy largely educational needs only, Cardwell has noted there was a reluctance on the part of industrial employers to recruit university-educated scientists and engineers. (5)

A somewhat similar pattern of flows into employment was obtained in the post war period after the First World War. Efforts directed to promote technological change in industry included the provision of scholarships for training in research techniques from the Department of Scientific and Industrial Research which became the means for obtaining higher degrees and employment in academic or teaching posts as the prospects shrank through the late 1920’s and 1930’s of industrial employment. (6)

Prior to the Second World War it appeared that there was reluctance on the part of many industrial employers to employ graduate scientists and engineers and there was a relatively low rate of growth of student enrolments in science and technology. (6)


(6) It has been estimated that the approximate total of 13,000 science and technology students in British universities in the late 1930’s marked an increase of only about 7% on the enrollment in 1920. J. B. Poole and K. Andrews The Government of Science in Britain London: Weidenfeld and Nicholson 1972.
### TABLE 1

**New degrees awarded in science and technology 1938-1967**

<table>
<thead>
<tr>
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<th></th>
<th></th>
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<tr>
<td>In science</td>
<td>2,167</td>
<td>3,972</td>
<td>6,570</td>
<td>7,559</td>
<td>11,264</td>
</tr>
<tr>
<td>In technology</td>
<td>1,048</td>
<td>2,306</td>
<td>3,415</td>
<td>3,466</td>
<td>6,563</td>
</tr>
</tbody>
</table>

Since the Second World War there has been a dramatic rise in the output of graduate scientists and engineers from the higher educational system and a substantial increase in the numbers employed in industry compared to the inter-war period, for example, the number of new degrees awarded in science and technology rose from a total of 3,215 in 1938-9 to 17,827 in 1967. (See Table 1) Despite these increases, unease about the use of graduates in industry and the readiness of the educational system to provide larger numbers of scientists and technologists continued throughout the post-war period and reached a climax in the period 1964-1968.
2. Post-War efforts to expand scientific and technological manpower resources.

(i) The 1940's: the 'Percy' and 'Barlow' Reports

To the various committees set up to advise on post war reconstruction the need for urgent attention to efforts to raise numbers of scientists and engineers was immediately obvious. The wartime experience demonstrated the power of scientific knowledge translated into advanced technology with the atomic bomb and radar as supreme examples, yet it had revealed weaknesses in the translation process. At the outset of war there was little information on the numbers of scientists and engineers in the country although by the end of the war the Ministry of Labour Central (Scientific and Technical) Register listed 45,000 scientists and it was estimated that there were a further 10,000 active scientists in the country. In mobilising these scientists during the war deficiencies in the ability of electrical engineers to cope with the new electronics technology were apparent in radar and the early start given to radar meant that many physicists had already been recruited to work in this sector when recruitment began for physicists to work on the atom bomb. The number of foreign-born physicists recruited to work on vital defence work led to some alarm and despondency about the dependency on aliens. (7)

For post war reconstruction a committee was set up by the Minister of Education in 1944 under the chairmanship of Lord Eustace Percy to review higher technological education. The Committee believed that the deficiencies apparent in wartime and the likely demand from industry in peacetime required responses from the educational system and set out to propose "an organisation of higher technological education which will be more responsive and adaptable to the needs of industry." (8) The Committee attempted to assess those needs and to match them against supply over the forthcoming ten years using information from the Professional Engineering Institutions. The Committee identified five categories of technically trained staff: (1) senior administrators, (2) engineer scientists and development engineers, (3) engineer managers (design, manufacture, operation and sales), (4) technical assistants and designer draughtsmen, and (5) draughtsmen, foremen and craftsmen. Of these categories only (1) and (3) were relevant to the enquiry and the Committee estimated anual output of three thousand engineers divided equally between mechanical, electrical and civil branches, would be necessary over the next ten year period (9). In making proposals to meet the potential demand the committee examined the recent pattern of supply. The pre-war output from universities and technical colleges had averaged approximately two thousand, of whom thirty-five per cent came


(9) Since (1) was largely the result of internal recruitment from (2) and (3) the Committee were directly concerned with (2) and (3).
from universities. During the war the national output reached three thousand and the university proportion reached forty-five per cent. In effect the Committee proposed that the war-time emergency efforts be continued with the same division of responsibilities between universities and technical colleges on numbers. The Committee was at some pains to introduce some rationale into the provision of technological education at many levels from national to local and believed that in terms of manpower categories the universities would concentrate on the training of scientists, engineer scientists and development engineers and the technical colleges on technical assistants and draughtsmen. However they recognised that there was overlap in the training of category (3), the technically qualified managers. Here they sought a rationale for a division of responsibilities between institutions in different emphases on the science and art aspects of technology and proposed that a limited number of technical colleges should develop advanced level courses to integrate academic and industrial studies to give a craft flavour over the course period compared to the university course taken wholly within the academic setting. (10) Yet there was a deep controversy within the Committee over the title of the award for these new advanced courses. Some sought a degree feeling that anything other than a degree would appear inferior by comparison with the traditional prestige of the

(10) It was proposed that the 1500 engineers in the annual output from technical colleges, 1000 should continue the existing practice of concurrent industrial work and that 500 should take the new advanced level courses which attempted industrial work and study and full-time academic study (i.e. sandwich courses).
university degree, recognised across disciplines and national boundaries. Other members of the Committee felt that a degree title would obscure the very distinctive aspects of non-university technological education and would invite judgement on the courses as inferior substitutes for the university courses. For contrast they sought a diploma as a nationally and internationally recognised qualification for a distinctive education. Ultimately Lord Percy proposed the compromise of nominating selected institutions as 'Royal Colleges of Technology' with the power to confer associateships and fellowships subject to the supervision of a National Council of Technology.

The general view of the Percy Report - "first, that the position of Great Britain as a leading industrial nation is being endangered by a failure to secure the fullest possible application of science to industry; and second, that this failure is partly due to deficiencies in education" - could serve as an introduction to many of the numerous reports which have been issued by Government advisory bodies in the post war period. They have seen failures in the industrial utilisation of science, partly attributed the failures to the educational system and then sought remedies largely through the educational system. Indeed the tendency to take this course became more rather than less pronounced. All the other features of the later debates were present in the report - concern about making the educational system responsive to industrial need, a search for rationales to allocate investment between universities and other institutions of higher and further education, and
dismay about the prestige of technology. In many ways these issues were not tackled with any greater degree of sophistication in the later debates of the 1960's, instead the qualitative issues became oversimplified as the preoccupation became that of quantification, forecasting, and numbers of scientists and engineers for industry.

The first concerted effort in the field of forecasting scientific and technological manpower began with the appointment of a committee by the Lord President of the Council under the chairmanship of Sir Alan Barlow to enquire specifically into the state of scientific manpower. Again, another Committee formed to assist in post-war reconstruction reported in 1946 that the needs for attention to increasing the output of scientists seemed immediately obvious.

"We do not think that it is necessary to preface our report by stating at length the case for developing our scientific resources. Never before has the importance of science been more widely recognised, or so many hopes of future progress and welfare founded upon the scientist. By way of introduction, therefore, we confine ourselves to pointing out that least of all nations can Britain afford to neglect whatever benefits the scientist can confer upon her. If we are to maintain our position in the world and restore and improve our standard of living, we have no alternative but to strive for that scientific achievement without which our trade will wither, our Colonial Empire will remain undeveloped and our lives and freedom will be at the mercy of a potential aggressor." (11)

Again this committee attempted to assess the potential demand for scientists and found likely deficiencies in supply.

From various studies, for example, one conducted by the Industrial Research Committee of the Federation of British Industries, the Committee estimated a minimum demand for 70,000 scientific workers in this country and the colonial service. A five year forecast was thought to be inadequate since it took three years to produce a scientist through his university course and the Committee made an estimate of a minimum demand for 90,000 scientific workers in 1955. Against this demand it was estimated that the national stock of scientists was 55,000 at the end of the War. In the previous years the average annual output from the universities had been 2,500 graduates and from the 1945 U.G.C. enquiry it appeared that this would rise to 3,500. When the Barlow Committee made appropriate adjustments for wastage and calculated the net additions to the national stock of scientists they estimated that there would be a stock of less than 60,000 scientific workers to be matched against a minimum demand of 70,000 in 1958, and a stock of 64,000 to be matched against a minimum demand of 90,000 in 1955. Thus the Committee called for a doubling of the output of graduate scientists from 2,500 to 5,000 each year as soon as possible but believed that this would

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(12) This estimate took account of the raising of the school leaving age and the demand for teachers, an assumption that industrial reconversion would be complete by 1950 and that demand thereafter would be for new scientific applications, an assumption of 'steady but not exceptional' increases in central and local government employment.

(13) The U.G.C. enquiry did break down total student numbers by discipline but was assured that science would expand less rapidly than the less costly Arts nor was there an indication of the time scale of expansion but the Barlow Committee believed that an output of 3,500 would not be achieved before 1950.
be unlikely before 1950 and the Committee drew the somewhat
gloomy conclusion about the future,

"... the only possible conclusion is that whatever is done
to increase the output of science graduates, the nation
will be seriously short of scientists in 1950 and that
without heroic efforts it is unlikely that supply will have
finally overtaken demand even five years later." (14)

In the event, however, the target of doubling was achieved
in five years. The Barlow Report and the Percy Report were in
broad agreement about the distinctive contributions of
universities and technical colleges to the output of scientific
and technological manpower, although the progeny of the
committees disagreed about the relative balance of contributions
to be made by the universities and technical colleges to the growth
of technological manpower.

Apart from their manpower forecasts these two committees made
recommendations for permanent machinery to advise in the fields
of manpower and education. From the Percy Committee came the
recommendation and establishment of the National Advisory Council
on Education for Industry and Commerce (N.A.C.E.I.C.) in 1947,
whose report in 1950 revived the Percy proposal for a Royal
College of Technology with a council and academic board to super-
vise the awards of associateships, memberships and fellowships
and further recommended that local authorities should get seventy-
five per cent grants to replace the then sixty per cent grants.
By 1950 the U.G.C. had issued a report to propose further
expansion of technology in universities but cautioned against
the swamping of universities by these developments. (15)

(14) Scientific Manpower op. cit. p.18.

(15) U.G.C.A. Note on Technology in the Universities London:
H.M.S.O. 1950 p.4.
In a White Paper, the Labour Government favoured the N.A.C.E.I.E. proposals for a College of Technology to supervise a new qualification and for increased support to technical colleges, although the proposal for a new technological university was rejected on the grounds of cost and likely delay.\(^{(16)}\) Following the 1951 General Election, the incoming Conservative Government rejected the proposals for a supervising college but accepted increased support for technical colleges. The new Government followed the spirit of the A.C.S.P. proposals in their decision to concentrate on the main existing institutions, the universities, with special provision for Imperial College, the government to aid advanced technical courses. These recommendations were in conflict with the reports of the advisory body which derived from the Barlow Committee. On the recommendation of the Barlow Committee, the Advisory Council on Scientific Policy (A.C.S.P.) was formed in 1947 to replace the wartime Scientific Advisory Committee to the Cabinet. In both the first and second of its annual reports the A.C.S.P. proposed that attention should be concentrated on universities in training a higher technological studies rather than general technical education, and further recommended that the development of technological education should rest largely with the U.G.C. \(^{(17)}\) In 1946 the U.G.C. had had its terms of reference extended to cover reference to 'national needs' and manpower considerations.


3. The mid-1950's: the forecasts of the Committee on Scientific Manpower

One political scientist, Norman Vig, has identified the period of the post-war years down to the mid-1950's as one in which both the main British political parties were in agreement about the priorities for Government support of science and the relevant pattern of civil science administration. Both policy and administrative structure, he argues, were derived from the coalition government and the exigencies of post-war reconstruction. (19) The overcoming of immediate crises and the opportunity for a re-evaluation of the extent of recovery in the mid-1950's witnessed the beginning of the breakdown of this bipartisan approach, according to Vig, as the two political parties began to draw different lessons from the situation and the Labour Party began to formulate its criticism of the Government record. A good deal of the information about the state of the manpower situation was provided in this period by the Scientific Manpower Committee established under the chairmanship of Solly Zuckerman by the Advisory Council in Science Policy (A.C.S.P.) in 1950.

In view of Vig's claims about the beginnings of the end of the bipartisan approach, events in 1956 appear somewhat paradoxical. The Labour and Conservative Governments differed in 1951-1952 on the relative balance of effort in university and technical college expansion as we have seen so that it is somewhat surprising that in the mid-1950's they should switch their emphasis to announce a major expansion programme in the technical colleges. The sources of alarm came from the reports of the manpower forecasters on the discontent of industrial employers and

international companions on the levels of scientific and technological manpower in the Soviet Union. In 1955 a report from the Committee on Scientific Manpower of the A.C.S.P. was based on a study of fifty firms spread across various sectors of engineering industry and revealed both a pattern of recruitment generally twenty-five per cent below company requirement levels and employer discontent with undergraduate education and its relevance to industrial practice. (20)

In this climate the revival by the N.A.C.E.I.C. of the Percy proposal for a body to supervise the sandwich type of course and a higher technological award was received favourably. The Conservative Minister of Education formed the National Council for Technological Awards (N.C.T.A.) to supervise courses leading to the award of a Diploma of Technology. (21) The more favourable attitude towards technical colleges was evident in the White paper on 'Technical Education' published in the following year. (22)

This paper opened with the declarations of the Prime Minister on the worldwide scientific revolution and the importance of educated scientific and technological manpower and proceeded to draw invidious comparisons between manpower levels in Britain and the U.S.A., U.S.S.R. and Western Europe. International comparisons,


(21) Thus one of Percy proposals was implemented eleven years after the Report, with the delay blamed on other educational priorities, complacency, ministerial changes and university opposition.

(22) Technical Education Cmd 9703 London H.M.S.O. 1956
the rate of expansion relative to requirements, and the realisation that manpower resources involve a spectrum prompted the conclusion in Government that the base of the pyramid of technical education should be broadened. To this end the Government proposed a five year programme to increase by approximately one half of the output of students from advanced courses at technical colleges and to double the numbers on part-time day release courses from employers. The hierarchy structure was defined in terms of the Colleges of Advanced Technology (C.A.T.) the regional colleges of technology, the area college of technology, and the local colleges of technology. The novel element in the plan was the C.A.T. which was to continue to promote the higher level technological courses on a sandwich basis, to shed lower level courses, and be permitted greater autonomy from local education authorities.

The intended targets in the 1956 White Paper had some basis in the statistics furnished by the Committee on Scientific Manpower of the A.C.S.P. During the years 1956-1964 this Committee presented four reports which gave accounts of the current situation and gave forecasts for the medium (three to five years) and long term (ten years). In 1956 they made both medium and long term forecasts following with a medium term forecast (1959) a long term forecast (1961) and a further medium term forecast (1962).(22)

In the medium term forecasts for 1956 and 1959 employers were asked how many people with scientific and engineering qualifications they would employ in three years' time on the assumption that the required number of recruits would be available.

The general impression given by these forecasts was of rapid growths in demand for qualified scientists and engineers which were not satisfied by available supply. Of themselves the statistics of expected increase compared to actual increase were difficult to interpret for the failure to achieve the estimated target may simply reveal the initial weakness to foresee actual requirements but when they were taken together with the various other surveys, such as that of the engineering industry and its recruitment of qualified manpower, they added confirmation of the need to expand the educational system.

For the 1956 long term forecasts the Committee assumed a fixed ratio of engineers and scientists to an index of industrial production and with a further assumption about growth of industrial production they arrived at the numbers of engineers and scientists necessary for the 1966 and 1970 production figures, in this case the Committee took a 1:1 ratio and a four per cent per annum growth rate in production output to arrive at totals of 220,000 (1966) and 328,000 (1970) compared to the current total of 135,000 engineers and scientists in 1956. These were the statistics which prompted the Government to undertake its programme on technical college expansion for although there was no breakdown of the totals of academic discipline the Committee on Scientific Manpower felt there would be shortages among the engineers in the mid-1960's. The 1961 long term forecast continues to arouse controversy in 1972. Admitting the possibility of shortages in
particular disciplines or skills, the Committee reached the conclusion about the overall total of scientists and engineers that "by 1965 supply and demand should not be much out of balance and that a surplus may exist after that date". (23) At the time this conclusion brought accusations of complacency in scientific circles which became even more dismissive in the latter part of the decade. (24) The statisticians had made their forecasts for the supply side on the basis of the post 1956 expansion plans and concluded that those would be sufficient. (See Table 2). After the experience of the much more dramatic expansion plans of the 1960's and the difficulties experienced in job seeking by graduates in all fields including science and technology in 1970, 1971 and 1972, the original statisticians of 1961 have begun to feel some vindication for their forecast of 1961 for the end of the decade. Whether they were 'right' for the 'wrong' reasons is another matter however. To reach their forecast of demand the Committee had attempted to surmount apparent difficulties in the assumptions in the 1956 long term forecast. The 1:1 ratio between growth of output and growth of demand for qualified appeared untenable over the period 1956-1959 when the growth rate in the economy was not the assumed for per cent per annum and when, despite a rise of only 2.1% on the index of industrial production, the growth of employment of qualified manpower was 8.5%. Therefore in the 1961 forecast the Committee attempted to

(23) The Long-term Demand for Scientific Manpower op. cit. p. 20

(24) See, for example, the comments of Hilary and Steven Rose Science and Society Harmondsworth: Penguin Books 1970 p.62-3.
**TABLE 2**

Available qualified manpower and estimated demand from the 1961 survey.

1959 and estimates for 1965, 1970 and 1975

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th></th>
<th>Scientists</th>
<th></th>
<th>Technologists</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Available manpower</td>
<td>Estimated demand</td>
<td>Available manpower</td>
<td>Estimated demand</td>
<td>Available manpower</td>
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<tr>
<td>1959</td>
<td>173.0</td>
<td>72.2</td>
<td>100.8</td>
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<tr>
<td>Estimates 1965(1)</td>
<td>255.0</td>
<td>254.5</td>
<td>107.7</td>
<td>104.5</td>
<td>147.3</td>
<td>150.0</td>
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<tr>
<td>1970</td>
<td>346.0</td>
<td>328.5</td>
<td>149.3</td>
<td>140.5</td>
<td>196.6</td>
<td>188.0</td>
</tr>
<tr>
<td>1975</td>
<td>463.5</td>
<td>..</td>
<td>206.0</td>
<td>..</td>
<td>257.5</td>
<td>..</td>
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</tbody>
</table>

(1) Estimated demand interpolated; the detailed estimates relate of 1970.

Source: The long-term Demand for Scientific Manpower p.18.
disaggregate the industrial sectors and estimated total employment within each industry, then between industries, followed by estimates of the density of qualified manpower required within the total required within the labour force of each industry. The latter point was important because it was assumed that the rate of absorption of qualified manpower into an industry would slacken off as the industry approached a 'fully manned' density, this level was estimated from discussions with industrialists and relevant Government departments about 'best practice' organisations in the industry. Further discussions with industrialists and Government departments allowed the Committee to form judgements about each industry and its manpower requirements to 1970. While implications for the supply of qualified manpower were that the rate of growth of the stock of qualified manpower (approximately 6% per centum) and the expansion of the educational system should be of the same magnitude as the three preceding years, 1956-59, the growth rates of employment sectors were to be different with central and local government and industry at a slower rate and the education sector at a faster rate for the years 1959-70 compared to 1956-59 (see table 3). The opportunity to drop the more obviously simplistic assumptions of the 1956 forecast gave the Committee greater confidence about their forecast for 1970 and assurance that it was grounded in more realistic assumptions.

There was a noticeable difference in the methodology and reception given to the medium and long term forecasts. The medium term forecasts associated with the technical manpower surveys and were largely based on employer forecasts about requirements on the assumption that employers could plan over
<table>
<thead>
<tr>
<th></th>
<th>1956 to 1959</th>
<th>1959 to 1970*</th>
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<tr>
<td>Total</td>
<td>6.1</td>
<td>6.0</td>
</tr>
<tr>
<td>Central and local government</td>
<td>4.2</td>
<td>2.9</td>
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<td>Public corporations</td>
<td>3.0</td>
<td>3.7</td>
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<tr>
<td>Industry</td>
<td>9.1</td>
<td>7.2</td>
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<tr>
<td>Education:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>3.9</td>
<td>6.1</td>
</tr>
<tr>
<td>Postgraduates</td>
<td>7.2</td>
<td>9.6</td>
</tr>
<tr>
<td>Other</td>
<td>2.7</td>
<td>3.4</td>
</tr>
</tbody>
</table>

*estimated.

Source: The Long Term Demand for Scientific Manpower p.18.
that time period. Over the longer period there were doubts about the reliability of employer views, largely because of the unknown nature of their assumptions, and so the manpower forecasters attempted to give an 'independent' and 'objective' view. For the longer term the manpower forecasters collected the views of employers but subjected them to their own independent scrutiny. Tucked away in this scrutiny are the forecaster's assumptions about political, economic and social developments and their impact on the development of employment sectors. Whatever these assumptions were they do not appear to have been shared by many commentators who tended to regard the long term forecasts as too conservative. Instead the commentators tended to prefer the tone of the triennial forecasts which included evidence of increasing industrial employer demand and failures to meet their targets and the medium term studies favoured the argument for expansion in the educational system.

In the 1962 triennial medium term forecast which followed a year after the 1961 long term forecast, the Committee on Scientific Manpower revised their judgements about the future to 1965 and tended to reaffirm the view of a shortage of engineers and scientists and to urge again the case for expansion. Two sources of new information prompted the change of view. Preliminary information from the 1961 census revealed that the total stock of qualified scientists and engineers had been underestimated and there were large numbers of scientists and engineers in non-scientific or non-technical employment.(25)

(25) The Census revealed 40,000 scientists and engineers working in areas not covered by the survey.
It was felt that if these groups were to expand then the 1961 forecasts would require an upward revision. Indications of a firm commitment by the Government to efforts to secure a 4% per annum rate of growth in the national economy was an additional cause for upward revision when it was believed that employers may not have taken this likely increased growth rate into account in the earlier enquiry.

4. The early 1960's: the 'Robbins Report'.

Given that it took three years for the completion of an undergraduate course it might be expected that educational planners would look to the long term forecasts of the manpower forecasters for guidance on the likely directions for future educational plans. In the early 1960's, however, the available advice of the manpower forecasters proved to be something of an embarrassment to the educational planners. To the educational planners, convinced of the need for a large expansion of higher educational facilities, the suggestion that the present rate of expansion was satisfactory was dismal evidence. This dilemma about educational expansion was resolved in the short run by questioning the methodology and likely accuracy of manpower forecasts, and in the 1962 Triennial Manpower Survey the manpower forecasters made upward revisions of their forecasts and joined the case for expansion.

After the relative euphoria of the 1959 General Election and the re-election of a Conservative Prime Minister who became renowned for the reminder to the electorate 'you've never had it so good', considerable anxiety developed about policy in higher education and science. On the one hand there was increasing
concern about the earlier projections from the U.G.C. in view of the 'bulge' (the effects of the post-war increase in birth rate as the cohort passed through secondary school) and the 'trend' (the tendency for a larger proportion of the eligible cohort to seek entry to higher education) and, on the other hand, there were the fears about possible shortages of scientists and engineers. (26) In addition there was increasing difficulty in university finance in the latter part of the 1957-62 quinquennium with the suspension of projects and indications that the 1962-67 quinquennium would reflect a period of Government financial stringency. These doubts about the future coupled with the effects of the attempted 'pay pause' on university staff salaries brought conflict between universities' staffs and Government. Sensitive to the educational issues the Labour Party took up the university grievances. Before the 1959 election the Labour Party proposed an enquiry into higher education, a proposal which was put into effect by the Conservative Government after the election by appointing a committee of enquiry under the chairmanship of Lord Robbins. In opposition the Labour Party went ahead with a Committee of inquiry on higher education under Lord Taylor and the report of this Committee

(26) In addition to the evidence of shortage in the triennial manpower surveys of 1956 and 1959, a survey of industrial R. &D. conducted by the Federation of British Industry claimed that manpower shortages were a major hindrance to current programmers. FBI, Industrial Research Committee Industrial Research in Manufacturing Industry, 1959-60 London: F.B.I. 1961.
advocating a five year crash programme to increase student numbers was published some months before the report of the Government appointed Robbins Committee in 1963.

The Robbins Committee undertook a massive exercise in the collection of evidence. Under very close questioning from Lord Robbins, the Chairman of the Committee on Scientific Manpower confirmed doubts about the reliability of available manpower forecasting techniques. (27)

Having vented the doubts about manpower forecasters as guides to the magnitude of educational expansion the Robbins Committee could adopt alternative criteria, those of 'social demand'. In proposing a response to 'social demand' the Committee were not proposing a move to the American scale of provision for higher education implied by the 'open door' college since they retained an ability constraint: 'courses of higher education should be available for all those qualified by ability and attainment to pursue them and wish to do so.' (28)

The implications of meeting 'social demand' (and the influences of the 'bulge' and the 'trend') that were drawn by the Robbins Committee were for large increases in the student population. The proposed targets were for an increase from 216,000 full-time students in all higher education in 1962 to 390,000 by 1973-4 and 566,000 by 1980-1. It was estimated that 60% of the expanded numbers would be in universities. Among the critics of the report were those who doubted the value of the ability constraint and under the slogans of 'more means worse' complained

of overexpansion and probable destruction of existing institutions. Such doubts and complaints came in the editorials of 'the Times' newspaper and were countered by the comparisons of provision in other countries in the Robbins Report appendices of evidence. Supporters of the proposals have cited the Report as a landmark of radical economic and social reform, as providing an increase of educational opportunity and increased reserves of educated manpower. Some historians have suggested that this praise and blame is wrongly attached to the Robbins Report, they hold that the major deliberations about expansion preceded the Robbins Report. They point to the unease about the 'bulge' and 'trend' felt in the U.G.C. and the conclusion reached by the U.G.C. in 1959 (four years before the Robbins Report) that the desirable student level should be raised from the estimate of 135,000 to 200,000 for the late 1960's. (29) In view of reluctance expressed in universities to raise existing targets to those new levels, the U.G.C. proposed a 'minimum first instalment' of 170,000-175,000 for 1967-8 in existing universities together with a proposal for several new universities. (30) Perhaps a critical factor for the eventual expansion was the speedy acceptance by the Government of the rationale for expansion in a White Paper published only twenty-four hours after the publication of the report. No doubt the impending election hastened acceptance.


(30) Thus although the supporters of the Robbins Report could claim that the Report called for rise in the target for 1967-8 from 172,000 to 197,000, the latter figure had been included in the U.G.C. proposals. Moreover it is interesting to note that the U.G.C. letter sent to universities after the publication of the Report which sought indications of the likelihood of the new target produced offers of 217,000 places. See R. Layard, J. King and C. Moser The Impact of Robbins Harmondsworth: Penguin Books 1969 p. 41.
of the Report for according to Vig the move (towards targets proposed by the Labour Party enquiry) effectively removed debate about higher education for political contention. (31)

Although the Robbins Committee proposed to eschew manpower forecasts as criteria for the magnitude of expansion, they were sensitive to manpower issues. In the first place the Committee recognised that a factor underlying the 'trend' (the increasing proportion of eligible schoolboy seeking further study) was the desire for further educational qualifications and through the 1950's there had been a tendency for a faster growth rate in science rather than arts disciplines in schools and universities. Taken together these two factors supported the Committee's suggestion that in the expansion growth should be greater in the science departments. A second point on which the Committee was sensitive to the scientific and technological lobby was in discussions about the relative prestige of technological studies in British education and the Committee made some proposals to strengthen technological studies. A significant feature of the prepared expansion was for an increase in postgraduate work (to cover 30% of graduates by 1980 compared to the 20% in 1962) and it was indicated that a high proportion of technological research should be included. This was intended to correct deficiencies in technological research compared to scientific research highlighted in the reports of post-war reconstruction committees and in subsequent studies. Further efforts to strengthen technological

(31) N. Vig op. cit. p.49.
studies included proposals for the creation of new institutions and significant changes in existing non-university institutions. In their collection of evidence the members of the Robbins Committee were impressed by the evidence presented by the Advisory Council on Science Policy and the Professional Engineering Institutions in their claims that technology was given a somewhat begrudging presence in the universities and schools. (32)

(32) Lord Todd, chairman of the A.C.S.P., presented the view that British universities had been sufficiently broad-minded to admit technological studies but retained an 'intellectual snobbery' such that these studies were discouraged in practice. (Higher Education Minutes of Evidence Appendix 1B pp. 423-5). This was a view which was advocated persuasively and popularised by Eric Ashby, the Master of Clare College. (Technology and the Academics London: Macmillan 1958). Todd and Zuckerman both propounded the popular view that British academics were infrequent collaborators with industry compared to American academics but as with most popular views they selected their cases and Todd regretted the lack of contact in mechanical engineering in Britain and Zuckerman commended the links in the American electronics industry and universities. When the members of the Robbins Committee expressed concern about the unfilled places in technology departments in northern universities and the failure rates among technology students compared to other disciplines, the representatives of the Joint Advisory Committee on Engineering Education of the Institutions of Civil, Electrical and Mechanical Engineers replied that this arose because "the best people do not go into engineering" and was attributable to the relative prestige of technology and pure science. (Higher Education Minutes of Evidence 1D pp. 1229-30).
The Committee advocated the creation of some new Special Institutions for Scientific and Technological Education and Research (S.I.S.T.E.R.'s) in an effort to develop institutions of comparable prestige to the great American Institutes of Technology in Massachusetts and California.(33) These new institutions were to have 3,500-4,500 students, half of whom were to be post-graduates. Another measure to raise the prestige of technological studies was contained in the proposal to raise the C.A.T.'s (designated in 1956) to university status with rights to confer first and higher degrees and receive finance from the U.G.C. rather than the local authorities.(34) The regional colleges of technology were to have wider advanced courses and both regional and area colleges were proposed for eligibility to offer courses leading to the award of a degree supervised by a new body under the Royal Charter, the Council for National Academic Awards (the C.N.A.A.). In view of these efforts to promote expansion and the status of technological studies it was felt possible to omit technology from the proposed new universities. Although this decision was initially accepted, it was reversed in 1965 as fears about the supply of technological manpower gathered momentum.

(33) Higher Education op. cit. p. 128. This was a proposal not implemented by the Government. In review of the report Lord Robbins believed that comparable developments were occurring despite the avoidance of a special designation on 'political grounds'. See Lord Robbins (in conversation with Boris Ford) 'Report on Robbins' Universitas Quarterly Vol. 20 No. 1 December 1965.

(34) Lord Robbins had some reservations about the way in which some C.A.T.'s had taken their elevation with changes of name and suspected a preoccupation with aping the traditional universities. "Report on Robbins" ibid p.5.
Despite the impetus given to expansion in student numbers and the efforts to favour the development of technological studies at undergraduate and postgraduate levels, some misgivings were expressed about the Robbins Report by some commentators. These commentators were dismayed by the relatively slight attention and discussion given to value judgements in the report and the concentration on student numbers and matters of administration. (35) Calls for a revaluation of the rationales underlying educational provisions tended to come from those who believed that the existing rationales were inappropriate in their assumptions of a limited pool of ability and concentration on scholarship to the neglect of applied studies, a neglect most evident to these critics in the attitudes to technology. A powerful plea for reconsideration was made by the principal of one of the C.A.T.'s to a conference organised by the Vice Chancellors and Principals of the British and Commonwealth Universities in the year before the appearance of the Robbins Report.

"A characteristic feature of our educational dilemma is the fact that in the future virtually the whole of our intellectual reserves in the advanced countries will be drawn first of all into the institutions of higher education and, after due processing, passed over to the services of industry and other economic activities. Whereas previously our higher educational institutions could afford not to worry too much about the nature of the gulf that might separate their culture from practice, since they were after all, only with a small fraction of the total intellectual reserves, in the future they will have virtually the whole responsibility as relatively few intelligent young people will escape the net of higher education. For this reason I believe it is of value to examine the unwritten postulate of most of our western higher

education institutions that they are concerned with producing the critical man, the uncommitted man, the objective and impartial man, the man who above all preserves the traditions and standards of culture, the search for truth, unfettered freedom of inquiry, from the eroding effects of the blind drive onward of material and mechanical development with its human consequence." (36)

Against this call for revaluation and change could be contrasted the re-affirmation of the case for the status quo asserted by an Oxford sociologist shortly after the publication of the Robbins Report,

"My concern is with the university in this role as an agency of intellectual and cultural transmission and dissemination. I leave aside its functions as a research institution. My premise is that as an education agency the university is an organisation with certain distinctive value commitments, its primary responsibility being to produce the educated man in the wide sense of the word...

"Institutional values have suffered dilution in the growth within universities of new types of discipline, particularly of applied disciplines, from business management to fuel technology. That these subjects should be taught somewhere is not in dispute; the only point at issue is that their introduction into universities has had consequences for these institutions themselves, altering them in unintended, unforeseen - and in terms of their commitments to their primary values - undesirable ways." (37)

In their very slight treatment of the 'aims of education', the Robbins Committee merely listed four possible aims of education, which included the satisfaction of manpower and vocational needs and the production of cultivated men and women mentioned in the last two quotes and added the research


and scholarly functions of universities and their contribution to the transmission of a common culture. (38) The Committee did not proceed to discuss any assignment of priority between aims nor whether they were fostered to a different degree in different institutions and thereby institutions might be given any priority in plans. It could be argued that the concentration on administration was an implicit expression of a belief that the past rationales for educational provision and the past order of priorities would hold good for the future. The Robbins Committee certainly believed that the universities were at the peak of a pyramid of prestige among educational institutions and that the pattern of progress for development in these non-university institutions was for the improvement of standards leading to their elevation to university status. (39) Yet if the calls for expansion of the university development programmes pre-dated the Robbins Report it must be recognised that many of these taken-for-granted assumptions about the aims of educational provision were shared by bodies which pre-dated the Robbins Committee. The Robbins Committee was not alone in its preservation of continuity in the development of higher education through implicit value judgements. Some studies have argued persuasively that the U.G.C. which had called for new universities in 1959 and was responsible for the overall supervision of their planning committees was strongly

(38) Higher Education op. cit. chapter 2.
(39) ibid. ch. 11.
influenced by a conception of 'the university' derived from Oxford and Cambridge. (40) In one interesting respect the U.G.C. overruled the Robbins Report recommendation that new universities should be based on industrial urban centres and preferred the rural outskirts of ancient towns or cities. In this way the U.G.C. at least made provision for continuity in the trends in university developments after the foundation of the large civic universities.

Against the emphasis on continuity some critics felt that little improvement was likely in the status of the engineer and engineering studies for they identified relationships between educational structures and occupational identities.

(40) Jobling and Cross followed the ideas of A. H. Halsey, expressed in the early 1960's, that the 'English ideas of a university' implied that for a new English university to succeed it would have to be a successful imitation of 'Ox-bridge' and examined the extent to which the seven new universities created in the 1960's revealed features similar to those spelt out by Halsey. These features were non-specialised largely non-vocational study, a collegiate structure, a highly selective entry, and institutions national in recruitment and orientation. Although the researchers did not find the new institutions identical to the Halsey hypothesis they did find a number of similar features and related these features to the U.G.C. (M. Cross and R. G. Jobling, "The New English Universities - a preliminary enquiry" Universities Quarterly Vol 23 No. 2 Spring 1969 and R. G. Jobling "Some sociological aspects of university development in England" Sociological Review vol 17 No. 1 1969). Niblett has traced the influence of Oxford (viz Balliol College) on the new University of Sussex by way of Keele University founded in 1949. (Expansion and Traditional Values" op. cit.) For an alternative emphasis on the extent of innovation in the new universities and the suggestion that the U.G.C. was disappointed that there were not greater and more adventuresome innovations away from traditional university institutions see the study by H. Perkin (New Universities in the United Kingdom Paris: O.E.C.D. 1969).
For example A. H. Halsey drew attention to the structure of relations between universities and other institutions of higher education and believed that particular kinds of educational devices produce particular kinds of persons and stated that 'given this structure, we slough off our dilemma on to the new institutions. The requirements of an industrial society need us to break away from traditional education.' (41) Efforts to break with tradition came after the 1964 General Election with the decision of the Labour Government to give additional support to the non-university institutions in the system of higher education. Curiously, however, discussions about educational devices did not lead the manpower forecasters to comment on the relations between universities and other institutions nor to comment on the relative sensitivity of institutions to public need and central. The manpower forecasters continued their preoccupation with numbers and university graduates.

APPENDIX TWO

THE PILOT STUDY: RECRUITMENT AND ADJUSTMENT
IN SCOTTISH ELECTRONICS COMPANIES

1. Introduction.

My starting point for the pilot study was an attempt to assess the extent to which industrial employers and graduates experienced difficulties in the utilisation of newly recruited graduate scientists and engineers and an investigation of the relevance to any 'mis-match' of those studies which referred to models of the professions. While the Kornhauser thesis appeared of little relevance to the British situation (and of doubtful assistance even in America), Box and Cotgrove presented some evidence to support a modified and limited version of the 'value clash' thesis: some students were identified as 'public scientists' who sought a high degree of autonomy and opportunities to publish the results of their work and these were assumed to be aspirations derived from acquaintance with the conceptions of scientific activity fostered in universities. Some writers (including Cotgrove) have suggested that the distinctions between scientists and engineers were those of degree rather than kind and it was possible to conceive of an engineer who emphasised technically elegant and sophisticated solutions and eschewed cost considerations, and sought autonomy and opportunities to communicate about his work beyond the boundaries of his employing organisation.

Box and Cotgrove suggested that the employment of these academically oriented scientists or technologists in industry would be an 'accident' since industrial managers would try to
eliminate them and the students would seek employment settings compatible with their conception of science or technology. This argument left open questions about the amount or kind of knowledge possessed by both parties in the labour market, since Box and Cotgrove emphasised beliefs and self-conceptions which they agreed could be ill-informed. Of interest in the study then, was the way in which knowledge of industrial demands and recruit activities was acquired and the kind of transformations which occurred during the learning experiences of entry to employment. A particular focus was on the extent to which the employers saw graduates as a distinctive class of employees, with distinctive patterns of utilisation, and the extent to which graduates held conceptions of themselves as a distinctive class of employees and found opportunities to maintain these conceptions.

In the following section a brief account is given of the electronics industry in Scotland. This account underlines the point made in the preceding chapters, that the electronics industry has been a very distinctive industry, greatly associated with progressive developments and phenomenal growth rate. The section on the company experiences of the labour market examines the extent to which managers saw graduates as a distinctive group by an examination of their recruitment and induction procedures. In many respects the experiences reflected the recent origins of their establishments and efforts to recruit graduates. The section on the graduates reports on their prior acquisition of information about employment settings by an examination of the factors involved in their entry to an occupation.
and an employment sector. While few of the graduates could be identified in the terms of the Box and Cotgrove thesis, as committed to the sources of academic science or technology, they did experience conflicts with their employers and these conflicts could be understood by reference to their university experiences and conceptions of themselves as highly-qualified people who should have intrinsically interesting work and considerable autonomy. The evidence of their conflict with industrial employers over induction and early assignments lent support to the original suspicions that these were significant problems in the utilisation of highly-qualified manpower and that these problems merited prior consideration to those problems of 'shortage'.

2. The Electronics Industry in Scotland.

In many senses the existence of this local science-based industry in Scotland was a strong stimulus to the form of subsequent enquiry for there were in Scotland echoes of all those beliefs about the promises of science-based industry in the post-war period mentioned in chapter one. Indeed the growth of the industry, from a factory of about three hundred employees on the wartime production of aircraft gunsights to an industry with 7,500 employees in 1959 and 30,000 employees in 1968, owed much to those who believed that this industry would be a significant factor in the regeneration of the Scottish economy from its heavy dependence on mining and heavy industry. (1)

In the mid-1950's various government departments, the Scottish based branch of Ferranti and the independent body of the Scottish Council (Development and Industry) attempted to graft electronics research and production knowledge on to a number of other companies in the engineering industry. (2) The relatively slow progress of those efforts prompted the Scottish Council to recruit companies for Scotland in England and the U.S.A. Certainly the Scottish Council could claim a large measure of success when the industry could boast an estimated eighty companies in Scotland by 1969. (3) However some misgivings were voiced in that few of these firms undertook research and development in

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(1) Glenrothes, a town built around a new coal mine, was advertised as the 'Capital of the British Electronics Industry' in the 1960's after the coal failed and the town attracted U.S. electronics subsidiaries.

(2) Account of these efforts is given in chapter 2 of what has become a classic among innovations studies. T. Burns and G. M. Stalker The Management of Innovation London: Social Science Paperbacks 1968.

(3) Sebastian de Ferranti 'How 30,000 Jobs Were Created' The Times Friday 23rd May 1969.
their Scottish establishments and they appeared relatively insecure bridgeheads. Another drawback was the lack of a scientific infrastructure compared to the English section of the electronics industry. In employment terms other observers have pointed out that the impact on male unemployment was relatively slight in an industry where a high proportion of the manufacturing and assembly labour force was female. One aspect of the employment impact was claimed as a major success, however. This was the employment of graduate scientists and engineers. The pilot study was undertaken against a background of newspaper headlines of success in the increases in job opportunities for science and engineering graduates in the Scottish electronics industry and a sharp decline in the extent of the Scottish 'Brain Drain' to the South of England.

(4) See, for example, the comments by David Kemp The Scotsman 15th February 1967. A more detailed and sophisticated study of the scientific infrastructure was being undertaken at the time of this study in the economics department of Edinburgh University, see Norman Clark "The techno-economic relationship between industry and the scientific infrastructure" unpublished Phd thesis, University of Edinburgh, 1971.

(5) S. de Ferranti op. cit.

(6) See, for example, Joy Larkham 'Fewer Scots go South' The Observer 15th October 1967 and Patricia Rowan 'Scotland's Brain Drain is over - thanks to electronics' Sunday Times 6th October 1968. One important aim in growth was to achieve an industry size such that an array of job opportunities could be provided. The notion of a critical mass to the industry was explained by a member of the Scottish Council, "Ten years ago you could have any job you wanted, provided it was with Ferranti. It wasn't so much the lack of opportunity as the lack of diversity of opportunity that made a man go down to the South East. There if he worked for G.E.C. or S.T.C., or someone like that, if he didn't like the way the work was going or if he was not getting the kind of experience he was impatient for, there were literally dozens of people ready to give him a job. All this was done in an environment like the South East where he did not have to sell up his home or change his children's schools, all that he did was to drive his car in a different direction. Whereas if he didn't like it with Ferranti then either he had to stay or go literally 400 miles. So he might as well go immediately after graduation. I'm not knocking Ferranti - they are good - but it was a product of uniqueness that was unavoidable." Some similar remarks about the importance of a threshold or critical size for an industry to attract and retain professional manpower have been expressed in an American study, see Albert Shapero.
appeared the inverse of the English problem, (that is in the sense that English problem was posed as one of finding graduates for jobs whereas the Scottish problem was that of finding jobs for graduates), the nature of employment offered and the reaction of graduates to it remained the essence of the problem in both settings.
3. **Company recruitment and employment.**

The questions to technical managerial and personnel staffs sought an assessment of the extent to which the companies attempted to meet those elements of the work setting most frequently claimed for professionals in their employment of newly-recruited graduates. Questions were directed to investigate the kinds of skills sought and the sources from which they were recruited (expertise), the kinds of time horizon over which the recruits' service were sought (careers and commitments), and the kinds of task assigned in the early employment period and nature of supervision, (the extent of autonomy). The questions about skills were directed to explore the rationales for graduate recruitment, the kinds of areas in which graduates were regarded as competent as a consequence of their university training, and to explore the nature of discontent in industry about university courses expressed by those managers concerned with recruitment and early assignments. Since some of the criticisms of graduates raised in manpower debates alleged an unwillingness to move beyond fields related closely to university study the questions about access assessed the extent to which companies sought to secure the commitment of the graduate over the long term and the functions in which these commitments were sought. Questions about recruitment procedures were directed to examine the manner by which companies contacted graduates and the extent to which the flow of personnel was linked to the flow of ideas and contacts between technical departments. Finally the questions about induction and assignments were related to the early discussion of skills recruited, for these questions explored the kinds of support given
to graduates making the transition from university to industry. It was the weakness of company induction procedures which lent support to my original view that there were significant utilisation problems.

(i) The recruitment of skills.

Some mention of the kind of skills sought has been anticipated already in the brief comments on company activities. Most of the companies undertook research and development activities with the emphasis on development rather than research, and in graduate recruitment greatest emphasis was laid on recruitment to those departments. Company A sought graduates for all functional areas from research and development through production to sales and annually sought approximately twenty graduates. The two computer companies B and C, sought graduates for a similar range of functions, the annual intake was about ten graduates to the development labs. Both these companies recruited graduates for software departments although these were not a part of the enquiry. The telecommunications company D sought graduates for development, production and marketing functions but had no regular fixed recruitment target because of its recent origins, and had recruited five graduates in 1967 and sought ten for 1968. Similarly the newly-established semiconductor company had recruited only three graduates in 1967 but planned an increased intake of fifteen graduates for 1968 to the research and development, production and applications lab. The two electronic instrument companies, F and G, stood in marked contrast to the other companies in that they sought graduates for their R & D department only. These two companies did not
have distinct production engineering or test engineering departments so that the development engineers were responsible for a new instrument from design through to the initial testing of production models. Although in the large companies graduates were a source of staff for work in a variety of functional areas, several technical and personnel managers commented on the difficulties of finding graduates for production departments.

For example, some commented that they preferred a recruit with industrial experience or an H.N.C. qualification, the full-time graduate was thought disadvantaged by lack of immediately useful skills, inflated ambitions, and pre-occupation with R.&D. One policy mentioned was to prefer 'honours' course students for R & D and 'ordinary' course graduates for production, this was in the belief that the courses imparted different intellectual qualities and ambitions. (7)

Preferences for either experienced or inexperienced recruits were important ingredients of recruitment policy. Companies moving into Scotland established their plants with key staff and workers from other establishments and could redirect new recruits from recruitment campaigns for other establishments. But the further growth of the establishment came from recruitment conducted on its own behalf. The two instrument companies claimed a distinctive company approach to their technology and held that the 'experiences' of 'experienced engineers' could prove handicaps in learning the company approach. Yet a preference for malleable recruits had to be balanced against overstocking with inexperience and stretching

ad hoc training resources. Indeed few of the companies had
formal induction and training schemes.

The instrument companies claimed that the annual intake
of four graduates did not stretch training resources and that the
small establishment could facilitate a fairly rapid transition
from 'inexperience' to 'experience' and a worthwhile contribution
to the R & D effort.

"A good man can be contributing within three to six
months, a mediocre one may take over a year. If he's
that bad then possibly we ought not to have employed
him. You could get a vocation student who could become
an expert on a particular aspect of a project, but it
would take a couple of years before a man's sufficiently
rounded in enough techniques to be what we would call
experienced."

"We tend to find that people coming in are very
nervous and apprehensive about what they will be expected
to do. They think that it will be a case of walking in
and after six months they will be asked to do something
responsible, whereas in fact they will have been in only
an hour and we give them something responsible. Of course
academic training does not fit them for the work here
it is only a foundation to build on, and we believe
they should start building very quickly. After about
six months he reaches a steady state of learning and then
he begins to learn at the same rate as everyone else in
the business."

Perhaps reflecting the somewhat greater complexity of organisational
structure in the larger establishments, even in their research
and development departments and the relationship of these
departments to other departments, the time horizon over which
the newcomer was expected to acquire experience and develop
their contributions to the company was somewhat longer.

"Initially I don't expect anything from the man. I
don't really expect anything for a year. If after a year
there is nothing coming out, there is something wrong
somewhere. For the first couple of months I put him on a
training number, an overhead. He's really finding out who's
who, where's what. I hope he's got a job to do. I don't
mind if he drops it and goes finding out where things and
people are. He might as well do it deliberately as in
haphazard fashion. But after a couple of months I expect
him to start settling down to the specific activity. One of the basic problems of running a design department is finding people with the basic ability of taking a small amount of direction and producing a result. This is what I mean by 'chiefs' - in contrast to 'indians' - whatever their title. And some of them show this after six to twelve months."

In contrast to these comments from the technical managers from research and development departments, those responsible for recruitment and supervision in the production departments emphasised at best a willingness to take only a few newly-graduated recruits and more frequently a preference for either experienced graduates or non-graduates. For example, the supervisor of an evaluation engineering department expected only one new graduate in a team of nine because the work of evaluating designs demanded a close monitoring of the new graduate's social skills in his relations with designers. 'Learning the ropes' in production departments was generally envisaged over a longer time period and the two year graduate apprenticeship was traditional for those departments.

So far the comments of managers have emphasised the acquisition of experience as a process of gradually broadening the scope of the task and the kinds of responsibility, yet other comments by those same managers suggested a different conception of the
process in which there was a disjuncture in the learning of skills. Despite the realisation that specific knowledge and skills could narrow the range of potential employment some managers criticised the low priority given to practical knowledge and skills in university courses, for example, one managing director claimed that this was a specialisation of an undesirable kind - 'his course should include a term or two of economics; we want them to be able to read a profit and loss account and realise that profit is the only thing that makes industry tick.' In this there was a suggestion that learning the skills of economist (or accountant) implied not the addition of a new skill but a change in the conception of industry and its rationale. Another comment on the disjuncture in the experiences of the graduate between university and industry emphasised the different aims of teachers and practitioners.

X 'One can always pick holes in a syllabus and you can't please everyone. But I think there is one criticism that I would raise and that is that universities are not staffed by practising engineers. Who would ever think of studying medicine under anyone who had never cut anyone up? But this is how engineers are largely taught - by people who have never practised engineering.'

McC 'You mean by people who have always been in a university environment?'

X 'Oh no, that doesn't stop them being practising engineers; they certainly don't have the commercial instinct in them, but many of them are entirely theoretical. That is bad because what this country needs is engineers who can be of service to the community, not people who can just write Ph.D. or D.Sc. theses. They tend to be paper design engineers rather than real life nuts and bolts engineers. And the lack of commercial experience is a serious drawback in producing engineers; it is not a lack of formal education so much as the approach to the problem.'

This theme is quite familiar in the literature on the professions,
and the engineering journals emerge with examples of the tensions between teachers and practitioners in the jokes against the academics. Examples of these jokes are the story told of the M.I.T. student who, when asked how to reverse a three phase motor gave the abstract and analytical reply that the matrix should be inverted rather than the obvious suggestion to switch wires over, and another story told the professor of fuel technology who died of exposure in a blizzard because he had forgotten the art of rubbing sticks together. Yet these stories and comments quoted are rather curious in the context of the electronics industry, for in this industry, which grew out of the influx of university physicists into Government and industrial labs to cope with practical problems, the use of the imagery 'we', 'the men of practice', and 'them', 'the men of science of theory', seems odd. The two managers quoted both held Phds and university visiting lectureships and these comments might reflect the limited mobility between employment sectors which has distinguished Britain from some countries and the incentive to those who make the move to signify the social distance between sectors.(8)

For the most part these companies sought readily employable knowledge and skills, the honours degree graduate was expected to have the analytical skills to analyse novel situations and problems appropriate to development departments and the ordinary degree, who was not expected to have these qualities to the same extent, was expected to have a more practical outlook and

(8) See, for example, the comments on mobility in the Swann Report, The Flow into Employment of Graduate Scientists, Engineers and Technologists, Cmd 3760 ch. x.
readiness to work in more routine departments. The desire for readily usable skills seems evident from the time scales over which they were expected to contribute, the points at which criticism was made of university courses and the comments on the time of expected employment reported in the next section.

(ii) Expected lengths of employment for new recruits.

There was little claim from most of these companies to offer a long term career in either technical activities or managerial posts to newly recruited graduates. A general expectation of length of stay was from two to five years, to be spent largely on technical activities. Of course companies did not suggest that the newcomer ought to leave after that period of time but tended to emphasise to potential recruits the benefits of their company as a starting point in an engineering career, for example, the small establishments claimed that they could offer experience of the whole range of engineering activities from research to sales while the larger establishments claimed that the scale of their activities offered a wide range of activities within development or production. In only company A was there a claim that recruitment was for both short term and long term requirements, for example in the comments of a personnel manager.

"We are recruiting a commodity which is fairly standard, generally without industrial experience, and the differences are largely those of personality and ability. It is difficult to judge these before they have worked for you, so there is a tendency to pay a standard initial salary. This year we are quoting for good honours graduates £1100-£1275 as a starting salary and that indicates the variation between the man who is just marginal and the man we are keen to get. In taking new graduates, we are not recruiting for specific jobs but recruiting the sort of person who will fit in and be useful in the future."
Even here, however, it was recognised that practice could diverge from the ideal for the divisional structure of the company and no poaching agreements between divisions could place barriers to a career within the company accompanied by moves between divisions. In the other larger establishments it was widely felt that graduates did not seek careers on their first job, although, as parts of the large English and American companies, moves and promotions to other establishments or within the Scottish establishments on the scale of operations increased could be held out as possibilities to a potential recruit.

(iii) Company recruitment procedures and experiences of recruitment.

Given the origins of the industry, the large research and development programme and the likely opportunities for contacts between the industry's R & D labs and university physics or engineering departments for sponsored research, I expected that there might be some links between these technical contacts and the contacts between companies and universities for the recruitment of personnel. However these technical contacts did not appear particularly relevant at the undergraduate stage except that technical staff had some idea of the bias of a department's research and teaching strength when they interviewed undergraduates. The other expectation was that recruiters would echo some of the difficulties in the recruitment of adequate numbers and adequate quality of graduates mentioned in the interim Swann Report and other commentaries on the manpower debate. This expectation was not met either, although it seemed possible that the stage of development of the electronics industry in Scotland may have had some bearing on this point.
All of the companies recruited graduates in an annual campaign through the university appointments boards in the spring. The two instrument companies were somewhat reluctant to enter this 'milk round'. For their numbers the outlay seemed too great and they attempted to secure their numbers through personal contacts with universities especially through engineering departments directly or by encouraging vocation students to re-apply. Unlike the larger establishments, these two companies were not 'household names' and these personal contacts would help to emphasise something distinctive about relatively little known companies. The larger establishments recruited (or were starting to recruit) in conjunction with their other establishments in other parts of the British Isles. The recruiting teams composed of personnel and technical staffs were expected to represent the company (rather than just establishment) and observe no-poaching agreements. Recognition of establishment interests allowed establishment representatives to cover the universities in their vicinity. Thus another aspect of policy was to seek out a graduate conscious of a Scottish identity and wishing to remain in Scotland.

From the initial contact established at the university by the personnel staff an acceptable and interested candidate was directed to a second interview with technical staff at the company. The criteria of acceptability and differences between some of the personnel and technical staff were matters of rich anecdote. Personnel staffs pointed to the limitations of the university twenty minute interview in picking reliable indicators. The technical staff claimed that they looked for the 'cream' and elaborated on this by other phrases such as
'the self-starters' or 'the chiefs rather than the indians'.
In so doing many were at pains to point out to a 'researcher'
their limitations as untrained interviewers, but their many
and lengthy excursions into their home-spun techniques suggested
that the interviewing aspect of recruitment was regarded as an
interesting and enjoyable challenge. Attempts to cut through
the interview patter and reach the 'real man' ranged from the
fearsome challenge in the question 'What do you want to do
when you grow up' to observations of candidates at lunch or
on the tour round the lab. The tour was used as a major part
of the assessment exercise by a technical manager who felt
that concealment was all too readily practised at interviews.

'The degree must be an important part of an initial
judgement, but I don't just take it on trust. I do attempt
to assess the man and I place more weight on this.
Obviously he's got to have been exposed to the right sort
of information. He's got to have the tools. There are
two things - the tools and the ability to use them.
Now I can't double for his final exam in a half-hour
interview, what is fundamental is his attitude. Does
he do it because his father thought it would be a good
ting to do? Why did he get into it? If he doesn't do
it because it's fun, life will be such hell that he
won't stand the strain of anything ...'

'The tour is the main thing. In the interview the
man is clever to know he's got to play a part. When you
walk round you can see his attitude showing - if it really
is exciting he can't contain it, if he isn't excited
similarly he can't synthesise it. I am looking for that,
the unquenchable desire to get cracking and get it done!'

Clearly in these comments attention was being drawn to what might
be called personality variables and to a consideration as to
whether the graduate would 'fit in'. Although these were
technical interviews and did raise questions about project work
and undergraduate courses as indicators of skill levels the
interviewers appeared more interested in the attitudes towards
the exercise of skills and rest content with the degree as the main indicator of an acceptable skill level. (9) They were interested to know at age and by what means the candidate had become interested in engineering as an occupation, whether his studies were supplemented by engineering hobby interests or reading. (10) It is a matter for some conjecture as to whether the physicist is disadvantaged in interviews and judged a poorer candidate on the basis of answers to those questions - for example, by a later decision to enter the occupation and lack of hobby interests. (11) The technical interviewers themselves regarded their criteria as at best highly subjective.

(9) The company supplemented interviews with an intelligence test for all candidates and aptitude tests were standard for prospective recruits to the software departments of the computer companies.

(10) In some of the companies the recruiter had a standardised tick list of items against which to grade the candidate, for example, in company B, items included 'creativity', 'drive', 'ambition', and so on. Some recruiters were somewhat disparaging about 'Americanisms' and suspicious of the forms as attempts to invest subjective judgements with an air of objectivity.

(11) In one company the personnel manager expressed a company reluctance to employ physicists whereas the technical manager expressed a contrary view. In another company a technical manager examined an interview form which had been completed during his holiday absence. The physics graduate had been given a poor assessment to the managers' surprise, and on this graduate's re-application after two years' experience in another company the technical manager was very interested.
The way I look at it is, partly from looking at people from before and seeing how they go on, but also by trying to recognise others such as myself. It is not so long since I joined, about six years ago, and I am looking to see what qualities they have and those that I had or thought I had ... Let me summarise the sort of qualities we are looking for. One is obviously high academic ability. Another is the awareness of the difference between what they have done in university and what they are going to do in industry. We look to see what they have done about their career. Usually we find that such people have already taken on some vacation training in other firms or organisations. They have taken some effort to learn something about it. Another is that we like them to be interested in the more practical side of things since they are now engineers and not scientists. In other words, they read journals concerned with the technical side of things. It may only be magazines like 'Practical Wireless' or 'Wireless World' but it shows that they are interested in the practice of application rather than just the theory of it. What we want in here is to make something, not just to have a discussion about it.'

Again the comments of another technical manager recognised the elements of subjectivity but added the caution that the interpretation could be misleading. Indeed the criteria employed appeared suspiciously close to a vote of confidence in the existing order.

'You are nearly always interviewing a man who has an established intelligence level, which is really all his degree demonstrates because it is very rare that any of his degree courses relate directly to what we want him to do. Even his electronics course is out of touch with current developments ... I look for a very general technical interest. In part this is recollecting my own background. I don't think you can avoid this when you are interviewing somebody, and you say 'has he the same interests that I had at the same age?' Of course, this may be unfair because there are lots of ways of getting interested. From the people I've taken on - and you always live with your mistakes - it doesn't seem too bad. A real interest in what makes things go. If he runs a car I want him to be interested in how it goes together; I don't want him to be a man who get in and it goes. Failing that and it is very easy to plead that you have no time if you are going to put your mind to your studies - I would look for an interest in popular science magazines, such as 'Scientific American', 'New Scientist', and so on.'
Since degree results of summer finals were not available for spring interviews, interviewers gave conditional firm offers on the basis of the estimated 'level of intelligence', sometimes the estimates were provided by candidates themselves and sometimes by the university referees (often the appointments boards).

The whole of this procedure for contacting graduates through the university appointments board was the main method for contacting potential recruits whatever misgivings might be expressed about the lack of information and high degree of subjectivity in judgements. The technical links via joint research seemed of potential benefit to the pre-recruitment of postgraduate recruits although only three establishments expressed interest in recruitment at this level. There were other ways of contacting undergraduates, one was through vacation employment and the other was through undergraduate projects. Most of the establishments took vacation students and some managers suggested that they were attempting to provide employment experiences which would favourably dispose the student to seek employment after graduation. Three of the establishments provided facilities for undergraduates projected in the department of engineering science at Edinburgh university. Although conceived as educational devices to give familiarity with 'real' problems where the industrial lab provided lab facilities and an 'industrial tutor', the establishments were aware that the student was likely to form judgements of the company on his visits. These projects were only beginning in 1967 and were at an elementary stage. Other more formal links with universities existed in two establishments through the procession of the industrial period for sandwich
course students and the participation of two companies in the Scottish Electrical Training Scheme which provided opportunities in vacation training and graduate apprenticeships.

Having set out the policies of companies with regard to required skills, the time scale over which these skills were sought and the criteria by which applicants were assessed, it remains to record company experiences of recruitment in the light of the naturally reported shortages of the early 1960's. In company A it was claimed that it had been possible to recruit adequate numbers and of adequate quality and to meet labour targets for planned expansion in some departments, partly by increased intake of new graduates and partly by internal transfers from some departments suffering cutbacks particularly in defence electronics. It was noted that some short-run difficulties might be attributable to the emergence of other electronics companies in Scotland but these were discounted as short-run problems for company representatives subscribed to beliefs in the benefits of an increased pool of labour in the long term. The computer establishments, B and C, mentioned no shortage of applicants and attributed this to the 'magic' and 'awe' attached to computers. In establishment B adequate numbers had been recruited but a ratio of two offers to secure one entrant was thought to indicate difficulty, and in C, although 1966 had been a disappointing year the personnel manager pointed to improvements in standards in 1967 and cited the example of an applicant rejected in 1966 who took a computer course but appeared lower on the accept-reject list on re-application in 1967. Establishments D (telecommunications) and E (semiconductors) had undertaken only
one recruitment campaign and were hesitant to make judgements, although personnel staff were a little sceptical of achieving the planned expansion projected by technical staff. The instrument establishments, F and G, had achieved acceptable numbers. Establishment F had been without a personnel manager and the technical staff were heavily interviewing and tended to take a jaundiced view of a 'rat race'. In contrast establishment G had not embarked on university visits but had relied successfully on applicants coming to it.

In a number of aspects the experiences of these company establishments in Scotland offered only a limited scope for comment on the discussion of shortages in the manpower debate. As relative newcomers to graduate recruitment in Scotland, some of the establishments faced the problem of making contact with the labour market, that is, with the universities and establishing a reputation for themselves as recruiters in Scotland. Yet in so far as the requirements of most establishments were for small numbers and the present companies had national reputations they could meet requirements for numbers quite readily. One other factor which marked out the Scottish establishments was that they could make inroads on the Scottish 'Brain Drain' mentioned in the beginning of this chapter. There was the possibility that these companies might have recruited those people who preferred employment in electronics in a Scottish location but in the past might have been 'forced' to take employment in the English electronics industry or the Scottish heavy electrical engineering industry, in other words these companies might have achieved their targets at the expenses
of other branches of the industry or other industries. The comments about the skills and attitudes of graduates mentioned in the section on the kinds of skills sought were similar to those in the manpower debates which criticised the universities as productive of skills and attitudes inimical to the effective utilisation of the new recruit in industry.

(iii) Assignments and supervision for newly-recruited graduates.

The descriptions of the desirable recruit as an 'initiator' or a 'selfstarter' appeared to indicate a readiness to grant the autonomy associated with claims to professional status. On the other hand the comments about a hiatus between industry and university and the need for reorientation and the acquisition of new skills suggested that both close supervision and a restriction on the range of tasks in initial assignments. A priori the absence of formal induction and training schemes suggested that companies believed that the new skills and attitudes could be readily acquired in on-the-job-training, and company literature added the further rationale that informal on-the-job schemes allowed provision for individual attention and a speedier introduction to the 'real' everyday work of the organisation. In their operation, however, it appeared more likely that managers sought 'safe' projects which kept the newcomer away from sensitive projects or sensitive aspects of the company. In some respects this meant that the new recruit faced the possibility of the double disappointment of being promised a direct-appointment with the challenge of 'real work' and then finding that he was funnelled off into non-essential work. In any event his situation was full of ambiguity when he neither carried the label of 'trainee' nor was recognised as a full member of a department.
TABLE 1

DEPARTMENTS FOR WHICH GRADUATES WERE RECRUITED

<table>
<thead>
<tr>
<th>ESTABLISHMENT</th>
<th>LARGE</th>
<th>SMALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>R &amp; D</td>
<td>A   B   D</td>
<td>F   G</td>
</tr>
<tr>
<td>NON R &amp; D</td>
<td>A   B   C</td>
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</tbody>
</table>
Training schemes operated on a limited scale in three of the companies, B and C (computers) and D (telecommunications). In B, the training officer sought two or three recruits from the ten or twelve intake for a two year graduate apprenticeship scheme designed to satisfy the professional institution requirements, and in C, a similarly small number were recruited for a two year management traineeship including circulation through production and other departments. In D a short rotation was planned for all graduates through three departments (development, production and marketing) over a nine month period, although direct entry was the only mode of entry at the time of the study. In all the other companies the bulk of training was given on-the-job. This mode of entry was most strongly favoured for the instrument companies (F and G), the radar and automation establishments of company A, and the technical departments of B (computers) and C (semiconductors).

In discussing the problems likely to confront the new recruit which emerged in the discussions with the managers, some distinctions can be drawn between large and small establishments, and between development and non-development departments, (i.e. production and marketing departments). While these distinctions yield a four-fold table, there is an empty box where the two instrument companies did not recruit graduates for production engineering. In each of the three categories, identified with companies in table 1 there were some distinctive problems in the provision of induction and early assignments.

The lack of specialist production or test engineering departments in the two instrument companies involved the R & D
departments more closely in production and test than in the R & D departments of the larger establishments and so it was likely that the recruit to the instrument company would enter production or test engineering quite early in his industrial experience. In this sense the R & D engineer in the small establishment was less likely to endure the encapsulation of larger establishments and was more likely to have opportunities to have experience of all phases of industrial activity than his counterpart in the large establishment. However in these small establishments there was a problem in that the lab was likely to carry few projects. Much of the activity and personnel of an R & D lab was organised into projects which varied in the civil field from six months to two years. Thus the small establishments of the instrumental companies might carry only two major projects, each with teams of ten engineers, and some small projects such as re-designs or adjustments on customer requests. These two conditions, project length and lab work load, set constraints to the opportunities for introducing graduates by preferred modes of induction. All the technical managers expressed a preference for assigning new recruits to projects in their early stages, as near to the feasibility studies as possible. After these stages there tends to be an agreed conceptualisation of the project in the lab, much of which may not have been documented, and the new entrant seems likely to undergo repeated demonstrations of his ignorance to remind him of his stranger status. The problems of late entry were outlined by the technical manager of one of the instrument
companies.

"We would prefer to bring people in at the very beginning of a project, so that their ideas are woolly at the same time as our ideas are woolly. When you bring someone in halfway through, everyone is familiar with what is going on and it takes him a long time to appreciate what is going on and he could get bored. If one could choose how you are going to recruit, the beginning is ideal. Unfortunately you have got to bring them in when the university says we are producing some. And he goes on to an existing project. It's not an ideal situation. It's particularly distressing for the new graduate because everybody is familiar with things. A lot goes unsaid. We have diagrams on the drawing board and people are staring at them for months and see bits changed here and there. Everyone working on that project knows that diagram off by heart. A lot is never written down and even drawings are rubbed off the board. The new man doesn't know this. It's a problem, and I don't see any way round it because you can't synchronise the activities of industry to the academic year."

The small establishment lab seemed particularly valuable to offering second-best induction experiences when it carried the few major projects in parallel phases.

The larger establishments appeared to have some advantage by their larger work load and variety of project lengths. Again with a preference for an assignment to the early stages of project, a technical manager from one of the large establishments indicated the opportunities for providing projects which covered the period between projects.

"There is little point in bringing a graduate in midway through a project. If he goes in at the beginning of a project then the project is at least as near to the other engineers as it is to him. Of course the others will have the advantage of previous experience, knowing how to set about it, where to obtain information and so on. If the new graduate walks in on the middle of a project, I don't think he would even be able to join in. It's nearly always possible to find a new project. The smaller projects last about six months and the bigger ones about two years, and on the bigger ones there is often a subsidiary project starting up on the way. But if there isn't a project starting up, then we could tidy up some of the small things hanging about, and then he would be ready to join a control project. We might ask him to look
at the prospects for a particular development, say, a new method of reading the holes in paper tape. We might suggest this for reasons. One reason is that it's an interesting job, quite small and sufficient for one man and it doesn't matter if he falls down on it because he will have another go at it later. The other big reason is that his theoretical work is all new and shiny compared to the man who has been in industry for a while."

While the particular example of a design project, mentioned in this computer establishment, might be attracting and appealing to the newcomer and play to his relative strengths in skills, the general ration of 'tidy up' jobs might be more depressing. The search for a project which was 'safe' and which did not put the department at risk carried the implication that the newcomer was not integrated into the department but kept at bay until he had 'proven himself' by satisfactory completion of the safe project. The self-contained project was sought because managers conceived of a disjuncture between the academic exercises in the undergraduate's university experience and the industrial problems encountered by new recruits. Just as the managers quoted earlier spoke of the broader range of considerations in industrial problems - considerations such as the compromise between technical elegance or economic feasibility - another manager spoke of 'close-ended problems' versus 'open-ended problems'.

In this latter contrast attention was drawn to the sense in which many 'set lab' exercises or written engineering problems had a single-valued answer which was known in advance to the tutor whereas industrial problems have an array of solutions which represented different compromises between criteria and where the 'correctness' of a solution involved some estimates of potential customer judgements. Thus to this manager the
management of graduate entrants consisted of the selection of problems which broadened the range of criteria in problems and solutions and this broadening process included acquaintance with production departments and other aspects of the industrial organisation.

"One of our main troubles is that the university tends to educate by providing closed problems; problems where the answer is already known. One of the greatest discontinuities in the man's career in my opinion is the fact that he leaves university and comes into industry where he is not presented with a closed problem but an open ended problem. Nobody, not even his superiors can tell him what the right answer should be. This I imagine would be quite a shock. We are continually suggesting to universities that they should not only rely on the closed problem - I know it's easy for them, they can get a mark out of it. The project is as near an open-ended problem as the university affords and we think we can gauge how he would tackle our open-ended problems by his approach to his undergraduate project ..."

"... (An applicant) may ask for a graduate apprenticeship. I do not recommend it and often refuse to give it. I explain my reasons for this. Because of the pressures of time, and because we do not have a classical organisation chart with clearly defined departments carrying out specified tasks, it is very difficult to introduce a new man in training. Each new man is given a job to do, suited to our interpretation of his abilities and on that we can give him every assistance. Ideally we give him a task involving the drawing office and the manufacturing facilities so that he finds out what the organisation is like. This may be on a narrow front and as he shows evidence of being able to cope the front gets broader deliberately. I referred to one man as a mistake. He will tell you that his original difficulty was that he was not given a sufficiently specific area. He might have some justification, but my own assessment is that the abilities I thought he had, he has not. He is not sufficiently creative. The really creative people don't need a very tight definition of their work - they create an area of work for themselves." 

This approach is similar to that quoted earlier where the management problem is seen as one of adding skills and broadening the scope of the task when the new entrant demonstrates his competence on the initial, relatively safe project. It is possible, however, to conceive the management problem as the
reverse of that stated by the managers. Ultimately the managers sought the 'self starters', 'self initiators', and so on, who were defined here as the 'creative people' who 'create an area of work for themselves' and this definition suggests that the management problem is to encourage the new entrants to set their own boundaries to problems, in other words, to be able to convert an open ended problem into a closed-ended problem such that a solution can be devised. To suggest that these skills should be acquired in an undergraduate education is to suggest that the educational system should provide a fully competent engineer at the end of three years, whereas it might be suggested that these skills can be (or should be) more readily acquired in industry and responsibility for this part of the educational and training process is one that should be borne by industrial management. One lab manager did indicate a desire to match his new entrants to senior engineers in something of a tutee to tutor relationships, but he added that this was a counsel of perfection which was not always possible.

"There are only a few senior engineers with whom I like newcomers to associate. This is because even senior engineers of considerable experience are sometimes slipshod in their thought, and I do not want a good young graduate to acquire slipshod habits. One or two people are razorsharp in this, they are ruthless and logical in their organisation of facts and in producing a logical outcome from these facts. These are the people I like graduates to meet because first impressions will be correct and they will not be encouraged to irrelevant and illogical thought. Of course, I don't always succeed in this."

The kind of constraints which hindered this matching were largely the availability of senior engineers and relevant projects. Ultimately the recruits were assigned to work loads rather than supervisors, and this constraint was rather similar to the one which operated against entry on new projects. In that case it
was suggested that industrial activity could not be geared to the academic year, and here, in the case of supervision, is another example of the priority to departmental work loads which set constraints on induction and training. While it has been suggested that the large establishments had some advantage over the small establishment in that a longer total research and development effort offered scope for a greater variety of projects to which new entrants could be assigned, this advantage was nullified to some extent by the division of the large establishment into several labs with complicated procedures for transfer between departments. These procedures which were designed to counter 'poaching' between departments meant that the new entrant could be assigned only within the scope of a subunit workload which could be comparable to that of the small establishment R & D lab.

In the small establishments of the two instrument companies the case of contact within the lab and across departments was emphasised by the physical design of the establishments where open-planning meant that people and their activities were readily visible. In contrast the larger establishments were organisationally more complex and activities were carried out in numerous distinct departments and physical settings. The existence of different departments and departmental interests was compounded by different categories of organisational membership with different rights and obligations. While some of these different rights and obligations could be recognised immediately in some establishments by marks such as separate dining facilities, there was some incentive to encapsulate the newcomer in his work situation until he could be judged to have understood the
conduct required of a member of his department in relation to other departments or a member of his company in relation to customers. This process of shielding the recruit is described in the quoted comments of a design and development lab manager who regarded the newly-recruited graduate as a compound of politically-naive engineer and organisationally-ignorant graduate.

"There is a sort of wall erected (between design engineers and customers) and the first line of defence is the field service engineer, who is more used to keeping his customer happy and not opening his mouth. The field service man and a salesman will be on a new job, often with a technical salesman if there are any critical aspects. It's really quite divorced, the sales side and the technical side run quite separately, and they send their orders to the factory and the factory deliver whatever equipment is in the product line. The product line is the list of things you are willing to sell, the salesman knows how these products go together to make particular units, and the technical salesman knows the limitations and best configurations for a particular problem, and they do all this on their own. Our involvement is with the specialist side when someone wants to attach his machine to one of our units and the specialist salesman sends a contact to us ..."

"... Our experience in the past has been that whenever the customer gets the chance to get hold of an engineer he pump him very thoroughly and you get in the most awful fuss. Engineers generally aren't the most political animals, they make factual engineering-type statements which can trigger off the customer into all sorts of demands ..."

"... By the time (a graduate) will have been introduced to that sort of thing in his own department he's learned to cope within his own department he'll go off and make some terrible boobs, such as going off and getting involved in some production problem or something he shouldn't touch because he's not aware he can get the department involved, he might go and see a lathe in the model shop and then we have union trouble. Great weights fall on him if he puts a foot wrong and after a couple of years he knows a little bit more of the way people work together in an industrial environment. You know that you don't write a letter to the head of another department claiming that his department is a complete shambles, he learns to go through a pecking order."
While this example was taken from a computer establishment where other commercial organisations were frequently customers, a similar process of encapsulation was evident in the radar establishment where the new entrant did not enter into contact with the Ministry representatives, the main customers and design authority.

Outside R & D departments, in the production and marketing departments of the large establishments, the premium put on social skills was even greater than that demanded in the labs. In production and marketing the functions for which graduates were recruited involved considerable liaison across organisational boundaries, for example, the evaluation engineer was responsible for vetting the work of design and development engineers before designs went to production in order to check on the ease of producing the designed item, and the applications engineer working in a marketing department was responsible for customer advice and liaison with R & D departments. The emphasis on technical analytical skills and logical, orderly thought in university courses to the relative exclusion of a knowledge of industrial organisation or social skills was thought an initial handicap for the graduate by a production manager in his comments on the difficulties in managing the entry of graduate recruits.

"The sort of difficulty I have had in the past is the inability to judge time scales, the inability to realise that he has to fit into a psychological atmosphere, the difficulty of taking to people on the shop floor. This was when I was in production engineering where I was dealing with the factory floor. Quite often a chap grumbles about an instrument, all that he is really saying is that he is in some sort of trouble. He comes up with a lot of garbled facts, to the scientific mind they are garbled. And to someone from an academic background he is talking tripe. A lot of degree people have no time for these people - they take them apart intellectually. And this bloke goes away upset because no one
listened and the degree person goes away thinking that someone has wasted his time ... 

"I usually explain to (the graduate) as I have to you. I say this bloke is in some sort of trouble, he's probably right but his method of expressing it needs understanding. Then you go and have a discussion with the foreman and you can draw him out - that requires skill, I had to learn it. Then you go to the person concerned and this foreman produces those symptoms. You have to find the cause. His job is producing instruments not engineering them."

Given these experiences, the charges against graduates of snobbery, inflated ambition and unsuitability in practical matters were understandable, as were the company policies to seek only experienced graduates or H.N.C. qualified engineers for production departments. In marketing departments too, it was pointed out that graduates were frequently required to advise quite senior managers from other companies who were often non-graduates and would resent any attempt to 'blind them with science'. In these non-R & D departments there was considerable emphasis on 'company loyalty' as an important quality which graduates were expected to find difficult to sustain initially. One production manager drew on a specific example to illustrate his points that a new recruit should show his willingness to contribute to overall company or departmental objectives irrespective of the degree of the level of job interest intrinsic to his task, and the university graduate was expected to find difficulty in this because he had been encouraged to look for intrinsically interesting tasks in his university courses and self-interest had been the main motivator in his courses.

"It all depends on where a graduate comes from, whether he's been full-time or part-time. The part-timer has probably done things in industry before, and so is a more complete thing in that he has had experience. When we get graduates the first thing we have got to touch them is that they are here to work for the company rather than
for themselves. They have had several years working form themselves, their education is for their benefit.

"It is advantageous to us to continue their education and we do. One lad has just come back from a course at (a) university. I know for a fact that he doesn't like production, he feels that research and development is more his life. Eventually we will move him there. I suppose fortune put him in my outfit rather than in research; I suppose he will think it hard luck. My comment to him has been that it is no bad thing to start at the rough end and do some work and find out what it is all about, before one goes across to research and development, and does a lot of very good work but possibly creates a lot of problems for production. I think it is no bad idea for a man to do a stint in production before going into his ivory tower. That is a pure production man's view which won't be shared by everyone you meet. People ought to do projects and to complete projects, because if they continue on this course they will always be running away. Dealing with paper situations and design is very nice and a pleasant way of spending one's life. But it is much harder to sit still and watch your design becoming a reality, because this is when things start to go wrong. I have been through this myself. One becomes very tense and looks for new pastures. You sit down and analyse the situation, find you are scared stiff, but you get over this. It is all part of one's education. I suppose that there are some people that you interview who are so airy fairy that they must obviously go straight into research and development. But I think that generally the man coming out of university is coming out of a sheltered environment and rather likes the idea of getting into research and doing great things. You persuade them to go into production and think they will like it. There is a great sense of urgency in production."

Again in these comments, the full-time university graduate was regarded as less likely to become the loyal company man compared to the part-time educated H.N.C. recruit. The way in which the graduate was shown that he was required to be loyal by showing self-denying acts such as the willingness to forge educational courses or undertake menial tasks can be illustrated by quoting the counter-comments of the graduate in the production manager's example.

"I feel I'm not settled in what I want to do. I've been here eight or nine months now. I have asked to be transferred to the research and development department."
My first application was successful, but after agreeing to it their decision was reversed ... I find what they want are engineering technicians rather than engineering scientists, which is what I want to be. My job comes down to sitting and waiting for snags, it's a job for someone with an H.N.C. It's just a question of fulfilment and I don't feel fully utilized and there isn't even a training scheme. I found that the person who interviewed me left the day before I joined and then I worked with someone else who has since left. Since November I haven't been learning very much; to someone just coming in, there is a great deal of technology to learn, to get to feel. I partly blame myself in that I didn't know what I was coming to. When you first come everything is so new. All these areas have esoteric names, now I realise they are just routine areas in industry. When you first come into a place you don't know what is routine and what is new.

When that man left it coincided with an advert in a Sunday paper for jobs in the research and development lab., and I asked about it. I was more interested in that kind of work. They just said no, that made things worse and gave me a grievance. The other department agreed to interview me if this department agreed, because they say protocol wouldn't allow them to take someone from another department.

Then I was almost sickened by the change of mind. Probably it was made worse by the fact that at school and university you always decide yourself if you want to do anything and no one stopped you. This was the first time anyone said you're not doing that ...

I blame myself for not knowing and being in the predicament I am in. But the attitude of the people here to further education is not what I hoped it would be. I've been told or warned off about reading. They seem to prefer you to talk among yourselves, talk about anything rather than sit at your desk and read a journal."

KMcC "Is this leg-pulling?"

"No, it's not leg-pulling. I blame the middle management structure. To take an example there is a course at a university. I first read about it through 'Electronics Weekly' and sent off for details, it looked very interesting. I approached my section head and he almost threw me out when he heard it would involve six spells of three weeks. Eventually, the chap I was working with took it up to the top (managing director) and they decided to have a company representative on the course. Another example is that on my university course I did very little electronics. So I was keen to have some electronics experience. I went to see my manager three times before
he let me go to the technical college on a course ...

This is another point: the three people I met (on the university course) were asked by their companies to attend and received total expenses, fares and so on. I was traveling each day and paying my own expenses. They were asked; I had to fight to go. This was an eye-opener ...

It seems they are not interested if I learn anything. I could just stay at the same stage I am at and there would be no complaints from anyone. One case was on a so-called project. I was reading up the technology when the section head came up and asked how the project was going. There was nothing I could do on it at the time, so he saw I was reading. Five minutes later he came back and gave me a most menial task which a technical assistant would get bored on. There again, on projects which he has given me, I have found that he knew certain facts which he hasn't told me; he seems to like to keep things near to his chest and not tell you everything ...

I had quite good relations with university staff. If you made an appointment one you were there they were very helpful. In this industry, perhaps I'm being cheeky, but I don't think they know very much anyway. I prefer to get as much from journals and textbooks as I can. Another reason I would prefer to go to the research lab is that they have a more experienced type there. Downstairs I'm not sure if I am the only graduate but they ask me more than I ask them.

While it might be concluded that this graduate was curiously naive, (and he was willing to admit this view), in the sense that his physics degree and lack of industrial vacation experience rendered him peculiarly ignorant of industrial organisation, vulnerable to misunderstanding job offers and unskilled in coping with his new situation, his case does represent a polar illustration of the kind of 'mismatch' between the educational system and industry. Moreover the case study illustrates the point advanced in chapter two that the mismatch might be understood in term of the expectations generated about employment by university experiences without reference to expectations in terms of socialisation into the values of academic or basic science. This graduate wanted supervision
by technically competent supervisors, contacts with universities, a greater degree of autonomy and free time to keep abreast of technical literature, but his conception of 'engineering scientist' declared an interest in producing hardware rather than just 'paper designs' and his complaint that he was not 'fully utilised' acknowledged the rights of others to direct his work, indeed his hope that they would direct him.
4. **Graduate adjustments to industrial employment.**

The discussions with managers revealed a number of ways in which managers felt that university graduates had deficiencies in skills and attitudes towards industrial work and the beliefs of managers that companies were constrained in the extent to which they could provide induction and training programmes to assist the entry of graduates. My interviews with graduate entrants attempted to assess the extent to which the transition from university to industry was experienced as problematic by graduates, the sources of any problems and the strategies used to cope with problems. My account of these interviews begins with an examination of the respondents' social background and educational experiences, followed by examination of their movement through the labour market into employment and finally an examination of their employment experiences.

(i) **Entry to an occupation.**

Sociological interest in the social background of recruits to particular occupations stems from an interest in the extent to which some backgrounds rather than others provide potential recruits with appropriate skills and orientations for entry, and this interest has been linked to the wider extent in the degree of 'openness' in a society, the extent to which movement between different social positions in the hierarchical rankings of wealth and prestige has been possible. For the most part study of social mobility has been conducted by looking at broad classes of occupations but this kind of analysis is both too broad and too narrow for study of the 'occupational inheritance.' The groups of occupations are too broad for a particular occupation and too narrow in the sense that an occupation may have members
at different positions in a social class ranking. One striking result of this study was that seventeen of the twenty-eight engineering graduates claimed family connections with engineering.\(^{(12)}\) The pattern of influence which was traced in comments was quite varied, from a graduate professional engineer to a T.V. sales manager or parental hobby interests.

'My father is the Scottish controller of a radio and T.V. firm and looks after a chain of shops and offices ... Both my parents were quite pleased at my going to university. For quite a few people in my class I know parents would have been upset if they hadn't gone to university. My father thought it would be good to have a degree. At school I found I was good on the practical and science side, I was interested in electronics and my father has quite close connections in this area so I think he was quite pleased. The chief engineer of my father's firm is a close friend and in the summer holidays I used to go into his workshop and there was always a radio or so lying about.'

'My father is a bank security officer. I don't know what he does in detail but it's on the clerical side and of some status. My electronics interest stems from him because he was in radar during the war and his hobby has always been in electronics. He set up a workshop servicing televisions and so on; I took an early interest and repaired radios for people. My grandfather owned a garage in the early days of motor cars, so there was a family interest in engineering, mechanical things.'

While the comments illustrate that there may be quite strong relationships between parental interests, educational experiences and eventual occupation, they do not indicate the weights attributable to factors or the timing of their influence. For example, there were outstanding questions about the manner of influence, whether parents were influential at the point of choice or at earlier stages in the provision of particular kinds

\(^{(12)}\) Using an amended version of the Registrar General Classification of Occupations yielded the following distribution of father's social class: I Professional (8) II Intermediate (13) III a inspectional, routine white collar (4) III b skilled manual (10) IV Semi-skilled (3) V Unskilled (0).
of experience (for example, 'radios lying about') and the fostering of particular skills (for example, 'radio repair') such that the scope of choice had been greatly restricted by the point of choice. The general impression was that parents were influential in both ways but that the second was recalled as of greater importance by respondents, and it might have been that parental preferences operated by disapprovals as much or more than positive approvals in regard to classes of occupations (for example, in the first graduate's comments on schoolfriends' disapproval of 'non-graduate occupations').

The other point of interest in social background is the way in which parents endow children with the motivation and resources to participate in the educational system. Of thirty-four responses to a question about parental views on the move from school to university, five emphasised that the move had been their own choice undertaken with little reference to parents or recalled that parents felt inexperienced and unable to comment. A further fifteen reported positive parental approval from homes where they were first generation graduates. These parents discouraged early leaving and interpreted higher education and qualifications as worthwhile investments, although the onus for decision rested with the children.

'I was the first one ever to go to university. They were very pleased and I only fully realised that later. They always gave any encouragement, any facilities, they would turn the television down in the next room and so on. Physics, chemistry, maths, were all Greek to them, so even at fifteen I decided to stay on. I've always decided.'

'They were keen that I should go (touniversity) assuming I was capable. They never pressurised me to do anything except perhaps that I've done electrical engineering because of my father's connection with the electrical industry. Although I couldn't think of any direct connection, on looking back on it I think there was a connection.'
In contrast to these two groups which characterised their passage from school to university as a choice process, with parental involvement largely passive in one case and active in encouragement but ignorant in detail in the other, a third group characterised their passage as a non-decision. The move to them was an automatic and required little in the way of discrimination and judgement. Of this group of fourteen, eight mentioned their graduate fathers and six cited their school as fostering a view of university as a desirable goal to which no alternative course of action was available to pose choice dilemmas.

'He was very much in favour of my going to university. He would have been surprised if I hadn't. It as a case where it was expected and I had no objections.'

'I hadn't really much option. I was told at school that it was 'the thing' to go to university. I hadn't much idea what it was all about other than the fact that university meant Oxford and Cambridge, and although I didn't go to either of them, it was still university.'

Thus parents provided both preferences about education and occupations and resources to support participation in the educational system. While resources ranged from financial supplements to quiet rooms, one of the more important supports was a rationale for university education. Sons of graduates were able to assume that their further studies were entirely 'natural' and needed no justification. The first generation graduate who had weighed alternatives and decided on university educated needed some justification for his venture into the unfamiliar world. To the son of a manual worker employed in manufacturing industry, industry was not an unknown area. It represented a relatively familiar environment in which to work and in which school friends and neighbours found employment. The university study of engineering therefore represented a recognisable path through
the unfamiliar world leading to the familiar, at least the environment was felt to be familiar by students and parents which was the important point in justifications.

'I could have become anything, a doctor or teacher, so long as in their (parents) eyes it was a respectable profession, so long as it was a recognised profession. I remember being interested in astronomy, and the line they took was that no one wanted an astronomer'.

'I think they probably think more of my being in engineering than if I had gone into pure science. People have a better idea of what you are doing in engineering, it might be the wrong idea but they have something to go along with.'

While these comments pictured the world of engineering and industry as familiar to schoolboys and parents in working-class settings, there were other comments about the relative unfamiliarity of schools with engineering or rather the view of engineering as less prestigious than pure science in the schools.

The educational experiences of the graduates and the way in which the experiences shaped responses to industrial employment was a central point of the enquiry. One way in which the consequences of university education were explored was by asking about the kinds of person that the graduate becomes in coping with the demands of university. The question 'what makes a good student?' was expected to yield definitions of the qualities required in the successful resolution of the central problems of being a student. (13) At the root of many of these responses the central problem appeared to be that of reconciling competing demands, typically those of faculty against the student's demands for 'free time' and a 'private life'. Success in resolving these demands, and these graduates were all successful to the extent that they met faculty demands by obtaining degrees, was one factor which lay behind graduate demands for autonomy and freedom.

(13) See E. C. Hughes Men and their work op. cit. pp 88-102
from supervision in work situations. Graduation marked the ability to work with little supervision.

The dominant theme of some responses was success in meeting faculty demands, in obtaining a degree, and the required qualities were spelt out in terms of 'work', 'hard work' and 'conscientiousness'.

'Industry, hard work. I did work fairly hard and was pleased with the result. (upper second). I don't regret it. I came from a working class area, the only one on our estate who went to university. At times I felt I would like to be like the other lads who went to the pictures or played football, but I don't regret it looking back.'

'Conscientiousness about work and interest in it - this is probably the most important thing.'

'Someone who does the work. Someone who gets a qualification at the end of it.'

A related theme took the degree qualification as one demand among others, certainly the demand which had priority but one which had to be set against the other competing demands. For these graduates the student problem was one of allocating resources, especially time, between competing demands. Here closer examination into this problem might have revealed different definitions and different resource allocations as different institutions made different demands on students and offered different opportunities to the student to meet his other priorities, for example for a particular style of life. These differences are hinted at in the second and third comments quoted below, the second from a graduate of a technological university, where attendance at lectures was checked by an attendance register, and the third from a Cambridge engineer.
'Someone who really applied himself to his work. O.K. he has outside interests, everyone has to have those, but his main thought is that he is working to get a degree and in a certain subject!

I wasn't a good student. I spent ninety per cent of my life studying and missed quite a lot. A good student is someone who spends seventy per cent of his time working. You've got to get through no matter what, but you should consider your social life.

'Someone who is capable of organising the day such that they get everything done they planned to do. For example, in the engineering department at Cambridge you had all your lectures, practicals and studies in the mornings, the afternoon and evening were yours. If you worked for four hours of your own time I think you were guaranteed a first'. A good student is someone who can work without supervision.'

These simple formulas of '70%-30%; work-social life' or 'four hours of your own time for a first' indicated various beliefs about the trade off between academic demands and the demands for a private sphere of life. A number of the comments which put the degree as a major aim had reservations about the levels of effort and resources necessary to gain academic distinction and a first class honours degree, and some added that the sacrifice of social life could be associated with disadvantages in industry, the lack of social skills of the 'hermit' and 'narrow-minded'.

Another question, 'how well do you think your university education prepared you for a job in industry?' was a more direct attempt to see how the graduates related their educational experiences. This revealed a number of different frames of reference, for the responses tended to indicate not only the extent to which the graduate did derive helpful resources from his university but the extent to which the courses should relate to industrial employment. Among the engineers there was an underlying feeling that the courses should relate to industrial
employment which perhaps accounts for the greater degree of
disappointment and criticism among graduate engineers compared
to the science (physics, maths and general science) graduates
who did not have such expectations and tended to give favourable
responses illustrated by the ways in which their courses developed
worthwhile and relevant qualities.

Among the twenty-eight electrical engineers, slightly
more gave unfavourable comments (15) than gave favourable
comments (13).

While there was broad agreement about the general features
of the situation, that the university concentrated on imparting
analytical skills to the relative neglect of practical skills,
the disagreements emerged in the judgements about the implications
and desirability of this situation. Unfavourable responses expressed
strong reservations about the relevance of university trained skills
to industry, the distinction which must be drawn between a
successful student and a successful engineer, and even from some
a belief that there might be an inverse relationship between
the two kinds of success. The comments quoted here which
illustrate these views come from graduates of different
universities and different degree classes.

'When I came out I found I knew very little about
designing circuits and circuit theory. What we were
taught was given a circuit analyse it, given a signal
to put in what sort of response would we get out of it.
It should have been given a certain function, how do you
design a circuit to produce it. It's very difficult to
teach design to people but it was so heavily biased
towards analysis.'

(Graduate engineer - lower second class honours).

'They are not teaching you to be an engineer but they
are teaching you to pass exams. There was a chap who had
a very good grasp of fundamentals and maths. If you showed
him a circuit he could see the circuit in such a fashion
that he could say the next stage the circuit should go in
order to produce some particular characteristic. It was
not just book knowledge but the knowledge to see how it should be developed. That's something I cannot do, if someone can show me a circuit to analyse I can usually carry out the maths. I think it's basically imagination, he was a good student and an even better engineer.'

(Graduate engineer first class honours.)

'The object while I was there to pass exams to get a degree at the end, and this was one thing I found I was able to do. I was able to learn sufficient, to learn the right things and to know them at the right time for the exam, and on the whole I got a good degree. A number of my friends didn't get good degrees but they knew the more practical aspects of it and knew exactly what it was related to, all I know was that I could work these sums out and that was all.'

(Graduate engineer upper second class honours.)

Those making favourable comments on university courses agreed with the above comments that the university courses concentrated on theoretical and analytical skills with a much lower priority on practical skills, but regarded this as a right and proper preoccupation. They held that the degree course should be sufficiently general to provide a basis for entry to a variety of engineering specialisms. They added that the more specific and practical skills could be acquired in industrial settings with the onus on the graduate and industry rather than the university. Again the comments quoted ranged across different institutions and degree classes.

'It depends on how much you prepare yourself for a job in industry. The course is so designed that you can get the necessary background for any specific job.'

(Graduate engineer, first class honours.)

'(It prepared me) probably fairly well. Ninety per cent of what I learn I don't use in this particular job, but to keep the degree fairly general and so that I could go to any part of industry this is necessary wastage. And the other ten per cent is very useful here. The other stuff I don't physically use but it is useful in reading up.'

(Graduate engineer, lower second class honours.)
'It gave me a background but nothing in particular. I found I couldn’t go out of university and say I am an expert in this because I wasn’t. On the practical side, the very practical side of getting a soldering iron in one's hand, it prepared me very badly. But whatever the initial strangeness of getting something to work - and universities don't bother very much about this for them it's the design that counts - once you get over this strangeness and get used to the approach, I found the university quite valuable. Although the background was not deep, it was wide and allowed me to look at the problems other people found baffling.'

(Graduate engineer, first class honours degree.)

Unlike these graduate engineers who moved into research and development labs, some of the respondents were engineers who moved into other departments or were science graduates. For them it seemed unreasonable to criticise university courses for impracticality in relation to their employment since they were not designed to be related. While they could not claim to have 'a background' on to which to develop they singled out their university experience as developing abilities in 'learning to learn'. The two physics graduates, for example, had had experience of working in production departments since graduation, areas in which they might be expected to feel acutely disadvantaged by the lack of practical skills, yet they emphasised the importance of training in an intellectual discipline, that any disadvantages were short run and that in the long run their capacities for learning would give them an advantage in coping with novelty over those with a 'practical' background.

'It taught me how to learn, to learn to sit down and read something. This is the great difference, I find compared to A.N.C. people I can sit down more readily and take it in that bit quicker.'

(Graduate physics second class honours.)

'The main thing about a university degree is that it shows someone is capable of sitting down and getting a degree and it shows that he has got the capacity to learn.'

(Graduate physics second class honours.)
The way in which satisfactions with university courses were strongly influenced by expectations about how the courses ought to relate to industry can be illustrated by the comments of an electrical engineer who became a systems analyst. He did not expect very much direct relation but, as in the case of the physicists, he described a training in enquiry and learning as of general application.

'(It prepared me) very well indeed. The actual subjects I learned are of little application, but that is of no importance. University taught me to organise myself. It showed me I had the ability to follow a thing from start to finish. It was highly involved, highly technical, which showed clear thinking and application ... I was good at planning, at exam technique. That was the best subject I had. In the first year I worked fantastically hard and found the best way to do it. In the second year I worked too hard, and wanted and got more social life in the third year, which I nearly failed. The fourth year was like planning a business project - and that information takes longer to learn and only gave the same marks as that piece of information. If so, then the notes went into the waste paper basket.'

(Graduate engineer, 1st class honours.)

Indeed through all of these comments and all of the favourable comments there is the suggestion that the process of making out in college is one in which qualities are developed which are of application in industry, and these qualities relate back to the discussion of the 'good student'. In this set of comments, the references to learning to 'prepare yourself', 'to sit down and read something', 'organise myself' and 'follow a thing from start to finish', all carry the implication of a graduate belief that he has acquired the capacity to work independently and with minimal supervision, and it is this expectation which is carried into industrial employment.
(ii) **Entry to an occupational milieu.**

Since much of the manpower debate in Britain was about graduate preferences for different sectors a questionnaire item sought information on which sectors graduates had sought employment and in which areas they had been offered employment. Apart from the industrial sector, the only other sector to which such application had been made was the public industrial sector of nationalised industries and public corporations (in particular the electricity board), (see table 2). The questions about 'serious considerations' revealed a wider range of interest, where among the respondents the industrial research associations received a large degree of interest, and somewhat lesser interest in the Atomic Energy Authority and independent research institutes. Sectors which received most displeasure were the civil service and schools. Interview commentary suggested that the forced choice questionnaire did not omit any considered sectors and that this group of engineers and scientists sought sectors in which to apply some of their university developed skills. Interview commentary provided reasons for choices in which the civil service was characteristic as hamstrung by red tape and a lack of incentive. Of the two sectors of interest in the interim Swann Report, universities and schools, both received rather mixed attention. Universities which were thought to be attractive for both further study and employment by the Swann Committee would not have been available to many of the sample (only seven of thirty-seven respondents had first or upper second class degrees). Even where university teaching careers were envisaged, in the long run, many had made disparaging remarks about the discrepancy between university education and industrial
### Table 2: Job Searches and Employment Sectors

Sectors in which respondents had:

(a) been offered a job;
(b) applied for a job;
(c) seriously considered an application;
(d) would never seriously consider an application.

<table>
<thead>
<tr>
<th>Sector</th>
<th>(a) offered</th>
<th>(b) applied</th>
<th>(c) seriously considered</th>
<th>(d) would never seriously consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nationalised industries or public corporations</td>
<td>7</td>
<td>7</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Industrial research associations</td>
<td>2</td>
<td>2</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Atomic Energy Authority</td>
<td>-</td>
<td>1</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Civil Service (defence or DSIR research)</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Independent research institutes</td>
<td>-</td>
<td>1</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Universities</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>CATs or technological universities</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Colleges of Technology</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Schools</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>10</td>
</tr>
</tbody>
</table>

N = 37
practice and noted that those lecturers with industrial experience were 'better teachers'. Of schools, some were unfavourable because ordinary degrees were thought poorly rewarded in Scottish teaching and others felt that teaching offered only repetition and boredom.

In their move from university to industry nineteen of the twenty-eight engineering graduates had had prior contact with their company of first employment either through vacation work or projects undertaken in university. This source of information was important in choices and additional to that gained from the institutions in the labour market. The majority of respondents had sought jobs during the period of company recruitment campaigns, collecting company recruitment literature and signing up for interviews at the university appointments board. In this process the student was using interviews and company tours to elicit information on which to base decisions about employment.

"I was concerned with finding out - speaking of college interviews which are very short - what they were doing technically and what they could offer. Then you go for a long interview at the factory and that's the time to assess what you might think of working with the people you see."

"I went for an interview with (electronics) radar display. I just thought it wasn't me, there was a lot of microwave stuff which didn't interest me. I suppose it depends on how you get on at university in the subject and I wasn't good at microwave ... I looked at the ages of the people if they were extremely young, then they all go and get out after a year, if they are all extremely old then nobody goes. You tend to be influenced by conditions a lot. To give an example when you go to London you expect the front of the factory to be quite plush but it was just a converted hangar. I don't think on that, again the work didn't interest me. After each interview I wrote down a notebook everything about the interview that I could remember, it may come in useful in future."

(14) Two graduates were in their second jobs at the time of the interview, in neither case had first employment lasted longer than eighteen months.
Both respondents returned as graduates to employment in which they had vacation employment. The function of the interviews depends to some extent on the information sought, (potential colleagues, technical work, and so on). For the majority interviews appeared to offer negative indicators which allowed a student to cross the company off his list. In one example, the last minute cancellation of interviews with department head 'confirmed' an impression of disorganisation acquired during vacation employment, while the personal attention of another company in which he took employment 'confirmed' the vacation employment experience of 'good organisation'.

Vacation experience played a curious part in the entry to employment, however. In all, twenty-nine of the thirty-seven graduates interviewed had had industrial experience in the electrical engineering industry (and of these twenty-one had been in electronics). For fifteen of the twenty-nine, first employment was a return to a vacation employer. Yet the return appeared to be in many respects in spite of, rather than because of, that experience, (nine of the fifteen gave unfavourable accounts of vacation employment). The most frequent complaints were of boredom with insufficient tasks assigned. Returners tended to 'explain' their return as a belief that vacation experience could not be repeated in full time employment, while those who did not return emphasised that vacation experience was one factor among others which prompted them to another company. Despite the majority of unfavourable comments about vacation employment, most graduates viewed vacation employment in industry as a necessary
part of the education and training of an engineer to be undergone before graduation. (15)

University or college teaching staff appeared little used in searching for jobs (six mentions) and little useful in finding jobs (two mentions), whilst only ten graduates could recollect university teaching staff offering advice about jobs in industry (table 3). The general view appeared to be that it was not the duty of the teaching staff to provide information. Two graduates from one university engineering department recalled that their own honours class had pressed academic staff for advice on industry but the Professor and staff demurred that their anecdotes would be of little help, possibly personal and prejudicial. Other comments included the views that university teachers were incapable and uninterested in industry. Since these comments came, in some cases, from departments with joint university-industry courses and research they may owe more to the efforts of the industry's new recruits to distinguish their situation from that of the university. In this sense the industry's recruits appeared to be taking on those characteristic views of 'them' and 'us' which technical managers outlined in an earlier Section. One of the striking features about these replies

(15) Amongst the benefits reported was that vacation work gave another perspective on engineering, a practical experience against which the theoretical university course could be compared. The opportunity was given in a protected form in the sense that it was a temporary situation and one in which mistakes would not be heavily sanctioned and the student's position was redeemable. On the other hand it was not a protected situation in that the vacation student had little rank in an industrial pecking order. For the potential entrant to a research and development department there was the opportunity to appreciate the role of a technician, and the future production engineer could gain shop floor experience.
**TABLE 3**

Sources of information used in seeking and finding first industrial employment.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sought</th>
<th>Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>University appointments board</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>&quot; teaching staff</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Adverts in national/daily/Sunday paper</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Adverts in technical press</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Employer visits university</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td>Wrote directly to company</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Scottish Electrical Training Scheme</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ministry of Labour</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Vacation work</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Number of multiple items</td>
<td>74</td>
<td>40</td>
</tr>
<tr>
<td>N =</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>
on the sources of information used is the way in which contacts between students and employers had become institutionalised in the spring-recruitment campaigns through university appointments boards. Despite the inadequacies of information indicated by both employers and students it was used as the main source of information and even those graduates with prior information from vacations tended to use it as their main source of information too.

(iii) 'Learning the ropes' in industry.

So far the process of entry to employment has been considered in the stages prior to actually joining a company. The pilot study revealed a number of ways in which families were felt to have influenced choices, for example, some families with engineering contacts made engineering a familiar world, giving both orientations and resources of information and skill, and all of the families added approval and encouragement to the gaining of educational qualifications as worthwhile investments. The analysis of the responses about educational experiences suggested ways in which these experiences influenced conceptions of appropriate work and the desire for autonomy. To a considerable extent there was evidence of anticipatory socialisation in family contacts with engineering or vacation work, but anticipatory socialisation always carries the possibility that there will be discrepancy between the situation as it is anticipated and the situation as it is experienced. The initial expectations derived from the managerial comments in the manpower debates were that graduates would find difficulties in meeting time scales, working within cost budgets, working within teams, and demonstrating the practical competence of professional engineers, further I expected that these difficulties would lead to conflicts
with supervisors. However, the difficulties experienced by this sample of graduates tended to reflect those of the earlier studies of the older samples of engineers in that there were complaints of underutilisation and lack of work. Moreover the process of learning about how to 'make out' in industry seemed to entail the lesson that engineering was not a long term career, that the rewards in industry lay in managerial careers.

Anticipations of potentially troublesome aspects of the move to industry showed a preoccupation with the likelihood of finding opportunities for demonstrating technical competence in the new employment. These responses (from ten graduates) showed both an awareness that they might lack technical skills and knowledge of the particular organisation and thus be found inadequate in the new setting. This feeling was compounded by an awareness that they were moving from one setting in which they had been successful to one in which the university degree might generate expectations of competence. Further problems were anticipated in the regulation of time (five mentions), and was related to 'student problem' of allocating time. Now the problem was seen as a likely resentment at having to meet employer demands for fixed hours of work and the student's prerogative of deciding when and where 'work' was done. Other problems were anticipated in the social relationships of work (six mentions), problems which were expected to arise from the dual problems of being dependent on others and being responsible to others. While twenty-one of the thirty-three interviewed, who answered this question, could recall some anticipated difficulty, twelve were unable to recall such anticipations.
For the most part these latter responses came from graduates returning to vacation employers. For the former vacation student the type of work, organisational structure and new colleagues were all felt to be 'known problems', and dismal vacation experiences have been seen already to have been written off.

The difficulties experienced in the move to industry revealed a rather different net of preoccupations from those anticipated. Of twenty-seven graduates who recalled difficulties, fourteen concentrated on the nature of their early assignments. In the main these were comments about the lack of work or work which did not engage their interest. This could arise for a student on an industrial scholarship from a company, possibly because of the division of responsibilities in large establishments between education and work departments. In any event the experiences of the particular graduate typified common views of graduate apprenticeship schemes where the central problem for the graduate apprentice was seen as that of seeking out a 'sponsor' who would provide work. (16) For those who entered directly into research and development labs there were problems in arriving at a late stage in the life history of a project with the boredom associated with routine work and the exasperation of not understanding the basis of the routines.

(16) Graduate apprenticeships raised sharply divided views from those who mentioned the advice of other graduates against such schemes and urged a start in full-time employment promptly to those who sought a 'breathing space' to review industry. Ultimately fourteen sought and twelve found graduate apprenticeships in either the collaborative Scottish Electrical Training Scheme (SETS) or independent company schemes.
"I was given a book on the system and I read that. Then I was given a problem to get the output on an amplifier stabilised. Output varies with temperature and you get 'drift' so that you have to stabilise for whether it is in North America or anywhere else. You have to find the cause and cure it. Measuring outputs meant a lot of data collection and going to the chief engineer to find out what to do. It was a bit grim that first job. I tended to be thrown in at the deep end, and it was a boring complicated job. I spent four months on it and it depressed me.... It was interesting for about two weeks. But it was the fact that it was already defined and I didn't know anything about it, I didn't know the problems when they initially designed it, the variations and so on."

"I went on to the project when it was halfway through. This was the wrong time to go in. It's much better to go in at the start of a project. But this is not always possible, the end of university does not always coincide with the start of a project, so you just have to fit as best as possible. But you don't achieve the same identification. I think this is possible at a more critical stage.... This was the problem in my own case. The system had all been created before I came and the time was spent as general labour. It was pretty high quality labour mind you, but it was quite definitely frustration. The project would drag on over the schedule and I seemed to spend the whole of the first year working on other people's projects rather than my own."

In two of the companies dealing with data processing equipment, several of the new entrants entered at a late stage in the development of equipment, in either a Systems Test department or commissioning department. (17) This was generally acknowledged to have been a valuable entry point by these graduates for although tests were routine they introduced existing equipments through-on-the-job-training. Here problems came with the second rather than first assignments as new entrants felt they had 'outgrown' their first assignment.

(17) Commissioning is the stage of checking out the equipment before handover to the customer. In one company the systems test department was regarded by a Design and Development manager as an ideal point for entry of graduates to learn of existing equipments and become internal recruits to his own department.
Among other difficulties experienced on entry those alleging a lack of guidance from supervisors (three mentions) were closely related to the problems of work mentioned above. The new pattern of regulating time brought little explicit anxiety (four mentions), while a similar number saw the main problems outside work in accommodation and the loss of friends in the South of England (four mentions).

The use of open ended questions usually means that the eventual categories of response will tend to have small numbers, when the total sample of respondents is also small, as in this pilot study, then the tabulated results seem insignificant. The results of questions on anticipated and experienced difficulties do have significance however, in the context of the manpower debate and the manager's comments on induction. The experiences suggested that the manager did not put a high priority on the guidance of new recruits into industry and the discrepancies between anticipations and experiences suggested a potential for disappointment with industrial employment. Most of graduates coped with this situation by pointing out that this was how things had always been and that initial assignments were matters of luck. Where some suggested changes they pointed to the need for lectures to visit industry and be more 'practical' in courses. The strategies adopted for the future were to try to select work within the company or to plan a move to another company where they would enter as an experienced engineers rather than a 'raw recruits' and have an enhanced bargaining position. One of the strategies for securing work was to seek out mathematical or theoretical problems which would capitalise on the graduate's assets. Yet this carried dangers for it could lead
the graduate away from these problems associated with the completion of projects or administration which were more highly rewarded as contributing to the main goals of the development department and company.

Since difficulties were not experienced to the extent expected over time scales or cost factors then the paucity of conflicts with supervisors might not appear surprising. What was surprising was that the disappointments about work did not rebound on to supervisors, (at least not in development labs), instead there were many favourable comments about industrial supervisors. One question sought a comparison of authority relations in university and industry by asking 'How would you compare the kinds of relations you have with those who supervised you in university and those you have with supervisors in industry?' Of twenty-eight answering the question only six drew a more favourable view of supervisors in industry (see table 4). Only one unfavourable response came from a research and development department, the others came from an applications lab (two mentions) and production departments (three mentions).

That most of the unfavourable responses came from the smaller proportion of the sample in the non-R & D departments might confirm the common impression that these departments are furthest removed in their activities from universities. The lengthy comments of one graduate in a production department about supervision have been quoted already in the section on 'assignments and supervision'. His comments about a lack of technical competence were taken up in other comments, but the main issues were complaints about assignments to routine and mundane tasks and demands that these should be undertaken out
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of commitment and loyalty to the department and company. In contrast to these remarks which pointed up difficulties with industrial supervisors, the majority in the R & D labs pointed to a preference for industrial supervision compared to their university situation. For the most part the underlying theme was that industrial supervisors acknowledged their competence and the relationship acknowledged their maturity both as engineer and person. It was this sense of a more equalitarian distribution of knowledge between supervisor and supervisee, rather than comments about sizes of university classes, which was crucial and was enunciated clearly in the following comments.

"It's better in industry. It's a closer, professional sort of relation. I feel that a lecturer realises that he is a lecturer, he knows that it is some sort of position which he has attained. I feel they know that they were the experts and should tell you what to do, not what to do, rather you submitted your ideas and although you could argue with them, they were the final authority. Here I feel the fact that you've got a section leader or senior engineer working with you that he's just the same as you only he's been working a little bit longer than you. (I feel) that because he's picked it up from practical experience the same way you are going to do he's probably picked it up wrong and you can have a good old argument about it and you've a chance of proving him wrong ... You realise that there are a lot of very bright blokes up there and that if you are going to make your mark you are not going to do it on sheer brainpower. You have to have more knowledge than they have and mathematics tends to be one of the things that's neglected up there."

"I don't have much experience of tutors. Engineering departments don't have tutorials as such, a lecturer may set examples and people in difficulty can get special help. A project leader is usually a person with a wide experience of the type of circuitry which you are dealing with. He sets out how the project should be tackled and later you go back and say how you went about it .... Both the tutor and project leader will set you problems and help you solve them.... The problem is different. The university is not concerned to produce a marketable product .... There is possibly a psychological difference because with a tutor
it's more like an individual examination. You are set this problem and if you don't solve it, he's not going to think very much of you, so you approach it in a different spirit. Whereas with the project leader, you both don't know the solution to the problem, you just have to prompt each other. The project leader has the benefit of greater experience and is more likely to reach the solution to a problem if he had the time to devote to it. He has the original idea, he is in the supervisory capacity. The tutor, however, knows the solution and guides the student to it."

Taken together with the earlier comments of the graduate in the production department the comments of these graduates illustrate some points about the kinds of work situation sought by graduates and the way these conditions were more likely to be found in the R & D lab in contrast to departments outside R & D. All three comments pointed to different possible sources for the validation of knowledge and competence - 'supervisors versus journals and textbooks' and 'practical experience versus theoretical-grounded knowledge and analytical skills' - and these sources were seen in this form as alternatives. The graduates saw their competence, attested by qualifications, in their abilities to use literature and employ theoretical knowledge and analytical skills, whereas supervisors had greater experience and practical skills. Whatever the orientations of the graduate, and it is apparent that few of this sample were unwilling entrants to industry, work opportunities were sought which allowed the demonstration of competence. Denial of these opportunities seemed more frequent outside R & D departments, whereas the area of discretion permissible in the R & D departments was welcomed by those who could claim that they were working with rather than for their supervisor, a claim which was obviously impossible in university and was difficult to sustain in the non-R & D
The tenuous position of someone attempting to deal wholly in technical matters or use only university skills was recognised by this sample of respondents. The importance of gaining experience, of developing an intensive 'feel' for problems and their solutions became apparent in numerous incidents. Moreover they began to see that the company research of income and authority lay outside the technical area. Seeking to be successful in industry carried the implication that the career would have to develop in a managerial direction and involved the development of new skills. In their discussion of careers the two dimensions were seen as relevant, the kind of activities undertaken and the sectoral settings in which they were carried out. The first dimension largely referred to technical versus managerial activities and the second referred to industrial versus government agencies or teaching.

The conception of a choice between two distinct lines of activity was expressed very clearly in one comment about experts and managers.

"Your career can go two ways. One is to carry on as I am doing more or less in what you call a 'vertical direction' and become what you can call a 'whizz kid': the absolute expert in logic design, computers and everything, becoming what you might call a 'computer expert'. You could move up this way and be packed with 'gen', and everybody would be coming to you and saying I've got a problem can you help me out. This would be the way if I stayed here. Now I don't want this. What I feel I must do is to progress outwards and across, up into the management side; controlling men and money, rather than just controlling the job."

In their speculation about the future, these respondents engaged in conjecture about the likely rewards from work activities and the likelihood that with their resources they

(18) Paradoxically the one unfavourable response from an R & D lab was that the supervisor was 'too bright', was 'always four steps ahead' which did not allow the graduate any opportunity for debate or discretion.
could secure these rewards. While available resources constrained most of the sample to seek wholly technical jobs, only seven graduates expressed a preference for continuing in a career of technical activities and they held that this would be very difficult in industry where the pressures were towards taking managerial responsibility. Pressures cited were the available rewards of income and prestige in organisations and a likely change in tastes for managerial rather than technical activities and the associated rewards. For these graduates the future was problematic because of suspected limitations or opportunities for technical careers in industry and some doubts about the relative distribution of their skills in technical and social skills, and the dilemma was summed up in a remark which could fit the archetype of a 'back room boy'.

"Management doesn't interest me at all, that's dealing with people. I don't say I'm wary of people but they are so contrary .... I don't say I couldn't cope, I hope I could, but I just wouldn't want to. People are so diverse whereas with nuts and bolts you always know where you are."

For this group the limited scope for technical careers prompted thoughts of university or technical college posts. Of the remainder twenty-four of the sample entertained the possibility of futures in management, although conceptions of this varied in clarity from technical, sales or production management to simply 'management'. While four graduates aspired to a technical entrepreneurship in their own company, the remainder were content with the management of companies in which the attractions were in the greater rewards of salary and prestige. If there was added incentive in the belief that the pace of technological change would make technical expertise difficult to maintain, the main emphasis was on the nature of the reward system and the sense of wholly technical jobs as a transitional state.
"We are in this business for the money not for love, and management is obviously where the money is. I have no pretensions to remain in a lab all my life."

"You will find in the lab there are very seldom old engineers, these are just engineers. Either you move out of the technical grade and into the technical management grade, or you move into production engineering or production management. As you get senior, there is only room for the brightest engineers who are creative. It's partly a problem of ageing and obsolescence but I think it's also that a person thinks that if he is going to be a lab engineer at the age of 55 then he will have failed somewhere. A lot of them must regard it as a transit process, to get to somewhere else like the boardroom or a management chair."

The notion of failure attaching to middle aged engineers has been commented upon by other writers, the important implication here is that there is some ambivalence about a commitment to engineering as an occupation.(19)

To the graduates who had been encouraged to take up engineering and scientific studies and bolstered by all the postwar discussion of shortages of scientifically and technically skilled people it now appeared that other activities were more highly rewarded. Moreover, there was some feeling of being both betrayed and misled, for the universities to which they had gone for qualifications had trained them in analytical skills which did not appear so highly valued in industry. Learning about the available career structures meant that while the graduates wanted to use their existing skills in the short term, they were prepared to see those activities as potentially threatening in the future.

"I don't want to be a tinker all my life."

"I don't fancy being a little man in a corner all my life."

"I don't want to be stuck with a soldering iron all my life."

(19) E. C. Hughes Men and their Work op cit. pp 42-55
Information gained from observations and conversations in the lab was supplemented by the careers journals and studies, such as those conducted by the Ministry of Technology into Professional Engineers, reported in the literature of the Institution of Electrical Engineers.

The impressions held by these graduates of these future careers matched those of their managers in that no-one sees his future as likely to be linked to his current employing organisation. In answer to a question, 'do you see any barriers to your career advancement in this company?', some saw barriers in the youth of their contemporaries and competition for promotion unless expansion continued and others saw barriers in company product markets and likely growth. Indeed all the companies were seen to have problems of various kinds. 'In three of the establishments it was claimed that American ownership would always imply uncertainty about a bridgehead operation from which retreat might be made if economic difficulties arose. The instrument companies were thought to have problems on the marketing side in sophisticated equipment markets. Of the two remaining establishments, one had suffered cutbacks in some departments from Government defence economics, for example, in the TSR2 cancellation, and the other, provoked doubts about the future following a merger. Yet other sources of barriers to career advance within existing employment were the young engineers' preferences to move to other companies for salary increases and further experience.'

(20) The nature of Government Contract work for one company was thought to impose Government incomes policies and constrain the rate of growth of salaries within a company and so encourage a desire to move. The desire for experience was summed up by one graduate in drawing attention to the alternative - 'specialisation is the very death of a graduate in industry' and the fears of a 'rut' characteristic of some other graduates.
In a number of respects these graduates have been revealed in attempts to distinguish themselves as a distinctive group with distinctive skills appropriate to distinctive kinds of work; work that was challenging and complex, original and varied. Yet relatively few of the sample could recall occasions on which they conceived of themselves as professionals, (only thirteen of the thirty-two answering the question). Where 'professional claims' were made, the mastery of an area of expertise was the basis of the claim and a university was taken to be the qualification which distinguished a profession from other occupations.

"It was the last year of university that gave me this feeling of professionalism, for the first time in the four year course I had a confidence in my mastery of the subject. I don't know whether it was the amount of work involved, I've never had to work so hard in my life, or the quality of the problem. I think it was a combination of both."

In only two cases was there any claim to render anything to 'esoteric service', this was in claims to exercise integrity in work. Yet integrity was rendered to the employer rather to a public in any wide sense. Altogether fifteen of the respondents, (including eight who had little use for the term 'professional'), were Associate Members of the Institution of Electrical Engineers (I.E.E.). Membership of the Institution was held to confer benefits such as journals and additional qualifications, attestations of relevant experience of engineering practice, in a situation where more qualifications might be marketable, for example, in the international labour market in the U.S.A. or Canada. But entry to the Institution was generally made as a student member and the degree was regarded as the main qualification. There were some doubts about the direct reliance of the I.E.E. to the electronics industry, the stress on individual experience was thought to be more appropriate to the Electricity and Hydro-electric Boards in Scotland.
At the threshold of entry to employment these graduates were not yet full members of a community of industrial scientists, nor was the professional institution actively sought out as the expression of such a community. The main preoccupations were with establishing career footholds within a company, but there was a tentative character about these efforts because the much sought skills of the university-trained scientist and engineer did not appear so earnestly sought or rewarded within the company. A move into management presented an opportunity to advance careerwise and escape some of the wider odium of the engineer.

Lay images of the engineer were thought to be uniformly low. The graduate engineers felt that they were confused with other users of the occupational title of 'engineer' such as gas fitters, electricians, mechanics and craftsmen, that their expertise and its consequences were little understood by the public compared to others with whom the public had greater contact and understanding, such as doctors and dentists. While twenty-four of the twenty-eight respondents felt that the engineer had low social status, reactions to the situation varied from personal strategies to present a more favourable image and hopes for a collective effort to raise the social prestige of engineers to a disavowal of public ratings and concentration on more narrowly-defined reference groups.

"I prefer not to call myself an engineer, I think it's unfortunate that we have such a low status. I call myself a logic designer and this obviously has more status than just an engineer."
"The image the public has of the engineer is the greasy man in overalls in oil and water with a big spanner in his hand. But the whole essence of science and technology - this is probably what Harold Wilson wants - depends on the relation with the inventiveness, the ideas of engineers. The engineer requires much more social significance than he has got at the moment. This is going to come - the engineer will be regarded as important as the doctor."

"I don't think the layman knows the lab engineer exists in the form in which he does. They tend to go from the fitter to the white-coated scientist without anything in between ....

It doesn't matter to me. Fellow engineers perhaps, I'd like them to feel I was competent ....

Within the company we R & D (engineers) have status. We are the people who know. If people have problems, in production or test, they come to us. We are the elite. But in society there is an awful lot of rubbish being written in the papers about the status of professional engineers in which I am not interested."

For most of the engineers the company was the important locus of evaluations and social significance of work activity. These graduates did not see themselves as engaged in anything resembling the community of scientists freely exchanging information or the body of professional with certified knowledge and a relationship of trust with society. Industrial supervisors were the source of assignments and evaluations subject to the limited bargains which could be struck. Moreover the rights of the company to restrict free access to information was regarded as right and proper, and company confidentiality extended to exclude 'friends'. Given that most of the graduates had come from Scottish universities and lived within the Central Belt of Scotland they could keep contact with their former student peer group to discuss their adjustment to employment yet all respondents recognised constraints on topics for discussion.
Norms about confidentiality came from many sources: from the S.E.T.s scheme instructions to students, the official Secrets Act in some departments on military contracts, company handbooks, and the suggestions of senior engineers. In one company it was recognised that vacation students would wish to talk about their experiences and they were 'allowed' to talk about the project name and techniques but asked not to mention the stage of the project which was considered to be the more critical information. Among these graduates in employment it was felt that there were other constraints on discussion too in the very particular nature of work limiting both the interest and the intelligibility of work to companies and employees in the same branch of technology.(21)

(21) A graduate, who found some technical discussion with a friend in another company helpful, commented that he would not report indiscretions by his friend to his own company. Allen had noted a similar respect for company confidentiality in a norm against releasing company reports loaned by friends to third parties as well as the constraint which derives from the specificity of the information. See Tom Allen 'Managing the Flow of Scientific and Technical Information' Alfred P. Sloan School of Management, M.I.T. unpublished Phd dissertation 1966.
5. Conclusions.

Evidence was found in the pilot study of conflicts between graduate recruits and their industrial employers. These conflicts were located in the different norms used to guide behaviour - managers and engineers in industry were seen by graduates as acting from rule of thumb criteria and anxiety to compromise. While the graduates countered that decisions and behaviour should be rooted in rigorous analysis, rational procedures and verified knowledge. Expression of these conflicts was most heightened in the non-R & D departments where the clash between appeals seemed most apparent. Two further quoted comments can underline this point where both were taken from graduates in non-R & D departments and picture a 'textbook view of organisations' gained from university and a 'muddle and compromise' view realised in industry.

"I had spent a year and a half in industry under conditions of employment during my university course, so I had no illusions about what industry was like and what I was entering .... The mentality of engineering type industrial production is quite different (from university). People no longer go by the book but go by what gets the job done. I had no illusions about industry being beautifully organised."

"When I came to (the company) my head was bristling full of ideas, facts and figures and no idea of how to put them into practice. The course did include some industrial administration and I came to industry expecting everything to be 'go'. I expected someone to say 'work' and something gets done, but I found it just isn't true. It may be something in (this company) but things seem to take longer, there's never a clear-cut decision. When you come from university you think no compromise is going to be made, but it isn't true."

Understanding these conflicts did not require any assumptions about the commitments of graduates to the values and norms of academic science or technology. Indeed the contempt expressed
for 'analysis' in some comments on university courses suggested that such commitments would be rare. Yet in the industrial situation analytical skills were all that graduates possessed and if they were to distinguish themselves by a distinctive contribution and not be compared unfavourably to the part-time qualified professional engineers or technicians then they had to seek out opportunities to use their skills. In the sense of having made side-bets by their acquisition of a university science of engineering education, these graduates were committed to advance a conception of engineering counter to that of their managers. However they recognised that maintaining defiant postures would not lead to organisational advancement in industry and it was evident from the discussion of prospective careers and relations with supervisors that the graduates maintaining only temporary bargaining positions. It was recognised that they would go through the same process of acquiring an intuitive knowledge of engineering, of 'picking it up by experience.'

Opinion among the graduates on policy to mitigate the difficulties of transition was evenly divided. While approximately half of the respondents took a view comparable to that of the managers, that the onus lay with university staff to become familiar with industry and omit much of the analytical work in order to include more project work and industrially relevant problems, the other half of the respondents saw the essence of a university education in its provision of general education and skills such as the ability to 'learn to learn'. These differences of opinion were closely related to student experiences, the engineers tended to demand more vocational relevance and the science graduates were content with a general education.
Surprisingly none of the graduates stated the view that there was an industrial responsibility to provide induction and training specifically for university graduates despite evidence of disappointment in work experiences. Perhaps the omission may have arisen from the view that it was not the responsibility of industry to provide education and training or the view that industry was not well-equipped to provide desirable education and training at least to judge by the common gossip about graduate apprenticeships. The most substantial conclusion to be drawn from the pilot study was support for the conclusions of Professors Carter and Williams expressed in the 1950's that there was a widespread lack of serious thought in industrial policies and procedures for the utilisation of scientists and engineers.

"We have not been able to say whether the latest plans for the expansion of higher education in science and technology are a reasonable response to the needs of industry. This attitude stems in part from our doubts about the adequacy of a statistical approach; these doubts carry with them the implication that flexibility is most important. The educational system should not be expected to produce young people like a series of keys, each shaped to open a particular lock (which may after all turn out not to need opening), but rather like a series of master keys, capable of varied use in the unknown future circumstances of industry. In consequence, specialisation must not be carried too far in school or university or technical college. But our inability to judge the adequacy of plans for expansion is due also to the fact that very little is known about the way in which scientists are used in industry. Industry itself has not thought very deeply about the best ways of using scarce scientific personnel; and we think that in places graduates and other highly trained staff are being mis-used, partly because of the shortage of technicians. Effective research on the use of scientists and technologists would make the planning of educational facilities much more reliable. (22)

Moreover there was the caution for policy advisers in this conclusion from Carter and Williams that investigation of utilisation of scientists and engineers in industry should precede

claims of shortage based on the summation of employer opinion-
returns or trend projections. This advice was ignored by the
Committee on Manpower Resources for Science and Technology
in their work but served as further stimulation to my own study.

Of course there were a number of features peculiar to
the electronics industry in Scotland which limited the scope
of generalisation to discussions about 'highly qualified
manpower' and 'industry'. There appeared to be a strongly
regional character to the graduate labour market which was
revealed in the history of the industry, relatively recent
arrival of companies in Scotland, concentration of priorities
on development and production with little research activity,
relatively little employment of physicists, a weak tradition
of technician education in Scotland, and the importance of
location in choices of company. Consequently it was important
for the main study to obtain the wider samples of companies and
their functions, and wider samples of graduates and their
educational experiences which were outlined in chapter three.
Survey on the recruitment and adjustment of graduate scientists and engineers to industry.

This survey is an independent project and part of a series of studies of occupations and studies of science and technology being undertaken in the University of Edinburgh. Financial support for the survey is being given by the Social Science Research Council.

The aim is to ask about the expectations and experiences of graduates leaving university in 1967 and 1968 and taking their first employment in industrial organisations. These are the expectations and experiences of university, first jobs, and careers, and in particular, the transition between the two environments of university and industry. It is hoped that this study will contribute some information about the way graduates see their university and its functions, some information on practices in different industrial companies for the employment of recent graduates, and the views of graduates about these practices.

The enquiry will involve a discussion lasting about an hour, and a questionnaire to be filled in later which will take about half an hour.

All the information given by individuals will be treated as confidential and anonymity will be ensured, and information will not be used in any connection other than the declared purposes of the research.

Thank you for your co-operation.
JOB DESCRIPTION

1. How would you describe your job to someone who knows very little about it?

2. How do you know what you are supposed to do in this job? How do you find out what your responsibilities are and what you have to do to meet them?

3. How much relation is there, if any, between what you did at university and what you are doing now?

4. To what extent would you say you have been able to define the job for yourself - how much leeway would you say you have over how you go about it?

5. Who is your immediate supervisor - the person to whom you are immediately responsible?

6. Suppose you were having some sort of difficulty in your job, to what extent do you feel that (the person to whom you are responsible) would be very willing to help?

7. When you strike a problem, how far do you feel you have to cope by yourself or get another opinion?

8. Who would you see in the first instance?

9. As far as you know does your supervisor usually let you know when he wants or expects you to do something, or does he often keep these things to himself?

   - always lets me know
   - usually lets me know
   - sometimes does
   - sometimes does/ sometimes doesn't
   - usually doesn't
   - never lets me know

10. How difficult do you feel it is to do what he wants from you?

    - extremely difficult
    - quite difficult
    - not too difficult
    - quite easy
    - very easy

   a) If 'extremely' or 'quite' difficult - why is that?

11. Do you usually feel that you know how satisfied he is with what you do?

    - I always know where I stand
    - usually
    - sometimes do /don't
    - am often in the dark
    - usually don't
12. We have been talking about the way people learn what is involved in their jobs. Do you feel you are as clear as you would like to be about what you have to do in this job?

13. Which of the following best represents how clear you are about what you have to do in the job?

- very clear
- quite clear on most things
- fairly clear
- not too clear
- not at all clear

14. How clear are you about the limits of your authority in your present position?

- very clear
- quite clear on most things
- fairly clear
- not too clear
- not at all clear

15. All of us occasionally feel bothered by certain kinds of things in our work. I'm going to read a list of things that sometimes bother people, and I would like you to tell me how frequently you feel bothered by each of them.

a) Feeling that you have too little authority to carry out the responsibilities assigned to you.

b) Being unclear on just what the scope and responsibilities of your job are.

c) Not knowing what opportunities for promotion or advancement exist for you.

d) Feeling that you have too heavy a work load, one you can't possibly finish in a normal working day.

e) Thinking you'll not be able to satisfy the conflicting demands of people over you.

f) Feeling you are not fully qualified to handle the job.

g) Not knowing what your supervisor thinks of you, how he evaluates your performance.

h) The fact that you can't get information needed to carry out your job.

i) Feeling you may not be liked and accepted by people you work with.

j) Feeling unable to influence your immediate supervisor's decisions and actions that affect your job.

k) Not knowing just what the people you work with expect of you.

l) Thinking that the amount of work you have to do may interfere with how well it gets done.

m) Feeling that you have to do things on the job that are against your better judgement.

n) Feeling that your job tends to interfere with your personal life.

All of us are concerned from time to time about the meaning of our work in our lives. I'd like to know how you feel about things that might lead to satisfaction or dissatisfaction on the job.

16. What aspects of your job do you find most satisfying?

17. What do you find least satisfying in your job?
18. If you could redesign your job so that it would be more satisfying for you, what would you have changed about it?

19. You probably do certain things in your job that are over and above your contract. Suppose you were justifiably dissatisfied but could do nothing about it short of finding another job. Would you in the meantime drop the extras? (probe - if you had a grievance, would you do a work to rule?)

20. Do you have time limits on jobs?

21. What happens if you exceed a time limit?

22. What happens if you have a smart solution to a problem?

23. How I would like to turn to a long range view of your career.

24. When you were young what did your family want you to be? Was there any particular occupation they wanted you to go into?

25. Can you recollect when you first thought of becoming an engineer?

26. Did you consider any alternatives to going to university or college? If yes, what were these?

27. What do you think makes a good student, you own personal definition?

28. What do you think makes a poor student?

29. What do you think makes a good engineer?

30. What do you think makes a poor engineer?

31. The following are said to be some of the benefits to be gained from attending college or university. Could you tell me how important each of these was to you personally?

   a) Opportunities to study in a particular field.
   b) Qualifications that will ensure a reasonably secure and wellpaid livelihood.
   c) A broader outlook on life.
   d) Opportunities to work in a university atmosphere.
   e) Personal freedom and social life.
   f) Training for a particular job.

   extremely important
   quite important
   somewhat
   not too important
   not at all important

32. Could you give me the rank order in which they were important to you personally?

1st. 2nd. 3rd. 4th. 5th. 6th.

33. How well do you think your college/university education fitted you for a job in industry?
33. How would you compare the sort of relations you had with college teaching staff to those you have with people who supervise you now?

34. What plans and ambitions did you have for the future when you left college?

35. What was the reaction of your parents to the idea of going to university?

36. What was the reaction of your parents to the idea of your studying (subject)?

37. What was the reaction of your parents to the idea of your becoming (occupation)?

38. Have you any older brothers or sisters?

39. Are you married? Planning to be married?
   If yes, a) what does your wife (fiancée) think of your present position?
   b) How does being married (or planning it) affect your career plans?

40. How would you expect your future standard of living (economic income) to compare with that of the family in which you were brought up?

41. Barring unforeseen developments do you think you could remain here permanently?
   (probe - feasibility vs. preference)

42. From a personal point of view, would you prefer a job that was primarily pure engineering or one that was primarily administration?

43. Could you tell me your starting salary with this company?

44. What is your current salary?

45. Do you think you are sufficiently well paid?

   How to change the subject somewhat... there has been a lot of discussion lately about the problems of graduate scientists and engineers going into industry. Perhaps you have read some of the articles in magazines and journals about this.

46. How do you feel about this transition?
47. How would you compare your move from school to college with your move from college to industry?

SOCIAL RELATIONS

48. Could you think of all the places you are likely to see other engineers off the job. How often would you say you spend time with other engineers off the job?

- never
- less than once a month
- once or twice a month
- once or twice a week
- nearly every day

49. Do you ever visit other (engineers) in their homes or do any (engineers) ever come to your home?

If yes: very often
- occasionally
- rarely

50. With whom do you actually spend more of your free time - other (engineers) or those outside (engineering)?

51. How would you compare the sort of relations you had with other students to those that you have with people with whom you work?

52. Could you tell me your three closest friends - their names and occupations?

PROFESSION

53. Do you think of yourself as a professional?

54. In your opinion are there any differences between professions and other occupations?
   (probe - hand in those terms do you see yourself as a professional)?

55. What do you think is the social status of the (engineer)?

Do you feel that there is anything that we have overlooked, or anything on which you would like to comment further?
This questionnaire has been designed to supplement the discussion in which you have been helping. Obviously it is helpful to indicate experiences to a number of background factors, such as type of education, family education, and pre-employment experience. To narrow discussion to concentrate on these experiences which you feel important, this demographic information is reserved for the questionnaire. There are also a number of other questions on specific attitudes which are included. To these questions there are no right wrong answers; what is important is to know the way graduates feel about these matters.

The questionnaire requires thirty to forty minutes to fill out. Please answer the questions as frankly and accurately as you can. Your answers will be absolutely confidential, and no individual's answers will be revealed in study reports, which will be used for statistical tabulations.

Most of the questions can be answered by drawing a circle and one or more numbers or letters in the right hand margins of questionnaire, for example:

I am now working in
  research and development 1
  test 2
  production 3

Some questions have instructions in brackets, for example,

1. (circle one) i.e. draw a circle around only the one number or letter which BEST DESCRIPTIONS your answer, even though one or other alternatives might be relevant.

2. (circle all that apply) i.e. circle as many or as few numbers or letters in the columns or rows as you think relevant.

If you are interested in the results of this study, please write to the address above.

Thank you very much for your help.
1. Name ........................ 2. Date of birth ..............
5. Are you (circle one) - single? 1 married? 2 year of marriage ...... number of children ....
6. Please give the following information about your father or guardian.
   a) At approximately what age did he leave school? ......
   b) Did he go to university? (circle one) Yes 1. No 2.
   c) What was his main occupation? (circle one) Employed 1. Selfemployed 2.
   d) In what industry or profession? ..............
   e) In what capacity? ..........................
      (Give title, rank or grade where appropriate)
7. Could you please give similar information about your mother -
   a) At approximately what age did she leave school? ......
   b) Did she go to university? (circle one) Yes 1. No 2.
   c) Did she ever have an occupation? (circle one) Yes 1. No 2.
   d) If yes, please state it ........................
8. Please give the following details of each school you attended from the age of 15 onwards.
   name town or district type or school At what age did you leave?
   a) ............................................. ...........................
   b) ............................................. ...........................
   c) ............................................. ...........................
9. Which college or university did you attend? ..............................
10. At university did you live: Year 1st. 2nd. 3rd. 4th.
    (circle as many as apply)
    home 1 2 3 4
    lodgings 1 2 3 4
    hall 1 2 3 4
    flat 1 2 3 4
11. What was your source of finance at university? (circle as many as apply)
   Local education authority 1
   University scholarship 2
   Industrial scholarship 3
   Parent 4
   Other (specify) ............. 5

12. What was the title of your degree and year of graduation?

13. What were the main subjects of your degree?

14. What class of degree did you obtain? (If seconds were divided, please indicate which you obtained)

15. People have different ideas about the MAIN PURPOSES OF COLLEGE EDUCATION. Some of their ideas are listed below. As you read this list, consider what educational goals you think the IDEAL college or university OUGHT TO EMPHASIZE.

   Indicate your opinion by writing:
   H (high) next to the goals you consider highly important in a university;
   M (medium) next to the goals you consider of medium importance;
   L (low) next to the goals you consider of little importance, irrelevant, or even distasteful to you.

<table>
<thead>
<tr>
<th>Importance</th>
<th>H, N, L.</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Provide vocational training; develop skills and techniques directly applicable to your career</td>
<td>.....</td>
<td>1, 2 etc.</td>
</tr>
<tr>
<td>b) Develop your ability to get along with different kinds of people</td>
<td>.....</td>
<td></td>
</tr>
<tr>
<td>c) Provide a basic general education and appreciation of ideas</td>
<td>.....</td>
<td></td>
</tr>
<tr>
<td>d) Develop your knowledge and interest in community and world problems</td>
<td>.....</td>
<td></td>
</tr>
<tr>
<td>e) Help develop your moral capacities, ethical standards and values</td>
<td>.....</td>
<td></td>
</tr>
<tr>
<td>f) Prepare you for a happy marriage and family life</td>
<td>.....</td>
<td></td>
</tr>
</tbody>
</table>

   Now GO BACK and rank the ones you rated H by writing next to each H:-
   1 for the most important,
   2 for the second most important,
   and so on for all the "H"s on your list. Do NOT rank the "M"s and "L"s.
15. Did you have any experience of the electrical engineering industry in your vacations? (circle one) Yes 1. No 2.

17. If yes to 16. Could you please name the companies and departments in which you worked?

19. When seeking a job, a) for how many jobs did you apply? b) how many jobs were you offered? 

19. Jobs can be roughly classified according to the type of employer concerned. Below are listed some of the main possibilities. When you were looking for your first job, had you made up your mind that you would NOT want a job which involved working for some such employers? (circle one)

   a) Decided against some such employers 1
   b) Not decided against any such employer 2

   a) If decided against some employers of these six which had you decided against? (circle as many as apply)

   Private firms
   Public corporations
   Civil Service
   Government grant-aided research institutions or associations
   Universities
   Local Education Authorities

20. Below is a list of various sources of information about jobs. Which of these did you use in seeking employment?

AND

21. In which ways did you come to hear about the first fulltime job which you took? (circle as many as apply) WAYS OF SEEKING WAY FOUND FIRST JOB

   University appointments board
   University teaching staff
   Adverts in national daily or Sunday press
   Adverts in technical press
   Employer visits to university
   Vacation employment
   Other students
   Family and friends
   Friend in the company
   Any other ways: no other ways
   wrote directly to firm
   letter (specify)
22. Listed below are different kinds of opportunities which a job might afford. If you were to seek a job how much importance would you personally attach to each of these, disregarding whether or not your present job provides them? Please indicate next to each item its degree of importance by writing the number 1, 2, 3, 4 or 5.

1 means not at all important
2 means not too important
3 means somewhat important
4 means quite important
5 means extremely important

a) To make full use of my present knowledge and skills
b) To grow and learn new knowledge and skills
c) To make a lot of money
d) To advance in administrative authority and status
e) To work with colleagues of high technical competence
f) To have congenial co-workers or colleagues
g) To associate with top executives in the organisation
h) To have congenial co-workers or colleagues
i) To work under chiefs of high technical competence
j) To associate with top executives in the organisation
k) To work on problems of value to the nation's well-being
l) To have freedom to carry out my own ideas
m) To contribute to broad technical knowledge in my field
n) To give me an opportunity to work with people rather than with things
o) To remain in the city or area in which I grew up
p) To get away from the city or area in which I grew up

Do you think your present job will satisfy most of the opportunities you marked 'quite important' or 'extremely important', or some of them, or only a few of them?
(circle one)

will satisfy most of them
will satisfy some of them
will satisfy few of them
will satisfy none of them

23. Below are given a number of reasons which people offer for choosing their particular job. Which of these applied when you decided to join this company?
(circle as many as apply)

a) a reputation for good training
b) the offer of graduate training
c) a recommendation from the university appointments board
d) a recommendation from university teaching staff
e) the location of the works
f) the type of products made
g) a favourable impression of the conditions of work
h) the starting salary offered
i) good prospects for the future
j) a favourable impression of the company recruiters
k) personal reasons (e.g. fiancée in the area)
l) vacation work in the company
m) personal contact with the company
n) the company ideals
o) favourable impressions of the industry's future
p) the company's reputation in the country
q) any other (please specify)
24. People differ in their comments about their work. Some comments often heard are listed below. How appropriate would these comments be as descriptions of your own job?

Please indicate your degree of agreement with the comment by writing 1, 2, 3, 4, or 5.

1 means strongly agree
2 means agree
3 means undecided
4 means disagree
5 means strongly disagree

a) "My job is like a hobby to me"

b) "My job is usually interesting enough to keep me from getting bored"

c) "It seems that my friends are more interested in their jobs"

d) "I consider my job rather unpleasant"

e) "I enjoy my work more than my leisure time"

f) "I am often bored with my job"

g) "I feel fairly well satisfied with my present job"

h) "Most of the time I have to force myself to go to work"

i) "I have a job that is no more interesting than others I could get"

j) "I enjoy my work more than my leisure time"

k) "I definitely dislike my work"

l) "I feel that I am happier in my work than most other people"

m) "Most days I am enthusiastic about my work"

n) "Each day of work seems like it will never end"

o) "I like my job better than the average person does"

p) "My job is pretty uninteresting"

q) "I find real enjoyment in my work"

r) "I am disappointed that I ever took this job"

25. Do you agree or disagree with the following statements about getting ahead? Circle the A if you agree, the D if you disagree, and the ? if you are not sure.

"In order to get ahead these days...

a) you can't afford to be squeamish about the means you use"

b) you have to be able to make people do what you want"

c) you really have to love your work"

Agree Disagree Not sure

26. Which of the following do you think is the more descriptive of the job position you have now?

(Circle one)

a) The job duties and activities would be essentially the SAME regardless of who held the job

b) The job duties and activities would CHANGE depending on the person who held the job
27. a) Please indicate your preference with respect to your working habits by circling one of the following.

b) At present, what are your ACTUAL working habits? (Circle one)

<table>
<thead>
<tr>
<th>Preference</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work alone, very seldom consulting others</td>
<td>1</td>
</tr>
<tr>
<td>Work alone, but have occasional work-related discussion</td>
<td>2</td>
</tr>
<tr>
<td>Work alone, but have frequent work-related discussion</td>
<td>3</td>
</tr>
<tr>
<td>Work closely with others, but not in a formal group</td>
<td>4</td>
</tr>
<tr>
<td>Work in a formal group</td>
<td>5</td>
</tr>
</tbody>
</table>

28. How well does your supervisor know the jobs he supervises? (Circle one)

| He knows very little about the jobs | 1 |
| He doesn't know the jobs very well | 2 |
| He knows the jobs fairly well | 3 |
| He knows the jobs very well | 4 |

29. How much is your supervisor interested in helping those who work under him to get ahead in the company? (Circle one)

| He doesn't want them to get ahead | 1 |
| He doesn't care whether they get ahead or not | 2 |
| He is glad to see them get ahead, but he doesn't help them much | 3 |
| He helps them get ahead if he gets a chance | 4 |
| He goes out of his way to help them get ahead | 5 |

30. Taking it all in all, how well would you say your supervisor does his job? (Circle one)

| He does a poor job | 1 |
| He does a fair job | 2 |
| He does a good job | 3 |
| He does a very good job | 4 |
| He does an excellent job | 5 |

31. How good would you say your supervisor is at dealing with the people he supervises? (Circle one)

| He is poor at handling people | 1 |
| He is not very good at dealing with people; does other things better | 2 |
| He is fairly good at dealing with people | 3 |
| He is good at this - better than most | 4 |
| He is very good at this - it's his strongest point | 5 |
32. What happens when someone on your level makes a complaint about something?
(Circle one)

It's hardly ever taken care of ............... 1
It's often NOT taken care of .................. 2
It's usually taken care of .................... 3
It's almost always taken care of ............ 4

33. Suppose you left your job or position in your employing organisation. Under present conditions how easy do you think it would be for you to get a similar position in another organisation?
(Circle one)

Very easy ..................................... 1
Fairly easy .................................... 2
Not very easy .................................. 3

34. In the next 5-10 year period, do you feel that the demand for your present kind of speciality will:
(Circle one)

increase sharply ............................. 1
increase gradually ............................ 2
stay at about the same level .............. 3
decline gradually ........................... 4
decline sharply ............................... 5

35. What do you think is likely to happen to the size of your research and development organisation in the next 5-10 year period?
(Circle one)

It is likely to increase in size sharply .... 1
It is likely to increase in size gradually .. 2
It is likely to stay about the same .......... 3
It is likely to decrease in size gradually .. 4
It is likely to go out of business ........... 5

36. Do you think about your career more as:
A) a series of opportunities to engage in activities you like to do,
OR B) a progression up one or more organisational ladders to a position in which you aspire to be?

Please indicate below which of these two statements is closest to your view of your own career.
(Circle one)

Almost entirely as A. Largely as A but also partly as B. Both. Largely as B but also partly as A. Almost entirely as B.
1 2 3 4 5
37. Scientists and engineers may differ widely in their characteristic approach to their work - both the kinds of problems that attract them, and the way they go about the task. How closely does each of the following statements describe the approach you typically prefer to use?

Please indicate next to each item your degree of preference by writing 1, 2, 3, 4 or 5.

1 means describes my preference completely
2 means describes my preference to a considerable extent
3 means describes my preference somewhat
4 means describes my preference very little
5 means describes my preference not at all

a) I mainly prefer problems that will help to build my professional reputation

b) I mainly prefer problems that will lead to advancement in my organisational status

c) I prefer areas where I can be fairly sure of some acceptable results, even though not spectacular

d) I prefer to map out broad features of important new areas, leaving detailed study to others

e) I prefer to probe deeply and thoroughly in selected areas, even though narrow

f) I'm effective as a 'right-hand man', carrying the ball for a more experienced advisor

g) I prefer to develop my ideas inside my head, before testing them against nature

h) I prefer to spend enough time to find general principles that apply to many situations

i) I prefer to find immediate solutions to specific problems

j) I find it fruitful to utilise abstract concepts several steps removed from direct observation

k) I like to bring about order and simplicity in chaotic or complex material

If you have any further comments following the interview and questionnaire could you please note them overleaf.
Thank you very much for your help.
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<thead>
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