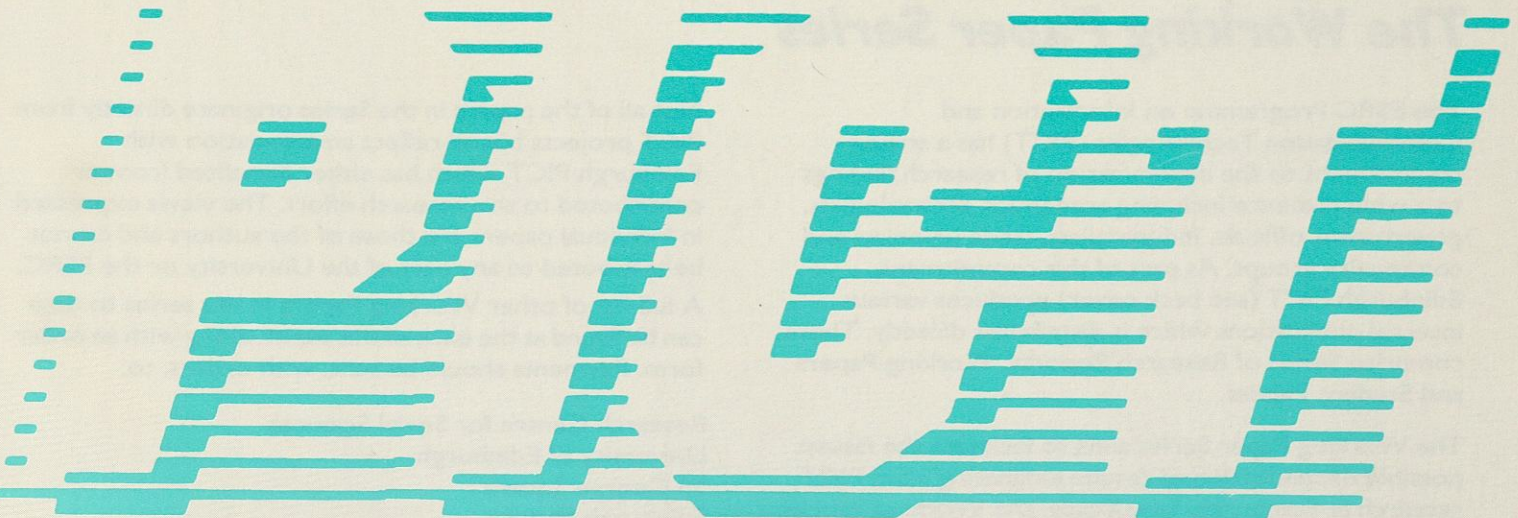


Da. 55 Soc. Sci.



PROGRAMME ON
INFORMATION &
COMMUNICATION
TECHNOLOGIES

Working Paper Series 47

**Sociotechnical constituencies as processes of alignment:
the rise of a large-scale
European information technology initiative**

Alfonso H. Molina



UNIVERSITY OF EDINBURGH

The Working Paper Series

The ESRC Programme on Information and Communication Technologies (PICT) has a strong commitment to the dissemination of research findings to a wide audience including academics, technologists, government officials, industrialists, trade unionists and community groups. As part of this commitment, Edinburgh PICT (see back cover) produces various internal publications which it distributes directly. These comprise Series of Research Reports, Working Papers and Student Papers.

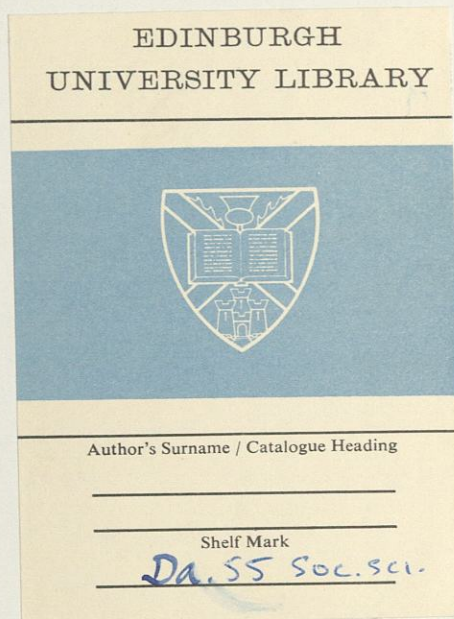
The Working Paper Series aims to facilitate the fastest possible dissemination of results emanating from PICT research at Edinburgh. Specifically, the Working Papers cover three types of results

- (i) preliminary results of research in progress
- (ii) results about specific aspects of the Information and Communication Technologies (ICTs), representing little known information of value by way of 'background briefing'
- (iii) conceptual or theoretical contributions to current policy or academic debate about technology in general or ICTs in particular

Not all of the papers in the Series originate directly from PICT projects but all reflect an association with Edinburgh PICT which has either benefited from or contributed to this research effort. The views expressed in individual papers are those of the authors and cannot be attributed to any part of the University or the ESRC.

A full list of other Working Papers in the series to date can be found at the back of this paper, along with an order form. Payments should be sent, with orders, to:

Research Centre for Social Sciences
University of Edinburgh
56 George Square
Edinburgh EH8 9JU



Sociotechnical constituencies as processes of alignment: The rise of a large-scale European information technology initiative

Alfonso H. Molina

Research Centre for Social Sciences, University of Edinburgh, Edinburgh, Scotland, U.K.

Edinburgh PICT Working Paper No. 47

The theme of this paper is the generation of technological capabilities at a European level. It analyses the recent emergence of a large-scale information technology initiative and seeks to extract some general lessons from it. The target of the initiative is the generation of an autonomous European capability in information technology. The study asks what is ultimately involved in the process in which an initially completely unaligned set of players was able to generate the programme of alignment of a capability-building initiative? The approach adopted is the sociotechnical constituencies approach, which highlights the existence of a process of alignment which gradually and programmatically integrates the stances of different organisations, and shapes technology. The empirical content consists of an analysis of the positions of, and interactions between, key players when the initiative was publicised. The paper also discusses the implications of the initiative for European integration through technology and vice versa, and the implications of general validity along with the main tactics and techniques deployed in the process leading to the successful emergence of OMI.

Paper submitted to Research Policy

1. INTRODUCTION

As the world moves forward towards the 21st century, the European Community (EC) is striving hard to gain greater self-reliance and international presence in the field of information and communications technologies (ICTs) (a, 35, 49). Policies seeking to strengthen the build up of ICT capabilities in the EC are being developed. The intention of this paper is to analyse the experience of the recent emergence of a large-scale European capability-building initiative.

In the present case, the large-scale capability-building initiative - known as OMI (Open Microprocessor Initiative) - is targeted towards the generation of an autonomous European microprocessor capability. Reflecting

Sociotechnical constituencies as processes of alignment: the rise of a large-scale European information technology initiative

Alfonso H. Molina

1993

ISBN 1-872287-54-9

The research for this paper was carried out while funding under the Economic and Social Research Council's Programme on Information and Communication Technologies (PICT). I wish to thank my colleagues at Edinburgh University, particularly James Fleck, for their support and illuminating discussions.



Sociotechnical constituencies as processes of alignment: The rise of a large-scale European information technology initiative*

Alfonso H. Molina

Research Centre for Social Sciences, University of Edinburgh, Edinburgh, Scotland, U.K.

The theme of this paper is the generation of technological capabilities at a European level. It analyses the recent emergence of a large-scale European information technology initiative and seeks to extract some general lessons from the experience. The target of the initiative is the generation of an autonomous European microprocessor capability. Many players from different nationalities and organizations participated in the definition of its programme. The study asks what is ultimately involved in the process in which an initially completely mis-aligned set of players was able to generate the programmatic alignment of a capability-building initiative? The approach adopted is the sociotechnical constituencies approach, which highlights the existence of a process of alignment which gradually and programmatically integrates the stances of different organizations, and shapes technology. The empirical content consists of an analysis of the positions of, and interactions between, key players when the initiative went public in Brussels. It reveals a process of European integration through technology and vice-versa. Finally, the paper identifies aspects of general validity along with the main tactics and techniques deployed in the process leading to the successful emergence of OMI.

I INTRODUCTION

As the world moves forward towards the 21st century, the European Community (EC) is striving hard to gain greater self-reliance and international presence in the field of information and communications technologies (ICTs) [8, 35, 49]. Policies seeking to strengthen the build up of ICT capabilities are being devised and implemented in order to enhance the region's positions in the global competitive arena. The intention of this paper is to analyse, and extract some general lessons from, the experience of the recent emergence of a large-scale European capability-building initiative.

In the present case, the large-scale capability-building initiative - known as OMI (Open Microprocessor Systems Initiative) - is targetted towards the generation of an autonomous European microprocessor capability. Reflecting

*The research for this paper was carried out with funding under the Economic and Social Research Council's Programme on Information and Communication Technologies (PICT). I wish to thank my colleagues at Edinburgh University, particularly James Fleck, for their support and illuminating discussions.



the widespread concern for Europe's weakness in this critical area, many players from different nationalities participated in the programmatic definition of the initiative, including companies, universities, laboratories, users, suppliers, competitors and government institutions. The process was essentially consensual and the common programme took around two years of complex and laborious negotiations to complete. Without such a common programme the whole initiative would have collapsed. Instead, agreement was reached and the document containing the programme became the first definite milestone of success in the evolution of the overall microprocessor capability-building process. Of course, from programmatic agreement to actually changing the world, there is a long and uncertain way, and success regarding the ultimate goal can hardly be guaranteed. At this stage, one can only say that the first major hurdle has been overcome - and that the agreement is the first product to result from, and indeed crystallise, a state of alignment of interests between all the diverse parties in the process. It is a snapshot of the early state of development of a collective European effort.

Below, my concern is precisely with the process leading to this first product, and hence with the shaping of the programmatic alignment of the emerging capability. Specifically, I want to look at how does a diverse range of interests, involving even competing companies, evolve into a coherent European programme? Or, what is ultimately involved in the process in which an initially completely mis-aligned set of players is able to generate the programmatic alignment of a capability-building initiative? Ultimately, I hope that by providing an answer to these sort of questions, the study will highlight the intrinsic role of human behavioural processes in the formation and development of technological capabilities.

I have argued that 'the generation of technological capabilities is a complex process in which technical and economic factors and trends interact with individual and institutional actors' expertise, visions, interests and cultural dispositions in a context of evolving market and political pressures.'^[38] In the process I am about to examine, we shall see the presence of most of these elements - working through and influencing perceptions, goals, decisions and, generally, the role of the individuals actually materialising the institutional interaction leading to the programme. Thus, the story will be

largely one of technological capabilities as a techno-political and behavioural process: a story of people, leadership, conflict, negotiation, pressures and understanding. It is a story framed in the context of an evolving European integration; a story of individual and collective behaviour, of nationalities coming together around a common goal: an autonomous European microprocessor capability.

Let me sharpen the focus of the discussion by identifying some of the main features characterizing the initial situation of the process leading to the initiative. This is important since it will help us not just to define more clearly the nature of the problem but, also, to identify some available concepts which may be useful to its treatment. As I see it, the following is the starting point:

- a) Some of the European semiconductor companies are suppliers of microprocessors, but none is a major force in a world market dominated by US companies. Thus, Europe is highly dependent on foreign sources.¹
- b) Many independent institutional players (from different countries), have a stake in microprocessors, but there was no organised or concerted interaction in pursuit of a European goal. In short, no targetted capability-building effort and hence, no overall organization for this purpose was in existence.
- c) Given (a) and (b), any attempt at a European targetted capability-building effort would be required to respond to the interests, expertise, and concerns of at least the major European players (suppliers, users, the Commission, etc.) in the microprocessor scene. In other words, a process of programmatic integration of these players' interests and demands would be necessary, and serious disagreements would be expected, especially among the institutions promoting competitor technologies.
- d) There was little that could facilitate or guide any such process of programmatic integration. For instance, no formal relations of authority

¹In 1988, European imports of microcomponents [i.e. general purpose microprocessors, microcontrollers and peripheral logic] totalled \$992M (representing 82% of the European market). [14, p.4].

existed among the institutional players: it would all be down to creative consensus-building. Also, the history of targeted capability-building initiatives on a European scale was rather recent. This meant that little accumulated experience, let alone systematic reflection, was available - not just to draw attention to potential risks and pitfalls but, also, to suggest positive approaches to progress. To a large extent, any process of programmatic integration would be a pioneering journey of discovery.

Given these 'initial parameters', and particularly the last point, it is not an overstatement to say that the nature and mechanisms of the processes leading to the generation of a large-scale European initiative are not well understood. Significant systematic work on these initiatives is needed. Their growing importance in the current evolution of the Commission of the European Communities's (CEC) policy towards ICTs is enough to justify such a demand [6, 8]. This paper attempts to contribute to such an endeavour by exploring the potential of the 'sociotechnical constituencies' approach. This approach has been used to deal with issues relating to the build up of technological capabilities [34, 36, 38]. In particular, I want to explore its potential in relation to the process of programmatic integration. This will require: a) the identification of conceptual tools to try to make sense of this process within a context of constituency-building; b) the implementation of this approach to the particular case-study of the OMI capability-building process.

Obviously, one does not start afresh. Many conceptual elements relevant to the problem exist and can be found scattered in studies from different disciplines. For instance, the recognition of the critical importance of goals, perceptions, conflict, negotiation and coalitions clearly criss-crosses disciplinary boundaries as analysts converge on such problems as the nature of decision-making or the development of the organization. In particular, it is possible to identify complementarities, overlappings, and convergences between various behavioural, sociological, historical, evolutionary economics and political science approaches.² This convergence of disciplinary insights also applies to the treatment of technological and policy processes. Thus, among other aspects, established are the sociotechnical nature of

²A review of important contributions from these various approaches is found in Molina [39].

technological processes;³ their socially shaped (constructed) character [3, 4, 29]; the importance of community-building [32, 57], network-building [13, 24, 26, 32, 40, 57] system building [19, 20, 50], and heterogeneous engineering [25]; the importance of interpretative flexibility [43], credibility [28], enrolment [5], power relations [22, 42]; and the fact that technology also plays a role in determining the character of networks/systems [19, 25, 29, 48]. In spite of the advances, however, I think it is fair to say that there is still a major requirement for refining and developing systematic approaches which help to make sense of complex technological processes by integrating concepts in an analytically operational way.

Observe, for instance, the use of concepts such as networks, communities and systems. It is far from uncontroversial. Not only is there a great variety of meanings attached to them [45].⁴ Also, most of the meanings have yet to develop a set of conceptual tools which makes them analytically operational beyond the metaphor - and for a general class of technological processes.⁵ A similar situation is found with the concept of 'heterogeneous engineering' [25] in spite of the appealing image conveyed by the metaphor. Just as communities/networks, this concept also lacks a set of conceptual tools which would make it analytically operational beyond the metaphor.⁶ True, the

³The sociotechnical school of thought has a long tradition that can be traced right back to Marx and his dialectical materialist analysis of the development of productive forces/social relations of production within capitalism. Since then, many scholars have understood technology not only as a social process embracing and interrelating devices (i.e., tools, machines, products, etc.), people, organisation, procedures, etc. but, also, as a process inseparable from society at large. In this view, society and technology reciprocally influence each other's development. See MacKenzie [27], Mishra [33] and Rosenberg [47] for Marx's conceptualisation of science and technology. A brief review of some important contributors to the sociotechnical tradition is found in Molina [34]. The work of the Tavistock Institute in the 1950s [55] is often associated with the concept of socio-technical systems as an attempt to deal with the relations between the technical and human aspects of work organisation.

⁴For Freeman [16] network activities are not new, they have long been part of industrial practice. The difference is the much wider scale of the networking processes of recent times, due to the diffusion of the information technology techno-economic paradigm.

⁵In a special *Research Policy* issue on networks, DeBresson and Amesse [11] argue for the incorporation of transaction-cost analysis in network approaches. For 'transaction cost' analysis, see Williamson [56]. On the other hand, political science approaches have attempted to develop taxonomies of networks [32, 46, 57] and, recently, Law and Callon [26] have distinguished between global networks and local networks in their analysis of the shape and fate of technological projects.

⁶Sørensen and Levold [54] have recently made the point that it is necessary now to move beyond just demonstrating heterogeneity.

concept of *sociotechnical constituencies*, which I purport to use here, also conveys a metaphorical image although, in reality, *constituency* is derived from *constituent-elements* and the complete phrase -sociotechnical constituencies- is designed to encapsulate the *ensemble of all constituent-elements* playing a part in the creation, production and diffusion of technologies.⁷ The relevant factor with the constituencies approach, however, is its gradual evolution towards the kind of systematic analytical environment which I have mentioned earlier.⁸ As we shall see below, 'constituencies' could be for any technological process. It adopts relevant insights from different disciplines and tries to develop new ones where this is convenient or necessary. For instance, the following discussion relies heavily on the behavioural concepts of perceptions and goals [10, 31, 53] as well as on the sociotechnical tradition of conceptualising technology. At the same time, the approach aims for consistency in both substance and language.

II SOCIOTECHNICAL CONSTITUENCIES

The sociotechnical constituencies approach starts from the premise that the generation of technological capabilities is a complex process in which technical and economic factors and trends interact with individual and institutional actors' expertise, visions, interests and cultural dispositions in a context of evolving market and political pressures [36]. Its aim is to provide a focus and an analytical environment -and set of conceptual tools- for a 'selective multidisciplinary' treatment of technology. Integration is a key word since the approach seeks to facilitate, on the one hand, the integration of new insights with relevant insights from different disciplines, and, on the other, the integration of the treatment of various issues and factors involved in technological processes. As illustrated in Figure 1, the 'constituencies' approach puts technology at the centre of the analysis, and the meaning of

⁷The term 'constituencies' is often found in the literature. By and large, however, it is used to refer to groups of people who are actual or potential players in the process of development of a technology.

⁸It must be noted that the development of conceptual tools for the 'sociotechnical constituencies' approach is a continuous process. In this sense, the approach is more like an unfolding programme of research. For instance, other work has developed concepts to enable an integrated analytical treatment of techno-economic trends from product to industry. Also, initial work has been done to conceptualize the role played by the specific nature of technology in the evolution of technological processes and industries [38].

technology (T) is not confined to a single specific product or process. Indeed, in this case the concern is with a capability-building initiative involving a range of microprocessors.

*Sociotechnical constituencies may be defined as dynamic ensembles of technical constituents (expertise, tools, machines, etc.) and social constituents (people and their values, interest groups, etc), which interact and shape each other in the course of the creation, production and diffusion of specific technologies.*⁹ Thus, the term 'sociotechnical constituencies' emphasises the idea of interrelation and interaction in technological development. It makes it possible to think of technical constituents and social constituents but always stresses the point that in the technological process both kinds of constituents merge into each other. This differentiates 'constituencies' from those versions of 'communities' and 'networks' which refer to people only. But constituencies are also different from 'actor-networks' which put both the animate and the inanimate in the same category of 'actors'. In 'constituencies', the constituent parts are all 'constituents' of the process, but it is only the social constituents who are the creators, the drivers, or 'purposive' - to use Mulder and Vergragt' term [40]. *Sociotechnical constituencies are never static, they are always evolving and changing their mix in ways which are reflected in growth or decline. A manifestation of this change may be seen, for instance, in the evolution of market shares of a constituency's products. But this is only one possible manifestation, because some constituencies may not be geared to the market at all, or simply fail to reach it. Thus, although a market share always implies the existence of a constituency, the opposite is not necessarily true.*

Within constituencies institutional interaction may be competitive, collaborative or a combination of both. In addition, this interaction may involve institutions of the same type (e.g. a number of companies) or institutions of different types (e.g. companies, universities, government). It may take place at a national or international level. Mechanisms of

⁹A recent paper seems to provide support for making sociotechnical constituencies the focus of technological analysis. 'I argue that we have move so far now that the original definition of *technical artefacts*...is too narrow. Instead, I propose to take *sociotechnical ensembles* as the unit of analysis.' [2, p.117]

collaboration may include business alliances or second-source agreements, but there might be constituencies with no such arrangements. The balance between collaborative or competitive interaction will fundamentally affect the evolution and dynamism of the resulting sociotechnical constituency. For example, competitive interaction between companies may stimulate technological dynamism by injecting a sense of urgency and threat. It may simultaneously lead to fragmentation of resources - and discourage constituents from addressing problems (often long-term) which are perceived as being beyond the resources of each individual constituent.

Collaboration may counteract this harmful fragmentation of resources, but it demands a careful approach; each institution is likely to have different interests, imperatives and expectations, dictated by its history, its current activities, and possibly by its ethical stance as well as by idiosyncratic practices. It is possible to regard institutional interaction as the interaction of a number of micro-cultures.

In this analysis, the extent to which any given technology is diffused is conditional upon the relative success or failure of the sociotechnical constituency creating and promoting it. *The success or failure of the sociotechnical constituency in turn depends largely on the ability of the constituents to strike a balance between their individual interests and the development of the constituency as a whole.*

Sociotechnical constituencies have certain essential features, which are highlighted in the example of Figure 1:¹⁰

1 The double-ended arrows indicate that *influence may be bi-directional*: from the inner circle of technology (T) towards the outer circles and vice-versa, in a single fluid process.

¹⁰It is worth stressing that not all sociotechnical constituencies will have the same mix of institutional constituents as the one exemplified in the diagram. For instance, some of them may be just national, some may not have any military constituent at all, etc. The variety can be infinite.

2 Moving outwards from the first, central circle (T), the second circle indicates that *technology is conditioned by the opportunities and constraints imposed by the physical world and its own nature and state of the art at any given time*. In other words, technology can only be shaped within the realm of the shapeable, or, 'the malleable' to use Law's term [25].

3 The third circle indicates that *technologies generally result from the integration of time and space, and human, material and financial resources*. These resources are not static quantities, but change continuously as the sociotechnical constituency evolves. A single new idea generated by an individual implies a change in the constituency.

4 The fourth circle shows that this *integration of resources is effected through the interaction of institutions*. Since these social constituents control the resources (directly or indirectly), they are able to influence the manner in which the resources are integrated. This allows them to shape the development of a given technology in accordance with their own interests, and generally in accordance with their relative weight within the constituency.

Thus, institutional constituents with control of resources make those resources available to further the development of a given technology because the development of that technology is perceived as furthering their own interests, as well as the various interests of collaborating constituents.

Despite their perception of benefit, institutions participating in a sociotechnical constituency do not invariably have a clear idea of where their specific interests lie in relation to a given technology. Nor does the development of this technology invariably follow the intended path or yield the results expected by the constituents. Often, unpredictable and possibly unidentifiable factors have unintended consequences which make the difference between success and failure. This uncertainty is inherent in the technological process, particularly where constituents are trying to break completely new technological ground.

II.1 Constituency-building as a process of alignment

How is it that large-scale sociotechnical constituencies are created? How does a diverse range of interests, involving even competing companies, evolve into a European capability-building initiative? What is ultimately involved in the process whereby different parties become constituents of a targeted technological programme?¹¹ Earlier, I defined the broad parameters characterising the initial situation of the OMI constituency-building process. These are important because they define the empirical terrain and hence, the potential for application of some of the available concepts. For instance, concepts such as 'interpretative flexibility' and 'closure' [43], where technological variants or alternatives die as a result of one variant becoming successfully established over competitors - are of limited applicability. In fact, by definition, large-scale constituency-building in a European collaborative dimension involves not a closure *à la* Pinch and Bijker, but the search for programmatic alignment between various, even competing, constituencies. In this respect, much more relevant is the realization that a programme is an outcome of a process of conflict and coalition-building, in which different perceptions and goals, bounded rationality, and negotiation are intrinsic to players' interaction [1, 10, 18, 41, 52, 53].

An important part of this analysis is the concept of *bounded rationality* [53]. This is a critique to the rationalistic model of human behaviour assumed by neoclassical economics which treats firms as if they were guided by managers who are able to weigh all the options and take the most rational or optimal decisions in accordance with maximizing principles, such as 'profits'. Simon propounded a humbler reality of 'human beings who *satisfice* because they have not the wits to *maximise*.' [53, p.xxiv]

¹¹A similar problem is identified by Nelson and Winter [41] in relation to the firm, '...to understand the behavior of the firm as a whole in terms of the divergent interests of various constituencies and the specific procedures by which those interests interact to produce the actions of the firm as such.' (p.57) These authors suggest, however, that, in empirical application, this line of theorization would suffer from 'limitations of access to data on the nature of constituent interests and on the structure of the internal political process - and also, when such access is possible, on the complexity of the phenomena and relative remoteness from the crude and aggregative measures of overt firm behavior with which the economist typically wants to deal.' (pp. 58-59) Nelson and Winter themselves take a different path into their evolutionary theory of economic change.

The thesis argued in this paper develops the sociotechnical constituencies approach into the area of *alignments and mis-alignments* in capability-building initiatives. It is based on the premise that the successful emergence of large-scale European initiatives implies a process of alignment which programmatically integrates the stances of different organizations. In addition, these organizational stances are not monolithic. They are articulated by individuals (i.e. representatives) and different individuals from the same organization may articulate different stances, or, they may articulate differently what looks like the same stance. With this in mind, alignment is the process whereby the separate players evolve a feasible programme *satisficing* the interests of each and everyone of them. Implicit here is the possibility of exclusion as a result of antagonistic mis-alignment. The concepts of perception- and goal-alignment (and mis-alignment) are crucial to analyse this process.

II.1.1 Perception- and goal-alignment

A situation of *perception-alignment* will be found when two or more interacting parties understand each other, that is, explicitly or implicitly, they agree with each others' interpretations of their motives and goals. The goals themselves need not be the same and may even be contradictory. In contrast, *goal-alignment* will be found when the parties agree not just in their perceptions but, most critically, in the actual pursuit of common or complementary goals that typically implies a convergence of interests, visions, and so on. Of course, there is always the possibility that some interacting parties may mistakenly perceive that they have an alignment of goals when this is not the case. Conversely, there may be a mistaken perception of goal mis-alignment when the problem really arises from distrust and suspicion about the ulterior motives of certain players. Perceptions and goals influence each other. A distinction is made to bring home the point that perception-alignment is about the effectiveness of communication between the different parties, whilst goal-alignment is about both communication and coming together around a common cause which may produce mutual benefits.

Ultimately, processes of alignment are deeply influenced by a variety of human aspects such as past experiences, beliefs, wishes, expectations, value system, trust and so on. A particularly influential role is played by different types of expertise and specialised languages. These tend to block the effectiveness of communication and transactions [56, 44, 15] through the kind of 'blinding' effect which has been associated with scientific and technological paradigms [12].

In most situations, however, alignment needs not be across the board. In practice, and especially for a large-scale initiative, interacting parties are most certain to find that they have alignments in some areas and mis-alignment in others. Behavioural concepts of *non-operational* and *operational goals*, and *means-end hierarchy of goals* are useful in this context. Non-operational goals tend to be grand statements of purpose but vague in the steps leading to their achievements, such as seeking to increase an organisation's profit, market share or general competitiveness.¹² On the other hand, operational goals, or subgoals, are those which provide detailed specific guides for actions. Non-operational and operational goals are related to each other. Simon for instance, talk of a *means-end hierarchy of goals*, in which each level is to be considered as an 'end' relative to the levels below it and as a 'means' relative to the levels above it. This means-end hierarchy, however, is seldom an integrated, completely connected chain. In fact, the connections between activities and ultimate goals are often obscure, leaving room for conflict and contradictions regarding both the goals themselves and the means chosen to attain them. The importance of these concepts is that they highlight not just the fallacy of a monolithic optimally integrated organizational reality. Simultaneously, they highlight the potential for co-existence between partial alignments and mis-alignments within the space of non-operational and operational goals or subgoals.

Equally important, perceptions and goals are never well-defined, static inputs which, if they fit into a satisfactory arrangement, bring about a situation of stable and permanent alignment. The fact is that not only is a constituency's world always changing. Also, especially at the start of a technological process,

¹²March [30] names them *superordinate goals*.

it is unlikely that all players will have a clear idea of what their specific interests and goals are. A more dynamic view acknowledges that perceptions and goals - at different levels - may in fact be altered and created all along the players' interaction, thus making possible consensus-building. Of course, it is also likely that what started with a genuine alignment of perceptions and goals may evolve into a mis-alignment later on. For purposes of this paper, it is important to note that a capability-building initiative may follow two main paths to facilitate alignment:

(a) allowing the space for co-existence of different goals, allowing for even a workable interaction between collaboration and competition - except in the special case where completely antagonistic goals kill the entire process or lead to the withdrawal of at least one of the contending parties;

(b) recognising the changeable nature of goals and perceptions, potentially allowing for the generation of alignment where initially there was none.

II.1.2 Programmatic alignment in the European context

When relations of power and authority exist among players, this may guide and even facilitate a process of alignment or decision-making. For instance, 'dominant coalitions' have been identified [7, 10, 23] within organizations, referring 'to those who collectively happen to hold most power over a particular period of time'... and hence constitute... 'the immediate source of major structural variation in organizations.' [7, p.13] In our large-scale constituency-building, however, no such clear source of decision-making was available. There was no organization, and few formal relations, between different players. This could only be an outcome: something to be created and shaped in a process of creative consensus. The task, however, is enormous. For, although alignment may exist on a non-operational goal, the process generally starts from a situation of serious mis-alignment in both perception and operational goals. And language differences do not make the process any easier. In addition, there is the risk of effective opposition even at non-operational levels. Normally, conflicting perceptions exist as to how the CEC's resources should be invested; and the larger the scale of an initiative, the greater the concerns and scrutiny it is likely to attract. All this influences

the attitudes of people towards each other, making large-scale constituency-building a very demanding and time-consuming task indeed. Success may reward those who, within the available time and resources, are able to generate the alignment of a sizeable and credible array of forces behind a programme which is feasible both technically and politically. But uncertainty can never be removed.

In practice, several outcomes are possible as players engage in the alignment/mis-alignment dynamics underlying constituency-building:

- 1) An emerging constituency-building process may fail to solve critical mis-alignments between potential institutional constituents, thus faltering on the way and eventually disappearing.
- 2) An emerging constituency is able to attract many and key European players who develop an interest in making it happen but, simultaneously, try to shape it in accordance with their own perceptions, expertise, interests and goals. In this case, the initial state of mis-alignment gives way to a process of perception- and goal-alignment - with the initial programme changing to reflect the incorporation or alignment of the new interests. The broader programmatic alignment often represents the *best possible* constituency-building solution at that point in time.
- 3) Key aspects of an emerging constituency-building process' strategy and goals are challenged by other European players promoting competing visions and, most probably, technologies. If the emerging constituency has already established enough momentum not to be stopped, two situations may develop:
 - a) No alignment is found and the opposition is not strong enough to impose fundamental changes. Eventually, the opposition drops out of sight.
 - b) At least partial perception- and goal-alignment is found (in the context of the broad programme) and the competition drops their objection to those key aspects they disagree with. The competition

joins the constituency-building process on the basis of the partial alignment, thus gaining the opportunity to shape the course of its development.

What will determine one result over another is extremely difficult to predict. All constituency-building has a major dose of specificity, idiosyncrasy and contingency. The means, tactics and alignment-solutions generated in one-constituency-building process will reflect this condition. Nevertheless it is possible to identify some elements of general validity, which, if not inexorable, may at least be a useful guide for processes pursuing similar programmatic alignment.

1) Having an appealing non-operational goal.- Large-scale constituency-building involving Brussels is almost certain to benefit from targetting on non-operational goals of recognised strategic importance for the European Communities. These are made visible through a variety of issues such as trade deficits, competitiveness, security, environment, and so on. The perceived importance of these issues varies with time and circumstances, but the fact of their importance for setting the overall vision and direction of constituency-building is a constant. For instance, in the case of microprocessors, their visibility is related to both a large trade deficit, and the fact that the technology is recognised as critically important for the future of European industry. Nevertheless, an appealing non-operational goal is never enough, and the challenge for constituency-building consists precisely in transforming the opportunity it provides into an programmatic alignment which is technically, commercially and politically operational.

2) Setting the game-board and building initial momentum.- A large-scale European sociotechnical constituency seldom starts from zero. They are more likely to start from the convergence or alignment of a few already existing constituencies seeking further avenues of growth. This means that many technical and social constituents are available to build upon, and, indeed, to build into the new emerging constituency. Building large-scale constituencies via Brussels, however, will normally demand broad European involvement, and should especially try to involve key industrial (techno-political) players in the field - if they are not part of the process already. Some of the new

What will determine one result over another is extremely difficult to predict. All constituency-building has a major dose of specificity, idiosyncrasy and contingency. The means, tactics and alignment-solutions generated in one constituency-building process will reflect this condition. Nevertheless it is possible to identify some elements of general validity which, if not inexorable, may at least be a useful guide for processes pursuing similar programmatic alignment.

1) Having an appealing non-operational goal. - Large-scale constituency-building involving Brussels is almost certain to benefit from targeting on non-operational goals of recognised strategic importance for the European Commission. These are made visible through a variety of issues such as trade deficits, competitiveness, security, environment, and so on. The perceived importance of these issues varies with time and circumstances but the fact of their importance for setting the overall vision and direction of constituency-building is a constant. For instance, in the case of microprocessors, their visibility is related to both a large trade deficit and the fact that the technology is recognised as critically important for the future of European industry. Nevertheless, an appealing non-operational goal is never enough and the challenge for constituency-building consists precisely in transforming the opportunity it provides into a programmatic alignment which is technically, commercially and politically operational.

2) Feeling the come-proud and building initial momentum. - A large-scale European sectoral constituency seldom starts from zero. They are more likely to start from the convergence or alignment of a few already existing constituencies seeking further avenues of growth. This means that many technical and social constraints are available to build upon and indeed to build into the new emerging constituency. Building large-scale constituencies via Brussels, however, will naturally demand broad European involvement and should especially try to involve key industrial (techno-political) players in the field - if they are not part of the process already. Some of the new

players, however, may be building strong competing constituencies of their own. Thus, although the rewards can be substantial for the initiators of the process, they run the risk of losing control of the initiative away from their interests and goals. If this risk is to be reduced, it is then critical for these players to ensure a strong positioning in the initial stage, prior to opening or expanding the constituency-building process to the entire European arena. This will require the simultaneous implementation of at least the following actions. Gain and keep control of the development of the proposal which will set the foundations for the future constituency-building process. And, second, privately try to generate an initial momentum for the constituency on the basis of alignment with friendly and bilateral contacts. If successful, the initiative and the agenda will tend to remain with the original players, who are thus advantageously positioned to shape significantly the course of the capability-building process. The *de facto* result is that important parameters defining the shape and direction of the technological entire process are already congealing at a very early stage

3) Knowing, making good use of, and adapting to the rules of the Brussels-game. - It is always important for an emerging constituency to know the terrain within which its fate will be decided. Leading players must strive to possess, or at least to have easy access to, the best possible contacts and knowledge of the mechanisms and rules defining the limits and opportunities available at every time. Here, previous experience in European collaborative projects can often make a great deal of difference in the effort to establish an early momentum. Critical to the alignment (and shaping) of a constituency-building process is the presence of constituency-

4) European expansion through perception-building. - Images, impressions and rhetorics always play an important role in the early days of a constituency-building process. At a time when many aspects may be just promises, and ultimate goals little more than statements of faith, the promotion of belief in the potentiality of the process becomes a critical constituency-building activity. All the more so, in the case of a Brussels-based large-scale European initiative which must capture and generate the interest of a tremendous variety of people, most of whom have their own constituency-building agenda. In this arena, once an emerging large-scale constituency becomes visible, it simply must generate the right perception

quickly. The rationale is simple: for a constituency to happen the perception must precede the fact. If potential constituents perceive that something may come out of the process, they at least tend to stick around in a way which at least helps the numbers. Others may decide to join in more actively in order to have their say in shaping the process. Others may come in to stop it, and end up joining in. All this may eventually lead an original 'something-important-may-happen-here' perception to become self-fulfilling. Use of authority, charisma, recognised expertise, appeal to potential participants' interests, and, even minor acts of 'deception', are all legitimate forms of building the right perceptions and, ultimately, the constituency itself.

5) From initial perception-building to perception-alignment.- From the initial perception of interest to more detailed perception- and goal-alignment, there is a world of difference and, indeed, of constituency-building to implement. Players may agree with each other in the non-operational goals, and may even perceive that there might be something for them in joining a particular technological process. But this 'something' is likely to be far from aligned or complementary to what other players may have in their minds at the level of operational goals. Of course, they may all want funding, but this is likely to be for activities which are fragmented and disjointed from each other. And this is precisely the *raison d'être* of the alignment process: transforming the separate pieces into an effective, techno-politically feasible, programme which satisfy the interests of all the participants.

6) Presence of active constituency-builders.- Critical to the alignment (and shaping) of a constituency-building process is the presence of constituency-builders, who are able to integrate the systemic diversity of inputs required to steer a constituency in a given direction. These players normally have a major influence in structuring the vision imprinted in the original proposal, and then in promoting the alignments which keep the constituency-building process on a feasible and consistent course. They often command expertise and respect which give weight and authority to their opinions and actions, but there might also be constituency-builders who gain their reputation in the process itself. Of course, constituency-builders cannot shape or manoeuvre processes at will. Like everybody else, they are not beyond the constraints of relative power, contradictions and limited resources. Thus, in a European

quickly. The rationale is simple: for a constituency to shape the perception must precede the fact. If potential constituents perceive that something may come out of the process, they at least tend to stick around in a way which at least helps the numbers. Others may decide to join in more actively in order to have their say in shaping the process. Others may come in to stop it and end up joining in. All this may eventually lead to an original 'something' important may happen here: perception to become self-reinforcing. Use of authority, charisma, recognized expertise, appeal to potential participants' interests, and even minor acts of deception, are all legitimate forms of building the right perceptions and, ultimately, the constituency itself.

2) From initial perception-building to perception-alignment - from the initial perception of interest to more detailed perception- and goal-alignment, there is a world of difference and, indeed, of constituency-building to implement. Players may agree with each other in the non-operational sense and may even perceive that there might be something for them in joining a particular technological process, but this 'something' is likely to be far from aligned or complementary to what other players may have in their minds at the level of operational goals. Of course, they may all want funding, but this is likely to be for activities which are fragmented and disjointed from each other. And this is precisely the reason why the alignment process - transforming the separate pieces into an effective, techno-politically feasible programme which satisfies the interests of all the participants.

3) Process of active constituency-builders - Critical to the alignment (and shaping) of a constituency-building process is the presence of constituency-builders, who are able to integrate the systemic diversity of inputs required to steer a constituency in a given direction. These players normally have a major influence in structuring the vision imparted in the original proposal, and then in promoting the alignment which keeps the constituency-building process on a steady and consistent course. They often command expertise and respect which give weight and authority to their opinions and actions, but there might also be constituency-builders who gain their reputation in the process itself. Of course, constituency-builders cannot shape or manoeuvre processes at will. Like everybody else, they are not beyond the constraints of relative power, contradictions and limited resources. Thus, in a future

consensus-based initiative, their shaping influence is firmly tied to the need for alignment of other players' (maybe also constituency-builders') interests. This is something constituency-builders understand and accept. Furthermore, they would in fact expect that, as potential institutional constituents join the process, the original vision will be challenged, enriched, modified, and, if successful, given a detailed programmatic substance which will represent the alignment of goals and interests of all parties in the constituency.

In this process, the key role of constituency-builders can be described as that of 'perception- and goal-aligners'. For, a lot depends on their ability to identify the mis-alignments and their roots, approach them constructively, trying to find, or even create, the common or potential spaces which will allow for an evolution into alignment. Or, when this proves impossible, simply contain the harmful and disruptive effects which antagonism can create in a constituency-building process. Questions such as the following summarize the kind of issues these players - explicitly or implicitly - are likely to face in their pursuit of successful constituency-building.

To what extent is the problem one of mis-alignment of perceptions rather than of goals or is it both?

If there is a mis-alignment of goals, is this completely antagonistic or could spaces be found which would allow for some degree of alignment and, hence collaboration? Can goals evolve in such a way that a common space is created? What are the limits of the negotiable, the flexibility for give-and-take, in the build up of the constituency?

To what extent is the problem really one of perception mis-alignment rather than an antagonistic positioning of contending scenarios? If a visible mis-alignment of perceptions exists, how can this be approached? How can a rapport be created in such a way that communication, and eventually alignment, may be facilitated? If visions, interests, and expertise differ widely how may people begin to relate to each other? Is it even possible within the time constraints of the constituency-building process?

If mis-alignment of goals and/or perceptions between a few parties is proving disruptive to the constituency-building process, what is the best approach to counteract its 'dissociating' effect and hence, prevent the overall alignment-process from becoming derailed altogether?

Since goals and perceptions are not static elements, once a process of alignment has made progress, how can it be kept from falling back into mis-alignments which could threaten the hard-won momentum of a constituency? Is it possible to generate a sort of tendency or inertia which may surreptitiously work in favour of the build-up of the constituency?

Whether consciously or not, these issues are likely to inform all along (and in one way or another) constituency-builders' actions in large-scale European constituency-building processes. It is in response to these problems that they implement tactics such as Latour's translation tactics, or other more specific ones. In what follows, a few key contentious situations are described and the way in which they were successfully treated in pursuit of programmatic alignment. We shall see how the results were imprinted in the shape of the (overall) initiative's technology, transforming the strategic direction of the original proposal and, ultimately, reflecting the progress made in terms of perception- and goal-alignment.

III OMI CONSTITUENCY-BUILDING PROCESS: THE PUBLIC PHASE

The story is taken up at the point when the constituency-building process of the Open Microprocessor Systems Initiative (OMI) went public in Brussels. Until then, most of the advances had been the result of rather private negotiations, often involving already interrelated companies. The real test was coming. This was the series of Industrial Working Group (IWG) workshops which threw the process wide open in Brussels. For the constituents leading the process, this was a time of considerable uncertainty, but with momentum already gathering, they expected the workshops to lead to a final programme which would make the initiative official. This process was envisaged to last for a year, roughly, until the end of 1991. If successful, the final programme would be submitted for the Commission's approval during the first half of 1991, and it would become part of the 1991 ESPRIT

Workprogramme. This would then be followed by a call for specific project proposals (within the agreed aims of the programme), which was estimated to take place by mid-1991, and the first projects would start around November of the same year.¹³ This was the approximate time frame the constituency would have to aim for. It would be more than two years, since the time when the first contacts were made with the Commission back in late 1989. Two years is a long time for constituency-building in microprocessors, but there was little the players could do about it. The time frame was set by the *modus operandi* of the ESPRIT programme and its process of consensus-building. Of course, the compensating factor was the potential scale of the initiative which, ideally, would ensure a speedy diffusion of the technology when this eventually reaches the market. The point was not to miss the deadlines imposed by the time frame, since this would probably bring the whole process into serious questioning. And, as we shall see, constituency-building via open workshops is not a straightforward affair.

III.1 IWG Workshops

'The reason for the workshops is to start making progress towards a plan but, of course, as much a reason as anything is to bring people together, and get them to talk to each other.'¹⁴ This is how one player described the purpose of the IWG workshops. In the workshops, however, the constituency-building process becomes open and every European player with an interest is entitled to participate and have their say for or against an emerging constituency. Thus, workshops can be both rewarding and risky constituency-building mechanisms. They may lead to a rapid expansion of the emerging constituency or to its demise. But for the Commission, workshops are certainly a useful device both technically and politically. On the one hand, they help to test the validity of an idea by subjecting it to a public-consensus process which, at the same time, represents an opportunity for all European players to participate. Thus, if a successful alignment occurs, workshops tend to act as 'fishing nets' for the catchment of the best European institutions may have to contribute. On the other hand, by their very nature of consensus-

¹³As it happened, the first projects only started around May 1992, following a longer-than- envisaged period of evaluation and funding negotiations.

¹⁴Interview with D. May, Inmos, 1990.

workshops. This would then be followed by a call for specific proposals (within the agreed time of the programme which was estimated to take place by mid-1991, and the first projects would start around November of the same year). This was the approximate time frame the constituency would have to aim for. It would be more than two years, since the time when the first contacts were made with the Commission back in late 1989. Two years is a long time for constituency-building in microprocessors, but there was little the players could do about it. The time frame was set by the nature of the ESPRIT programme and its process of consensus-building. Of course, the compensating factor was the potential scale of the initiative which, ideally, would ensure a speedy diffusion of the technology when this eventually reaches the market. The point was not to miss the deadline imposed by the time frame, since this would probably bring the whole process into serious questioning. And as we shall see, constituency-building via open workshops is not a straightforward affair.

III.1 IWG Workshops

The reason for the workshop is to start making progress towards a plan for course as much as a reason as anything is to bring people together and get them to talk to each other. This is how one player described the purpose of the IWG workshops. In the workshop, however, the constituency-building process becomes open and every European player with an interest is entitled to participate and have their say (or to against an emerging constituency. Thus workshops can be both rewarding and risky: constituency-building mechanisms. They may lead to a rapid expansion of the emerging constituency or to its demise. But for the Commission workshops are certainly a useful device both technically and politically. On the one hand, they help to test the validity of an idea by subjecting it to a public consensus process which at the same time represents an opportunity for all European players to participate. Thus if a successful agreement occurs, workshops tend to act as rallying points for the catchment of the best European institutions may have to contribute. On the other hand, by their very nature of consensus

¹⁵As it happened, the first projects only started around May 1991, following a longer than envisaged period of evaluation and funding negotiations.
¹⁶Interview with D. King, January 1990.

building mechanisms, workshops tend to protect the Commission against such common charges as being involved in 'picking winners'. The process is open to all European institutions (and increasingly non-European institutions which genuinely wish to contribute) and, in practice, the winners are simply those who are more successful in building alignment around their own constituencies. Such a process is beyond the control of the Commission itself. True, the Commission may provide, at a certain point, the arena, the opportunity, and the catalytic lure of funding and prestige for emerging constituencies. But only the players promoting the technology can truly make it happen.

For the emerging OMI constituency this was no different. The series of workshop which took place in 1990 attracted not just the support of some players, but also the scrutiny, criticism and opposition of others. Of course, the groundwork and advances already made by the originators of the constituency would make it difficult for any alternative scenario to succeed in taking over the direction of the process already in motion. More likely would be a modification of the original proposal as the parties would confront their positions and, if amenable, find the space for alignments which would transform pure confrontation into collaboration/competition.

III.2 The State of Play at the Start of the Workshops

As players converged within the workshops, it is important to recap that some important pieces (and rules) of the constituency-building game had already been positioned on the Brussels board. In particular, there was alignment at the level of non-operational goals: the desirability for Europe to possess an autonomous microprocessor capability was widely recognised in European circles. Taking advantage of the opportunity, the two microprocessor constituencies of European origin - the Transputer and the ARM (Acorn RISC Machines)¹⁵ - had joined forces - and had initiated, gained,

¹⁵The Inmos' transputer and the Acorn Risc Machine (ARM) are the main European microprocessors currently in the market. They are of British origin, but now much more pan-European as Inmos has become part of the Franco-Italian company SGS-Thomson and Acorn part of the Italian company Olivetti. Although the ARM and the transputer belong to the general class of RISC (reduced instruction set computers) microprocessors, they show significant technical differences, since they were conceived to address different sectors of the

and kept control of the development of a concrete proposal. Not unexpectedly, this initial proposal reflected primarily the alignment of these two constituencies, including the strong European emphasis on its name: European Microprocessor Initiative (EMI). A key technical element was the idea of developing hardware and software (including design tools) to interface and communicate the ARM and the transputer. This technical constituent crystallised the alignment of the two initiator constituencies, with the potential result that Europe could then provide silicon systems incorporating one or more of these processors in combinations which would be the most appropriate for the tasks at hand. The EMI proposal became the centre around which the IWG workshops would debate. In sociological terms, the transputer and the ARM had made it an 'obligatory point of passage',¹⁶ simultaneously, ensuring for themselves an advantageous position to shape the course of the large-scale initiative. Most importantly, these two aligned constituencies had also succeeded in establishing two 'beach-head' projects which were explicitly spearheading the initiative with the support of the Commission. These are project GP-MIMD (General Purpose Multiple Instruction Multiple Data), and project EMI-MAP (European Microprocessor Initiative - Microprocessor Architecture Project). The main aim of GP-MIMD is the development of a standard parallel-processing machine architecture and standard applications support interfaces. The main aim of EMI-MAP is to initiate the long-term activity of the large-scale initiative by defining an architecture for scaleable general purpose parallel computing.

The other potential alternative constituencies had nothing of the kind. These were the alternatives coming from ACRI (Advanced Computer Research Institute), a young company created in November 1989 by J. Stern (ex-

microprocessor market. Thus, the ARM provides support for conventional general-purpose *sequential processing* and it was created by Acorn for use in its low-cost workstations. Whereas, the transputer was created by Inmos to compete in the general purpose 32-bit microprocessor market, and, in contrast to the ARM, the objective was the production of a high-performance chip for *single or multiprocessor applications*. Much has been written on the transputer in recent years. For an examination as well as bibliographic references, see Molina [36]. The ARM has received much less attention than the transputer, perhaps because Acorn is a computer and not a semiconductor company. For an architectural review of the ARM, see Furber and Wilson [17].

¹⁶'Obligatory point of passage' would relate to the process whereby technologists and institutions succeed in making their products a necessary reference for other people [5, 26].

and kept control of the development of a concrete proposal. This
unexpectedly, this initial proposal reflected primarily the alignment of these
two constituencies, including the strong European emphasis on its name.
European Microprocessor Initiative (EMI). A key technical element was the
idea of developing hardware and software (including design tools) to interface
and communicate the ARM and the transputer. This technical consensus
crystallised the alignment of the two initiator constituencies, with the
potential result that Europe could then provide silicon systems incorporating
one or more of these processors in combinations which would be the most
appropriate for the tasks at hand. The EMI proposal became the centre
around which the IWG workshops would debate. In technical terms, the
transputer and the ARM had made it an obligatory point of passage, to
simultaneously, ensuring for themselves an advantageous position to shape
the course of the large-scale initiative. Most importantly, these two aligned
constituencies had also succeeded in establishing two 'beach-head' projects
which were explicitly spearheading the initiative with the support of the
Commission. These are project GP-MIND (General Purpose Multiple
Instruction Multiple Data) and project EMI-MAR (European Microprocessor
Initiative - Microprocessor Architecture Project). The main aim of GP-MIND
is the development of a standard parallel-processing machine architecture
and standard applications support interfaces. The main aim of EMI-MAR is to
initiate the long-term activity of the large-scale initiative by defining an
architecture for scalable general purpose parallel computing.

The other potential alternative constituencies had nothing of the kind. Their
were the alternatives coming from ACRI (Advanced Computer Research
Institute), a young company created in November 1989 by J. Stern (ex-

microprocessor market. Thus, the ARM provides support for conventional general purpose
sequential processing and it was created by Acorn for use in its low-cost workstations. Whereas
the transputer was created by law to compete in the general purpose 32-bit microprocessor
market and, in contrast to the ARM, the objective was the production of a high-performance
chip for high or multiprocessor applications. Much has been written on the transputer in
recent years. For an examination as well as bibliographic references see Wilson (1991). The ARM
has received much less attention than the transputer, perhaps because Acorn is a computer and
not a semiconductor company. For an architectural review of the ARM, see Parker and Wilson
(1991).
The obligatory point of passage would relate to the process whereby technology and
industries succeed in making their products a necessary element for other products to be

President of Groupe Bull), and aiming to build the most powerful
supercomputer by 1993. ACRI perceived that a single architecture is needed
for the entire data processing market, and totally disagreed with the
Inmos/Acorn view that a single architecture could effectively cater for the
entire microprocessor market, which would include both embedded control
and data processing.

The most powerful challenges, however, were those promoted, on the one
hand, by Philips and Matra around their licensed Sun SPARC microprocessor;
and, on the other, by Siemens around their licensed MIPS R×000 (R-
thousand) microprocessor. These two microprocessors are RISC architectures
of US origin and were not included in the original EMI proposal. The
problem was that Philips wanted to see SPARC as the central architecture for
a European microprocessor initiative, and the company was not interested in
long-term work on a future architecture - mostly influenced by a 'short-
termism' resulting from a period of significant financial losses. Siemens
wanted to protect their investment in MIPS, and were hardly in a position to
accept an EMI proposal centred around the interlinking of the transputer and
the ARM only. Siemens, however, unlike Philips, had joined both of the
'beach-head' projects led by the transputer constituency. The mis-alignment
was clear, and so was, to a certain extent, the path to alignment: spaces would
have to be opened to accommodate the non-European architectures. A
programmatic alignment would be based not on an EMI, but on an *Open
Microprocessor Initiative (OMI)*.

III.3 *Stirring the Melting Pot of European Integration: From EMI to OMI*

During 1990, the mis-aligned positions publicly faced each other in the IWG
workshop series. Of course, the complete picture of the interaction is more
complex, including, for instance, bi-lateral exchanges and the normal use of
personal contacts and relationships to try to influence the process in one
direction or another. I make no attempt to try to capture the full richness of
this process. My concern is mainly with showing the way in which the
original EMI strategy evolved significantly, as all parties converged on
Brussels arguing their different positions while, simultaneously, trying to
evolve into an alignment which would give Europe a common

President of Groupe Bull) and aiming to build the most powerful supercomputer by 1993. ACRI perceived that a single architecture is needed for the entire data processing market and tentatively disagreed with the Inmos/Ascom view that a single architecture could effectively cater for the entire microprocessor market which would include both embedded control and data processing.

The most powerful challenges, however, were those promoted, on the one hand, by Philips and Mats around their licensed Sun SPARC microprocessor and, on the other, by Siemens around their licensed MIPS R4000 (R-thousand) microprocessor. These two microprocessors are RISC architectures of US origin and were not included in the original EMI proposal. The problem was that Philips wanted to see SPARC as the central architecture for a European microprocessor initiative, and the company was not interested in long-term work on a future architecture - mostly influenced by a short-termism resulting from a period of significant internal losses. Siemens wanted to protect their investment in MIPS and were hardly in a position to accept an EMI proposal centred around the interlocking of the transputer and the ARM only. Siemens, however, unlike Philips, had joined both of the 'best-head' projects led by the transputer constituency. The misalignment was clear, and so was to a certain extent the path to alignment: spaces would have to be opened to accommodate the non-European architecture. A programmatic alignment would be based not on an EMI, but on an Open Microprocessor Initiative (OMI).

III.3 Shifting the Making Pot of European Integration: From EMI to OMI

During 1990, the mis-aligned positions publicly faced each other in the IWG workshop series. Of course, the complete picture of the interaction is more complex, including for instance bilateral exchanges and the normative of personal contacts and relationships to try to influence the process in one direction or another. I make no attempt to try to capture the full impact of this process. My concern is mainly with showing the way in which the original EMI strategy evolved significantly, as all parties converged on Brussels arguing their different positions while simultaneously trying to evolve into an alignment which would give Europe a common

microprocessor initiative. In this process, the target was to achieve the greatest possible goal-alignment within the time restrictions imposed by the Commission's *modus operandi*. This means that the mis-alignments discussed above had to be 'solved', one way or another, and this was certainly not an easy task. After all, it was not a conflict over minor points. On the 'goals' side, for instance, we have seen how Philips wanted to concentrate solely on the short-term RISC/SPARC solution, whereas the transputer/ARM constituents had been promoting not just a different short-term RISC solution but, also, long-term work on the generation after RISC. On the 'perception' side, the main problem was one of distrust and suspicion about the ulterior motives of the transputer/ARM endeavour. Both Philips and ACRI, for instance, had come to believe that the EMI effort was much more about providing money for the transputer and Inmos than about any true pursuit of a European capability. This was an interpretation which key transputer/ARM players would find mistaken. The important point, however, is not whether these perceptions have been correct or not. The relevant point is that these mis-alignments did exist at the start of the EMI IWG workshops, and they influenced the attitudes of people and groups towards each other. As we have indicated, a lot would depend on the constituency-building abilities of the leading players in the initiative. We shall see how the results of the process were imprinted on the shape of the overall initiative, transforming the strategic direction of the original proposal and, ultimately, reflecting the progress made in terms of perception- and goal-alignment.

III.3.1 No alignment, no place in the constituency

As the EMI constituency-building process unfolded in Brussels, ACRI's perceptions, vision, and goals came face to face with those of the transputer/ARM constituents. Remember that ACRI had only come into existence in November 1989, about the same time as EMI was publicly launched. Thus, the company was young and small and, certainly, had not yet developed a strong enough clout to induce major changes of direction in an unfolding large-scale project such as the EMI. Yet this seems to have been the preferred strategic option pursued by ACRI. In particular, ACRI's perception that the EMI was exclusively (and wrongly so) about the transputer

microprocessor initiative. In this process the target was to achieve the greatest possible goal-alignment within the time restrictions imposed by the Commission's media campaign. This means that the mis-alignments discussed above had to be 'resolved', one way or another, and this was certainly not an easy task. After all, it was not a conflict over minor points. On the 'goals' side for instance, we have seen how Philips wanted to concentrate solely on the short-term RISC/SPARC solution, whereas the transputer/ARM constituency had been providing not just a different short-term RISC solution but also long-term work on the generation after RISC. On the 'perception' side, the main problem was one of distrust and suspicion about the ulterior motives of the transputer/ARM constituency. Both Philips and ACRI, for instance, had come to believe that the EMI effort was much more about providing money for the transputer and James than about the true pursuit of a European capability. This was an interpretation which key transputer/ARM players would find mistaken. The important point, however, is not whether these perceptions have been correct or not. The relevant point is that these mis-alignments did exist at the start of the EMI IWG workshops, and they influenced the attitudes of people and groups towards each other. As we have indicated, a lot would depend on the constituency-building abilities of the leading players in the initiative. We shall see how the results of the process were influenced on the shape of the overall initiative, transforming the strategic direction of the original proposal and ultimately reflecting the progress made in terms of perception and goal-alignment.

III.3.1 No alignment, no place in the constituency

As the EMI constituency-building process unfolded in Brussels, ACRI's perceptions, vision and goals came face to face with those of the transputer/ARM constituency. Remember that ACRI had only come into existence in November 1989, about the same time as EMI was publicly launched. Thus the company was young and small and certainly had not yet developed a strong enough clout to induce major changes of direction in an unfolding large-scale project such as the EMI. Yet this seems to have been the preferred strategic option pursued by ACRI. In particular, ACRI's perception that the EMI was exclusively (and wrongly so) about the transputer

seems, at the time,¹⁷ to have discouraged any effective search for alignment spaces.

As a result, ACRI publicly raised their architectural approach as an alternative path for the constituency only to find that the momentum of the transputer/ARM-led proposal was too great to be disturbed by their challenge. Most importantly, ACRI had done little grassroots constituency-building, so it was not surprising to see their alternative given almost no attention, as it was belatedly presented during an IWG workshop around October 1990. Indeed, since the mis-alignment of goals was so patently obvious, it is clear that even its acceptance to discuss it in a workshop would have, at least momentarily, derailed the constituency-building course already established by other players. For this reason, nobody complained as members of the transputer/ARM constituency simply argued that ACRI could not expect to re-direct the discussion at a late stage in the process, just by coming to Brussels and putting forward an alternative proposal. Not surprisingly, this acted to reinforce the existing mis-alignments because ACRI representatives did not play any noticeable part in the few Brussels IWG workshops that followed the presentation of their alternative.¹⁸

III.3.2 From potential 'constituency-killing' to active constituency-building

Constituency-building via Brussels attracts a variety of players with initially a variety of motives. Some may find that they want to transform an emerging constituency, others may find it more appropriate to try to 'kill' it altogether. For instance, 'I'd be looking at the process in its own right...how can that initiative be useful and successful, or, how can it be killed if it's not going to be?'¹⁹ Whether a person chooses the role of 'constituency-killer' or 'constituency-builder' will depend a lot on the perception he/she develops of the potential benefit of the constituency. Some players may undergo

¹⁷For instance, as late as October 1990, after a workshop in Brussels, ACRI concluded that 'there was no way to discuss anything else than the Inmos transputer technology at all.' (Interview with J. Stern, ACRI, 1990).

¹⁸Later on, after the workshops, ACRI began to change their perception and, indeed, a common space enabling some degree of goal-alignment has now developed between ACRI and the transputer/ARM constituency. They are now collaborating in one of the OMI projects.

¹⁹Interview with M. Chesney, Meiko, 1990.

seems at the time¹⁷ to have discouraged any effective search for alignment spaces.

As a result, ACRI publicly raised their architectural approach as an alternative path for the constituency only to find that the momentum of the transputer ARM-led proposal was too great to be dented by their challenge. Most importantly, ACRI had done little grassroots constituency-building, so it was not surprising to see their alternative given almost no attention, as it was belatedly presented during an EWG workshop around October 1990. Indeed, since the mis-alignment of goals was so patently obvious, it is clear that even its acceptance to discuss it in a workshop would have at least momentarily dented the constituency-building course already established by other players. For this reason, nobody complained as members of the transputer/ARM constituency simply argued that ACRI could not expect to re-direct the discussion at a late stage in the process, just by coming to Brussels and putting forward an alternative proposal. Not surprisingly, this acted to reinforce the existing mis-alignments because ACRI representatives did not play any noticeable part in the few Brussels EWG workshops that followed the presentation of their alternative.¹⁸

III.3. From potential 'constituency-killer' to active constituency-builder

Constituency-building via Brussels attracts a variety of players with initially a variety of motives. Some may find that they want to transition an emerging constituency, others may find it more appropriate to try to kill it altogether. For instance, I'd be looking at the process in its own right... how can that initiative be useful and successful, or how can it be killed if it's not going to pay?¹⁹ Whether a person chooses the role of constituency-killer or 'constituency-builder' will depend a lot on the perception he/she develops of the potential benefit of the constituency. Some players may undergo

¹⁷For instance, as late as October 1990, when a workshop in Brussels, ACRI concluded that there was no way to discuss anything less than the latest transputer technology at the [interview with] Jean ACRI, 1990.
¹⁸Later on after the workshop, ACRI began to change their position and, indeed, a common space enabling some degree of co-alignment has now developed between ACRI and the transputer/ARM constituency. This is now reflected in one of the OMI papers.
¹⁹Interview with M. Cheneay, March 1990.

significant changes of perceptions leading in one or the other direction. In the case of the EMI, one of the most revealing occurrences was the conversion of a very active player from a potential 'constituency-killer' into a forceful constituency-builder for the EMI. The *initial* perception of this player reflected that of his institution and was very similar to that of Philips and ACRI - namely, that the Franco-Italian semiconductor company SGS-Thomson (after acquiring Inmos) just wanted money to fund Inmos and the transputer through ESPRIT.

However, as contacts were made with the EMI constituency-building process in Brussels, it soon became clear to this player (in marked contrast to ACRI's approach) that he 'could not go against history, or to kill this activity...because politically, there was too much force behind it.'²⁰ Furthermore, he actually began to develop a positive perception of the potential benefits of a European microprocessor initiative. A process of goal- and perception- alignment had begun. 'I saw a lot of people who were actually very interested in doing something ... I felt that if I could convince them that if they could produce something really useful, they could actually make even more money.'²¹ Expectedly, this 'something really useful' was also an opportunity to advance the interest of his own organization. As another EMI participant observed, 'I think he just decided that the power of a constituency like the EMI forming would give him enormous sort of leverage to the kind of work they were doing.'²²

An important aspect contributed by the new constituent, however, was that he particularly perceived and promoted the critical importance of involving microprocessor users in a big way in the early shaping of the initiative. He thought that the original goal of the proposal was too much about just another microprocessor - next generation microprocessor. Consequently, he tried to steer it into a much more strongly defined application-driven direction.

²⁰Interview with OMI player who wishes to remain unidentified.
²¹Ibid.
²²Interview with another OMI player.

In his recollection, he believes that the initial perception and reaction of ARM/transputer constituents to his campaigning was not really welcoming: it was rather one of suspicion and fear that he was trying to change the initiative away from their goals. 'I think there was fear in the minds of Acorn and Inmos that they couldn't see anything else. If I went to a meeting, or something, they were very happy if somebody else went in my place. It was real fear.'²³ Clearly, a mis-alignment of perceptions was at work here. But, the interesting point is that, at the same time, there was no real mis-alignment of goals. Thus according to the same player, '[O]ut of all of the people, Inmos was the company who I saw wanted to make money in this thing ... It meant moving them away from transputer to something else. That was my goal, and I think after a lot of hassling, and heated discussions, and so on, *they really did come around to that concept.*'²⁴

An important element in eliciting this alignment of goals and perceptions seems to have been the position taken by the many other players in the process. In effect, once the initiative went to Brussels, consensus was always going to be the dominant decision-making mechanism. Thus, carrying a majority behind a particular position would almost certainly oblige other players to give careful consideration to the benefits of that position. 'So what we did, a few of us, I got in touch with a few people in the systems company. And a lot of these people started saying the same thing, and people from the business world, office and business systems, were saying the same thing. And so, this is how this activity started moving away...'²⁵

Of course, there are always two or more sides to a story, and Inmos and Acorn may have a different account of the evolution of the EMI process. Indeed, the argument could be made that they were interested in the participation of users from the very beginning. This particular player, however, strongly promoted the 'embedded-control' side of the initiative, and, from this viewpoint, his account seems to fit the evolution of the original proposal towards embedded-control applications. Whatever the situation, the relevant fact for our purposes is contained in the final sentence of one of the

²³Interview with OMI player who wishes to remain unidentified.

²⁴ibid. Emphasis mine.

²⁵ibid.

quotations above ('they really did come around to that concept'), which implies a clear alignment of goals and perceptions between the parties.

III.3.3 Technical solutions to political problems: From EMI to OMI

The evolution from EMI into OMI was the result of the most critical case of mis-alignment of goals, involving all the European semiconductor manufacturers. In the title, the change from European into Open may appear to be a mere change of one word. In practice, it meant a major reshaping in the strategic direction of the initiative and its technology. The following is a brief interpretation of the main events.

The beginnings of openness in fact go back to the first encounter of the transputer/ARM constituents with the Commission in October 1989. At the time, it was already clear that the original proposal had little in it to satisfy the interests of the semiconductor houses of Siemens and Philips. As we know, both of these major European players had licensed US RISC chips and the proposal made no mention of them at all. Following the meeting with the Commission, however, a new section was introduced in the original proposal, suggesting technical paths for interfacing the transputer/ARM with both SPARC and MIPS. Basically, the same solution linking the ARM and the transputer was being extended to link the European to the non-European architectures. Admittedly, the alignment would still be very much around the transputer and the ARM. But the important fact was that the opening was there, and further evolution was possible. Siemens and Philips took different lines on this situation, particularly, because Philips' vision of an EMI (see above) was narrower and shorter-term and, above all, there was little room for change given the survival atmosphere pervading the company. Siemens, on the other hand, was able to be more flexible and room for alignment was found rather quickly. Let us examine both experiences, starting with Siemens.

a) Siemens

As the largest electronics company in Europe, Siemens is involved in many European projects. This may lead some people to think that gaining

Siemens' participation may have been easy, since the company tends to get involved in almost everything. In the case of EMI, however, Siemens' involvement was not without difficulties, given their position as MIPS constituent. Also, it is relevant to note that Siemens had considered the transputer in the past and had taken the decision 'not to cooperate on the transputer, mainly by one lack, not Unix compatible.'²⁶ Siemens' position was then made clear.

We explained that if EMI is only transputer, we will not participate in the future. It never will be a European solution. It's a company specified solution, with all its advantages, but, if we say it is a European Microprocessor Initiative, then it cannot be only a transputer one, because SPARC, or MIPS, or DEC Alpha, whatever, are well established in very important European systems equipment, and they have essential advantages in some applications. EMI is never acceptable to us if it is really one or two systems.²⁷

Inmos had little choice, if they wanted to facilitate Siemens' alignment they had to respond to this concern - and so they did. The alignment solution proposed by Inmos has been described as follows:

I suggested to them that, in terms of the shorter term activity, there would be no harm at all, and potentially quite a lot of benefit, from having interfaces between Inmos links and MIPS processors because, again, just like the ARM they are logical. An there are very, very few applications for which you'd actually have difficulty deciding whether to use MIPS or a transputer.²⁸

In other words, the technical links acted simultaneously as the political bridges through which Siemens could join the EMI process - while still being a member of the MIPS constituency. For Siemens, this techno-political solution sounded reasonable. It incorporated the company's shorter-term interests, while the work on the future architecture offered the possibility of a more powerful processor by the late 1990s. In addition, the features being envisaged for this longer-term processor seemed to fit well some of the

²⁶Interview with Otto Pöbl, Siemens AG, Components Group.

²⁷Ibid.

²⁸Interview with D. May, 1990.

present trends in the microprocessor industry, which are pointing to the existence of fundamentally more powerful processors by the end of the century [37]. At the same time, none of this would preclude Siemens' ability to license any new processor that came along and which the company wanted to use. The license option, however, is something that the company is in no position to predict with complete certainty, since the control of the process is in hands of the proprietors of the architecture. Thus, maybe it was not such a bad idea to support a European processor in which they would have some say in the long-term.

As a result, Siemens did join very early on in the activities leading to the formulation of the Initiative. In particular, as we have seen, the company joined the EMI-MAP 'beach-head' projects aimed at defining a future architecture for scaleable general purpose parallel computing (see above). Of course, in EMI-MAP, the microprocessor work is led by an Inmos/ARM team. Thus, although Siemens' involvement clearly reflected a degree of alignment between the parties, it is also true that, maybe, it would be more comfortable for the company to see the long-term work for the next generation architecture in the hands of some more neutral party. Indeed, during an OMI workshop in October 1990, Siemens did put forward the proposal that 'Research/university institutes investigate system requirements and architectural concepts for a new, post 1995 ("next generation") microprocessor.' [51, p.3] This proposal, however, did not go very far and it never became an issue of major contention. Obviously, it was in clear misalignment with the goals of the transputer/ARM constituency and, indeed, with the purpose of the EMI-MAP project itself. Siemens representatives did not make a strong show for it either, so it was quietly forgotten to the benefit of the programmatic alignment struck in the early days of the constituency-building process. In any case, by playing the MIPS card within the OMI, Siemens is simultaneously in a position to consider, and even promote, this architecture as an alternative for the microprocessor of the future.

b) Philips

The same solution allowing for the technical interfacing of the MIPS, and the political alignment of Siemens, was suggested to Philips in relation to the

SPARC and the future processor. But, as we have indicated, Philips' perceptions and vision were dominated by a crisis mentality in which alignment along the lines of longer-term preoccupations had not much place to flourish. Understandably, then, Philips representatives tended to stick to their short-term strategy, trying to make the SPARC architecture the centre of the initiative. The problem was that this 'survival' approach could not offer space for alignment, particularly, to the transputer/ARM constituents. Philips argued that the proposed Initiative's next generation microprocessor was a continuation of the transputer and hence, a mis-guided activity as far as the RISC workstation market was concerned.²⁹ The perception was that Inmos had already cornered the EMI-MAP 'beach-head' project for the transputer and, consequently, the new architecture was almost bound to be shaped in the direction of this technology.

The E1 [codename for the future microprocessor] is totally directed towards the transputer, this is a waste of money for me. OMI is actually putting on silicon the design idea of what OMI-MAP would say. So, it's all locked. This is of no interest for us. [And as far as influencing OMI-MAP is concerned] I would say wishful thinking. Yes, we have no power, they get the contract, they do what is written on the contract, they get the money, they do what they please.³⁰

Of course, unlike Siemens, Philips had remained outside EMI-MAP altogether. The feeling of exclusion, then, was probably strong and even justified. On the other hand, the company was promoting a shorter-term strategy and effectively excluding itself from the process of shaping any longer-term future microprocessor. Not surprisingly, Philips was much more comfortable with the idea that the OMI should have no E1 (future

²⁹This opinion was shared by Matra MHS, another European semiconductor company which had licensed the SPARC architecture. According to Matra, they had a good understanding with Philips, 'first because they [Philips] were in the SPARC camp and, second, because they fully agreed with us that EMI was an scandal in terms of the scope of what was suppose to fund. I would say that Philips was much stronger than we were in criticising the project...We opposed it but it was a tactical move so that we would be invited to share our part of the cake.' Interview with representative from Matra MHS.

³⁰Interview with J. B. Theeten, Philips, 1990. E1 was the codename used during the workshops to refer to the long-term future microprocessor. The interviewee's use of OMI-MAP, and not EMI-MAP, reflects the change of name of the overall initiative (from EMI to OMI) by the time of the interview.

SPARC and the future processor. But as we have indicated, Philips' perceptions and vision were dominated by a crisis mentality in which alignment along the lines of longer-term preoccupations had not much place to flourish. Understandably, then, Philips representatives tended to stick to their short-term strategy, trying to make the SPARC architecture the centre of the initiative. The problem was that this survival approach could not offer space for alignment, particularly to the transputer/ARM constituencies. Philips argued that the proposed initiative's next generation microprocessor was a continuation of the transputer and hence a mis-guided activity as far as the RISC workstation market was concerned.³¹ The perception was that James had already contacted the EMI-MAP 'branch-head' project for the transputer and, consequently, the new architecture was almost bound to be slipped in the direction of this technology.

The E1 (codename for the future microprocessor) is totally directed towards the transputer, this is a waste of money for me. OMI is actually getting on with the design, less of what OMI-MAP would say. So it's all locked. This is of no interest for us. I and as far as influencing OMI-MAP is concerned, I would say, without thinking. Yes, we have no power, they control the contract, they do what is written on the contract, they get the money, they do what they please.³²

Of course, unlike Siemens, Philips had remained outside EMI-MAP altogether. The feeling of exclusion, then, was probably strong and even justified. On the other hand, the company was pursuing a shorter-term strategy and effectively excluding itself from the process of shaping any longer-term future microprocessor. Not surprisingly, Philips was much more comfortable with the idea that the OMI should have no E1 (future

³¹This opinion was shared by James (the author's European semiconductor company which had licensed the SPARC architecture). According to James, they had a good understanding with Philips, but because their involvement in the SPARC camp and, second, because they fully agreed with us that EMI was an essential part of the scope of what was supposed to fund I would say that Philips was much stronger than we were in cancelling the project. We opposed it but it was a tactical move so that we would be invited to share our part of the cake. Interview with representative from Matsuhita.

³²Interview with J. B. Theisen, Philips, 1992. E1 was the codename used during the workshop to refer to the long-term future microprocessor. The interviewee's use of OMI-MAP and not EMI-MAP, reflects the change of name for the overall initiative (from EMI to OMI) by the time of the interview.

microprocessor component), since this was a decision best left to each company. 'It is up to everybody to try to have their own solution, be it transputer, be it SPARC, be it MIPS. I don't want to pay for a microprocessor of another kind.'³¹

As mentioned earlier, this position was not much of a base for rapid programmatic alignment within the emerging constituency. Unlike ACRI, Philips does carry a great deal of clout within the Commission and there was an implicit acceptance that the company could not be left out. Seemingly, Philips' people realised this as well and they made a good effort to carry the initiative their way. Philips' grassroot work, however, was not as effective as that of the transputer/ARM constituencies and, indeed, tended to rely on the company's clout rather than anything else. The result was a protracted argument which went from IWG workshop to IWG workshop until the process was basically exhausted, by the end of 1990, with SPARC failing to capture the initiative but becoming one of its important constituent processors. Unlike Siemens, however, Philips has stuck to their shorter-term goal, and their alignment is basically in the area of inter-processor communication between existing architectures, where they carry the SPARC flag. In this respect, a new component called Heterogeneous Inter-processor Communications (HIC) (see below) has become, for Philips, the critical technical constituent allowing for the partial alignment of all players within the Initiative.

The only thing which should be funded by Brussels is the inter-processor communication, because that's the only thing which is unifying people...A common viewpoint would be to have all C1 [codename for the HIC] and zero E1, that would be the ideal, that would be the most constructive part, because it is not paying for anything else than the exchange basis for everybody's solution.³²

Obviously, this would be only a partial common viewpoint and not one likely to keep the emerging OMI constituency together. Eventually, Philips representatives have come to accept this reality and they have *de facto* accepted the presence of work on a new generation architecture although,

³¹ibid.

³²ibid.

microprocessor component), since this was a decision best left to each company. It is up to everybody to try to have their own solution be it transputer, be it SPARC, be it MIPS. I don't want to pay for a microprocessor of another kind.³¹

As mentioned earlier, this position was not such of a loss for rapid programmatic alignment within the emerging constituency. Unlike ARM, Philips does carry a great deal of debt within the Commission and there was an implicit acceptance that the company could not be left out. Significantly, Philips' people realised this as well and they made a good effort to carry the initiative their way. Philips' greatest work however, was not as effective as that of the transputer/ARM constituency and indeed, tended to rely on the company's clout rather than anything else. The result was a protracted argument which went from IWC workshop to IWC workshop until the process was basically exhausted by the end of 1989, with SPARC failing to capture the initiative but becoming one of its important constituent processors. Unlike Siemens however, Philips has stuck to their shorter-term goal, and their alignment is basically in the area of inter-processor communication between existing architectures where they carry the SPARC flag. In this respect, a new component called Interprocessor Architecture Communications (IAC) (see below) has become for Philips the critical technical constraint allowing for the partial alignment of all players within the initiative.

The only thing which should be funded by Philips is the inter-processor communication because that's the only thing which is making people. A common viewpoint would be to have all CI (contains for the IAC) and VLSI that would be the ideal that would be the most constructive part because it is not paying for anything else than the exchange basis for everybody's solution.³²

Obviously, this would be only a partial common viewpoint and not one likely to keep the emerging OMI constituency together. Eventually, Philips representatives have come to accept this reality and they have as a rule accepted the pressure of work on a new generation architecture through

thus far, they have not tried to get involved in it. Basically, this had been the general solution proposed early on by the transputer/ARM constituency. Indeed, some members of the transputer/ARM constituency had been at pains to understand the original Philips' refusal to embrace a programme which would involve SPARC. They think that probably Philips semiconductor people were over-cautious as a result of the difficult situation of the company and the fact that, having adopted SPARC, they were in the rather sensitive position of having to explain supporting an initiative which included other microprocessors and, even more problematic, which was perceived as mostly dominated by the transputer constituency.

The negotiations with Philips presented perhaps the trickiest hurdles to the process of formulation of the initiative. At times, it was clear that some impatience was beginning to develop against Philips' position, particularly, from the transputer/ARM people. It was seen as holding back and, potentially, threatening the whole initiative. Late in the process, the dominant perception was that Philip's representatives in the workshops were becoming increasingly isolated.³³ On the other hand, Philips' perception was that they were in fact articulating the unspoken feelings of a lot of silent people.³⁴ Unfortunately for Philips' representatives, 'silent' or non-visible support is no effective support in a situation where discussion is the main path towards achieving consensus. In the workshops, for instance, the impression was almost inevitably left that the Philips' position was on the weaker side. I think that Philips' representatives also realised this and, indeed, this may have been one of the reason why they eventually dropped their objection to the work on the future microprocessor.

It must be said that a key element in inducing the consensus was the pressure of the approaching deadline in accordance with the timing of the

³³With Philips the whole thing really started to backfire on them. I think most people think that, because they started sending representatives along who were clearly trying to sort of kill the thing and undermine it. But, of course, by that time there were far too many people in the room...They got themselves into a position where really they are now attracting hostility from the community that's being built.' (Interview with D. May, 1990)

³⁴I think what is interesting is that every time one of the key Philips' guys stands in front and plays the bad guy in the formal sequence of the discussion, at the tea-break or the coffee-break, most of the other silent people come and say: "I am glad you said so, and why don't you shout more because it's a realistic viewpoint." (interview with J. B. Theeten, 1990)

Commission's established procedure for calls for proposals. Everybody knew that the deadline for consensus was in late 1990, otherwise the initiative would miss a year and, in all probability, would fail to take off altogether. In this context, it was Prof. Aigrain (Chairman of the Task Force entrusted by the Commission to steer the OMI process), who drove home the message. '[He] concluded one meeting by saying that unless the main parties could reach some accord, then the whole thing was about to die - it was a very serious moment!'³⁵ This 'align-or-perish' choice had a positive effect. Nobody, including Philips, wanted the OMI to die. By now, many people had been investing a lot in the process and were unwilling to see it collapse in front of their eyes. Thus, when Aigrain raised his stark choice towards the end of 1990, everybody realised that time was up for discussion and that a consensus had to be achieved. And so it was!³⁶

Had the role of Philips' representatives then been a futile exercise? Not in my view. In practice, Philips had played the role of 'devil's advocate' by questioning the wisdom of the transputer/ARM initiative. This may have caused delay and even hostility at times, but it had the beneficial side that many of the difficult questions any initiative has to face were openly discussed. Ultimately, this could only strengthen the quality of the initiative. Eventually, Philips embraced the initiative very much in the way Siemens did, that is, on the basis of the techno-political solution crystallised in the inter-processor communications chip. In the process, the change of the EMI into the OMI was reinforced. Now, SPARC, the leading RISC architecture for workstations had become part the Initiative, and this could only enhance its potential for a successful implementation of the open-systems philosophy right down to the level of silicon.

c) *The Heterogeneous Inter-processor Communications (HIC). A 'European Integrator' component.*

³⁵Personal communication with C. Whity-Stevens, Inmos, 1992.

³⁶'At the beginning there was all the fighting, most of them against the idea to start with, but they were patient, at the same time they accepted the rule of consensus-building.' Interview with Pierre Aigrain, Chairman of the OMI Task Force.

Implicit in the acceptance of non-European architectures such as MIPS and SPARC was the strategic shift from *European* to *Open* initiative. The first step had been Inmos' proposal to use the Inmos links to interface the non-European processors to the transputer, thus expanding inter-processor communication beyond the ARM and hence, Europe. This solution, however, did not prove to be the final 'aligning factor'. It was still too much centred around Inmos and the transputer, and during the IWG workshops, it became apparent that players such as Groupe Bull were also in possession of very advanced link technology. The alignment was found in the definition of the new Heterogeneous Inter-processor Communications (HIC), which would have the Inmos links as one option among others. The HIC was to take the concept of inter-processor communication to a new level, by enabling communication among all processors and not just around the transputer.³⁷ The concept of openness had now taken its final shape and, as we have seen from Philips enthusiasm, the HIC may rightly be seen as perhaps the key technical constituent aligning the initiative together.

The HIC is a 'European integrator' component and, in this respect, a beautiful example of *technology through European integration and vice-versa*. It was not found in the original proposal and its purpose is to enable not just the bridging between the different present architectures but, also, the bridging between the present architectures and the architecture for the next generation. As described in the final OMI proposal, the objective of this aspect of the initiative is 'to specify and promote an overall architecture and a high performance interface standard to allow interworking between existing accessible microprocessor architectures, as well as the O1 [previous E1 codename for the new generation architecture]. The connection architecture may have several different physical implementations.'⁹, p.V-3]³⁸ In this definition, the term 'accessible' is an important one to notice since some architectures now on the market (e.g. Intel's 80x86) are not licensed, with the result that the technical details necessary to establish the interface are not

³⁷This openness 'was a big help to everyone because that was the only way to convince the political people that there was something to do all together.' Interview with representative from Matra MHS.

³⁸The emphasis put on the word 'accessible' is mine. Note that the codename of the future generation architecture has changed from the E1 used before to O1. This is a reflection of the change from European to Open in the whole initiative.

readily available. They are proprietary. In contrast, technical details of both SPARC and MIPS are readily accessible through their licensing by Philips and Siemens, and this explains why the HIC is about these two existing non-European architectures and no other as yet (besides the future generation). Maybe, in the future, other architectures will become accessible and may be considered.

For the time being, as it stands today, the HIC technically crystallizes the state of development of the OMI constituency. It is a revealing 'fossil' of the initiative's strategic evolution (its interactions, conflicts and alignments) towards technical as well as institutional openness.³⁹ It is an evolution which is enhancing the OMI constituency's chances for success in more than one way. For instance, the image of the initiative stands to benefit from the ability to give a positive response to potentially damaging criticisms of 'fortress Europe' mentality. More fundamentally, OMI user-constituents stand to gain a great deal. They will have choice of components and the capability to combine them into customised chips giving them the best functional performance for their specific needs. For European microprocessors, there is also an opportunity that the technical bridges might eventually become the paths which could facilitate the migration of institutional members of other constituencies into the European fold. Of course, the risk is that bridges work both ways and emigration rather than immigration is an equally likely possibility. The plus for the constituency is that such a threat should spur the European constituents into better competitive performance, thus dynamising the development of the initiative as a whole. Finally, the initiative has truly become the first declared attempt to take the concept of *open systems* right down to the level of the silicon chip; and this carries the potential to induce a radical shift in the global microprocessor market. Thus far, the microprocessor market has evolved on the basis of single-processor proprietary architectures. Now, Europe is taking the lead into an open-systems capability which would combine different architectures on a single chip. And the reason of it all: open systems was the technical solution to the political necessities of constituency-building via Brussels.

³⁹In the process, the interests, expertise, conflicts, visions, etc. became "fossilised" in the shape of the machines.' [36, p.321]

III.4 IWG Workshops: Tactics and Techniques for Perception- and Goal-Alignment

We saw above that the purpose of IWG workshops is to start making progress towards a plan by bringing relevant people together and getting them to talk to each other. Workshops make people think about an initiative, gradually familiarising them with it and, if successful, through their involvement making them feel that it is also their idea. Of course, the existence of a mechanism does not guarantee success. Critical to the success of workshops is an ability to keep the lines of communication open and to steer their progress towards a dynamic of constructive and convergent contributions, while staving off negative or diversionary contributions. Generating a psychology of positive thinking is what the game seems to be all about. For there seems to be a fine psychological step between people beginning to make positive contributions in the discussion and them evolving into active members of the constituency. *As a general rule, one could say that the more the expertise/visions/interests of contributors become part of the programme, the more the programme is likely to become part of the contributor.* Of course, the tricky bit is to make the contributions converge into a manageable and realistic programme, which is within the scope of the potential resources available. In the following, several tactics used to this end in the course of OMI workshops are exposed:⁽⁴⁰⁾

1. Criticise-but-contribute.- As indicated before, one of the main risks of constituency-building through workshops is that opposition becomes public and, if effectively articulated, it may affect the perception of uncommitted people with the result that the viability of the entire process may be thrown into question. Hence, the need for skills to steer the workshops towards a dynamic of constructive and convergent contributions while staving off those which are negative or diversionary. During my own attendance at some of the workshops, I had the opportunity to witness the application of such skills in a very effective manner. Specifically, the Chairman of the meeting, very

40. The following are based mainly on my interviews and observations of players' interactions during the Industrial Working Groups (IWG) Workshops of the second half on 1990 in Brussels. I am sure there will other techniques which could be added to the list.

early on, made it clear that one important rule for the good conduct of the meeting was that anybody who wanted to criticise should at the same time offer some solution or constructive thought to the problem being raised. At a stroke, the guidelines were set in such a way that even those who wanted to criticise were being encouraged to contribute positively to the improvement of the initiative. At the same time, anybody who had the intention to be just negative or disruptive about it was being discouraged.

2. Build-from-the grassroots.- Large-scale initiatives such as the OMI are normally the arena for inter-constituency interactions. In their development various interested constituencies converge to try to gain an influential and shaping position more akin to their specific interests. Hence, for instance, the importance of the early shaping positioning gained in the process by the transputer/ARM constituencies. However, at any time, a legitimate challenge to the central direction of a large-scale initiative may come from constituencies offering an alternative technological scenario.

4. Sociotechnical argumentation.- Building up sociotechnical constituencies. Again this happened in a meeting. As soon as the meeting started one of ACRI's representative made a case for a different architectural direction than the one already under discussion. He argued for the meeting to consider this alternative in a move which would have diverted the agenda off the course which the transputer, ARM, MIPS and SPARC constituents had been negotiating. This was quite late in the series of workshops that took place during 1990. Thus, the timing was simply not right. Nevertheless, the challenge was made and had to be dealt with. The prompt retort from the Chairman was that an important rule of the European game was to try first to gain support by talking and persuading people. Everybody has to try to build from the grassroots and it was not the best approach to just come to a meeting where others have been working and expect to take it into a different direction. The ruling was accepted and the meeting went on in the envisaged direction.

3. Winning-by-isolation.- Sometimes opposition may be more resilient to alignment, and conflicting exchanges may drag on for considerable time. In these circumstances, it is important to stimulate the perception of the opposing side being in the minority or isolated position. Otherwise, a sense

... of the ...
... meeting was that anybody who wanted to ...
... other some solution or constructive thought to the problem being raised. At a ...
... under the guidelines were set in such a way that even those who wanted to ...
... critics were being encouraged to contribute positively to the improvement ...
... of the initiative. At the same time anybody who had the intention to be just ...
... negative or disruptive about it was being discouraged.

2. Build-from-the-ground - Large-scale initiatives such as the OMI are ...
... normally the arena for inter-constituency interaction. In their development ...
... various interested constituencies converge to try to gain an influential and ...
... shaping position more akin to their specific interests. Hence, for instance, the ...
... importance of the early shaping positioning gained in the process by the ...
... transfer/ARM constituencies. However, at any time a legitimate ...
... challenge to the central direction of a large-scale initiative may come from ...
... constituencies offering an alternative technological scenario.

Again this happened in a meeting. As soon as the meeting started one of ...
... ACR's representatives made a case for a different technical direction than ...
... the one already under discussion. He argued for the meeting to consider this ...
... alternative in a move which would have diverted the agenda of the current ...
... which the transfer, ARM, MIL's and SPARC constituencies had been ...
... negotiating. This was done late in the series of workshops that took place ...
... during 1990. Thus, the thing was simply not right. Nevertheless, the ...
... challenge was made and had to be dealt with. The proposal never won the ...
... Chairman was that an important role of the European group was to try to build ...
... gain support by talking and persuading people. Everybody has to try to build ...
... from the grassroots and it was not the best approach to put ourselves in a ...
... where others have been working and expect to take it into a different ...
... direction. The ruling was accepted and the meeting went on in the envisaged ...
... direction.

3. Winning-by-isolation - Sometimes opposition may be more well-timed to ...
... agreement and conflicting exchanges may drag on for considerable time. In ...
... these circumstances, it is important to understand the perception of the ...
... opposing side being in the minority or isolated position. Otherwise, a sense

of stalemate may begin to develop which may undermine everybody's ...
... confidence in the constituency-building process. An added advantage is that a ...
... sense of isolation is also likely to put an effective pressure on the mis-aligned ...
... party to conform, at least partly, to the consensus emerging from the ...
... meetings.

In the OMI, this situation was exemplified by the role of Philips. Late in the ...
... process, it is fair to say that Philip's representatives in the workshops were ...
... looking rather isolated. Of course, some constituency-building techniques are ...
... also on order here. For instance, a little bit of isolation-tactics sometimes does ...
... help to reinforce the desired perception. An example is the weakening of a ...
... speaker's presentation by scheduling it at a time when the mood is not very ...
... much one of listening. This seems to have happened on one occasion when, ...
... apparently, a Philips' presentation was scheduled to start at quarter to one, a ...
... time when everybody was getting hungry.

4. Sociotechnical argumentation - Building up sociotechnical constituencies ...
... is always a thoroughly multidisciplinary process where the technical, the ...
... economics, the politics, etc., tend to conflate. Nowhere is this fact more ...
... explicit than in trying to build constituencies in the context of government ...
... and, in our case, the European Commission. As such, during discussions, it ...
... pays for players to be able to navigate from one disciplinary angle into ...
... another, shifting or simply dropping convenient hints as the process of ...
... argumentation requires. To an important extent this ability implies systemic ...
... thinking, i.e. keeping a sense of the multivariate ramifications of the ...
... constituency, and the ability to play one aspect against another at the right ...
... time and in the right place. Nobody is perfect in this ability but there are ...
... people who are more effective than others (especially constituency-builders) ...
... in displaying and making use of it. During OMI workshops, for instance, ...
... constant references to technical trends, market trends, European dependence, ...
... the environment, the Commission's policies, etc., were made to support the ...
... constituency-building process in one or another direction. This shifting of ...
... angles kept reminding people that technical issues were just one side of the ...
... initiative, and that much more was necessary if it was to have a good chance ...
... of taking off.

An important element in this dynamic is the possession of inside or exclusive information from authoritative circles or committees. Those who possess it, or are perceived to possess it, are likely to strengthen their credibility and authority, and hence the potential impact of an argument. For instance, some OMI players sit on the ESPRIT Advisory Board (EAB), a body with direct influence on the eventual success or failure of the initiative. Thus, it was both possible and credible for them to make allusions to the latest policy thinking within ESPRIT, and suggest the most convenient avenues.

5. Background steering.- An important role of workshops is that they provide an opportunity to 'sense the mood' and concerns of the participants. Informal conversations during breaks, lunches, etc., are a well-known source of information. If properly tapped, this information may be an extremely useful input into the constituency-building process. In Brussels, this is a role which tends to fall on the Commission officials since they are available to talk to everybody and, above all, they are likely to be approached by all the interested parties given their ultimate control of the purse. For the same reason, the suggestions of Commission's officials are also likely to be regarded as quite influential, acting as a sort of 'background steering' for the build up of the constituency. This is quite appropriate because it is neither the role, nor in the interest, of Commission's officials to side with any group. Ultimately, they want to be associated with successful Initiatives. Thus, once they begin to support the build up of one, they want to see it through the difficult process of aligning different interests and, indeed, if appropriate, do their own constituency-building to take it to a successful launching.⁴¹

The interesting aspect of this 'background-steering' constituency-building technique is that it is almost unnoticeable and has a legitimate image of neutrality. It can obviously be of great benefit to an initiative, particularly, as powerful conflicting interests may become deadlocked into intransigent

⁴¹Not everybody in the Commission will play this constituency-building role. In the OMI case, however, 'I would say they played their role very cleverly, no doubt about that. If I compare them with other Esprit systems I would say our C.E.C. people played each job excellently.' Interview with Otto Pöbl, Siemens AG.

situations which need the intervention of an 'external', 'neutral' force to solve it or unlock it.

6. Counteracting the 'Tower of Babel' syndrome.- All large-scale initiatives have common problems such as large transaction costs (associated with the simple interaction of different and scattered European players) and the easing out of misalignments between people with different expertise and institutional cultures. However, a specific European problem of building large-scale European constituencies is the communication barriers resulting from simple differences in national languages, and the fact that proficiency levels in the 'common' working language (English in the case of the OMI) tend to vary greatly. If not handled properly, this 'Tower of Babel' situation may be quite damaging to the prospects of an initiative. It may underlie the rise of mis-alignment of perceptions about other people's motives and ideas, thus undermining the emergence of the common vision necessary to galvanise the constituency together. During the OMI process, it was the case that sometimes heated discussions dissipated quickly once the same idea was reorganised in a different way.

There is no quick solution to this communication problem. Translations are certainly one way, efforts to improve the proficiency of the 'common' working language is another. They are obviously non-exclusive. It seems to me that, in the long run, the solution is slowly taking shape through the process itself, that is, European integration through technology and vice-versa.

7. Spaces for Alignment: Type A/Type B projects.- An interesting distinction made for projects within ESPRIT is that of Type A and Type B projects. The official definition is that a Type A project is one that is well-defined in all its aspects, including time-scales, milestones and results. A type B project amounts to little more than an interesting idea which may unfold into a well defined project. In a large-scale initiative such as the OMI, all the core R & D activities need to be well-defined so they normally achieve the status of Type A projects. Around Type A projects, however, there are often related activities, which either could not receive the same degree of priority-definition or are more related to a specific interest of some particular player.

Type B projects offer a way of handling these activities. Most interestingly, by so doing, they simultaneously act as spaces or mechanisms to facilitate the overall process of perception- and goal-alignment between the many different players. In effect, Type B projects help to accommodate specific interests and demands, by giving players a slot which carries the opportunity for their idea to become a real project. In the overall picture of a large-scale initiative, therefore, they allow for two important constituency-building aspects. First, the integration in the constituency of players and activities which are likely to play a useful complementary role to the core R & D activities. And, second, the promotion of partial alignments within the constituency, together with a diffusion of potential tension towards the edges of the core R & D activities. In this respect, Type B projects provide a good mechanism to materialise the general rule identified above: the more the expertise/visions/interests of contributors become part of the programme, the more the programme is likely to become part of the contributor.

8. Align or else: The pressure of deadlines.- Constituency-building within ESPRIT is subject to the time rules of the Framework Programme⁽⁴²⁾ and the designated dates for the Call for Proposals. Players then have definite time limits within which to try to succeed in getting initiatives off the ground. These limits may sometimes be inconvenient, most times they provide an effective device to pressurise players into reaching - faster - a workable perception- and goal-alignment (if they possibly can). Players know that missing one Call for Proposals normally means months of waiting for the next one, and this can prove lethal for an initiative, especially in areas where the competition is moving fast. Thus, the existence of definite deadlines for project submission puts a clear pressure on, and horizon to, the process of its formulation.

This is particularly important for large-scale initiatives such as the OMI, since they are likely to attract a lot of players with the potential risk that a search for alignment could go on forever (were time to be open-ended). In contrast, the OMI experience showed that deadlines tend to develop a sense of urgency

42. The Framework Programme sets and coordinates the R & D priorities of the European Community. It is a multiannual programme under which several broadly targeted programmes are operated [21].

(Aigrain's align-or-perish choice) which puts the pressure on the participants to achieve compromises, if these are possible. Time is up and this provides an ideal opportunity for sharp constituency-building by those who are leading the process into a targetted vision. This clearly happened, particularly, during the last two or three OMI workshops. The need to begin to 'freeze' the shape of the proposal was explicitly raised by the Chairman. One by one, a succession of matters were agreed which, thus, became the aligned content of the OMI proposal.

IV SUMMARY AND CONCLUSIONS

This paper set out to analyse the experience of the recent emergence of a large-scale European capability-building initiative. In particular, it looked at how does a diverse range of interests, involving even competing companies, evolve into a coherent European programme? Additionally, it reflected on this experience with a view to contributing to our general understanding of the nature of technological capabilities.

With this aim, the paper first conducted a selective multidisciplinary tour in search for some useful concepts. This looked at insights from behavioural studies of the organization (involving elements from social psychology, psychology of perception and cognition, and behavioural and evolutionary economics); political sciences, especially, elements from 'bureaucratic politics' and 'policy networks/communities' analyses; and from sociology and history, for instance, in the contributions of the 'social history' and 'the social construction of technology', as well as the 'actor-networks' and 'technological systems' approaches. This multidisciplinary tour revealed clear complementarities and convergences between diverse disciplinary approaches. In particular, we saw how the critical importance of goals, perceptions, conflict, negotiation and coalitions, is quite a common ground for analysts dealing with, for instance, the nature of decision-making, or the development of the organization. The same is valid for the treatment of technological and policy processes, which has established many relevant insights - for instance, the sociotechnical (heterogeneous) nature of technological processes; their socially shaped (constructed) character; the importance of community/network/system building (heterogeneous

engineering); the issues of flexibility, credibility, enrolment, power relations, viability; and the fact that technology also plays a role in determining the character of networks/systems. The review, however, also established that the use of concepts such as networks, communities, systems and 'heterogeneous engineering' is far from unproblematic.

This highlighted the importance to develop further the 'sociotechnical constituencies' approach, seeking to incorporate some of the relevant conceptual insights. This was done by looking at the process of constituency-building as one of perception- and goal-alignment between the many different players involved in the capability-building effort. It is through alignment that the separate pieces evolve into a feasible programme *satisficing* the interests of all the eventual constituents. This is how a diverse range of interests, involving even competing companies, evolve into a coherent European programme. Obviously, this gave the behavioural concepts of perceptions and goals a central role in our general understanding of the nature of technological capabilities. The idea of coalition-building, and the realization that a programme is an outcome of a process of conflict and consensus-building in which there are different perceptions/goals, bounded rationality, and negotiation, are also essential. More generally, the 'constituencies' approach remained firmly within the sociotechnical tradition of conceptualising the technological capabilities.

It was argued that uncertainty can never be removed from the misalignment/alignment dynamics of constituency-building, let alone in the case of a complex large-scale European initiative involving even competing players. Various possible outcomes were thus identified, but no mechanistic prediction offered. It was stressed that all constituency-building has major doses of specificity, idiosyncrasy and contingency, and, that, to an important degree, this is reflected in, or by, the means, tactics and alignment-solutions generated by a particular process. The transference of these elements to other experiences, therefore, will be dependent on the similarity of the new situation, but it is unlikely to be complete and absolute. In other words, contextualisation and adaptation are important. Thus, the *enlightening value* is always likely to be greater than the *replication value* of a single experience, although the greater the similarity the greater the potential for

replication. With this in mind, several elements of more general validity for large-scale European capability-building initiatives via Brussels were discussed. If not inexorable, they seem to provide useful guidance for processes pursuing programmatic alignment similar to our case.

The paper then focused on the mechanism of public (IWG) workshops, since it was here that the initiative's mis-alignment/alignment process became most visible. A few critical contentious situations were examined, highlighting the techno-political solutions generated in pursuit of programmatic alignment. The analysis empirically substantiated the understanding of capability-building as a fundamentally techno-political and behavioural process: a story of people, leadership, conflict, negotiation, pressures and eventual alignment. And, we saw how the results were imprinted in the shape of the (overall) initiative's technology, transforming the strategic direction of the original proposal from an *European* to an *Open* microprocessor initiative. Finally, an effort was made to distil some of the tactics and techniques used during the OMI workshops in order to stimulate the process of alignment. Again, these may provide useful guidance for processes pursuing programmatic alignment through similar mechanisms as OMI

The whole experience of large-scale constituency-building via Brussels is indeed a sort of melting-pot for a process of European integration through technology and vice-versa. It is also an adventure in which there is a great deal of what an old Spanish song says: 'Caminante no hay camino, se hace camino al andar.'⁴³ OMI has successfully reached programmatic alignment, but, now, the complexity, difficulties and potential risks are entering into a different stage: delivering the promise !

In this new stage, the greatest understanding and care will be needed - at least for a few years - to nurture the most effective development of the constituency. A sizeable amount of money will be on the line and some may say that it is only now that the real work is about to start. This means that the

⁴³'Traveller there is no path, the path is made as you go.' (song from J. M. Serrat based on a poem by Antonio Machado).

replication. With this in mind, several elements of more general validity for large-scale European capability-building initiatives via Brussels were discussed. If not inextinguishable, they seem to provide useful guidance for processes pursuing programme alignment similar to our case.

The paper then focused on the mechanism of public (PWG) workshops, since it was here that the initiative's mis-alignment/alignment process became most visible. A few critical, contentious situations were examined, highlighting the techno-political solutions generated in pursuit of programme alignment. The analysis empirically substantiated the understanding of capability-building as a fundamentally techno-political and behavioural process: a story of people, leadership, conflict, negotiation, pressures and eventual alignment. And we saw how the results were imprinted in the shape of the (overall) initiative's technology, transforming the strategic direction of the original proposal from an European to an OMI microprocessor initiative. Finally, an effort was made to distil some of the tactics and techniques used during the OMI workshops in order to stimulate the process of alignment. Again, these may provide useful guidance for processes pursuing programme alignment through similar mechanisms as OMI.

The whole experience of large-scale constituency-building via Brussels is indeed a sort of melting-pot for a process of European integration through technology and vice-versa. It is also an adventure in which there is a great deal of what an old Spanish song says: 'Camino no hay camino, se hace camino al andar'. OMI has successfully reached programme alignment, but now, the complex, difficulties and potential risks are entering into a different stage: delivering the promise!

In this new stage, the greatest understanding and care will be needed - at least for a few years - to nurture the most effective development of the constituency. A sizeable amount of money will be on the line and some may say that it is only now that the real work is about to start. This means that the

traveller there is no path, the path is made as you go, (song from I. M. Garcia based on a poem by Antonio Machado)

coherence of the programme, the quality of its implementation and, indeed, whether or not the constituency was really up to the challenge it set for itself, will be under much closer public scrutiny. With the OMI, the policy stakes are high. After all, this is a programme where Europe is probably throwing its best shot to generate an autonomous capability explicitly targetted to achieve an impact on a key market. This means that all players will have to live up to their commitment, giving their best to make it happen. Ultimately, the outcome will depend on a combination of factors, among them, the effectiveness of OMI players' commitment, their relative power and control of resources within the boundaries of the Initiative, their ability to grow and to continue to negotiate a balance between competition and collaboration. Simultaneously, since the Initiative does not exist in isolation, it will depend on the success of OMI's own constituency-building process relative to those of other competing constituencies populating the microprocessor field. This is not a short-term process. Judgement may well have to wait towards the end of the decade.

[6] M. Carpentier, *After Maastricht: Paving in the New Electronics Policy Framework*, XIII Magazine (5, March 1992) 3.

[7] J. Child, *Organizational Structure, Environment and Performance: The Role of Strategic Choice*, *Sociology* (6, 1, 1972) 2-32.

[8] Commission of the European Communities (C.E.C.), *The European Electronics and Information Technology Industry: State of Play, Issues at Stake and Proposals for Action* (C.E.C./DGXIII, Brussels 1991).

[9] C.E.C., *Background Material to the 1991 Esprit Workprogramme* (C.E.C., Brussels, 12th June 1991).

[10] R. Cyert and J. March, *A Behavioral Theory of the Firm* (Prentice-Hall, Englewood, Cliffs, NJ, 1963).

[11] C. DeBresson and F. Amesse, *Networks of Innovators: A Review and Introduction to the Issue*, *Research Policy* (20, 1991) 363-379.

[12] G. Dosi, *Technological Paradigms and Technological Trajectories*, *Research Policy* (11, 1982) 147-162.

[13] B. Eizen, B. Enserink and W. Smit, *Weapon Innovation: Networks and Guiding Principles*, *Science and Public Policy* (17, 3, 1990) 171-193.

References

- [1] G. Allison, *Essence of Decision: Explaining the Cuban Missile Crisis* (Little, Brown and Co., Boston, 1977)
- [2] W. Bijker, Do not Despair: There Is Life after Constructivism, *Science, Technology and Human Values* (18, 1, 1993) 113-138.
- [3] W. Bijker, T. Hughes, and T. Pinch (eds), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (The MIT Press, Camb., Mass., London, 1987).
- [4] W. Bijker and J. Law, *Shaping Technology/Building Society: Studies in Sociotechnical Change* (The MIT Press, Camb., Mass., 1992).
- [5] M. Callon, Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay in J. Law (ed.), *Power, Action and Belief: A New Sociology of Knowledge?* (Routledge and Kegan Paul, London, 1986) 196-233.
- [6] M. Carpentier, After Maastricht: Filling in the New Electronics Policy Framework, *XIII Magazine* (5, March 1992) 3.
- [7] J. Child, Organizational Structure, Environment and Performance: The Role of Strategic Choice, *Sociology* (6, 1, 1972) 2-22.
- [8] Commission of the European Communities (C.E.C.), *The European Electronics and Information Technology Industry: State of Play, Issues at Stake and Proposals for Action* (C.E.C./DGXIII, Brussels 1991).
- [9] C.E.C., *Background Material to the 1991 Esprit Workprogramme* (C.E.C., Brussels, 12th June 1991).
- [10] R. Cyert and J. March, *A Behavioral Theory of the Firm* (Prentice-Hall, Englewood, Cliffs., NJ, 1963).
- [11] C. DeBresson and F. Amesse, Networks of Innovators: A Review and Introduction to the Issue, *Research Policy* (20, 1991) 363-379.
- [12] G. Dosi, Technological Paradigms and Technological Trajectories, *Research Policy* (11, 1982) 147-162.
- [13] B. Elzen, B. Enserink and W. Smit, Weapon Innovation: Networks and Guiding Principles, *Science and Public Policy* (17, 3, 1990) 171-193.

- [14] ESPRIT Industrial Working Group, *Open Microsystems Initiative. 1991 Workprogramme* (IWG Plan 5 December 1990, ESPRIT, Brussels).
- [15] J. Fleck, The Effective Utilisation of Robots: The Management of Expertise and Knowhow in T. Brock (ed.), *Proceedings of the 6th British Robot Association Annual Conference* (Birmingham, UK, 16-19 May 1983) 61-69.
- [16] C. Freeman, Networks of Innovators: A Synthesis of Research Issues, *Research Policy* (20, 1991) 499-514.
- [17] S. Furber and A. Wilson, The Acorn RISC Machine - An Architectural View, *Electronics and Power* (June 1987) 402-405.
- [18] R. Hilsman, *To Move a Nation: The Politics of Foreign Policy in the Administration of John F. Kennedy* (Doubleday & Co., New York, 1967).
- [19] T. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (The John Hopkins University Press, Baltimore, 1983).
- [20] T. Hughes, The Seamless Web: Technology, Science, Etcetera, Etcetera, *Social Studies of Science* (16, 1986) 281-92.
- [21] *JFIT News* (DTI/SERC), European R & D (43, May 1993).
- [22] R. Kaplinsky, *Automation: The Technology and Society* (Longman, London, 1984).
- [23] J. Kotter, An Integrative Model for Organizational Dynamics in L. Schlesinger, R. Eccles and J. Gabarro (eds), *Managing Behavior in Organizations* (McGraw-Hill Book Co., NY, 1983) 413-428.
- [24] B. Latour, *The Prince for Machines as well as for Machinations* in B. Elliot (ed.), *Technology and Social Process* (University of Edinburgh Press, Edinburgh, 1988) 20-43.
- [25] J. Law, The Anatomy of a Socio-Technical Struggle: The Design of the TSR2, in B. Elliot (ed.), *Technology and Social Process* (Edinburgh University Press, Edinburgh, 1988) 44-69.
- [26] J. Law and M. Callon, The Life and Death of an Aircraft: A Network Analysis of Technical Change in W. Bijker and J. Law (eds), *Shaping Technology/Building Society: Studies in Sociotechnical Change* (The MIT Press, Camb., Mass., 1992) 21-52.
- [27] D. MacKenzie, Marx and the Machine, *Technology and Culture* (25, 3, 1984) 473-502.

- [28] D. MacKenzie and G. Spinardi, The Shaping of Nuclear Weapon System Technology: US Fleet Ballistic Missile Guidance and Navigation: Part I: From Polaris to Poseidon, *Social Studies of Science* (18, 1988) 419-63.; and Part II: 'Going for Broke' - The Path to Trident II, *Social Studies of Science* (18, 1988) 581-624.
- [29] D. MacKenzie and J. Wajcman, (eds) *The Social Shaping of Technology* (Milton Keynes, Open University Press, 1985).
- [30] J. March, The Business Firm as a Political Coalition, *The Journal of Politics* (24, 1962) 662-678.
- [31] J. March and H. Simon, *Organizations* (John Wiley, NY, 1967) (1st edition, 1958).
- [32] D. Marsh and R. Rhodes (eds), *Policy Networks in British Government* (Clarendon Press, Oxford, 1992).
- [33] R. Mishra, Technology and Social Structure in Marx's Theory: An Exploratory Analysis, *Science and Society* (43, 2, 1979) 132-157.
- [34] A. Molina, *The Socio-Technical Basis of the Microelectronics Revolution: A Global Perspective*, Ph.D. Thesis, 2 Vols. (Edinburgh University, Edinburgh, 1987).
- [35] A. Molina, 1992 and European Integration: Opportunities and Difficulties in High-Technology Collaboration, *Futures* (June 1990) 496-514.
- [36] A. Molina, Transputers and Transputer-Based Parallel Computers: Sociotechnical Constituencies and the Build-Up of British-European Capabilities in Information Technologies, *Research Policy* (19, 1990a) 309-333.
- [37] A. Molina, Competitive Strategies in the Microprocessor Industry: The Case of an Emerging v/s an Established Technology, *International Journal of Technology Management* (7, 6/7/8, 1992) 589-614.
- [38] A. Molina, In search of insights into the generation of techno-economic trends: Micro- and Macro-Constituencies in the Microprocessor Industry, *Research Policy* (22, 5/6, 1993) forthcoming.
- [39] A. Molina, Insights into the Successful Generation of a Large-Scale European Initiative: From Mis-alignments to Programmatic Alignments in the Build Up of Sociotechnical Constituencies in R. Mansell, *Information, Control and Technical Change* (ASLIB, London, 1993a) forthcoming.

- [40] K. Mulder and P. Vergragt, *Social Networks as an Explanation for Different Technological Strategies*, Paper presented to 4S Conference, Irvine, November 1989.
- [41] R. Nelson and S. Winter, *An Evolutionary Theory of Economic Change* (Harvard University Press, Camb., Mass., 1982).
- [42] D. Noble, *Forces of Production: A Social History of Industrial Automation* (Alfred Knopf, New York, 1984).
- [43] T. Pinch and W. Bijker, The Social Construction of Facts and Artefacts: or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other, *Social Studies of Science* (14, 1984) 399-441.
- [44] M. Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (Routledge & Kegan Paul, London, 1958).
- [45] C. Raab, Taking Networks Seriously: Education Policy in Britain, *European Journal of Political Research* (21, 1992) 69-90.
- [46] R. Rhodes, *The National World of Local Government* (Unwin Hyman, London, 1986).
- [47] N. Rosenberg, Marx as a Student of Technology, *Monthly Review* (28, 3, 1976) 56-77.
- [48] N. Rosenberg, *Perspectives on Technology* (Cambridge University Press, Cambridge, 1977).
- [49] M. Sharp and C. Shearman, *European Technological Collaboration* (Routledge & Kegan Paul, London, 1987).
- [50] W. Shrum, Scientific Specialties and Technical Systems, *Social Studies of Science* (14, 1984) 63-90.
- [51] Siemens AG, *OMI-Meeting* (OMI, Brussels, October 1990) mimeo.
- [52] H. Simon, Birth of an Organization: The Economic Cooperation Administration, *Public Administration Review* (13, 1953) 227-236.
- [53] H. Simon, *Administrative Behavior* (The Macmillan Co., NY, 1957).
- [54] K. Sørensen and N. Levold, Tacit Networks, Heterogeneous Engineers, and Embodied Technology, *Science, Technology and Human Values* (17, 1, 1992) 13-35.

[40] K. Mulder and P. Vergragt, Social Networks as an Explanation for Different Technological Strategies, Paper presented to 45th Conference, Irvine, November 1989.

[41] R. Nelson and S. Winter, An Evolutionary Theory of Economic Change (Harvard University Press, Cambridge, Mass., 1982).

[42] D. Noble, Forces of Production: A Social History of Industrial Automation (Alfred Knopf, New York, 1984).

[43] T. Pinch and W. Bijker, The Social Construction of Facts and Artifacts or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other, *Social Studies of Science* (1984) 399-441.

[44] M. Polanyi, Personal Knowledge: Towards a Post-Critical Philosophy (Routledge & Kegan Paul, London, 1958).

[45] C. Raab, Taking Networks Seriously: Education Policy in Britain, *European Journal of Political Research* (1992) 69-99.

[46] R. Rhodes, The National World of Fact: Government (Unwin Hyman, London, 1986).

[47] N. Rosenberg, Marx as a Student of Technology, *Monthly Review* (28.3) 1976) 56-77.

[48] N. Rosenberg, Perspectives on Technology (Cambridge University Press, Cambridge, 1977).

[49] M. Sharp and C. Shestern, European Technological Collaboration (Routledge & Kegan Paul, London, 1987).

[50] W. Shrum, Scientific Specialties and Technical Systems, *Social Studies of Science* (14) 1984) 63-90.

[51] Siemens AG, OMI-Matrix (OMI, Brussels, October 1990) mimeo.

[52] H. Simon, Birth of an Organization: The Economic Cooperation Administration, *Public Administration Review* (19) 1959) 227-236.

[53] H. Simon, Administrative Behavior (The Macmillan Co., NY, 1957).

[54] K. Sørensen and N. Levin, Tactic Networks, Heterogeneous Partners and Embodied Technology, *Science, Technology and Human Values* (12.1) 1992) 16-35.

[55] E. Trist and K. Bamforth, Some Social and Psychological Consequences of the Longwall Method of Coal Getting, *Human Relations* (4, 1, 1951) 3-38.

[56] O. Williamson, Transaction Cost Economics: The Governance of Contractual Relations, *The Journal of Law and Economics* (22, 1979) 233-261.

[57] M. Wright, Policy Community, Policy Network and Comparative Industrial Policies, *Political Studies* (36, 1988) 593-612.

Edinburgh PICT Working Paper Series

1. *Edge, David*, The social shaping of technology.
2. *MacKenzie, Donald*, 'Micro' versus 'macro' sociologies of science and technology.
3. *Williams, Robin and Russell, Stewart*, Opening the black box and closing it behind you : on microsociology in the social analysis of technology.
4. *Fleck, James*, Innofusion or diffusation? The nature of technological development in robotics.
5. *Peláez, Eloína*, Parallelism and the crisis of von Neumann computing.
6. *MacKenzie, Donald*, Parallel computing : some issues for social research.
7. *Williams, Robin*, The development of models of technology and work organisation with information and communication technologies.
8. *Webster, Juliet*, New technology, old jobs : secretarial labour in automated offices.
9. *Fleck, James*, The development of information-integration : beyond CIM?
10. *Peláez, Eloína*, What shapes software development?
11. *Molina, Alfonso*, Information technology : anatomy of a successful European collaboration.
12. *Webster, Juliet*, Gender, paid work and information technology.
13. *MacKenzie, Donald*, The influence of the Los Alamos and Livermore National Laboratories on the development of supercomputing.
14. *Fleck, James, Webster, Juliet and Williams, Robin*, The dynamics of implementation : a reassessment of paradigms and trajectories of development.
15. *Rooney, Brendan*, The implementation of CIM in rubber manufacturing : a flexible response : case study of Avon Rubber.
16. *Fransman, Martin*, Cooperation, competition and international competitiveness : the case of Japanese central office switches.
17. *Webster, Juliet*, The shaping of software systems in manufacturing: issues in the generation and implementation of network technologies in British industries.
18. *Oakley, Brian*, Look back in Alvey: why support for R&D is not enough.
19. *Molina, Alfonso*, The development of public switching systems in the UK and Sweden: the weight of history.
20. *Fransman, Martin*, Controlled competition in the Japanese telecommunications equipment industry: the case of central office switches.
21. *Webster, Juliet*, Automation in the social office: women's skills and new technology.
22. *Tierney, Margaret & Williams, Robin*, Issues in the blackboxing of information technologies.
23. *Peláez, Eloína*, From symbolic to numerical computing: the story of thinking machines

Edinburgh FICT
Working Paper Series

24. *Molina, Alfonso*, Building up a neural network sociotechnical constituency: a contribution to the formulation of a UK strategy.
25. *Tierney, Margaret*, The formation and fragmentation of computing as an occupation: a review.
26. *Howells, John & Hine, James*, Competitive strategy and the implementation of a new network technology: the case of EFTPoS.
27. *MacKenzie, Donald*, Economic and sociological explanations of technical change.
28. *Edge, David*, Mosaic array cameras in infrared astronomy.
29. *Fleck, James & Tierney, Margaret*, The management of expertise: knowledge, power and the economics of expert labour.
30. *Tierney, Margaret*, The evolution of Def Stan 00-55 and 00-56: an intensification of the 'formal methods debate' in the UK.
31. *Howells, John, Alexander, Nicholas & Hine, James*, New technology and the changing bank - retail industry relationship.
32. *Howells, John*, A socio-cognitive model of innovation.
33. *Tierney, Margaret*, Negotiating a software career: informality and 'the lads' in an Irish software installation.
34. *Fleck, James*, Selectionism dominant: an essay review of books by Basalla, Giere, and Hull.
35. *Faulkner, Wendy*, Understanding industry - academic research linkages: towards an appropriate conceptualisation and methodology.
36. *Molina, Alfonso*, Pressures for change in the global distribution of the microprocessor industry: is US domination about to come to an end?
37. *Fleck, James*, Innovation during implementation: configuration and CAPM.
38. *MacKenzie, Donald*, Negotiating arithmetic, constructing proof: the sociology of mathematics and information technology.
39. *Molina, Alfonso*, Europe's IT strategy shifts into second gear: the targetted and application-driven approach of the emerging open microsystems initiative (OMI).
40. *Fleck, James*, Configuration: crystallising contingency.
41. *Williams Robin & Edge, David*, Social shaping reviewed - research concepts, findings, programmes and centres in the UK.
42. *Molina, Alfonso*, Current trends, issues and strategies in the development of the microprocessor industry.
43. *Faulkner, Wendy*, Conceptualising knowledge used in innovation: a second look at the science-technology distinction and industrial innovation.
44. *Molina, Alfonso*, Understanding the emergence of a large-scale European initiative in technology.

45. *Graham, Ian, Spinardi, Graham, Webster, Juliet and Williams, Robin* The dynamics of EDI standards/development.
46. *Molina, Alfonso*, Networks, communities, systems and sociotechnical constituencies: analysing failure in a European technological initiative.
47. *Molina, Alfonso*, Sociotechnical constituencies as processes of alignment: the rise of a large-scale European information technology initiative.
48. *Faulkner, Wendy*, Policy and management issues in industry research linkage with academic and government laboratories.
49. Spinardi, Graham, EDI in publishing.
50. *Molina, Alfonso*, Struggling to be accepted: the early industrial life of formal methods technology.

Edinburgh PICT
Student Paper Series

1. *Reids, David*, A review of value added and data services and their implications for the City of Edinburgh.
2. *Franks, D.L. Arthur*, A critical evaluation of the industrial robot: use of a strategic perspective to enhance management ability to derive corporate benefit from its implementation.
3. *Almonson, Stefan*, Consequences of the Single European Market on multi exchange manufacturers - prospects for UK producers.
4. *Harwood, Gillian*, A simple planning board and a jolly good memory: time, work organisation and production management technology.
5. *Kozminski, Radoslaw*, The shaping of computer information systems for franchised car dealerships in Brazil: a case study.

Please supply copy(ies) of Edinburgh PICT Working Paper(s) Nos.....

at a cost of £5 per copy inclusive of postage.

I enclose a cheque for

Please make cheques payable to 'The University of Edinburgh' and send to Mrs Barbara Silander, RCSS, The University of Edinburgh, 56 George Square, Edinburgh, EH8 9JU

Please make cheques payable to 'The University of Edinburgh' and send to Mrs Barbara Silander, RCSS, The University of Edinburgh, 56 George Square, Edinburgh, EH8 9JU.