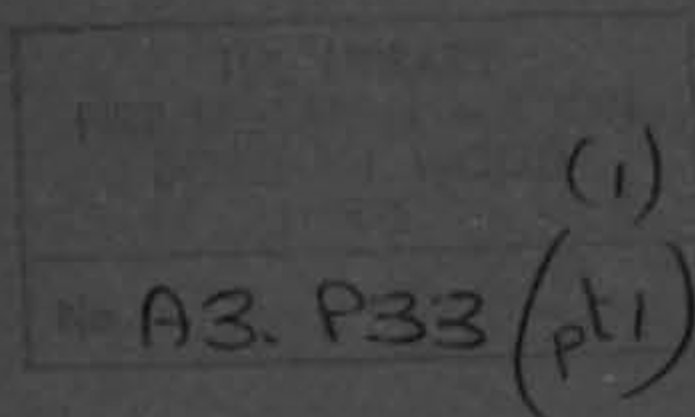




The Costing of Handling and Storage in Warehouses

1. Conventional Warehouses

The Costing of Handling and Storage in Warehouses

1. Conventional Warehouses

C. E. Williams, B.Sc., DAE, Senior Research Fellow, Materials Handling Research Unit, Cranfield Institute of Technology, Cranfield, Beds. A physicist and industrial engineer with a background of equipment development and management in the photographic and light engineering field; his interest has developed in the direction of management, systems design and cost control.

For the last three years, he has studied the design, operation and economics of many of the latest warehousing and distribution installations in the UK, Europe and United States. This first report on the subject is to be followed by a second book on Mechanised and Highbay Warehouses, currently in preparation.

His work in this field has convinced him of the demand for a unified approach to the design and subsequent production implementation of conventional and mechanised warehouse systems, integrating the latest technological 'knowhow' with a leavening of practical warehouse and distribution management. At the same time, a down-to-earth appreciation of the specific aspects of design is needed; principally, the problem of fire and the possible use of computers in the warehouse and distribution control systems.

Department of Trade and Industry
1 Victoria Street
London SW1

SBN 11 470219 5

Preface

The successful exploitation of available resources in any organisation depends to a large extent on the availability of accurate cost analysis. Sometimes it is erroneously thought that the cost of assessing costs is higher than any resultant savings, and opportunities for advancing the technology may be missed.

The following analysis of warehousing costs illustrates the wide variation that exists in this sector of industry and suggests that there is a need for a reappraisal of these costs, which in turn, would enable companies to vary their investment policy to meet the actual situation.

In this first report on conventional warehousing, we have developed an operational costing system which endeavours to establish costs of buildings, equipment and personnel in any warehousing situation. Using this system, a survey of the detailed costs of handling and storage in the warehouses of a number of British companies has revealed marked differences in performance, in terms of 'cost per cubic yard' and 'cost per ton' of goods handled through the system.

The objectives have been:

1. To establish handling and storage costs in warehouses.
2. To define the type and use of the data.
3. To describe extraneous factors which affect the design and performance of warehouses and put them in relation to the costing data.
4. To give a guide to company boards and general management in assessing:
 - (a) the organisational problems and expense of introducing a uniform system of warehouse costing and
 - (b) its possible use for designing future warehouse systems, and for assisting management control of warehousing costing and finance.

The second report will primarily deal with the latest and best practises in the storage of materials in high-bay warehouses and it is hoped will illustrate the advantages of economy in the use of available floor space in conjunction with the latest type of equipment for handling materials which are stored at high level.

This work would not have been possible without the co-operation and time so readily given by many individuals and all the participating companies. My acknowledgments go to Douglas Garbutt, Senior Lecturer in Management Studies at Cranfield Institute of Technology, Cranfield, for his inspiration and his wide experience in all accounting matters; to A. W. Pemberton and E. Kay, Materials Handling Research Unit, Cranfield for their helpful and constructive suggestions during the progress of this work; and not least, to the many individuals in the participating companies who have made this survey possible, and who gave time and help when they were often under heavy production pressure.

It would be invidious to single out companies and personalities; in fact this is not possible at present because of the confidence, mutually agreed with all participating companies from the start. The author hopes he has expressed his thanks adequately to every company and collaborator.

C. E. WILLIAMS
Senior Research Fellow
Materials Handling Research Unit
Cranfield Institute of Technology

July 1970

The first objective of this publication is to provide a comprehensive overview of the current state of the art in the field of [illegible]. The second objective is to identify the key challenges and opportunities in this area. The third objective is to provide a roadmap for future research and development in this field.

The following chapters are organized into three main parts. The first part, [illegible], provides a general overview of the field. The second part, [illegible], focuses on the specific challenges and opportunities. The third part, [illegible], provides a detailed roadmap for future research and development.

In this part, we provide a general overview of the field. We start with a brief history of the field, followed by a discussion of the current state of the art. We then discuss the key challenges and opportunities in this area. Finally, we provide a roadmap for future research and development.

1. To provide a general overview of the field.
2. To identify the key challenges and opportunities in this area.
3. To provide a roadmap for future research and development.
4. To provide a detailed overview of the current state of the art.
5. To provide a detailed overview of the key challenges and opportunities.
6. To provide a detailed overview of the roadmap for future research and development.

From 20 October 1970 the Department of Trade and Industry assumed the functions of the Ministry of Technology in relation to this publication.

The following chapters are organized into three main parts. The first part, [illegible], provides a general overview of the field. The second part, [illegible], focuses on the specific challenges and opportunities. The third part, [illegible], provides a detailed roadmap for future research and development.

The second objective of this publication is to identify the key challenges and opportunities in this area. The third objective is to provide a roadmap for future research and development in this field.

The following chapters are organized into three main parts. The first part, [illegible], provides a general overview of the field. The second part, [illegible], focuses on the specific challenges and opportunities. The third part, [illegible], provides a detailed roadmap for future research and development.

In this part, we provide a general overview of the field. We start with a brief history of the field, followed by a discussion of the current state of the art. We then discuss the key challenges and opportunities in this area. Finally, we provide a roadmap for future research and development.

C. R. W. [illegible]
[illegible]
[illegible]
[illegible]

1970

The following chapters are organized into three main parts. The first part, [illegible], provides a general overview of the field. The second part, [illegible], focuses on the specific challenges and opportunities. The third part, [illegible], provides a detailed roadmap for future research and development.

Contents

	Page
1. Introduction	1
2. The need for cost control in warehousing and its relation to systems design	2
3. The survey of warehouse costs in a number of companies	3
4. The development of a standard system of costing	4
5. Detailed results of the survey	27
6. Problems encountered during the survey with tentative suggestions for solution	34
7. Cost effectiveness of the uniform costing approach in individual companies	40
8. Investment appraisal for warehousing projects	42
9. Future programme	43
10. Conclusions	44
11. Bibliography	45
Appendixes	
1. Definition of main cost centres	46
2. 'Company' and 'uniform' elements of cost and performance indices by volume	48
3. 'Company' and 'uniform' elements of cost and performance indices by weight	55
4. Categories of personnel employed in warehousing situations, with wage rates for 1967-8	59
5. Method for transforming capital charges into annuities over the life of the assets	88
6. Examples of details of survey of Company No. 9	89

© Crown copyright 1970

Extracts from the text may be reproduced
provided the source is acknowledged

Figures

	<i>Page</i>
Fig. 1. Distribution and warehousing	7
Fig. 2. Storage in industrial situations	7
Fig. 3. Flow of goods through any storage situation showing main functions	8
Fig. 4. Main cost centres shown as a functional flow of goods in a general warehouse situation	9
Fig. 5. Warehousing and storage situations goods control system	12
Fig. 6. Sub cost centres shown as a functional flow of goods in a general warehouse situation	13
Fig. 7. Code list of materials handling elements of cost	15
Fig. 8. The single cost framework	17
Fig. 9. Detail of complete cost framework	17
Fig. 10. Performance array – Company X	18
Fig. 11. Performance array – ‘Company’ costs and ‘uniform’ costs – Company X	21
Fig. 12. Breakdown of ‘company’ average annual costs	22
Fig. 13. Breakdown of ‘company’ volume performance indices	23
Fig. 14. Breakdown of ‘uniform’ average annual costs	23
Fig. 15. Breakdown of ‘uniform’ volume performance indices	24
Fig. 16. Applying the uniform costing system to a warehousing situation	35

Tables

	<i>Page</i>
Table 1. Rules of allocation of depreciation of equipment and buildings used in participating companies, warehousing and storage situations	5
Table 2. Equipment price changes 1954–68—Engineering and allied industries	19
Table 3. Warehouse building price changes 1958–1968	19
3a. Warehouse rates	19
Table 4. Allocated services – Cost factors	20
Table 5. Data summarised from the detailed cost analyses of the various companies	31
Table 6. Summary of expense per cubic yard – Allocated services	32
Table 7. Summary of expense per cubic yard – Equipment	32
Table 8. Summary of expense per cubic yard – Labour	32
Table 9. Summary of expense per cubic yard – Control System	32
Table 10. Analysis of ‘uniform’ volume performance indices for building, equipment, labour and control system	33

Glossary of Terms

Semi-manual refers to situations where work is done by humans using special tools, e.g. fork lift trucks, pallet trucks, conveyors.

Semi-automatic implies control by human intervention, but the majority of the work being accomplished by mechanical means.

Automatic implies operations which are machine controlled, but follow an invariable pre-set programme.

Automated implies automatic control which is in some way adaptive to changing circumstances, by means of a control feedback loop.

High-bay warehousing refers to any type of installation in which loads are placed in and removed from cellular static racking by means of stacking cranes running in narrow aisles.

Fixed costs are those which it may be difficult or impossible to change in the short-term, for example, some equipment and building costs.

Controllable costs are those which may be directly regulated by warehouse management in the short or medium term.

Variable costs are those which vary in direct proportion to activity.

Throughput is defined as the total volume or weight of goods which goes into the warehouse which must be broadly the same as that which comes out of the warehouse over a period of time. This is a similar concept to the output from a production line and so hereafter the terms throughput of goods or throughput will be used but will be synonymous with output of goods.

Unit Load generally implies the stacking of a number of the components or goods together for convenience of handling. A common example – ‘cartons stacked on a standard pallet’.

In this report the total volume of the annual throughput of goods can be measured in terms of either (a) total number of unit loads multiplied by the average volume of the unit load or (b) by multiplying the total number of packages or cartons passing through in a year by the average volume of the package or carton. This is not always easy to establish and may involve studying a distribution of individual package sizes where a range of sizes in fact exists.

Similar considerations apply to assessing the total weight of the goods throughput in a year.

1. Introduction

For several years past it had become increasingly apparent to many associated with materials handling and storage, both in industrial and commercial management and in the various associations such as the National Joint Council for Materials Handling and the Materials Handling Research Unit at Cranfield that there existed a need for more detailed information on the costing and economics of handling and storage situations, in conventional warehouses and in the latest more advanced mechanised or automated warehouse units.

We have set out to investigate the detailed costs of warehousing and the associated organisational problems of isolating these detailed costs; this investigation is also complementary to the theoretical work on the mathematical model of a warehouse initiated by Mr. Emile Kay, Senior Research Fellow of the Materials Handling Research Unit at Cranfield. (Refer: A Mathematical Model of a Warehouse, by E. Kay. Pergamon Press.)

It was agreed that a number of large and medium sized British companies should be invited to participate in a national survey of the details of their individual warehousing costs, and in the great majority of cases this co-operation has been readily given.

This report seeks to set out the detailed facts of costing in warehousing and to outline the practical problems which have been encountered whilst working with the various companies in attempting to establish a standard costing approach to warehousing situations.

The results of the survey will be published in two stages:

Stage 1 The survey of over a dozen British warehouse situations, including some with order-picking activities. This survey, partly embodied in this report should be completed shortly.

Stage 2 A similar survey of the latest and more specialised 'high-bay' mechanised or automated warehouses, both in Great Britain and in Europe. This second stage of the full survey will be completed in the latter half of 1969.

The reader will recognise that this report does not suggest that the final solutions to warehouse costing problems have been achieved, but in the absence of other specific data it is offered as an initial approach to the subject.

Exclusion of stock control

It has been assumed that stock levels and their forecastable variations or long-term statistics (averages, dispersion) are given and acceptable to the particular management. In other words, the investigation does not concern itself with stock control and does not deal with related costs such as ordering costs and stockholding costs. However, the investigation still measures the costs of space required to hold the stock.

2. The need for cost control in warehousing and its relation to systems design

It is becoming increasingly recognised that the proportion of materials handling and storage costs in many companies can represent a very large part of the total factory or distribution costs, although there still exists a dearth of literature and facts on the subject.

In companies engaged in commercial distribution and warehousing, the latter function will usually represent a large proportion of the total operating cost, whilst even in industrial situations, the total costs associated with raw materials and finished goods storage may be so large as to demand regular review and constant management control.

It seems reasonable to expect a progressive company to have two main, and to some extent, interdependent objectives in establishing its detailed costs of handling and storage:

1. To be able to exercise day-to-day management control of activities (mainly direct or indirect labour) which gives rise to controllable costs.
2. To amass sufficient cost data to enable the company to
 - (a) predict future controllable costs with confidence;
 - (b) establish and predict 'fixed' costs (mainly equipment and allocated services) so that equipment replacement policy may be on a sound financial accounting basis;
 - (c) enable the economics of alternative proposed handling and storage projects to be accurately assessed before commitment to capital expenditure on equipment and buildings.

Undoubtedly, some companies have very full cost data and use it effectively in meeting the objective stated above, but their data and methods may not for commercial reasons be disseminated to the less talented or fortunate. Further, the design of modern complex handling and storage functions is still only partially understood, let alone appreciated, and it is suggested that there remains a case for integrating a costing approach, with an operations research approach, to the design of handling and storage systems, together with their associated buildings.

It is, therefore, hoped that this report will be useful in providing some basic cost data for companies either to use or to compare with their existing data, as a small contribution to the encouragement of reduction of unnecessary capital expenditure and daily running costs. It is further hoped that this report will persuade interested parties that the introduction of a standard costing system into a company wishing to improve its cost performance of handling is not necessarily an onerous or an expensive operation, and that it may yield acceptable returns.

Hitherto, it appears that in the majority of companies the stress has been laid on controlling the 'controllable' costs and not in isolating and controlling the 'fixed' costs (equipment, building, ancillary services and functions), bearing in mind that a diff
The facts disclosed in this report show that the 'fixed' costs can represent as much as two-thirds of the total 'cost per cubic yard' or 'cost per ton' and it seems logical to stress that careful study and design of equipment and buildings, associated with the overall handling and storage systems, must pay worthwhile dividends.

3. The survey of warehouse costs in a number of companies

In order to collect enough data to be fairly sure of having a representative sample of companies, the following factors were considered:

- (a) The types of commercial or industrial company should be as diverse as possible, although the actual type and quality of the goods handled and stored may have little or no bearing on the methods and efficiency of the handling and storage systems.

Time has not allowed for an exhaustive survey of many industries, but the survey included as diverse a sample as motor car components, retail foods, metal cans, books and mail-order parcels.

- (b) If possible, similar situations within the same group of companies should be compared. This was achieved in Companies 2A and 2B, 5A and 10A, 5B and 10B, 12A and 12B.

- (c) The survey should include several situations requiring order-picking, and this has been achieved in Companies 6, 9, 11, 12, and 14.

The survey therefore represents a limited inter-firm cost comparison of handling and storage costs in warehousing. It was considered to be important from the start that the co-operation and confidence of the companies willing to participate should be established and maintained by allotting to each company a code number known only to that company and to the author, and that any information disclosed would be treated as strictly confidential. To date, this approach has worked very satisfactorily. Clearly, at a later date if any company is willing, after consultation, to disclose its identity, there seems no reason why this should not be possible.

The companies invited were approached on an arbitrary basis, by personal contact at top and middle management level.

4. The development of a standard system of costing

4.1. Costing versus financial records

It is necessary before introducing and detailing any costing system for warehousing that the difference between cost accounting and financial accounting should be established in this context.

When cost information is collected it will fall into three categories according to the purpose for which it is used:

1. For financial accounting
2. For management control
3. For decision making.

The costs collected for financial accounting purposes will not necessarily all be the same as those collected for cost accounting purposes nor will they be analysed and presented in the same form.

The principal objectives of financial accounting are to establish cost data at a particular point in time which can be presented in (1) a profit and loss account and (2) a balance sheet, both of which give a picture of the company's assets, liabilities, and financial performance as far as the shareholders are concerned; for example, profit/earnings ratios. They do not show the cost performance of either one product against another, or of one process or production line against another; neither do they serve to help management to isolate those areas of production, storage, distribution, sales etc which are unsatisfactory from a costing point of view.

Nevertheless, some of the data collected for financial accounting objectives can be used for investment appraisal (the assessment of capital expenditure required for, say, new warehouse project proposals, and further, assessment of the return on the proposed capital outlay). Some comments will be made later in this report on investment appraisal with particular reference to warehouse projects; and the ways in which investment grants, tax allowances and treatment of depreciation are involved.

We are concerned here, firstly, with the development of a cost accounting system which will isolate all detailed costs of any warehouse system in order that they may be examined by management and used to control day-to-day running costs and secondly to enable designers of warehouse systems/buildings to take appropriate account of the interaction of cost with system design. The term 'designer' is used here in a general sense to include architects, consultants, systems designers, industrial engineers, warehouse management.

Broadly, there are two kinds of costing system which may be employed in industrial and commercial situations of the kind dealt with in this report:

(a) *Product costing systems*

Such would be used where the emphasis is on establishing and maintaining the unit cost of the various products of the particular industry, separated in terms of material, labour and overhead expense.

(b) *Process or operational costing systems*

These would be employed where the range or type of product is small or where only one product is manufactured in regular batches or continuous flow. Here the emphasis must be on collecting and controlling the costs of the producing equipment and its associated ancillary equipment and buildings and services.

TABLE 1. Rules of allocation of depreciation of equipment and buildings used in participating companies warehousing and storage situations

Firms' code No.	1	2	3	4	5	6*	7	8†	9	10	11	12‡	13	14	15§	Average proposed uniform rules of allocation
Cranes	10		10	10	15	20	10	10	10% declining balance	15	15	10				12
Stacker cranes	10		10			15 motor 5 electric	10	10	7	10		15				12
Fork-lift trucks	5	5	10	5	10	10	3	4	7	5	5	12 diesel 8 electric	5 electric	10		Electric 7.5. Batteries 4. Diesel 10. Chargers 10.
Hand & powered hand trucks	5	5	10		5	5	3	4			5	10	5	10		5-75
Underfloor towing conveyor													10	10		(10)
Driverless trucks						10			7	5						10
Trailers			10		5	5		10		15		10	10	10		6-5
Conveyors	10		10	10	15		10	10			15	5	10			11
Bins	3 (over £1000)		10 (over £50) or annual expense	10		Annual expense		10	10% declining balance	10		10	Annual expense			6
Racking	3 (over £1000)	10	10 (over £50) or annual expense	10	10	10	10 (20 high-bay)	10			15	15 high-bay	15	10		11
Wooden pallets	3	3		1	5	3					5	3	Annual expense	10		3
Steel pallets			10	10			10	10			10	10	5			10
Stillages																
Handling containers						Annual expense		10	7			3				7
Data processing			12 or rental may apply						10% declining balance		5		7			10
Buildings	40	50	36 Parts Dept. 30 Manuf. Div. 30 high-bay	40	50	30	40 high-bay	30	2½% declining balance	50	40	25	50	50		45 high-bay 25

*Any item under £5 written off as annual expense
†International policy dictated by foreign patent company but now being modified in light of this survey
‡15 high-bay
§Periods of 3-15 years approximating to actual lives of the assets

Before describing an operational costing system as the most suitable for assessing the cost performance of any warehouse system, it is important to mention the differences apparent between the 'write-off' period for assets (say warehouse handling equipment and buildings) selected for financial accounting reasons on the one hand and cost accounting reasons on the other. The financial 'write-off' period may be selected to represent a conservative treatment of depreciation in order to avoid showing profits which might not be substantiated, and also to avoid paying dividends on profits which might be eroded later should capital investment be required earlier than anticipated by financial write-off.

The procedure adopted in this report is first to arrive at a value for the 'company' average annual cost of an item of equipment or building by dividing the initial capital charge (in every case the present price or present equivalent price) by the particular company's estimated life of that particular asset. Secondly, to arrive at a value for the 'uniform' average annual cost of an item or equipment or building, the same initial capital charge is divided by the *average* life of the particular type of equipment or building. These *average* values are the average values of all companies participating in the survey and are shown in Table 1. The derivation of these 'uniform' costs is an attempt to make them more directly comparable between different housing systems and thence between different

It should be made clear that this straightforward procedure for arriving at average annual costs assumes no residual monetary values of the assets on disposal. In other words, if a company wishes to understate its profits, it will write off its assets more quickly because this would overstate the depreciation. The effect provided it takes place before the whole of the cost of the old assets has been written off.

Profits would rise in circumstances where new capital investment was *delayed* since there would then be a period between the writing off of the old assets and the purchase of the new assets when the old assets were in use but were not being depreciated. Other things being equal, this would result in higher reported earnings.

For the cost accounting system developed here, the write-off possible to reflect the actual lives of the equipment and buildings, which in practice means a realistic estimate of the actual lives.

In any warehouse situation, the emphasis of cost control will be to minimise the costs of handling and storage of goods as they flow through the warehouse, similar in concept to the flow of material or goods through a batch or continuous production line. Although the shape, size and unitised form of the goods through any warehouse will be diverse, the flow in unit time can be equated in terms of:

- (a) the total volume of goods through the warehouse
- (b) the total weight of these goods
- (c) the number of unit loads or packages making up these goods.

It must be emphasised that the values of the performance indices (cost per cubic yard or ton, throughput of goods) represent the first stage of a more complex investigation.

An exact inter-firm comparison of performance cost indices may take some account of factors such as the number of 'lines' handled, the rate of handling and maximum storage volume of each separate 'line', seasonal storage requirements, the type and value of goods handled, and marketing strategy. There may well be other factors to be taken into consideration. It seems reasonable, therefore, to adopt an operational costing system for warehousing in which the separate contributions of all handling and storage factors are analysed in cost terms and equated to some measure of each standard unit load passing through the warehouse. The operational costing system will, therefore, be capable of yielding information in terms of unit cost of handling a unit load. The details of the system are described below.

It is necessary to define for the purposes not only of this report but also for the operational costing system itself, the practical boundaries within which the system will be framed and outside which no costs will be collected. These physical boundaries are illustrated in Figs. 1 and 2, the dotted lines showing the break-points inside which the handling and storage activities will be costed. Basically, the costing starts from the point at which goods are handled off the incoming transport (and including this handling activity) to the point at which goods are handled on to the outgoing transport (and including that handling activity).

FIG. 1 Distribution and warehousing

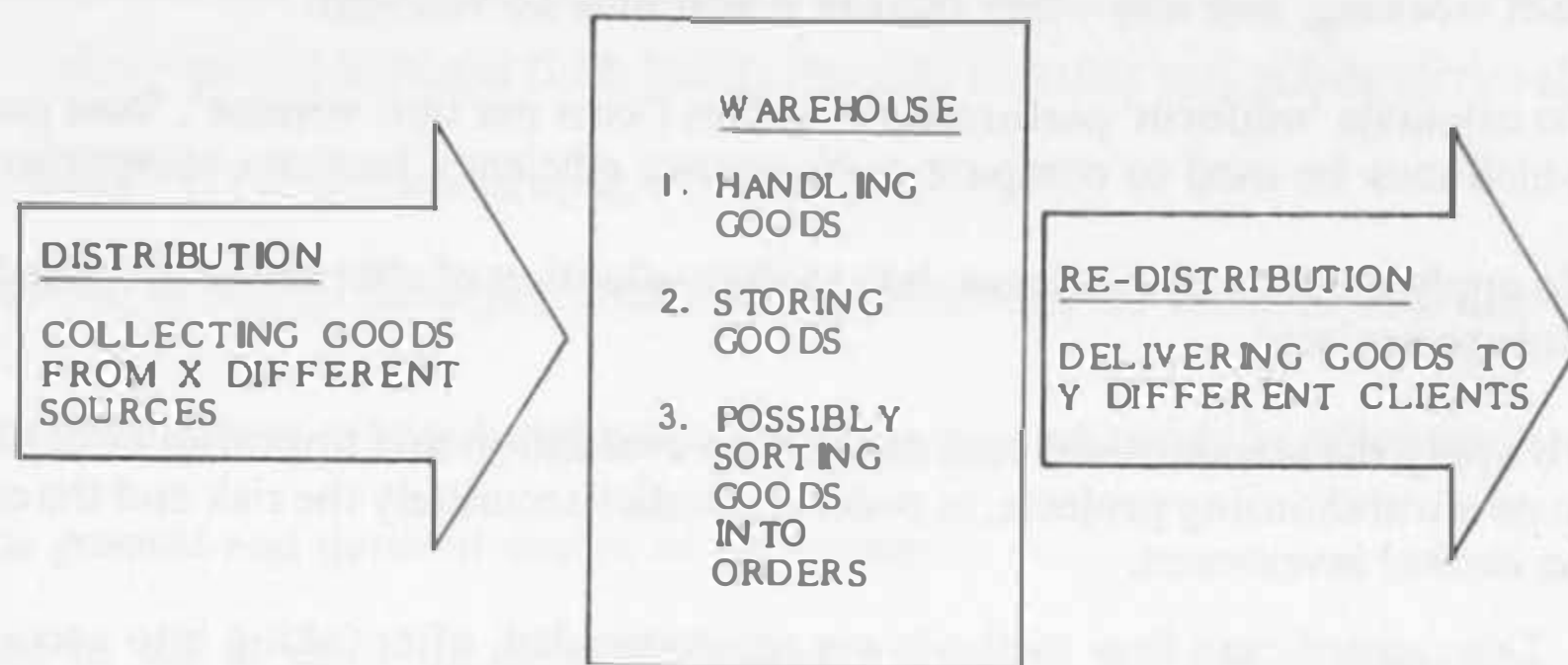
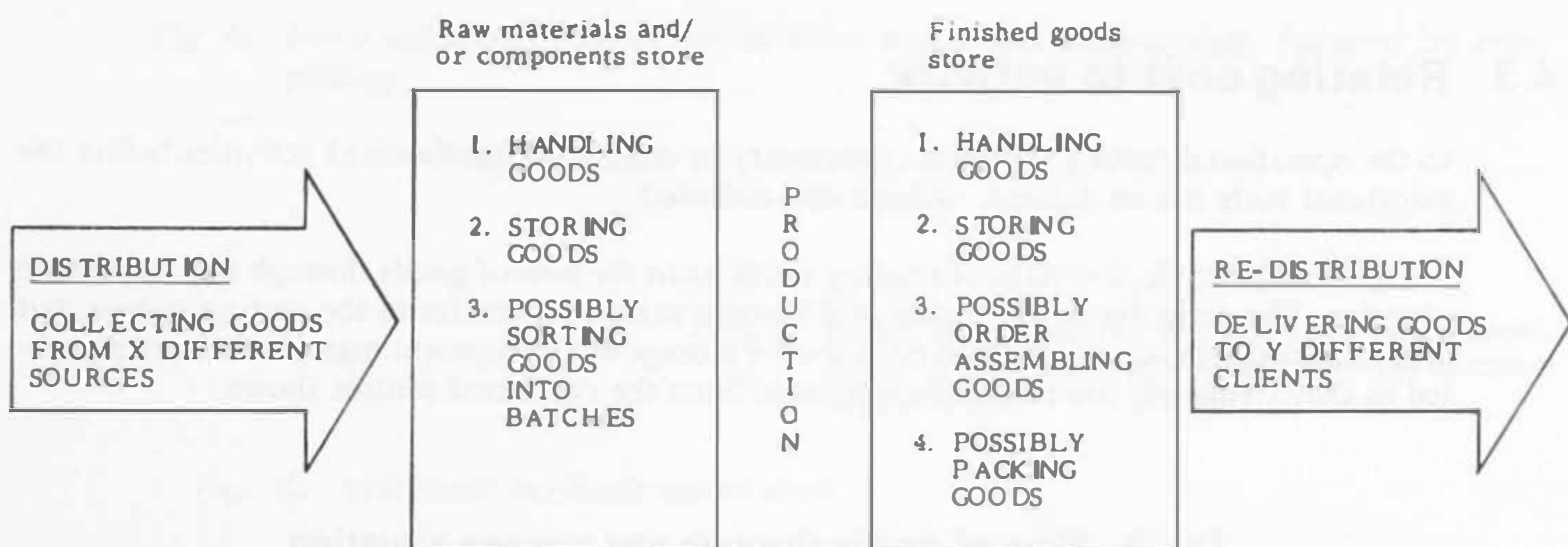


FIG. 2 Storage in industrial situations



4.2. The objectives of the operational costing system

- 4.2.1. To isolate all material handling costs.
- 4.2.2. To distinguish between 'controllable' costs (mainly direct and indirect labour) and 'fixed' costs (mainly equipment and allocated services).
- 4.2.3. To collect and examine the rules of cost allocation and apportionment exercised currently by companies participating in the survey.
- 4.2.4. To define uniform rules of allocation and apportionment of warehouse costs which will be acceptable to most companies.
- 4.2.5. To define standard main and sub cost centres for the various functions of handling and storage.
- 4.2.6. To collect existing costs within the defined cost centres for a suitable unit time. (In the survey the period of one year has been convenient, although shorter periods of collection, months or weeks, might be more useful or effective in particular circumstances.)
- 4.2.7. To define the unit loads handled and stored and to measure their throughput in unit time (per year, month, week) in terms of volume or weight or any other unit which may be relevant.

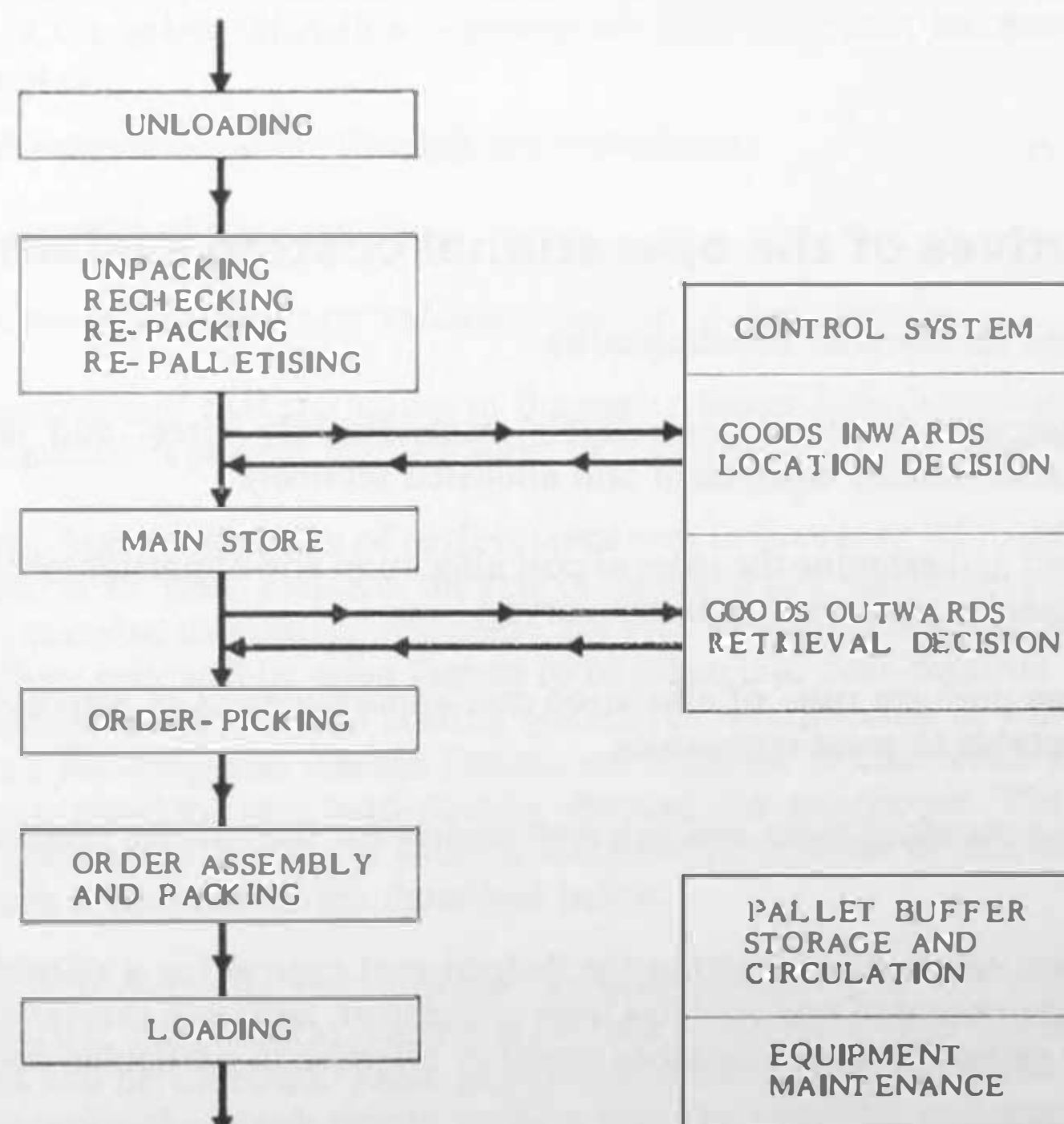
- 4.2.8. To distinguish how 'controllable' and 'fixed' costs vary with levels of output, types of shift working, and any other factors which may be relevant.
- 4.2.9. To calculate 'uniform' performance indices ('cost per unit volume', 'cost per unit weight') which may be used to compare performance efficiency between companies.
- 4.2.10. To apply the standardised cost data to the evaluation of alternative proposed handling and storage projects.
- 4.2.11. To apply the standardised cost data to the evaluation and appraisal of capital investment in new warehousing projects, in order to predict accurately the risk and the expected return on capital investment.
Discounted cash flow methods are recommended, after taking into account any investment grants and tax allowances which may be claimed.
- 4.2.12. To be able to feed the standardised cost data for any warehousing situation into a computer program which would print out (i) the performance indices, (ii) detailed results indicating cost centres with poor or good performance.

4.3. Relating cost to activity

In the operational costing system it is necessary to define the standardised activities before the associated costs can be defined, isolated and collected.

Figure 3 shows the first stage of relating activities to the flow of goods through any warehouse situation. The activities in the 'boxes' will become main cost centres in the costing system, but note that auxiliary services such as pallet buffer storage and equipment maintenance are separated as they frequently are physically separated from the other cost centres shown.

FIG. 3 Flow of goods through any storage situation showing main functions



As all functions will not always be required in practice, some may not exist

It is useful to bear in mind whilst the system is explained, that the primary objectives of the introduction and use of the costing system are:

- 1. To satisfy service demand both goods inwards location and goods retrieval.
- 2. To satisfy (1) at minimum cost.

The extent to which these performance objectives can be satisfied depends mainly on two aspects:

- 1. The fluctuations of input and output and the type of goods handled and stored.
- 2. The general and detailed design of the system.

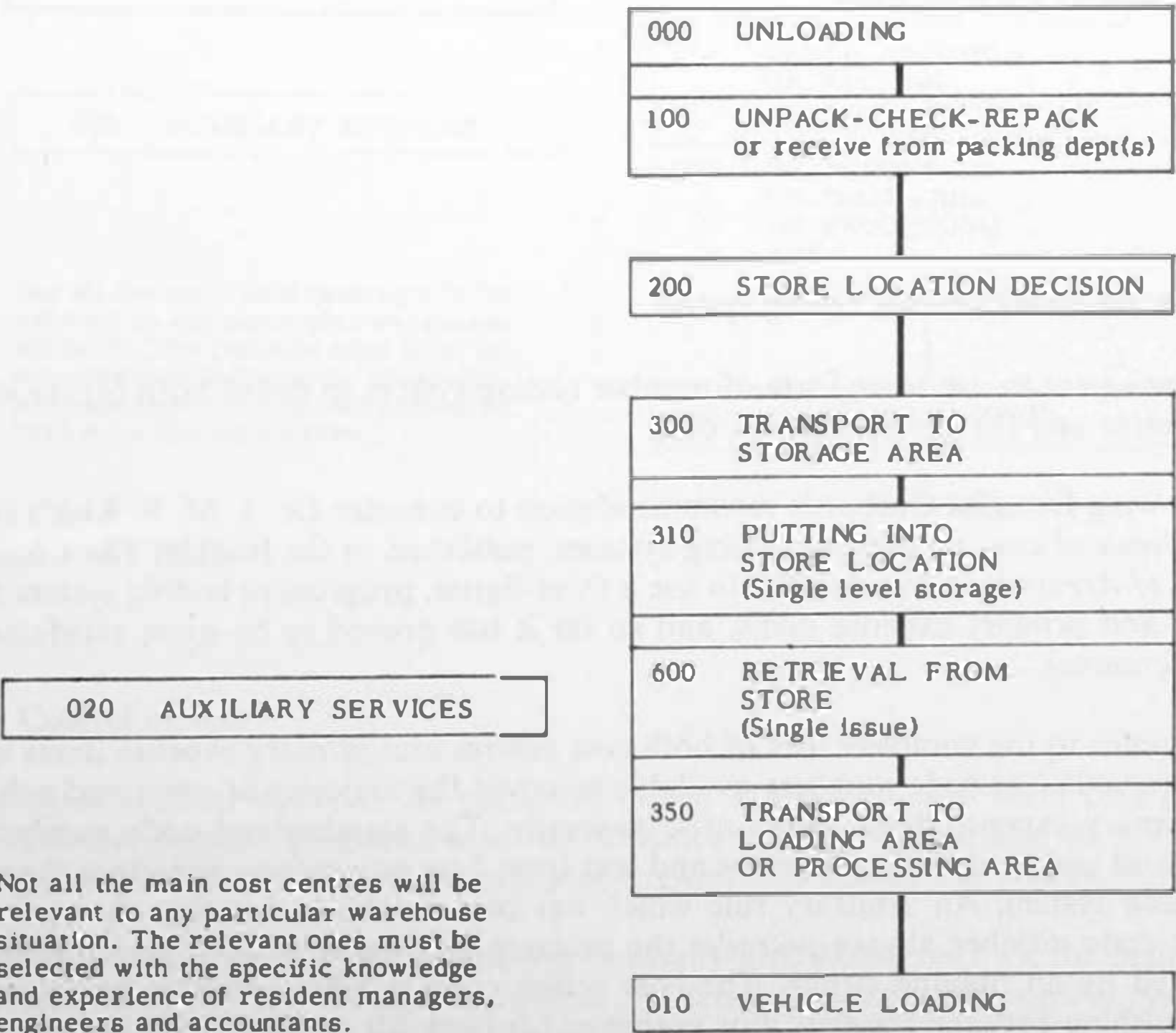
Figures 4a, 4b, 4c show the development of Fig. 3 into the actual main cost centres. There are three alternative flow lines shown, any one of which may be chosen as being relevant to the particular situation to be analysed:

- Fig. 4a For a situation of unit loads in/loads out of store.
- Fig. 4b For a situation of unit loads into single stage (single level) storage, followed by order picking.
- Fig. 4c For a situation of unit loads into two stage (two level) storage, followed by order picking.

FIG. 4 Main cost centres shown as a functional flow of goods in a general warehouse situation:

Fig. 4a unit loads in / loads out of store

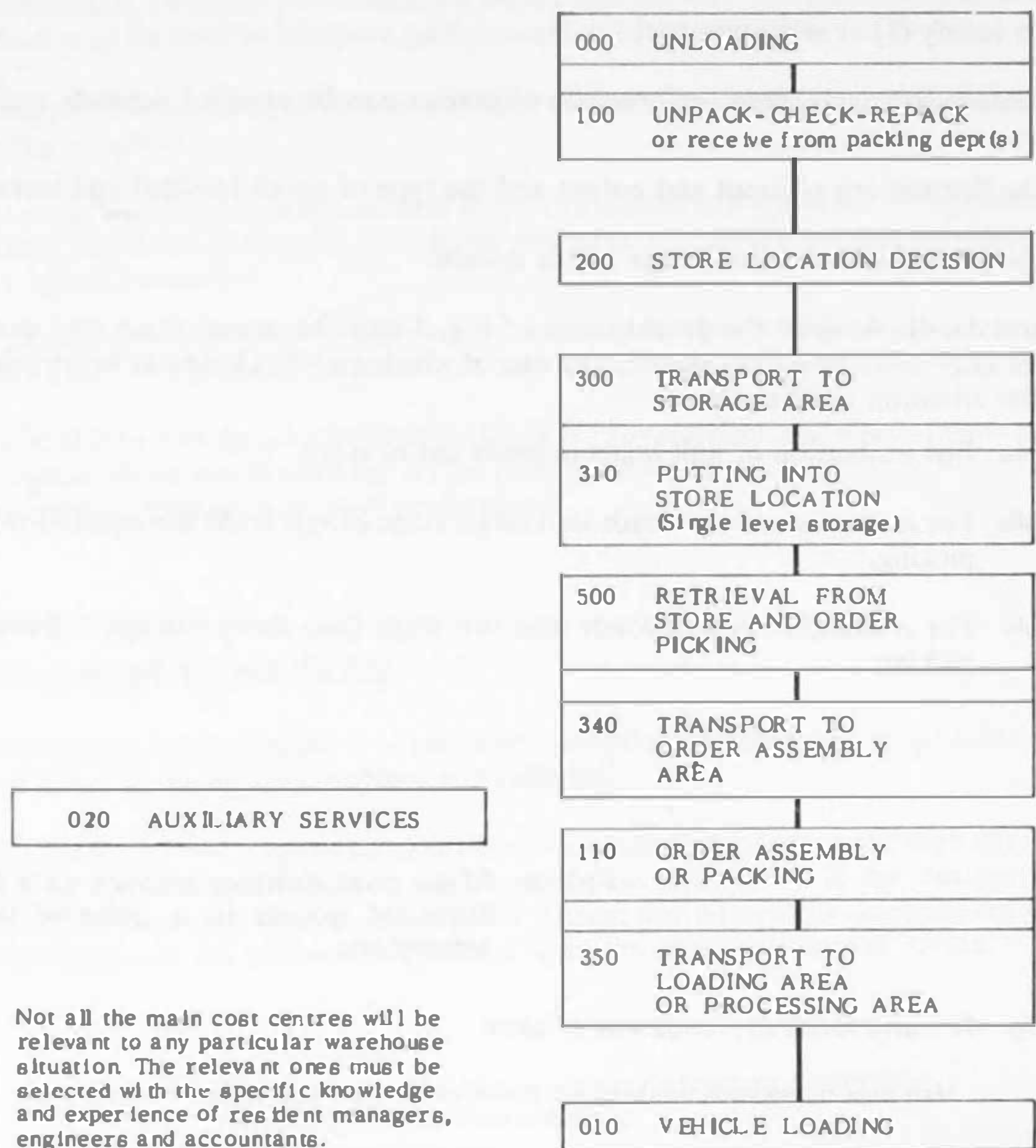
Main cost centre code numbers are shown on left hand side of cost centre blocks



Not all the main cost centres will be relevant to any particular warehouse situation. The relevant ones must be selected with the specific knowledge and experience of resident managers, engineers and accountants.

Fig. 4b unit loads into single stage storage, followed by order picking

Main cost centre code numbers are shown on left hand side of cost centre blocks



4.3.1. A shorthand number coding system

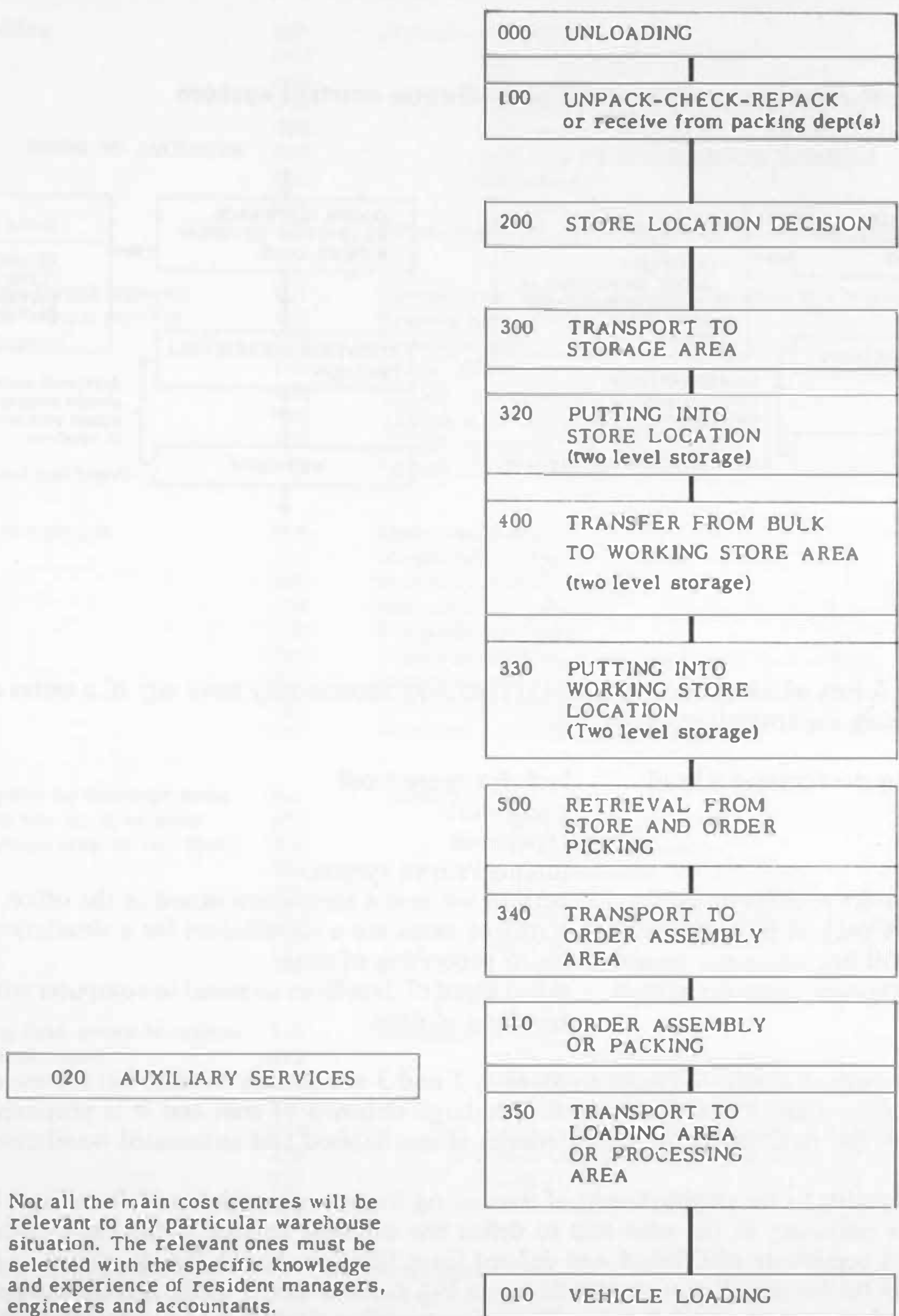
It is convenient to use some form of number coding system to define both (a) the main and sub cost centres and (b) the elements of cost.

Following Douglas Garbutt's recommendation to consider Dr. J. M. S. Risk's investigations and reviews of cost accounting coding systems, published in the booklet *The Classification and Coding of Accounts*, it was decided to use a three-figure, progressive coding system for both cost centres and primary expense items, and so far it has proved to be quite satisfactory for both (see references).

Reference to the complete lists of both cost centres and primary expense items indicates that there are sufficient code numbers available to cover the majority of main and sub cost centres and primary expense items which arise generally. The standardised code numbers have been introduced and used in the diagrams and text from here onwards to introduce the reader to this shorthand system. An arbitrary rule which has been established is that the main or sub cost centres code number always *precedes* the primary expense item code number, the two being separated by an oblique stroke. The cost centre code number can also be underlined to aid distinguishing between the two. For example; (a) Fork lift truck activity in the unloading bay coupled with the basic wage payments would be 004/101; (b) Fork lift truck depreciation cost in the order assembly department would be 114/402.

Fig. 4c unit loads into two stage storage, followed by order picking

Main cost centre code numbers are shown on left hand side of cost centre blocks



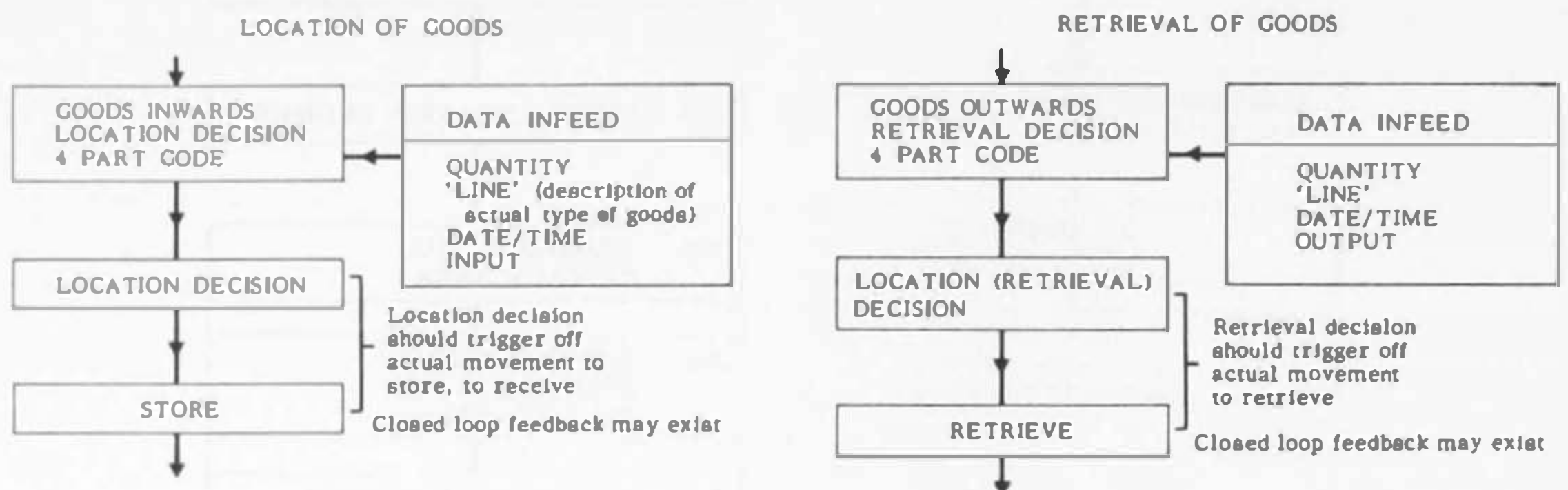
4.3.2. Control system

The control system, whatever its particular form, is shown under main cost centre heading 200 – Control System. Its position in the flowlines on Figs. 4a, 4b and 4c is to some extent arbitrary as control activity will generally be present throughout the system.

In practice the control system costs are normally distributed over all the main cost centres, and it is difficult to separate and apportion the detailed elements of control system costs (for example, computer costs) to each of the main cost centres. It will be explained later in greater detail that the total control system costs will be apportioned to the main cost centres in proportion to the relative costs of building, equipment and labour in these cost centres.

Figure 5 shows the basic elements of any control system, which basically has two parts, the first to receive data on the goods arriving and use these data to decide what goes where in the store and when; the second to receive data on the goods which must be retrieved from the store. Part of the in-fed data may be used for stock control, invoicing and advising functions.

FIG. 5 Warehousing storage situations—Goods control system



The forms which the total control system may assume may have any of a series of degrees of increasing sophistication as follows:

1. In the foreman's head
 - look for nearest cell
 - guess work
 - experience
 - foreman's own system.
2. A set of rules on paper
 - with or without a simulation board in the office.
3. A pack of punched cards
 - a tray of cards are a substitution for a simulation board.
4. Off-line computer system
 - batch processing of data.
5. On-line computer system
 - direct input of data from terminal to computer with automatic handling of data.

The costs of control systems to stage 1, 2 and 3 are usually modest but the use of computer control to stages 4 and 5 may introduce large elements of cost and it is proposed to analyse these in the next report on the economics of mechanised and automated warehouses.

Returning to the establishment of the costing framework, which we left at Figs. 4a, 4b, 4c it is now necessary as the next step to define the sub cost centres within each of the main cost centres previously established and defined from Figs. 4a, 4b, 4c. To do this it is necessary to consult the list of sub cost centres shown in Fig. 6. An example of the layout is shown in Appendix 6 of this report. It takes only a short time to define those sub cost centres which are relevant to each previously selected main cost centre.

It is convenient to establish a standard layout for the basic cost framework by setting out the main cost centres across the page in flow sequence, each main cost centre code number being followed by the appropriate sub cost centre numbers, thus forming the columns of the table. Under each main or sub cost centre the appropriate primary expense items are set down in rows; it is convenient to set them down in the order of labour, equipment and allocated services. The recommended format is shown in Fig. 8 and in code form in Fig. 9.

The main and sub cost centres of activity have now been selected as being relevant to the particular warehousing situation and the second and final stage in setting up the costing framework is to select and define the corresponding elements of costs which will be collected under each and every main and sub cost centre. These costs will be collected for a unit time which is considered to be the most convenient or useful. (In practice, a time of one year has been used in the survey, but there is no reason why a shorter period of time should not be selected; it may be that it would be more effective in specific situations to collect for a series of successive periods of months or weeks.)

FIG. 6. Sub cost centres shown as a functional flow of goods in a general warehouse situation

Sub cost centre code numbers are shown on left hand side of each item

000 Unloading	001	Unload – manually
	002	“ with unpowered machines
	003	“ with powered trucks
	004	“ with mechanical fork lift trucks
	005	“ with underfloor towing conveyors/driverless trucks
	006	“ with auto conveyors, gravity conveyors
	007	“ with cranes
	008	“ check contents of loaded vehicles
	009	Temporary storage in temporary or permanent location
100 Unpack, check-repack (or receive from packing department(s))	101	Palletise manually (or receive ex packing department)
	102	Palletise automatically
	103	Quantity check
	104	Quality check
	105	Unpack or repack manually
	106	Unpack or repack semi-automatically
	107	Unpack or repack fully automatically
	108	Prepare documents/issue orders
200 Control system	201	Marry documents
	202	Transit documents
	203	Decision on store location
	204	Issue order to transport
	205	Computer hardware
	206	Computer software, including tapes, cards, papers, etc.
	207	Computer interfaces
	208	Computer personnel
	209	Computer building and/or installation
300 Transport to storage area (Putting into store location either single level or two level)	301	Transport – manually
	302	“ with unpowered machines
	303	“ with powered trucks
	304	“ with mechanical fork lift trucks
	305	“ with underfloor towing conveyors/driverless trucks
	306	“ with auto conveyors, gravity conveyors
	307	“ with cranes
	308	“ with tractor/trailers
320 Putting into store location two level store	321	Transport – manually
	322	“ with unpowered machines
	323	“ with powered trucks
	324	“ with mechanical fork lift trucks
	325	“ with underfloor towing conveyors/driverless trucks
	326	“ with auto conveyors, gravity conveyors
	327	“ with cranes
	328	“ with tractor/trailers
400 Transfer from bulk to working store area – two level storage	401	Marry documents
	402	Transmit documents
	403	Decision on store location
	404	Issue order to transport
330 Putting into working store location	331	Transport – manually
	332	“ with unpowered machines
	333	“ with powered trucks
	334	“ with mechanical fork lift trucks
	335	“ with underfloor towing conveyors/driverless trucks
	336	“ with auto conveyors, gravity conveyors
	337	“ with cranes
	338	“ with tractor/trailers
500 Retrieval from store – Serial or parallel order picking	501	Collecting – manually
	502	“ with unpowered machines
	503	“ with powered trucks
	504	“ with mechanical fork lift trucks
	505	“ with underfloor towing conveyors/driverless trucks
	506	“ with auto conveyors, gravity conveyors
	507	“ with cranes
	508	“ with tractor/trailers

340	Transport to order assembly area	341	Transport – manually
		342	“ with unpowered machines
		343	“ with powered trucks
		344	“ with mechanical fork lift trucks
		345	“ with underfloor towing conveyors/driverless trucks
		346	“ with auto conveyors, gravity conveyors
		347	“ with cranes
		348	“ with tractor/trailers
110	Order assembly	111	Palletise manually (or receive ex packing department)
		112	Palletise automatically
		113	Quantity check
		114	Quality check
		115	Unpack or repack manually
		116	Unpack or repack semi-automatically
		117	Unpack or repack fully automatically
		118	Prepare documents/issue orders
350	Transport to loading area or processing area	351	Transport – manually
		352	“ with unpowered machines
		353	“ with powered trucks
		354	“ with mechanical fork lift trucks
		355	“ with underfloor towing conveyors/driverless trucks
		356	“ with auto conveyors, gravity conveyors
		357	“ with cranes
		358	“ with tractor/trailers
310	Putting into store location – single level storage	311	Transport – manually
		312	“ with unpowered machines
		313	“ with powered trucks
		314	“ with mechanical fork lift trucks
		315	“ with underfloor towing conveyors/driverless trucks
		316	“ with auto conveyors, gravity conveyors
		317	“ with cranes
		318	“ with tractor/trailers
600	Retrieval from store – single issue (only applies to bulk transfers)	601	Transport – manually
		602	“ with unpowered machines
		603	“ with powered trucks
		604	“ with mechanical fork lift trucks
		605	“ with underfloor towing conveyors/driverless trucks
		606	“ with auto conveyors, gravity conveyors
		607	“ with cranes
		608	Prepare documents/issue orders
010	Vehicle loading	011	Load – manually
		012	“ with unpowered machines
		013	“ with powered trucks
		014	“ with mechanical fork lift trucks
		015	“ with underfloor towing conveyors/driverless trucks
		016	“ with auto conveyors, gravity conveyors
		017	“ with cranes
		018	“ Check contents of loaded behicle
		019	Temporary storage in temporary or permanent location
020	Auxiliary services	021	Pallets or other containers in use outside system
		022	Pallets or other containers in buffer storage outside system
		023	Check condition of pallets for high-bay stacking

It is clear from an examination of Fig. 7 that the elements of costs fall broadly into three categories:

1. Labour – direct and indirect
2. Equipment
3. Allocated services – i.e. buildings and associated costs.

Some explanations and definitions of the main cost centres are shown in Appendix I to give some guidance in the practical selection of the main cost centres.

FIG. 7. Code list of materials handling elements of cost

Coding 000-099. Direct Materials, is not applicable and therefore not considered.

100-199 Direct labour

- 101 Wages – Normal hours or normal rate. Based on number of weeks actually worked per year.
- 102 Wages – Overtime hours or Premium Rates – Time and one half
- 102 Wages – Overtime hours or Premium Rates – Double time
- 104 Incentive bonuses
- 105 Shift allowances
- 106 Employer's contribution to Social Security – National Insurance and Graduated Pensions but excluding SET, REP and training levy.
- 107 Holiday pay – based on 2 or more weeks per year
- 108 Company merit awards and long service awards

200-299 Indirect labour

- 201 Wages – Normal hours or normal rate. Based on number of weeks actually worked per year
- 202 Wages – Overtime hours or premium rates – Time and one half
- 203 Wages – Overtime hours or premium rates – double time
- 204 Incentive bonuses
- 205 Shift allowances
- 206 Employer's contribution to Social Security – National Insurance and Graduated Pensions but excluding SET, REP and Training Levy
- 207 Holiday pay – based on 2 or more weeks per year
- 208 Company merit awards and long service awards

300-399 Materials handling – Misc (Indirect materials)

- 301 Packing materials
- 302 Damage in transit (where cost exceeds 00% of unit load throughput)
- 303 Pilfering in transit (where cost exceeds 00% of unit load throughput)
- 304 Loss in transit (where cost exceeds 00% of unit load throughput)
- 305 Cost of documents

400-499 Equipment charges

- 401 Fork Lift Trucks Hire/Rental or Depreciation (diesel)
- 402 " " " Depreciation (electric)
- 403 " " " Maintenance – Labour – Internal
- 404 " " " Maintenance – Materials – Internal
- 405 " " " Maintenance – Labour – Outside maintenance
- 406 " " " Maintenance – Materials – Outside maintenance
- 407 " " " Operating expenses Fuel oil/Gas/Petrol/Electricity
- 408 " " " " " Depreciation Batteries or Engines
- 409 " " " " " Replacement Tyres
- 410
- 411 Cranes Hire/Rental
- 412 " Depreciation
- 413 " Maintenance – Labour – Internal
- 414 " Maintenance – Materials – Internal
- 415 " Maintenance – Labour – Outside maintenance
- 416 " Maintenance – Materials – Outside maintenance
- 417 " Operating expenses – Power
- 421 Conveyors – unpowered – Depreciation
- 422 Powered – Depreciation
- 423 " – Maintenance – Labour – Internal
- 424 " – Maintenance – Materials – Internal
- 425 " – Maintenance – Labour – Outside maintenance
- 426 " – Maintenance – Materials – Outside maintenance
- 427 " Operating expenses – Power
- 431 Pallets – Hire/Rental
- 432 Stillages (wooden) – Depreciation
- 433 " – Maintenance – Labour – Internal
- 434 " – Maintenance – Materials – Internal
- 435 " – Maintenance – Labour – Outside maintenance
- 436 " – Maintenance – Materials – Outside maintenance
- 437 Pallets (steel) – Depreciation
- 441 Trailers – Hire/Rental
- 442 " – Depreciation
- 443 " – Maintenance – Labour – Internal
- 444 " – Maintenance – Materials – Internal
- 445 " – Maintenance – Labour – Outside maintenance
- 446 " – Maintenance – Materials – Outside maintenance

451	Racking – Hire/Rental
452	„ – Depreciation
453	„ – Maintenance – Labour – Internal
454	„ – Maintenance – Materials – Internal
455	„ – Maintenance – Labour – Outside maintenance
456	„ – Maintenance – Materials – Outside maintenance
461	Stacker Cranes – Trolleys – Depreciation
462	„ „ – Stacker Cranes – Depreciation
463	„ „ – Maintenance – Labour – Internal
464	„ „ – Maintenance – Materials – Internal
465	„ „ – Maintenance – Labour – Outside maintenance
466	„ „ – Maintenance – Materials – Outside maintenance
467	„ „ – Motors – Depreciation
468	„ „ – Turret Truck – Depreciation
469	„ „ – Turret Truck Motor – Depreciation
471	Handling Containers/bins – Hire/Rental
472	„ „ – Depreciation
473	„ „ – Maintenance – Labour – Internal
474	„ „ – Maintenance – Materials – Internal
475	„ „ – Maintenance – Labour – Outside maintenance
476	„ „ – Maintenance – Materials – Outside maintenance
481	Driverless trucks or tractors – Control System – Depreciation
482	„ „ „ – Depreciation (Truck)
483	„ „ „ – Maintenance – Labour – Internal
484	„ „ „ – Maintenance – Materials – Internal
485	„ „ „ – Maintenance – Labour – Outside maintenance
486	„ „ „ – Maintenance – Materials – Outside maintenance
487	„ „ „ – Operating expenses – Fuel oil/Gas/Petrol/Electricity
488	„ „ „ – Replacement Batteries or Engines
489	„ „ „ – Replacement Tyres
491	Underfloor towing – Hire/Rental
492	Conveyors – Depreciation
493	„ – Maintenance – Labour – Internal
494	„ – Maintenance – Materials – Internal
495	„ – Maintenance – Labour – Outside maintenance
496	„ – Maintenance – Materials – Outside maintenance
497	„ – Operating expenses – Power
498	Overhead conveyor – Depreciation
500-599 Allocated Services to Materials Handling	
501	Main storage building – Depreciation
502	Building maintenance
503	Building cleaning
504	Building Rental/Hire
505	Rates
506	Insurances
507	Heating
508	Lighting
509	Ventilation
510	Refrigeration
511	High-bay building (excluding racking)
512	High-bay building steel racking
513	High-bay building concrete racking
514	Auxiliary building (conventional)
515	Conventional building – Fire detection and control system
516	Janitor service
517	Telephone service
518	High-bay building – Fire detection and control system

Note : Allocation of charges from other service departments are uncontrollable and excluded from this analysis.

4.4. The exact relation of costs to activity

We have at this stage established the costing framework, and we can proceed to collect the individual primary costs for one year under each element of cost. This will yield the total cost for the year, but it would be more meaningful if we could relate it back to:

(a) Activity

(b) Performance in terms, say, of cost per unit volume
per unit weight
per unit load
per unit X – unknown at this stage.

FIG. 8 The simple cost framework

	000 UNLOADING	310 MAIN STORE	500 ORDER PICKING	110 PACKING	010 LOADING	200 CONTROL	020 AUXILIARY SERVICES	
BUILDING (Allocated services)	E	E	E	E	E	E	E	B _T
EQUIPMENT	E	E	E	E	E	E	E	E _T
LABOUR	E	E	E	E	E	E	E	L _T
	000 _T	310 _T	500 _T	110 _T	010 _T	200 _T	020 _T	TOTAL

E = Element of cost collected for unit time.
Unit time must be pre-selected,
e.g. 1 year, 1 month, 1 week, etc.

FIG. 9 Detail of complete cost framework

	000	004	100	001	200	201	011	014
BUILDING (Allocated services)	504						04	
	505						505	
							503	
	503							
EQUIPMENT		402	432				432	402
		403	433				433	403
LABOUR		101		101			101	101
		106		106			106	106
		004	101		£ 999C		£ 1,120U	

It seems reasonable then to divide the analysed cost by one or more of these factors to find these *Performance Indices*. In fact, the following factors have been chosen:

- (a) Volume (cubic yards of goods throughput handled in one year)
- (b) Weight (tons of goods throughput handled in one year).

We are considering currently other functions of volume, weight, density and number of unit loads, also the value of goods handled.

Figure 10 shows the simple performance array of data; we have simply *divided* the analysed *costs* throughout by the *average annual volume*. A similar array would be produced by dividing throughput by weight or any other relevant factor, as explained above.

FIG. 10 Performance array : Company X

Measure of performance =
Total volume output per year (average)

	000	310	500	110	010	
BUILDING	$\frac{B}{V}$	$\frac{B}{V}$	$\frac{B}{V}$	$\frac{B}{V}$	$\frac{B}{V}$	$\frac{TB}{V}$
EQUIPMENT	$\frac{E}{V}$	$\frac{E}{V}$	$\frac{E}{V}$	$\frac{E}{V}$	$\frac{E}{V}$	$\frac{TE}{V}$
LABOUR	$\frac{L}{V}$	$\frac{L}{V}$	$\frac{L}{V}$	$\frac{L}{V}$	$\frac{L}{V}$	$\frac{TL}{V}$
	$\frac{T000}{V}$	$\frac{T310}{V}$	$\frac{T500}{V}$	$\frac{T110}{V}$	$\frac{T010}{V}$	$\frac{T_c}{V}$ & $\frac{T_u}{V}$

Total cost/unit volume
'Company' and 'Uniform'

4.5. The relation between 'company' and 'uniform' costs

Certain of the detailed annual costs consist of the average annual allocation of depreciation. These expenses will arise from amortisation of the initial capital expense of items of equipment and buildings. As discussed previously, the actual average annual value of allocation of depreciation will therefore depend on the number of years selected over which the asset is written off. Although the values arising within individual companies may be agreed and satisfactory to themselves, it would not be possible to compare directly these average annual depreciation expenses between different companies, where the selected lives of the assets were different.

It is therefore necessary to find a method of attempting to produce 'uniform' values, in order to be able to compare expenses and cost performance data between companies.

The method selected has been to survey the rules of allocation of depreciation of all companies participating in the survey and to find average values for every type of asset normally encountered. Table 1 sets out these rules of allocation of depreciation together with the average values for the whole survey.

The 'company' values of average annual depreciation of each asset (e.g. fork-lift truck) are obtained by dividing the equivalent present initial capital charge of the asset by that particular company's life for that asset.

The 'uniform' value is obtained in the same way by dividing equivalent present initial capital charge by the average value of 'write-off' shown in the end column of Table 1.

An explanation is now required for the use of 'present equivalent price' of assets. We are attempting to compare the detailed costs of different handling and storage systems and it would be meaningless to compare, for example, the annual costs of two fork-lift trucks, one of which was purchased twenty years ago whilst the other is a similar piece of equipment but brand new. We have therefore taken throughout the present equivalent prices for equipment and buildings. In this way, the values of annual costs used may not always correspond very closely with the actual values in the books of each company, but the 'uniform' costs in the survey will be more representative of the handling and storage systems used and their comparison between different companies will be more valid.

Where the present equivalent price is not available, but the price at the year of purchase is known, then the latter price must be modified to present equivalent price. Tables 2, 3 and 4 show the percentage changes which have been used, described as follows:

Table 2 shows the percentage increases in mechanical equipment prices yearly for the past fourteen years, as published by the Board of Trade. These figures were accepted and used in the absence of more specific information on price changes for mechanical handling equipment. Although the use of this type of index is arbitrary, at least its use is consistent in the uniform costing system described here.

Table 3 shows the percentage price changes for equivalent warehouse structures over the last ten years. These data were recommended by the Royal Institute of Chartered Surveyors.

Table 3a shows the actual rates paid per annum in terms of shillings per square foot of floor area. The assessment of the rateable value of the storage building depends on a number of factors and the judgement of the local authority. The details of the mechanism of rating warehouses will be dealt with in some detail in the next report.

TABLE 2. Equipment price changes 1954–68 – Engineering and allied industries

Year	Index	Annual % change	Cumulative % change
1954	100·0		41·6
1955	104·7	+ 4·7	35·24
1956	109·9	+ 4·9	28·84
1957	113·5	+ 3·3	24·76
1958	115·6	+ 1·9	22·5
1959	116·9	+ 1·1	21·12
1960	118·9	+ 1·7	19·1
1961	121·9	+ 2·5	16·16
1962	123·1	+ 1·0	15·0
1963	124·0	+ 0·7	14·19
1964	127·3	+ 2·7	11·23
1965	131·8	+ 3·5	7·43
1966	136·5	+ 3·6	3·74
1967	137·9	+ 1·0	2·7
1968	141·6*	+ 2·7*	—

*Average of last 5 years, in absence of published data.

Source: Board of Trade

TABLE 3. Warehouse building price changes 1958–68

Year	Averaged index	Annual % change	Cumulative % change
1958	100·0		62·5
1959	106·5	+ 6·5	52·58
1960	112·5	+ 5·63	44·44
1961	118·5	+ 5·33	37·13
1962	125·0	+ 5·49	30·0
1963	133·5	+ 6·8	21·72
1964	142·5	+ 6·74	14·04
1965	149·5	+ 4·91	8·69
1966	150·5	+ 0·67	7·97
1967	155·5	+ 3·32	4·49
1968	162·5*	+ 4·49*	—

*Average of last 5 years, in absence of published data.

Source: Royal Institute of Chartered Surveyors

TABLE 3a. Rates

Company code No.	Actual equivalent rates/sq ft p.a. paid	Age of building
1	3·57	1963
2A	4·0	1930 (average)
2B	0·73	1963
3	3·50	1967
4	0·98	1958
5	2·0	1958
6	3·25	1963
7	3·5 (estimated)	1966
8	1·95	1957
9	0·58	1963
10A	1·20	1963
11	2·81	1968
12A	1·5	1953
12B	2·5 (estimated)	1968

Average 2·29 shillings/sq ft/p.a.

TABLE 4. Allocated services – Cost factors

(Shillings /sq ft except where otherwise stated)

Company code No.	1	2A	28	4	5	6	7	8	9	10	11	12	13	14	Average
501 Building cost*	3·78	3·7	1·32	5·0	6·3	2·66	5·0	4·88	2·63	3·56	3·77	3·75 3·5H8	4·0	2·9	3·804
502 Building maintenance	0·309	0·104		0·0796	0·444	0·270	0·810	0·453	0·129	0·272		1·0	0·341	0·147	0·363
503 Building cleaning		0·921		0·226	0·093	0·054	0·825	0·272	0·465		0·0515		0·18		0·343
504 Building hire/rental															
505 Rates	3·57	4·0	0·073	0·098	2·0	3·25	3·5	1·95	0·58	1·20	2·81	1·5	2·26	2·25	2·074
506 Building insurance	0·096	1·19	0·376	0·48	0·12	0·36	0·27	0·23	0·06	0·097		0·5	0·155	0·115	0·311
507 Heating†	0·0304	0·074	0·0500	0·0269	0·0155	0·0766	0·0657	0·099	0·0357	0·0261	0·0488	1·1	0·018	0·0266	0·121
508 Lighting	0·031	0·074	0·068	0·053	0·044	0·095	0·570	0·091		0·090	0·0112	0·6	0·095	0·22	0·157
509 Ventilation													0·095		0·095
516 Janitor service	0·055		0·515			0·085		0·227	0·276		0·343		0·26		0·252

*Equivalent current initial cost of building in £/sq ft.

†Heating factor given in shillings/cubic ft.

Company No. 3 not shown but with value of 3·5 shillings/sq ft.

Table 4 shows a summary of the Allocated Services cost factors for all companies participating in the survey and the survey average values which have been used to obtain the 'uniform' values of cost.

Figure 11 shows the arrays for 'company' costs and performance indices and for 'uniform' costs and performance indices.

FIG. 11. Performance array – 'company' costs and 'uniform' costs: Company X

	000	310	500	110	010		000	310	500	110	010	
BUILDING	$\frac{Bc}{V}$	$\frac{Bc}{V}$	$\frac{Bc}{V}$	$\frac{Bc}{V}$	$\frac{Bc}{V}$	$\frac{TBc}{V}$	$\frac{Bu}{V}$	$\frac{Bu}{V}$	$\frac{Bu}{V}$	$\frac{Bu}{V}$	$\frac{Bu}{V}$	$\frac{TBu}{V}$
EQUIPMENT	$\frac{Ec}{V}$	$\frac{Ec}{V}$	$\frac{Ec}{V}$	$\frac{Ec}{V}$	$\frac{Ec}{V}$	$\frac{TEc}{V}$	$\frac{Eu}{V}$	$\frac{Eu}{V}$	$\frac{Eu}{V}$	$\frac{Eu}{V}$	$\frac{Eu}{V}$	$\frac{TEu}{V}$
LABOUR	$\frac{Lc}{V}$	$\frac{Lc}{V}$	$\frac{Lc}{V}$	$\frac{Lc}{V}$	$\frac{Lc}{V}$	$\frac{TLc}{V}$	$\frac{Lu}{V}$	$\frac{Lu}{V}$	$\frac{Lu}{V}$	$\frac{Lu}{V}$	$\frac{Lu}{V}$	$\frac{TLu}{V}$
						$\frac{Tc}{V}$						$\frac{Tu}{V}$
	Total Cost/Unit Volume (Company)						Total Cost/Unit Volume (Uniform)					

'Uniform' performance/cost data can be collected and compared between as many companies as required

The derivation of (1) 'company' and (2) 'uniform' cost items for allocated services, equipment and labour is as follows:

Allocated services – 'Company'

1. Find present equivalent price of building
2. Divide by 'company' write-off period → annual depreciation
3. Rates – as paid per annum.
4. Allocated services – as paid per annum.

Allocated services – 'Uniform'

1. Find present equivalent price of building
2. Divide by 'uniform' write-off period → annual depreciation
3. Rates – correct to national average expense/sq. foot
4. Allocated services – correct to survey average.

Equipment – 'Company'

1. Find present equivalent price of equipment
2. Divide by 'company' write-off period → annual depreciation.

Equipment – 'Uniform'

1. Find present equivalent price of equipment
2. Divide by 'uniform' write-off period → annual depreciation.

Labour – 'Company'

1. Current average employer's gross payments.

Labour – 'Uniform'

1. Convert hours worked to uniform rates/hour
2. Uniform rates/hour derived from (a) survey averages and (b) national averages.

The average values of payment rates per hour were obtained from the detailed Tables in Appendix 4.

An important aspect which must be mentioned at this stage is the question of the best method of calculating capital costs (the treatment of capital charges). Because alternative systems have different degrees of capital intensity, it is important that capital charges are assessed properly. To overstate them is to favour the more labour intensive warehouse system; to understate them will favour the more mechanised system.

In this report the approach has been to find the current equivalent price of equipment and buildings and to represent the average annual expense (depreciation) as this figure divided by the years of useful life of the particular asset. Although this has removed the inflationary element, no account has been taken of the opportunity cost of capital involved. The figures therefore tend to undervalue capital.

Research at the Ministry of Transport during the last year has highlighted this problem of handling capital charges with particular reference to studies of alternative bulk container systems. A proposal arising from this work has been to suggest that the simplest way to measure capital charges is to transform the capital sum into an annuity over the life of the asset. The reasoning, methods of calculation and assumptions are shown in Appendix 5. Consideration will be given in the study of high-bay warehouse systems now in progress to assessing this method of comparing capital charges.

At this stage we have all the information required to produce a complete list of all 'company' and 'uniform' costs for the period of one year as this has been selected as the most useful period. It remains to produce the 'performance indices', principally the 'cost per unit volume'. The precise units which have been adopted initially for the performance indices, subject to further research are:

- (a) Pounds sterling per cubic yard of goods throughput from the system.
- (b) Pounds sterling per ton (2240 lbs) of goods output from the system.

It is therefore necessary to obtain the average annual output of goods in cubic yards and tons. This will usually entail calculating as exactly as possible the volume and weight of the unit load or unit loads, and multiplying by the average output of unit loads for 48 weeks.

The information is punched onto paper tape and fed into a computer where a simple program sorts out the cost, and apportions the control system costs to equipment and labour cost (this will be explained below). The computer prints out four arrays:

1. Company costs broken down by main cost centres—000 Unloading, 310 Main Store, 500 Order-picking, 110 Order Assembly and Packing, 010 Loading. Within each of these main cost centres the cost is broken down into buildings, equipment and labour.
2. Performance indices (£ per cu. yard) or (£ per ton).
3. Uniform costs.
4. Performance indices (£ per cu. yard) or (£ per ton).

The key figures are the uniform costs and performance indices. An example of typical arrays are shown in Figs. 12, 13, 14, and 15.

No account has been taken of investment grants or employment premiums which might be available in Development Areas for two main reasons:

1. The grants may be increased, reduced or annulled at any time at short notice.
2. We are attempting to cost and compare handling and storage systems and it would be unsound to include grants and premiums in some situations and not others.

It must be recognised, therefore, that the 'uniform' costs presented in this report are designed to compare systems rather than reproduce exactly the costs which the financial accountant of each company would present in practice.

FIG. 12. Breakdown of 'company' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building depreciation and allocated service costs	3991·000	40603·000	0·000	6198·000	5555·000	56347·000 = Tc B
Equipment depreciation, maintenance and running costs	11841·039	35524·184	0·000	8604·296	17094·480	73064·000 = Tc E
Labour, direct and supervisory costs	59434·000	21966·000	0·000	6309·000	32463·000	120172·000 = Tc L
TOTALS	96432·436 = Tc 000	125679·055 = Tc 310	0·000 = Tc 500	27048·238 = Tc 110	70611·272 = Tc 010	319771·000 = Tc

Note: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

The inclusion of investment grants and Regional Employment Premiums would reduce the unit costs to some extent and would tend to improve the profitability of a warehouse project. The effect of the inclusion of grants and premium on the cost models of warehouses will be discussed in a later report, together with the financial accounting aspects of presenting discounted cash flow measures of profitability.

FIG. 13. Breakdown of 'company' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building depreciation and allocated service costs	0.005	0.055	0.000	0.008	0.007	0.076 = $\frac{T_c B}{V}$
Equipment depreciation, maintenance and running costs	0.016	0.048	0.000	0.012	0.023	0.099 = $\frac{T_c E}{V}$
Labour, direct and supervisory costs	0.080	0.030	0.000	0.009	0.044	0.162 = $\frac{T_c L}{V}$
TOTALS	0.130 = $\frac{T_c 000}{V}$	0.170 = $\frac{T_c 310}{V}$	0.000 = $\frac{T_c 500}{V}$	0.036 = $\frac{T_c 110}{V}$	0.095 = $\frac{T_c 010}{V}$	0.431 = $\frac{T_c}{V}$

Note: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

FIG. 14. Breakdown of 'uniform' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building depreciation and allocated service costs	2676.000	27651.000	0.000	5793.000	4422.000	40542.000 = $T_u B$
Equipment depreciation, maintenance and running costs	11727.756	30187.343	0.000	2640.983	14596.918	59153.000 = $T_u E$
Labour, direct and supervisory costs	54189.000	20191.000	0.000	5749.000	29604.000	109733.000 = $T_u L$
TOTALS	88903.519 = $T_u 000$	1101134.342 = $T_u 310$	0.000 = $T_u 500$	18382.657 = $T_u 110$	63020.482 = $T_u 010$	271441.000 = T_u

Note: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

FIG. 15. Breakdown of 'uniform' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building depreciation and allocated service costs	0.004	0.037	0.000	0.008	0.006	0.055 = $\frac{Tu\ B}{V}$
Equipment depreciation, maintenance and running costs	0.016	0.041	0.000	0.004	0.020	0.080 = $\frac{Tu\ E}{V}$
Labour, direct and supervisory costs	0.073	0.027	0.000	0.008	0.040	0.148 = $\frac{Tu\ L}{V}$
TOTALS	0.120 = $\frac{Tu\ 000}{V}$	0.136 = $\frac{Tu\ 310}{V}$	0.000 = $\frac{Tu\ 500}{V}$	0.025 = $\frac{Tu\ 110}{V}$	0.085 = $\frac{Tu\ 010}{V}$	0.366 = $\frac{Tu}{V}$

Notes: 1. Total system costs are included and apportioned across equipment and labour costs (see below).
2. The format is similar to that printed out by the computer.

4.6. Apportionment of control system costs

The control system of any warehouse or storage situation must have two primary objectives:

- 1. To ensure that any incoming goods can be put into an *empty* space or cell when required and with minimum delay.
- 2. To ensure that any outgoing goods which must be retrieved from storage, can be located and withdrawn when required and with minimum delay.

Figure 5 illustrates the basic essentials of any control system and suggests the developing stages of complexity which may be designed into a handling and storage system, depending on the performance and rates of goods movement which are anticipated. If 'order-picking', 'order-assembly' and 'packing' activities are present or required then the control system may also be required to give commands to these areas, and these commands may or may not be interlocked with the input and output demands of the basic storage system.

In any case the costs of the control system used will vary considerably with the degree of innovation called for; in most cases the total costs are small compared with the costs of the other main cost centres (unloading, main storage, order-picking, order assembly, loading, auxiliary services). In fact, it seems more important that the control system should primarily be designed as an integral part of the warehouse system and should fulfil its service demands with great reliability than that its design should be cut to a price. A correctly designed control system with built in flexibility and reliability should more than pay for itself in at least two ways:

- 1. If the location and retrieval system and the pre-programmed location of each 'line' are correctly designed, this will result in considerable cost reductions of the volume of storage and therefore of the cost of building the main storage block.
- 2. The system can avoid the necessity to recruit extra staff at peak times or for emergencies which arise under other systems. This will result in a saving on daily running costs.

The control system is shown as a separate block 200 on Figs. 4a, 4b and 4c and it is convenient to collect all the control system expenses under one cost centre, namely 200. In fact, the control system activity, and therefore expense, will be directed to some or all main cost centres; it is a unified control system even though it controls the operations of the separate cost centres and it is not appropriate to try to estimate the exact amount each cost centre takes of this expense. It is, however, reasonable to assume that the control effort is in proportion to expenditure controlled. Therefore, in the costing system the apportionment of 'control' expense is in proportion to all 'other expenditure', assuming that whatever control system is appropriate to the circumstances.

In practice, the computer program adds the total control system expense and re-allocates it to the main cost centres 000, 310, 500, 110, 010 in proportion to the totals of equipment plus labour expenses of each of them. This is an arbitrary but logical and simple approach and it avoids the complication of deciding exactly how much control system expense is inherent in each and every cost centre.

4.7. Introductory talk to explain the costing system

As a result of discussions with participating companies, a talk illustrated by slides has been developed, lasting about $\frac{3}{4}$ hour to one hour. In several cases the talk has been used as an introduction to the particular participating company and has proved useful in describing the costing system and its objectives to a group comprised of top and middle management. It is also useful in showing those personnel concerned with the detailed collection of data, exactly what is required right from the beginning of the investigation, and this helps the survey to start and progress smoothly and quickly.

4.8. Allocation and apportionment of building costs

4.8.1. The system adopted for the allocation and apportionment of building costs is set out as a series of steps below.

Generally the system is based on the assumption that building expenses should be allocated on a volume rather than a floor area basis. This approach seems logical and straightforward since the concept of handling and storage activities, particularly the latter, are on a three-dimensional basis. Furthermore, recent developments in the design of warehouses has shown a tendency to build higher and the relationship between the length, breadth and height of the main storage function has assumed greater importance and has become more critical.

The system therefore defines both the areas and the maximum useable heights of all functions associated with the handling and storage system to be analysed. These functions are again standardised as the main cost centres:

- 000 Unloading
- 100 Unpack-check-repack
- 310 Main storage
- 500 Order picking
- 110 Packing or Order assembly
- 010 Loading
- 020 Auxiliary services.

The term 'volume', used here, denotes the maximum usable volume (space) which could be used; that is, up to the eaves of the particular cost centre, and not the actual height which is being used for sorting goods. In this way it is considered that we are measuring the efficiency with which we utilise the space we have previously built. In other words we are defining volume as the maximum operating capacity and not the normally achieved operating capacity. These definitions will include any extra 'volumes' which will affect the cost of performance of the total handling and storage system being analysed. For example, (a) buffer pallet storage, whether inside or outside the building; (b) garages or workshops for repairing and maintaining handling and storage equipment.

In some cases, the activities isolated under the main cost centres defined above may be carried out in the same physical area. For example (a) unloading and loading, or (b) order-picking, may be carried out in the main storage area rather than in a separate area. In such cases it is necessary to apportion the volumes between the separate activities in a rational way.

4.8.2. The second step is that of space apportionment; the volumes of main cost centres 000 (including 100), 310, 500, 110, 010 and 020 are calculated and the volume of auxiliary services is re-apportioned back into the five main cost centres. This operation is shown on Form 3A in the example in Appendix 6, and is a convenient way of re-absorbing the space cost of auxiliary services 020 into the cost per unit load which will finally be calculated for the five main cost centres. The actual method of re-absorbing has been based on:

- (a) the relative space used by activities in the cost centres 000 through 010;
- (b) the relative activities or outputs of goods demands on the auxiliary services.

The corrected volumes of 000, 310, 500, 110, 010 are treated as decimal fractions of unity; it is these factors which are used to apportion the total building and allocated services expenses to these main cost centres.

4.8.3. The third step is to find either:

- (a) the present price of the building (or the present equivalent price);
- (b) the original price of the building.

In either case it is convenient if the building price is available in pounds sterling per square or cubic foot for each main cost centre; if it is not, then it may be necessary to estimate a realistic price by conferring with the resident architect or works engineer.

In the system the price and cost of the land upon which the warehousing activities have been built have not been included as they do not reflect the performance of the handling and storage system and they do vary widely depending on locality, land scarcity and other factors. There is no reason why the land cost cannot be included in the overall costs of the warehouse system, but it did not seem logical to include this factor as one which would influence performance of the system in terms of cost per unit load.

4.8.4. The fourth step is to correct the original price of the selected main cost centres to present day values. This is necessary in order to obtain a direct comparison between alternative handling and storage systems. To allocate the price of a building forty years old and a new building to the same (a) type of system and (b) measures of output performance would be meaningless.

The correction to present day values will usually be an increase of so many per cent per annum. Table 3 shows the correction factors adopted to transform original building prices to equivalent current prices.

4.8.5. For the fifth step, the building price, corrected for the age of the building, will be divided by the 'company's' or the 'uniform' adopted life of the building in order to obtain the average annual expense per cubic foot of the building space. For example, the depreciatory life of the building may be 25 years as laid down by the company's rules, but the average of this survey is shown to be 45 years in Table 1. Thus the equivalent current cost in £ per cubic foot divided by 25 and 45 will yield the 'company' and the 'uniform' average annual expense per cubic foot respectively.

Simple multiplication of these expense factors by the number of cubic feet assigned to each main cost centre will give the actual cost apportioned to each per annum.

4.8.6. This method of apportioning building costs has been based on cubic capacity, as it is considered that it has the inherent advantage over an area basis of (a) taking into account the vertical usage of space for handling and storage, (b) taking into account how the space is utilised; that is to say whether the total space available, particularly in the main storage area, is fully used all or part of the time.

5. Detailed results of the survey

5.1. This first report on the survey should be read as an interim one for the following reasons:

- (a) Although it describes the complete standardised costing system developed and used to produce the results discussed below, not all the detailed data for the complete survey have been collected and processed.

The processing of the data supplied by these companies perhaps with some others, will complete the active work for the first part of the survey of conventional warehouse situations, although the second stage of discussing and evaluating the results with the participating companies has only partly been carried out, and the overall picture will probably not be available for some time.

- (b) The average factors of the survey used to calculate the 'uniform' costs have of necessity been based only on the data available from some of the participating companies, and will need to be modified when more detailed data is finally amassed and collated. Fortunately this work should not take long as it will only involve transforming a small part of the data of each company and re-processing it in the standard computer program, where the average run-time is only about three minutes.

5.2. Provisional results

The provisional results of the survey to date are shown in the form of standardised arrays of:

- (a) company elements of cost
- (b) company performance indices-cost per cubic yard and ton
- (c) uniform elements of cost
- (d) uniform performance indices-cost per cubic yard and ton.

A sample of these arrays are shown in Appendix 2 (by volume) and Appendix 3 (by weight). We did not want the report to be too unwieldy and have not included all the computer summaries for all the companies. However, they are available at the Materials Handling Research Unit, Cranfield Institute of Technology, Cranfield, Bedford.

A summary of the performance indices is shown in Tables 5, 6, 7, 8, 9 and 10, but it has already been stressed that the full significance of these data cannot be assessed until more detailed discussions with individual companies have taken place, and until the complete data for these and other tables in this report are available in the near future. Nevertheless, it is hoped that they will be of some interest in the meantime.

The summarised results are shown on Graphs 1 and 2.

Graph 1 shows the value for each participating company of its volume performance indices, excluding the increments for order-picking, and order-assembly/packing, although these have been shown in several cases and are indicated. These values have been plotted against the absolute values of volume of throughput of goods, to indicate any effects of economies of scale which might exist, and this aspect of the results is discussed again later in this section of the report.

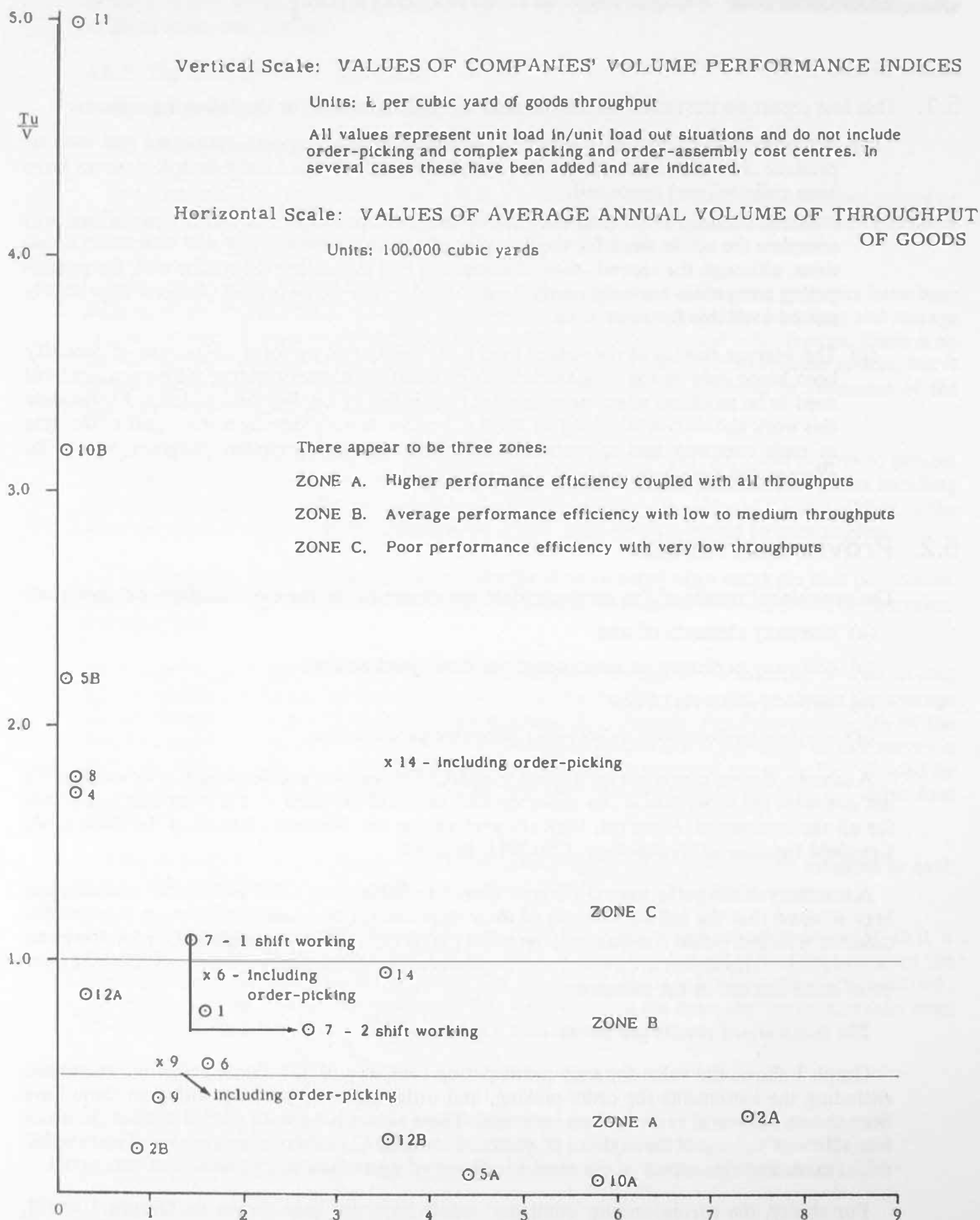
For clarity, the corresponding 'company' values have not been shown on Graphs 1 and 2, although they can be read off Table 5. In most cases, the differences between the 'company' and 'uniform' volume or weight performances indices for each company are not great, and generally much less than the difference between the performance indices of different companies.

Graph 2 shows the values of weight performance indices for the participating companies in the same way as the volume performance indices are set out in Graph 1.

The following assessment of results is based on the 'uniform' values of performance index rather than the 'company' values and the following points are of interest:

5.2.1. The range of values of performance index is large, being 40 to 1 in the case of volume (even ignoring Companies 5B and 10B which handle a very high density material and may be a special case) and 10 to 1 in the case of weight.

GRAPH I (Refer to text for full explanation)

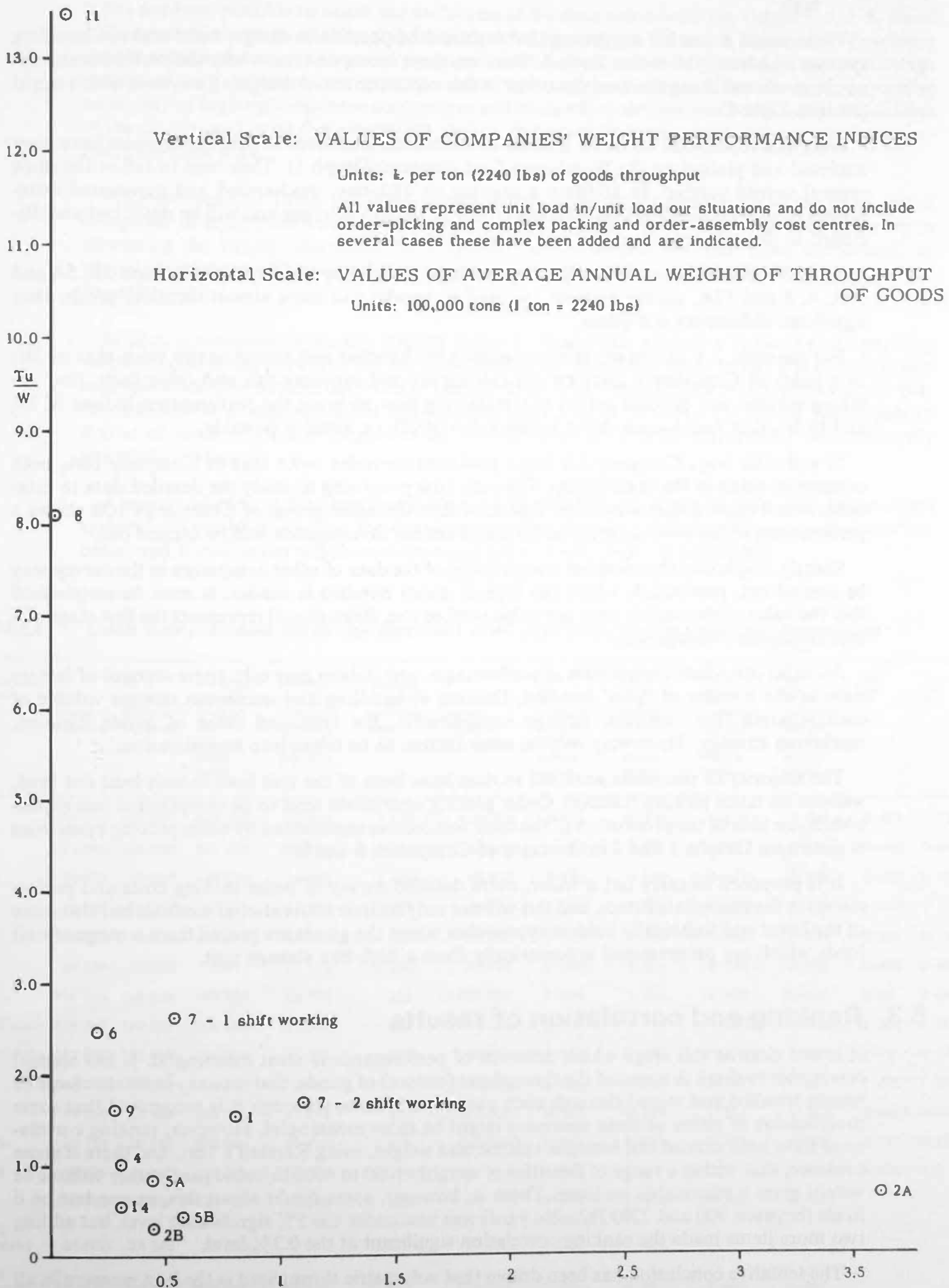


5.2.2. Since the difference between 'company' and 'uniform' costs are relatively small, it tends to confirm that 'uniform' costing can be used to measure inter-company performance. If the uniform costing system is logical, the wide range of performance indices values is prima facie evidence that efficiency varies widely; part of the reason may be that too many companies are unaware of their handling costs.

5.2.3. As indicated on Graph 1, there appear to be three zones:

- Zone A companies with higher performance efficiency coupled with high throughputs.
- Zone B companies with average performance efficiency, and with low to medium throughputs.
- Zone C companies with poor performance efficiency and with very low throughputs.

GRAPH 2 (Refer to text for full explanation)



There can be two main reasons why performance may fall in the undesirable Zone C:

1. The level of throughput of goods is much too low for the general concept of design of the handling system, or for some reason is not maintained at the design level.
2. The costs of some of or all the functions in the handling system are too high, and this may be readily pin-pointed by referring to the summarised computer print-outs. Here the problem may either be that the design concept is extravagant or inefficient for the level of goods to be handled or specific prices asked and paid for buildings, equipment or labour are too high.

There seems a case for suggesting that it should be possible to design, build and run handling systems which can fall within Zone A. Further, there seems no reason why the performance cannot be predicted along the lines discussed in this report, to avoid designing a system which might fall into Zone C.

Since this report was written a number of warehouse situations in other companies have been analysed and plotted on the Warehouse Cost diagram (Graph 1). They tend to fall in the same general overall pattern. In addition a number of high-bay, mechanised and automated warehouses have been plotted; again the same general pattern emerges and will be described and discussed in the next report.

5.2.4. Where results are directly comparable as in the case of Companies 2A and 2B, 5A and 10A, 4, 8 and 12A, similar systems are used to handle and store almost identical goods, then significant differences still occur.

For example, 2A has an expense per cubic yard handled and stored nearly twice that of 2B; as a result of Company 2 carrying out this survey and exposing this and other facts, they are taking general and detailed action in considering how to bring the performance indices of 2A and their other warehouses down to the value of 2B, or lower if possible.

In a similar way, Company 5A has a performance index twice that of Company 10A, both companies being in the same group. They are now proposing to study the detailed data to establish where these differences arise. Again, within the same group of Companies 10B shows a performance index twice as great as 5B and a similar investigation will be carried out.

Shortly, it is hoped that detailed comparisons of the data of other companies in the survey may be carried out, particularly where the type of goods handled is similar. It must be emphasised that the value of the indices (cost per cubic yard or ton, throughput) represents the first stage of a more complex investigation.

An exact inter-firm comparison of performance cost indices may take some account of factors such as the number of 'lines' handled, the rate of handling and maximum storage volume of each separate 'line', seasonal storage requirements, the type and value of goods handled, marketing strategy. There may well be other factors to be taken into consideration.

The majority of situations analysed to date have been of the unit load in/unit load out kind, without an order picking function. Order picking operations tend to be complicated and expensive. Some idea of the proportion of the total cost indices represented by order picking operations is shown on Graphs 1 and 2 in the cases of Companies 6 and 9.

It is proposed to carry out a wider, more detailed survey of order picking costs and performance in the immediate future, and this will not only include conventional methods but also some of the latest and technically boldest approaches where the goods are picked from a range of unit loads which are programmed automatically from a high-bay storage unit.

5.3. Ranking and correlation of results

It is not clear at this stage which criterion of performance is most meaningful. It has seemed reasonable to think in terms of the throughput (output) of goods, that is to say in total volume or weight handled and stored through each particular system, although it is recognised that some modification of either of these measures might be more meaningful. However, ranking correlations have been carried out between volume and weight, using Kendall's Test, and there is some evidence, that within a range of densities of roughly 1000 to 4000 lb/cubic yard, either volume or weight gives a reasonable measure. There is, however, some doubt about this, as one test on 6 items (between 900 and 2200 lb/cubic yard) was just under the 5% significance level, but adding two more items made the ranking correlation significant at the 0.3% level.

The tentative conclusion has been drawn that volumetric throughput is the best measure in all cases, as we are in the main studying the use of space; only in the case of very heavy goods should some allowances be made.

It is proposed, in the light of this information, to continue calculating both volume and weight performance indices until the completion of this survey, in order to carry out the ranking correlation of volume and weight again when more results are available. It may well be that this will show that to take volume alone will be satisfactory.

5.4. Summary tables of detailed performance indices

It has not been possible to assess the usefulness of the data summarised in Tables 5, 6, 7, 8, 9 and 10 because of shortage of time and the incompleteness of the Tables. It is hoped to develop a simple extension to the computer program which will automatically compare the percentage change of each individual performance index with say the average of the survey as a possible rapid way of high-lighting those cost centres and costs which deviate markedly from the averages of the survey, and print these items out. Again, this possible development must await the collection of further data.

With reference to Table 10, it will be noted that a significant proportion of the total cost is composed of equipment and building costs. This will tend to be the case where the company is increasing the capital investment in a system. As the system becomes more automated, so capital investment will rise and the proportion of allocated costs rises in comparison to the variable costs.

In fact, a company is usually trading a rise in fixed costs against a reduction in operating variable costs in the hope that the net result will be favourable in profit terms. Since there is also an implication that the size and scale of the operation is increasing, then it is often assumed that the net costs of a large operation will be lower than a series of small operations. This argues in favour of more efficiently designed handling systems which should need smaller more efficiently designed buildings.

A major objective in the programme of analysing high-bay warehousing costs using the uniform system is to establish whether the development of such systems necessarily promotes lower net costs, and if not, under which circumstances lower costs could be established.

TABLE 5. Data summarised from the detailed cost analyses of the various companies

Company code No.	Tc Total company expense	Tu Total uniform expense	Average annual through- put volume cubic yards	Average annual weight of goods through- put tons	Density of goods lb/cubic yard	N average annual through- put of units	$\frac{Tc}{V}$ company volume perform- ance index	$\frac{Tu}{V}$ uniform volume perform- ance index	$\frac{Tc}{W}$ company weight perform- ance index	$\frac{Tu}{W}$ uniform weight perform- ance index	$\frac{Tc}{N}$	$\frac{Tu}{N}$
1	128 213	124 657	160 000	79 990	1 120	160 000	0.801	0.779	1.603	1.558	0.801	0.779
2A	320 000	282 000	741 315	368 220	1 458	335 000	0.432	0.38	0.87	0.766	0.955	0.842
28	15 871	16 457	83 216	44 000	1 458	40 000	0.191	0.198	0.361	0.374	0.397	0.411
4	30765	35 273	17 811	30 000	3 773	30 000	1.727	1.98	1.026	1.176	1.025	1.172
6A	46 023	41 271	442 370	44 100	223	176 243	0.099	0.089	1.044	0.936	0.261	0.234
58	30 189	28 346	9 412	56 470	17 750	61 900	3.208	3.012	0.535	0.502	0.488	0.458
6	196 945	189 479	165 592	18 776	254	10 000000	1.189	1.144	10.489	10.692	0.20	0.019
7 (2 shift)	199 397	190 733	269567	111 500	925	96 000	0.74	0.708	1.788	1.711	2.077	1.987
7 (1 shift)	162 660	147 626	134 783	65 750	925	48 000	1.133	1.095	2.738	2.648	3.18	3.075
8	41 078	36 649	20 296	3 393	375	29 200	2.024	1.806	12.107	10.801	1.406	1.256
9	50 428	62 396	108 800	27 818	573	2 448 000	0.463	0.573	1.813	2.243	0.0206	0.0255
10A	26 784	29265	572 560	60170	223	240059	0.047	0.051	0.445	0.486	0.111	0.122
10B	36 671	40 139	8 725	52 350	17 750	67410	4.203	4.6	0.7	0.767	0.639	0.7
11	270758	233 581	20 460	6 920	758		13.234	11.416	39.127	33.754		
12A (2 shift)	31 852	28248	28 986		2 584	27 700	1.099	0.875				
128 (2 shift)	103 177	92779	356 064	165 424	937	259 200	0.261	0.29	0.663	0.597		
14	619 348	659 538	353 339	31 702	200	3 381 560	1.753	1.867				

TABLE 6. Summary of expense per cubic yard – Allocated services

Company Code No.	000		310		500		110		010		TOTAL	
	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform
1	0·013	0·011	0·315	0·281	0·000	0·000	0·000	0·000	0·013	0·011	0·341	0·304
2A	0·005	0·004	0·055	0·039	0·000	0·000	0·008	0·008	0·008	0·006	0·077	0·057
2B	0·004	0·006	0·011	0·017	0·006	0·009	0·000	0·000	0·004	0·006	0·024	0·037
4	0·178	0·231	0·566	0·735	0·000	0·000	0·000	0·000	0·000	0·000	0·745	0·966
5A	0·001	0·001	0·037	0·025	0·003	0·002	0·000	0·000	0·002	0·001	0·043	0·029
6B	0·085	0·050	0·811	0·473	0·000	0·000	0·000	0·000	0·029	0·017	0·925	0·539
6	0·041	0·031	0·099	0·074	0·084	0·061	0·023	0·017	0·026	0·020	0·273	0·201
7(1)	0·028	0·024	0·305	0·288	0·000	0·000	0·000	0·000	0·028	0·024	0·362	0·336
8	0·085	0·073	0·203	0·224	0·109	0·098	0·000	0·000	0·000	0·000	0·397	0·395
9	0·009	0·020	0·046	0·094	0·012	0·025	0·000	0·000	0·024	0·049	0·092	0·189
10A	0·000	0·000	0·017	0·018	0·000	0·000	0·000	0·000	0·004	0·004	0·021	0·023
10B	0·064	0·068	0·424	0·451	0·000	0·000	0·000	0·000	0·014	0·014	0·501	0·533
11	0·072	0·063	2·123	1·932	0·560	0·509	0·757	0·797	0·112	0·102	3·624	3·404
12A	0·105	0·073	0·208	0·133	0·000	0·000	0·000	0·000	0·000	0·000	0·313	0·207
12B	0·005	0·006	0·026	0·035	0·000	0·000	0·004	0·005	0·006	0·008	0·041	0·054
13*												
14*												

TABLE 7. Summary of expense per cubic yard – Equipment

Company Code No.	000		310		500		110		010		TOTAL	
	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform
1	0·003	0·004	0·327	0·334	0·000	0·000	0·004	0·006	0·002	0·003	0·335	0·346
2A	0·002	0·001	0·049	0·043	0·000	0·000	0·012	0·004	0·009	0·006	0·072	0·053
2B	0·016	0·015	0·036	0·034	0·004	0·004	0·002	0·002	0·017	0·016	0·074	0·069
4	0·084	0·087	0·357	0·385	0·000	0·000	0·158	0·153	0·000	0·000	0·599	0·626
5A	0·004	0·005	0·010	0·011	0·001	0·001	0·001	0·001	0·002	0·002	0·018	0·021
5B	0·055	0·065	0·284	0·324	0·000	0·000	0·199	0·224	0·031	0·035	0·570	0·649
6	0·023	0·026	0·050	0·049	0·040	0·038	0·009	0·008	0·005	0·005	0·128	0·125
7(1)	0·003	0·003	0·641	0·641	0·000	0·000	0·003	0·003	0·003	0·003	0·649	0·649
B	0·213	0·201	0·201	0·171	0·069	0·073	0·014	0·011	0·000	0·000	0·497	0·456
9	0·012	0·012	0·043	0·046	0·005	0·007	0·000	0·000	0·003	0·004	0·063	0·069
10A	0·001	0·001	0·008	0·009	0·001	0·001	0·001	0·001	0·003	0·003	0·013	0·015
10B	0·367	0·424	0·871	0·963	0·000	0·000	0·659	0·725	0·094	0·104	1·991	2·216
11	0·103	0·083	1·022	1·066	1·162	1·186	1·316	1·150	0·287	0·284	3·889	3·768
12A	0·022	0·026	0·105	0·104	0·000	0·000	0·035	0·035	0·000	0·000	0·162	0·165
12B	0·029	0·030	0·071	0·079	0·000	0·000	0·010	0·010	0·002	0·002	0·113	0·121
13*												
14*												

TABLE 8. Summary of expense per cubic yard – Labour

Company code No.	000		310		500		110		010		TOTAL	
	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform
1	0·023	0·023	0·050	0·052	0·000	0·000	0·008	0·008	0·006	0·007	0·087	0·090
2A	0·080	0·073	0·030	0·027	0·000	0·000	0·009	0·008	0·044	0·040	0·162	0·148
2B	0·016	0·015	0·025	0·025	0·018	0·019	0·002	0·002	0·005	0·005	0·066	0·066
3*												
4	0·162	0·175	0·033	0·032	0·000	0·000	0·113	0·109	0·000	0·000	0·308	0·317
5A	0·011	0·011	0·011	0·011	0·002	0·002	0·001	0·002	0·004	0·005	0·029	0·031
5B	0·179	0·184	0·697	0·739	0·000	0·000	0·572	0·613	0·054	0·056	1·502	1·593
6	0·118	0·123	0·095	0·101	0·202	0·215	0·108	0·117	0·041	0·043	0·564	0·600
7(1)	0·025	0·023	0·007	0·007	0·000	0·000	0·007	0·003	0·015	0·014	0·054	0·047
8	0·424		0·269		0·232		0·032		0·000			
9	0·051	0·047	0·044	0·039	0·105	0·114	0·000	0·000	0·060	0·067	0·260	0·267
10A	0·002	0·022	0·004	0·005	0·001	0·001	0·001	0·001	0·002	0·003	0·010	0·011
10B	0·184	0·187	0·709	0·785	0·000	0·000	0·692	0·658	0·058	0·063	1·543	1·693
11	0·631	0·279	0·601	0·459	1·548	1·106	1·959	1·355	0·468	0·333	5·107	3·631
12A	0·193	0·185	0·307	0·290	0·000	0·000	0·091	0·090	0·000	0·000	0·592	0·565
12B	0·049	0·053	0·000	0·000	0·000	0·000	0·008	0·008	0·008	0·008	0·065	0·069
13*												
14*												

TABLE 9. Summary of expense per cubic yard – Control system

Company code No.	000		310		500		110		010		TOTAL	
	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform	Company	Uniform
1	0·001	0·002	0·034	0·035	0·000	0·000	0·000	0·001	0·001	0·001	0·038	0·039
2A	0·019	0·017	0·029	0·024	0·000	0·000	0·006	0·003	0·012	0·011	0·066	0·056
2B	0·006	0·005	0·011	0·011	0·004	0·003	0·000	0·000	0·004	0·003	0·027	0·026
3*												
4	0·020	0·017	0·044	0·043	0·000	0·000	0·013	0·011	0·000	0·000	0·075	0·071
5A	0·002	0·002	0·005	0·005	0·001	0·001	0·001	0·000	0·001	0·001	0·009	0·008
5B	0·017	0·019	0·098	0·102	0·000	0·000	0·043	0·055	0·006	0·008	0·165	0·183
6	0·004	0·003	0·005	0·005	0·007	0·007	0·003	0·003	0·002	0·001	0·020	0·021
7(1)	0·004	0·002	0·060	0·056	0·000	0·000	0·001	0·001	0·003	0·002	0·068	0·061
8	0·068	0·057	0·056	0·057	0·038	0·034	0·004	0·003	0·000	0·000	0·168	0·151
9	0·010	0·009	0·017	0·017	0·017	0·017	0·000	0·000	0·014	0·016	0·057	0·057
10A	0·000	0·000	0·002	0·002	0·000	0·000	0·000	0·000	0·000	0·000	0·003	0·002
10B	0·020	0·020	0·069	0·064	0·000	0·000	0·043	0·040	0·006	0·005	0·139	0·131
11	0·033	0·030	0·182	0·195	0·159	0·159	0·195	0·187	0·042	0·041	0·602	0·612
12A	0·009	0·012	0·019	0·022	0·000	0·000	0·005	0·005	0·000	0·000	0·033	0·048
12B	0·016	0·016	0·019	0·021	0·000	0·000	0·004	0·005	0·003	0·003	0·042	0·046
13*												
14*												

* Information not yet available

TABLE 10. Analysis of 'uniform' volume performance indices (VPI) for building, equipment, labour and control system

Company code No.	VPI Building	% of Total VPI	VPI Equip-ment	% of Total VPI	VPI Labour	% of Total VPI	Control System % of Total VPI	Total VPI
10A	0·023	45	0·015	29	0·011	22	4	0·051
5A	0·029	33	0·021	24	0·031	35	8	0·089
2B	0·037	19	0·069	35	0·066	33	13	0·198
12B	0·054	19	0·121	42	0·069	24	15	0·290*
2A	0·055	15	0·080	22	0·146	40	23	0·366
9	0·189	33	0·069	12	0·267	47	8	0·573
6	0·227	21	0·141	13	0·675	63	3	1·067
8	0·396	22	0·456	25	0·804	44	9	1·806
1	0·304	39	0·346	44	0·090	11	5	0·779
12A	0·207	21	0·165	17	0·565	58	4	0·975
7(1)	0·336	31	0·649	59	0·047	4	6	1·095*
7(11)	0·168	24	0·426	60	0·050	7	8	0·708*
4	0·966	49	0·626	32	0·317	16	13	1·980
5B	0·539	18	0·649	22	1·593	53	7	3·012
10B	0·533	12	2·216	48	1·693	37	3	4·600
11	3·404	30	3·768	33	3·631	31	4	11·416

*High-bay

Aver %	28%	28%	38%	8%
Range	15-49%	13-60%	11-63%	3-23%
(Excluding high-bay warehouses)				

High-bay warehouses

Company 7 (1)	31%	59%	4%	6%
Company 12B	19%	42%	24%	15%

6. Problems encountered during the survey with tentative suggestions for solution

- 6.1. This section of the report deals with some of the practical problems which have been and are still being encountered whilst carrying out the survey, together with suggestions for their possible elimination. The degree of success which can be achieved is a measure of how easily and cheaply a costing survey of the kind described in this report can be implemented in any company which wishes to review its costing and organisational arrangements in its handling and storage areas.

6.2. Initiative from Board level

Who recognises the need to have an accounting system for the cost control of handling and storage? The impression from this survey is that this area of cost is usually rather a 'Cinderella' in the shadow of factory product costing, and is regarded rightly or wrongly as of secondary importance. This attitude may have been influenced in the past by the inadequacy of many costing systems when it comes to isolating detailed expenses and predicting accurately any future capital expenditures and running costs.

One senses however, that during the last year or two, many managements have become conscious of the large amounts of money which are frequently involved and they are therefore taking an increasing interest in analysing warehousing costs. (Doubtless the same interest applies to the associated distributional costs, which are not within the scope of this report.)

Ideally, the initiative to review the warehousing costing will come from Board level, and if the scale of operations justifies it, then the appointment of a director or general manager for these operations will be a positive step towards implementing such modifications and additions to the organisation as may be required to improve cost control. The 'warehousing' director will be able to confer with the financial director on the subject of whether existing financial and cost accounting systems are adequate for the analysis and control of warehousing costs, and again, if they agree that improvements or modifications to system(s) and the personnel who have to run them are needed, then the financial director should be in a strong position to motivate a plan, preferably in co-operation with the 'warehousing' director.

Initiating a company costing investigation

The data required to fill in 'pigeon holes' in the numerous tables of the survey results are, in theory, quite easy to define and to collect. Nevertheless, in the absence of expert advice prior to embarking on the survey, it was not clear initially how to go about it, who would be willing to help, who to see and how long it would take to complete the exercise in widely differing circumstances.

The initial period of meeting people, absorbing the 'flavour' of their particular organisation and company, attempting to define exactly what was wanted and how to get it, took considerable time, bearing in mind the firms' endemic problems – promotions, people leaving the company, sickness, weather, changes in priority in the accounting departments—set backs which may be encountered anywhere.

A pattern emerged suggesting key points in the approach to carrying out an initial survey of warehousing; as in Fig. 16.

6.3. The importance of teamwork

The introduction of teams is suggested for tackling the planning, control and costing of warehouse projects. Just as factory management will normally convene regular production meetings to discuss how performance of output is reconciled with forecasts or budgets, so warehousing

management should require at least two teams with executive powers to be convened and to meet regularly:

1. The day-to-day Management Control Team.
2. The future Projects Team.

These teams would not necessarily be a fixed part of the organisation structure but would be superimposed on the regular structure to co-ordinate functionally the objectives.

FIG. 16 Applying the 'uniform' costing system to a warehousing situation

STEP 1

TOP MANAGEMENT REPRESENTATIVE
RESPONSIBLE FOR WAREHOUSING &
DISTRIBUTION MAKES DECISION TO
CARRY OUT COSTING ANALYSIS

STEP 2

THE COSTING TEAM IS SELECTED AND
BRIEFED WITH (1) OBJECTIVES
(2) DETAILS OF THE COSTING SYSTEM

WAREHOUSE MANAGER (CHAIRMAN)
MATERIALS HANDLING ENGINEER,
CHIEF COST ACCOUNTANT,
CHIEF INDUSTRIAL ENGINEER

or their respective assistants

STEP 3

THE TEAM ESTABLISHES THE BASIC COST
CENTRE FRAMEWORK



STEP 4

THE TEAM MEMBERS COLLECT DETAILED
DATA

REFER TEXT

STEP 5

THE TEAM TRANSFORMS THE COLLECTED
DATA TO STANDARD FORM

REFER TEXT FOR DETAILS OF
NATIONAL SURVEY AVERAGES AND
ASSOCIATED DATA

STEP 6

THE STANDARD DATA IS PROCESSED TO
PRINT OUT 'COMPANY' & 'UNIFORM'
PERFORMANCE INDICES

WILL BE EXPEDITED BY USING
STANDARD COMPUTER PROGRAMME

STEP 7

PERFORMANCE INDICES ARE COMPARED WITH
NATIONAL SURVEY DATA TO PINPOINT
DETAIL AREAS FOR POSSIBLE IMPROVEMENT

WILL BE EXPEDITED BY USING
CRANFIELD COMPUTER PROGRAMME

STEP 8

THE TEAM REPORTS TO TOP MANAGEMENT
WHERE POSSIBLE IMPROVEMENTS CAN BE
MADE

BACK TO STEP 1

STEP 9

A PLAN OF SYSTEMS IMPROVEMENT AND
RE-BUDGETING IS ESTABLISHED AND
BACKED AT BOARD LEVEL

BACK TO STEP 1

1. Day-to-day Management Control Team

Objectives: To combine expertise and data to set up short-term output targets for the warehouse and to control activities to hold to pre-planned targets. To combine expertise and data to overcome short-term technical and engineering problems.

Members of the Team: The Warehouse Manager (*Chairman*)
The Cost Accountant
The Materials Handling Manager or Engineer
The Industrial Engineer
Anyone else specially required. } or their delegates

Meeting: Weekly or fortnightly. Appointed secretary issuing brief progressing minutes promptly.

Accountable: To the 'warehouse' director, probably at longer intervals.

2. Future Projects Team

Objectives: To discuss long-term output targets and to combine and co-ordinate expertise and data in planning adequate future systems design(s) to meet future targets.
To translate proposed system(s) design into practical personnel, equipment and building terms.
To predict as accurately as possible the future capital investment envisaged and the reductions in running costs inherent in future alternatives and additions.

Members of the Team: The 'Warehouse' Director or
Materials Handling Manager (*Chairman*)
The Financial Accountant
The Management Services Representative
The Cost Accountant
The Industrial Engineer
Anyone else specially required. (Some of these functions might be combined in smaller companies.) } or their delegates

Meeting: Monthly or two-monthly depending on the scale of operations and the urgency. Appointed secretary issuing detailed minutes of discussion and decisions.

Accountable: To the Board, through the 'warehouse' director. Other informal meetings and sub-groups would naturally arise from the progress of the main teams.

One of the *indirect* benefits of operating in this way is that it generates expeditiously a spirit of co-operation and understanding in any company.

First: To seek the support of the director responsible for warehousing and to gain his co-operation in immediately establishing a team consisting basically of the warehousing manager, the cost accountant, and the materials handling manager/engineer (it is useful, but not essential to include the industrial engineer).

Second: To recognise that the team cannot obtain all the information required in one fell swoop, and that a process of mutual education and understanding must be allowed to take place while the team and its constituent members are trying to extract the data required in the form required.

In these circumstances, it has been found necessary to plan a series of visits over a considerable period, absorbing only a limited amount of 'know-how' and data at each session.

In practice, the collection of the data can be accomplished in three or four visits to the particular company, each lasting three or four hours. Obviously there will be some variation depending on the ease or difficulties of data collection.

A standard questionnaire has been developed asking for most of the key data required, but most people's reaction to questionnaires is similar to the writer's; they either answer the questions in a superficial manner or the missive is consigned, possibly justifiably, to the waste-paper basket. The standard questionnaire is therefore offered as an *aide m  moire* at some stage in the investigation.

6.4. Technical aspects – Accounting and engineering

6.4.1. In the process of collecting and sorting costing data for this survey, a number of technical aspects which caused problems became apparent. These are discussed below; it is important to point out that each problem was not necessarily present in all companies and it is not proposed to carry out or show any quantitative analysis of which problems emerged in which companies. Rather, it seems more useful to say that any of these problems could arise in any company which decided to carry out a systematic survey along the lines advocated in this report, and they are offered as a tentative contribution to expediting a survey in any interested company.

6.4.2. Problems of establishing main and sub cost centres

The first stage in initiating a costing investigation is to define and agree the main and sub cost centres of activity in terms of the standardised system developed. Usually these could not coincide with the existing accounting systems cost centres which were often not broken down into very much detail.

It is usually convenient to relate the standardised costs to the relevant warehouse or storage areas by using an $\frac{1}{8}$ " scale drawing and using physical areas, rather than supervisory areas. Further, there are sometimes problems of defining interfaces between cost centres with no easily noted break-points from an industrial engineering viewpoint since equipment and personnel will not always be confined entirely to each standardised cost centre.

In practice, it may be found that fewer than the 15 or so main and sub cost centres are needed to investigate and control warehousing systems and that 6-8 may prove to be sufficient. However, it was decided to establish a system which was as detailed as possible before embarking on the survey.

When specific data on allocated services are not available, then agreement with the investigating team must be sought to agree on sensible apportionment of the total annual budget for the factory or division. This has usually been done on a floor area (square footage) basis.

The allocated services will be apportioned directly proportionally to the activity of the equipment in each cost centre. Far more precise apportionment is possible, where the industrial engineering department has previously made studies of equipment and personnel activities.

Generally, the most difficult problem was the isolation and apportionment of the allocated services costs (building depreciation, rates, insurances, heating, lighting and so on). Often these are presented only on a divisional or general factory overhead basis and the existing accounting system does not make provision for the separate collection of these costs for separate warehouses, let alone the main and sub cost centres within each warehouse or storage situation. Although it may be argued that this degree of detail may not be justified or necessary, it appears from the results of the survey that a significant proportion of the total cost of most warehouse systems is represented in the allocated services, and although often no changes or modifications to the allocated service costs can be made in the short term, it is this part of the total cost which can be reduced significantly in the longer term by designing and planning more efficient and less costly systems and buildings. Smaller, higher, more efficiently designed buildings will give reduced allocated services costs.

6.4.3. Establishment of company rules of apportionment of costs

Difficulties may arise in establishing the rules of apportionment of costs to the main cost centres. Generally, these are apportioned on an area (square footage) basis, except in the case of heating, where it was considered that a volumetric basis would be more meaningful.

However, further refinements to the apportionment of 'allocated services' costs (and running costs) may be required. For example, the building cost (£ per cubic foot) may vary 3:1 as the height increases from 12 to 60 feet, so the apportionment of factory budgeted expenses to the particular warehouse building on a square footage basis may not always be the most accurate. Similarly, rates, insurance, heating, lighting and other auxiliary services are often not assessed or mentioned separately, so that exact apportionment of expense is not possible. Further observations on the problems of apportionment of these factors will be made in the second report.

6.4.4. The detailed collection of expenses within the standardised cost centres, therefore, sometimes necessitated estimation of apportionment of cost. This is generally straightforward where

personnel (labour expense) is concerned since the number of people associated with the agreed main and sub cost centres are usually easy to define.

The apportionment of equipment costs to the agreed standardised main and sub cost centres is not always so straightforward and may need arbitrary but sensible agreement amongst the members of the investigating team.

Attempts to find the reasons for the selection of the particular lives of the assets have met with less success. The following are the comments which were available:

Company 1

Depreciation rules tend to be based on the economic life of the equipment. A general policy is to treat equipment in units. If the unit is of small value, say under £100, it is treated as expense; if over £100 then it would generally be capitalised.

The financial replacement policy for pallets has been reviewed in the light of the possibility of eligibility for investment grants, even for items under £25.

Company 2

Rules of allocation have been selected because of company policy and method of tax assessment.

Company 3

Depreciation rules tend to be based on the actual lives of the assets, although in practice all materials handling equipment would be included in one depreciation group. They are satisfied that in practice any errors incurred are very small.

Company 4

Building capital assets are appreciated in their books. However, for the purposes of the costing analysis, buildings will be depreciated in the proposed standard method.

Company 7

Long established company policy

Company 8

International policy

Company 9

To match expected life of the assets, a traditional policy based more on the life of the assets than for financial accounting reasons.

Other companies could find no specific reasons and concluded that the rules were historic. Since the survey started several of the companies have reviewed their rules of allocation of depreciation and intend to alter them to line them up better with the expected lives of the assets.

A problem remains that with some important items of warehousing equipment such as the latest high-bay warehouse structures (often with integrated racking), stacker cranes and electronic control equipment, it is difficult to establish realistic lives, since to date little experience has been gathered; these items are relatively new. An occasional review of the rules would seem advisable.

It has been explained earlier that to attempt to compare costs between companies, it has been necessary to establish and use a set of uniform rules of allocation of depreciation. In the absence of published data, it has been decided to use the average of the survey's values for each category of asset. It is not possible to say how representative these values are either generally, or whether they are representative of generally experienced lives of assets in all included categories. Certainly, more information would be useful, particularly of the expected life of the items mentioned above.

6.4.5. Selection of the unit time for collection of cost and output data

It is necessary for the investigating team to decide at an early stage the period of time during which the expenses recorded for their survey are to be collected. In practice, a convenient time is one year and in fact the data collected for this survey have been collected in most cases for the

period 1967–68. In several cases the warehousing system has not been completed or is not yet in regular production use, so predicted or budgeted costs for the first year of steady operation are being collected.

In the time available, it has only been possible to take average annual values for detailed cost and output data. The possible shortcoming is that both output and reflected costs may vary considerably from month to month; this will be so where the warehousing system is affected by seasonal trade for example. Most of the companies in the survey have quite steady throughputs but a few are affected by seasonal variations. It might be necessary to collect the output and cost data of say twelve monthly periods, in order to analyse the variation of cost with output satisfactorily.

6.4.6. Definition of unit loads

The difficulties of defining the goods handled and stored through each warehouse system have varied; the specification of, for example, a standard pallet of cartoned goods is straightforward in terms of volume and weight and numbers, but in a mail-order or supermarket order-picking and packing situation, it is not so clear. In such cases it is not easy to estimate or measure the actual total volumes and weights although in each case the data collected and agreed have been double-checked from several approaches. However, the actual number of unit loads in terms of packages becomes vague and this is one of the reasons for preferring to estimate performance in terms of total volume or weight rather than numbers of unit loads.

To date, only the average annual volumes and weights have been used in the analysis. In some cases, two or more different types of unit load are handled and stored, mainly differing in the dimensions of the transporting medium. For example, automobile components may be handled in several sizes of steel cage pallet.

An arbitrary rule has been used throughout for estimating the volumes and weights of the output of goods. Only the volume or weight of the goods themselves has been included; thus the internal volume of the cage pallet has been included, irrespective of whether the internal space is completely filled with goods, which in a case like metal castings could never be the case. The volume of the pallet has not been included, or its equivalent weight. It is argued that the efficiency of the system could be improved theoretically if the pallet were reduced in volume and weight and should not figure in the performance data in terms of actual goods handled and stored. However, it may be that a review of these arbitrary rules may be required in the light of further investigation and research.

To date no specific investigation of the effect of the monetary value of the goods handled has been made; it is not clear how much bearing this factor could have, if any, on the actual activity (and thence cost) of handling and storing any kind of goods. Nevertheless, it seems reasonable to carry out some more research in this area.

Where several different types of unit load are handled through simultaneously, there appear to be no great difficulties in separating and apportioning the costs to each type of unit load, if this is required. This introduces the product costing concept if required, although the proposed system is an operational costing one.

Section 6 has outlined some organisational and engineering problems but has only made tentative suggestions for solutions for implementing the uniform costing system.

In later reports it is hoped that the effectiveness of these proposals will be evaluated by reference to actual case studies where the system has been implemented and the benefits assessed.

7. Cost effectiveness of the uniform costing approach in individual companies. Feedback from the companies

7.1. The questions

Any director or responsible manager may well pose the following questions before taking action in reviewing handling and storage costs:

- (a) Is it worthwhile to carry out the first costing survey in part or all of my organisation?
- (b) If we do so, how long will it take, who will be involved, how much time will be required and what will be the cost?
- (c) When we have assessed the results, what potential savings seem possible over the short-term and the long-term and how does their magnitude relate to the cost of the initial survey?
- (d) If we are encouraged by any possible justification for more permanent implementation of new or modified costing systems, what organisational changes will be required, what will be the effect on personnel, can we budget extra expenses which may be incurred and set them against accurate predictions of savings in handling and storage? What methods are available to aid prediction?

7.2. Survey impressions to date

It is too early to attempt to answer fully the questions posed because all the results are not yet available, and, secondly, the questions posed are still being discussed with participating companies. However, some evidence and impressions have been formed already.

Unfortunately it is not possible to answer (a), only the person concerned can judge; however he may be encouraged by the experience of others (refer to the report of company 2 below). The benefit obtained by carrying out the initial survey will presumably vary considerably; we can only suggest that the company tries it.

The amount of time required to carry out the initial survey does not seem to be great in most cases. Probably, half a dozen meetings of the investigating team over a period of several weeks will suffice, with a total of perhaps 25 to 200 man hours collecting and sorting data behind the scenes. The collation and transformation of results to feed into the simple computer program takes some hours, the punching of the paper tape one hour and the computer run several minutes.

The answers to (c) and (d) must await further discussions and results. However, the report of Company 2 which follows, is encouraging. It is hoped to publish the detailed comments of other companies in the next report.

The question of assessment of the costs of implementing new or modified costing systems against possible future savings are discussed briefly in the next section on investment appraisal, but again must wait until specific case studies are available for assessment.

Initial report by Company 2

'Although the project has involved us in many hundreds of man hours of work, it has been well worth it from these viewpoints:

1. Our existing costing system is very inadequate, and is currently being investigated by the Management Accountants Department. The cost centres involved in the project are

entirely logical and can be incorporated with many proposals made for a better Management Information System.

2. It has made us do useful work in finding out what our warehousing is costing. Factors that have not been previously clearly shown are now apparent, of particular interest to us is the apparently high costs of mobile handling equipment.

The only minor disadvantages found were:

1. Defining interfaces between cost centres with no easily noted break-point.
2. Assigning the man hours, equipment and unit loads correctly to one of 10-15 cost centres used in that warehouse area. (This could mean that we have a badly laid out warehouse!) However, both these were easily overcome.

The methods used in tackling both the large and small warehouses were:

1. Obtain a thorough understanding of the scheme's requirements. A one hour lecture with slides/diagrams would be useful.
2. Draw a flow diagram for the warehouse, getting Line Management to agree to it. This identifies cost centres.
3. Decide which sub cost centres and primary costs are applicable to each cost centre. This can be done by discussion with Line Management or measurement.
4. Correctly apportion man hours, equipment, overheads etc., between cost centres. This can be done by measurement or discussion.
5. Decide the number of unit load modules, and measure the quantity of each applicable module for each cost centre.
6. Put costs to the above and complete the forms.

In general for routine information, a simpler system grouping two adjacent cost centres together might be used. This would give Line Management the basic information needed. If deviations were to be investigated, the information used to compile the original system could be used, or a special investigation made. This is a personal viewpoint that generally 6-8 main cost centres should supply routine information quite adequately. However, this decision can only be made when the detailed study is complete. When our information is completed, it will be studied, and action taken on cost centres that appear out of line.

We should save far more money than the investigation has cost us.'

8. Investment appraisal for warehousing projects

8.1. The appreciation of suitable methods

The question of assessment of new projects in handling and storage situations will frequently arise, and will generally fall into one of the following categories:

- (a) Small scale modifications and additions to existing systems.
- (b) Large scale projects – shall we have a complete replacement for our present warehouse or warehouses? Should the replacement be conventional or high-bay?
- (c) Replacement of existing equipment and buildings, because of wear or obsolescence.

It is recommended that a discounted cash flow approach to investment appraisal should be used. A reference list of some of the many books and articles which have been published on this subject is given below. Probably the easiest introduction to this subject is to study '*Investment Appraisal*', HMSO (unfortunately, this booklet is being revised and is temporarily out of print—the revised edition should be available shortly), and '*A Simple Introduction to Capital Expenditure Decisions*', by Douglas Garbutt.

8.2. The application of investment appraisal methods to specific warehousing projects

It is hoped to analyse some case histories of new projects in warehouse situations in the next report and to show how the application of discounted cash flow methods can be effective in helping top management to assess the best way of investing their capital in handling and storage situations.

9. Future programme

Subject to feed-back resulting from discussion of this report, the following stages will be investigated and completed.

- 9.1 The completion of the collection and processing of the data from several companies which will bring the data required for the survey to completion. When these data are available, then the tables, detailed analysis and transformations can be completed and the final results represented.
- 9.2 A similar survey is being conducted for high-bay warehousing systems both in the UK and in Europe and it is hoped to publish the detailed results before the end of the year.
- 9.3 To discuss the detailed results with the individual companies themselves and to take the research to the stages of establishing whether overall uniform methods are suitable for comparing the performance of handling between any types of system in terms of cost. This programme has been active for some time.
- 9.4 To present several case histories of the practical and detailed implementation of new or modified costing systems, including the changes that had to be made and exactly how the cost data are collected from the shop floor, analysed and presented.
- 9.5 To attempt to find the general relationship between the main parameters which influence the design and economic viability of any handling and storage system/building. These could include:
 - The stock profiles.
 - The rates of input/output of the various 'lines'.
 - The average and maximum volume of storage required for the various 'lines'.
 - The relation between activity and cost of various types of handling equipment.
 - The relation of these factors on the size and shape of the warehouse building shell and its associated cost.
 - The evaluation of these factors considered together in terms of
 - (a) cost per unit volume/weight/unit load;
 - (b) initial capital expense required and the profitability return measured by discounted cash flow methods.
- 9.6 To attempt to build models of handling and storage systems based on the aforementioned parameters which could be used to predict the future performance of the actual equipment and building chosen. In this context, performance would be assessed in two ways which are not necessarily directly dependent; they are:
 - (a) Will the system as a whole satisfy 'client' requirements?
 - (b) Is (1) the predicted 'cost per unit load' and is (2) the 'profitability index' satisfactory, not only as far as the financial criteria of the particular company are concerned but in comparison with the uniform values which have been established in this report?

10. Conclusions

- 10.1. An operational costing system has been developed to isolate, collect and analyse costs of buildings, equipment and personnel in any warehousing situation. This uniform system has been used in a dozen differing conventional warehousing situations to produce the data summarised in this first report.
- 10.2. The system is being applied currently in a further half dozen conventional warehousing situations to complete the data for the survey.
- 10.3. The costing data have been compared with the throughput of goods handled in all the main cost centres, in order to assess efficiency in terms of 'cost per cubic yard' and 'cost per ton' of goods throughput.

This has shown up large differences in performance indices, not only overall, but between similar warehousing situations handling similar or identical goods, and this indicates that this system or a similar one may be effective in assessing rapidly the performance and costing efficiency of any warehousing system, and in comparing widely differing systems directly.

- 10.4. Experience to date suggests that the time and difficulties of introducing the standardised system into any company are not great and the costs consequently modest. Some suggestions as to how to introduce the costing investigation have been made.
- 10.5. It is proposed to complete the survey of conventional warehousing situations shortly and to improve further the speedy computer analysis of data.

In the meantime, a similar survey of high-bay warehouse systems is progressing and should be completed later in 1969.

- 10.6. Further research and discussions with participating companies are progressing currently to establish the validity of a general approach to comparing any company's handling performance.

11. Bibliography

HENRICI, S. B. 1960. *Standard costs for manufacturing*. McGraw Hill

MOST, K. S. 1961. *Uniform cost accounting*. Gee & Co. Ltd.

RISK, J. M. S. *The classification and coding of accounts*. The Institute of Cost and Works Accountants.

ROBERTSON, ANDREW. *Management and finance quarterly survey of business opinion*. Hallam Press

Selective Employment Payments Act 1966. Department of Employment and Productivity

Regional Employment Premium. Department of Employment and Productivity

The costing of materials handling. First report of a study group convened by the Institute of Production Engineers at the request of the National Joint Council on Materials Handling and in association with BIM and Institute of Materials Handling.

KAY, E. 1968. *A mathematical model for handling in a warehouse*. Pergamon Press

GARBUTT, D. 1967. *A simple introduction to capital expenditure decisions*. Pitman

Investment appraisal. HM Stationery Office (now under revision)

Investment grants – a guide to industry. 1968. Ministry of Technology

KINGSHOTT, A. L. 1969. *Investment appraisal*. Ford Business Library

ALFRED, A. M. and EVANS, J. B. 1965. *Discounted cash flow*. Chapman and Hall

MERRETT, A. J. and SYKES, A. 1966. *Capital budgeting and company finance*. Longman

MERRETT, A. J. and SYKES, A. *The finance and analysis of capital projects*. Longman

The accountant and industry. *Financial Times Survey*, 20th August 1968

How to quantify hunches. *Financial Times–The Executives' World*, 23rd July 1968

HARRIS, ANTHONY. Uses of comparison. *Financial Times–The Executives' World*, 22nd May 1968

HITCHENS, A. P. Reasons and discounts. *Financial Times–The Executives' World*, 9th July 1968

An acolyte's catechism to discounted cash flow. *The Times*, 27th January 1969

Appendix 1

Definition of main cost centres

000 – Unloading. Preparation of storage items for processing through part or whole of the warehouse. In other words, getting the storable items ready for putting through the store processes or activities, inside what is defined as the warehouse area. Unloading could, of course, be unloading from vehicles, from trains, from ships etc. by various means and methods, but the overall description of the activity is to get the items to a point where they can be put inside the storage process.

100 – Unpack, check, repack (or receive from packing department/s). Packaging storable items to fit storage requirements and testing whether they conform with set quantitative and/or qualitative standards.

These two activities need not necessarily go together. In other words not every storable item received needs repackaging but what is meant by packaging for example is:

1. If you receive cartons but store in pallets.
2. The reverse of (1) above, i.e. receive in pallets but store in cartons.
3. If you get raw material in bulk and have to sack it or otherwise make unit loads for storage purpose.

As to checking, quantitative checks may be straightforward counts of items received, or may contain an element of decision making. For example, a count of 96 against an order for 100 may be classified as complete order, but any receipts less than 90% of order classified as part receipts.

Qualitative standards, of course, depend on the item and may be statistical quality checks, acceptance checks or chemical analyses, etc.

200 – Store location decision. Decision in accordance with stated principles and practices as to where in the storage space to put any given unit of storage items, following activities 000 and 100.

This is dependent on the circumstances. This may not be a laid down activity in the sense that rules exist but may exist only in the heads of the foreman, supervisor, or warehouse manager. On the other hand, if we have got an organisation which is run with the aid of a computer, there may be very detailed and exact routines. If a warehouse is run on optimality principles, then the location of where to put any single item is very important indeed. Note should also be taken that at this point we start talking about storage units as against storable items. 'Storable items' is a given quantity of units to fit storage requirements.

300 – Transport to storage area. Moving one or more units of the storable items into the vicinity of the location given under 200.

310 and 320 – Putting into store location – Two level storage or single level storage. Physically locating any given unit following 300 in accordance with the decision of 200.

A single level storage is defined as a storage pattern where outgoing items are taken straight from the location where they were first put. In other words, where no preparation or rearrangement inside the store takes place before issuing or order picking.

A two level storage usually known as *bulk store and working store* requires that items, before actually being chosen to leave the store, have to be moved to a location from which they can be easily picked. An example of a two level store which appears physically to be a one level store is a pallet racking store in which the lower tiers are used to pick outgoing units, whilst the upper levels are used as bulk storage and cannot be reached by the people or machines used to extract items for despatch.

This is a special activity which in either case may be linked to 300. For example, if you use a fork lift truck to move a unit into the vicinity, then the actual physical moving and locating of the unit is effectively one activity. If on the other hand you have, for example, a conveyor system and a crane or other means of physically locating, then a distinct difference between activities 300, 310 and 320 exists.

400 – Transfer from bulk to working store area for two level storage. Moving any given unit from its location given by 200 to the vicinity of another location which is decided in accordance with stated principles and practices.

This actually is implied in the definition of two level store, since in order to remove a unit from store only a certain part of the total store is available, stores units which are not in that designated part have to be moved before they can be issued.

330 – Putting into working store location (two level storage). Physically locating any given unit from 400. Same considerations apply as for 310 and 320.

500 – Retrieval from store, order picking serial or parallel. Decision to move any given unit from location given by 310, 320 or 330 in accordance with stated principles and physically removing it in preparation for 340.

This is a similar activity to 200. In other words the form of decision making may vary from a simple expertise of a supervising foreman to a fixed computer program, but the activity will be triggered off from an order from the warehouse. In other words, a clerical process will be involved.

Serial (sequential) order picking deals with the orders in sequence; that is, selecting all the commodities required for a single order, at a time.

Parallel order picking means that a number of orders are dealt with in parallel, by selecting the total quantity of one commodity at a time required for that number of orders and distributing it to each order.

340 – Transport to order assembly area. Moving one or more units from 310/320 to indicated area.

110 – Order assembly. Physically re-arranging units in the assembly area in accordance with given routines.

For example, in the case of parallel picking, 110 is actually equivalent to a serial picking within a very restricted area. In the case of serial picking, the activity in the assembly area may consist purely of arranging picked items into lorry loads or putting the picked items into containers ready for further removal, but it is in any case a re-arrangement of the picked items. It may include packing of picked orders.

350 – Transport to loading area or processing area. Moving re-arranged units from 110 to indicated area. This applies, for instance, in cases where picked items are put under activity 110 in an area grouped in single vehicle loads; then 350 comprises the shifting of each group to the vehicle loading point.

It may also mean the shifting of picked items in containers to a place where containers are attached to despatching vehicles.

010 – Vehicle loading. Final actions to physically delete items originating from 110 and 350 from storage process.

This is the reverse of group 000. It means loading and despatching vehicles, but the definition is purposely kept very wide, because, whatever vehicles are being loaded and by whatever means, this action also has a feed-back to the clerical side of the procedures, as the moment the action is finished the item is deleted from the store holding completely, both physically and clerically.

600 – Retrieval from store (single issue). Decision to move and physically removing any unit ex 310 in accordance with stated principles.

This is a special activity more often encountered with 'in-process' storage than in the type of warehouse storage considered here. It can arise, however, in warehouses when bulk transfers are made between warehouses or when items are released because of deterioration or obsolescence.

Appendix 2

'Company' and 'uniform' elements of cost and performance indices by volume

Table 1/App. 2. Breakdown of 'company' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	1033	5040	1342	0	2591	10006 = Tc B
Equipment, depreciation, maintenance and running costs	1341	4666	531	0	326	6864 = Tc E
Labour, direct and supervisory costs	5599	4815	11401	0	6510	28325 = Tc L
TOTALS	8896·171 = Tc 000	16202·345 = Tc 310	14810·959 = Tc 500	0 = Tc 110	10518·525 = Tc 010	50428 = Tc

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 2/App. 2. Breakdown of 'company' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·009	0·046	0·012	0	0·024	0·092 = $\frac{Tc B}{V}$
Equipment, depreciation, maintenance and running costs	0·012	0·043	0·005	0	0·003	0·063 = $\frac{Tc E}{V}$
Labour, direct and supervisory costs	0·051	0·044	0·105	0	0·060	0·260 = $\frac{Tc L}{V}$
TOTALS	0·082 = $\frac{Tc 000}{V}$	0·149 = $\frac{Tc 310}{V}$	0·136 = $\frac{Tc 500}{V}$	0 = $\frac{Tc 110}{V}$	0·097 = $\frac{Tc 010}{V}$	0·463 = $\frac{Tc}{V}$

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 3/App. 2 Breakdown of 'uniform' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	2122	10279	2767	0	5377	20545 = Tu 8
Equipment, depreciation, maintenance and running costs	1331	5042	790	0	395	7558 = Tu E
Labour, direct and supervisory costs	5077	4203	12440	0	7340	29060 = Tu L
TOTALS	9310·881 = Tu 000	21311·329 = Tu 310	17461·449 = Tu 500	0 = Tu 110	14312·341 = Tu 010	62396·000 = Tu

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 4/App. 2 Breakdown of 'uniform' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·020	0·094	0·025	0	0·049	0·189 = $\frac{\text{Tu B}}{\text{V}}$
Equipment, depreciation, maintenance and running costs	0·012	0·046	0·007	0	0·004	0·069 = $\frac{\text{Tu E}}{\text{V}}$
Labour, direct and supervisory costs	0·047	0·039	0·114	0	0·067	0·267 = $\frac{\text{Tu L}}{\text{V}}$
TOTALS	0·086 = $\frac{\text{Tu 000}}{\text{V}}$	0·196 = $\frac{\text{Tu 310}}{\text{V}}$	0·160 = $\frac{\text{Tu 500}}{\text{V}}$	0 = $\frac{\text{Tu 110}}{\text{V}}$	0·132 = $\frac{\text{Tu 010}}{\text{V}}$	0·573 = $\frac{\text{Tu}}{\text{V}}$

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 5/App. 2. Breakdown of 'company' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	2224	12407	0	1940	2801	19372 = Tc 8
Equipment, depreciation, maintenance and running costs	10625·507	28136·923	0	3678·396	743·173	43184 = Tc E
Labour, direct and supervisory costs	18737	0	0	2920	2920	24577 = Tc L
TOTALS	37402·604 = Tc 000	48009·369 = Tc 310	0 = Tc 500	10110·591 = Tc 110	7654·437 = Tc 010	103177 = Tc

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 6/App. 2. Breakdown of 'company' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·006	0·035	0	0·005	0·008	0·054 = $\frac{\text{Tc 8}}{\text{V}}$
Equipment, depreciation, maintenance and running costs	0·03	0·079	0	0·01	0·002	0·121 = $\frac{\text{Tc E}}{\text{V}}$
Labour, direct and supervisory costs	0·053	0	0	0·008	0·008	0·069 = $\frac{\text{Tc L}}{\text{V}}$
TOTALS	0·105 = $\frac{\text{Tc 000}}{\text{V}}$	0·135 = $\frac{\text{Tc 310}}{\text{V}}$	0 = $\frac{\text{Tc 500}}{\text{V}}$	0·028 = $\frac{\text{Tc 110}}{\text{V}}$	0·021 = $\frac{\text{Tc 010}}{\text{V}}$	0·29 = $\frac{\text{Tc}}{\text{V}}$

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 7/App. 2. Breakdown of 'uniform' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	1661	9263	0	1447	2093	14464 = Tu B
Equipment, depreciation, maintenance and running costs	10311·298	25419·081	0	3533·046	812·575	40076 = Tu E
Labour, direct and supervisory costs	17480	0	0	2821	2821	23122 = Tu L
TOTALS	35185·222 = Tu 000	41432·989 = Tu 310	0 = Tu 500	9319·529 = Tu 110	6841·26 = Tu 010	92779 = Tu

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 8/App. 2. Breakdown of 'uniform' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·005	0·026	0	0·004	0·006	0·041 = $\frac{\text{Tu B}}{\text{V}}$
Equipment, depreciation, maintenance and running costs	0·029	0·071	0	0·01	0·002	0·113 = $\frac{\text{Tu E}}{\text{V}}$
Labour, direct and supervisory costs	0·049	0	0	0·008	0·008	0·065 = $\frac{\text{Tu L}}{\text{V}}$
TOTALS	0·099 = $\frac{\text{Tu 000}}{\text{V}}$	0·116 = $\frac{\text{Tu 310}}{\text{V}}$	0 = $\frac{\text{Tu 500}}{\text{V}}$	0·026 = $\frac{\text{Tu 110}}{\text{V}}$	0·019 = $\frac{\text{Tu 010}}{\text{V}}$	0·261 = $\frac{\text{Tu}}{\text{V}}$

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 9/App. 2. Breakdown of 'company' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	4709	107043	57189	3454	4709	177104 = Tc B
Equipment, depreciation, maintenance and running costs	2336	39017	22272	21372	631	85628 = Tc E
Labour, direct and supervisory costs	28975	80018	141403	59651	13116	323163 = Tc L
TOTALS	38076·643 = Tc 000	238986·435 = Tc 310	233474·730 = Tc 500	89300·405 = Tc 110	19509·787 = Tc 010	619348 = Tc

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 10/App. 2. Breakdown of 'company' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·013	0·303	0·162	0·01	0·013	0·501 = $\frac{Tc B}{V}$
Equipment, depreciation, maintenance and running costs	0·007	0·11	0·063	0·06	0·002	0·242 = $\frac{Tc E}{V}$
Labour, direct and supervisory costs	0·082	0·226	0	0·169	0·037	0·915 = $\frac{Tc L}{V}$
TOTALS	0·108 = $\frac{Tc 000}{V}$	0·676 = $\frac{Tc 310}{V}$	0·661 = $\frac{Tc 500}{V}$	0·253 = $\frac{Tc 110}{V}$	0·055 = $\frac{Tc 010}{V}$	1·753 = $\frac{Tc}{V}$

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 11/App. 2. Breakdown of 'uniform' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	5180	117769	62926	3799	5180	194854 = Tu B
Equipment, depreciation, maintenance and running costs	2587	36221	21416	20032	631	80887 = Tu E
Labour, direct and supervisory costs	33520	103087	135691	65693	14739	352730 = Tu L
TOTALS	43327·927 = Tu 000	269785·003 = Tu 310	230909·819 = Tu 500	93949·41 = Tu 110	21565·841 = Tu 010	659538 = Tu

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 12/App. 2. Breakdown of 'uniform' volume performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·015	0·333	0·178	0·011	0·015	0·551 = $\frac{\text{Tu B}}{\text{V}}$
Equipment, depreciation, maintenance and running costs	0·007	0·103	0·061	0·057	0·002	0·229 = $\frac{\text{Tu E}}{\text{V}}$
Labour, direct and supervisory costs	0·095	0·292	0·384	0·186	0·042	0·998 = $\frac{\text{Tu L}}{\text{V}}$
TOTALS	0·123 = $\frac{\text{Tu 000}}{\text{V}}$	0·764 = $\frac{\text{Tu 310}}{\text{V}}$	0·654 = $\frac{\text{Tu 500}}{\text{V}}$	0·266 = $\frac{\text{Tu 110}}{\text{V}}$	0·061 = $\frac{\text{Tu 010}}{\text{V}}$	1·867 = $\frac{\text{Tu}}{\text{V}}$

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Appendix 3

'Company' and 'uniform' elements of cost and performance indices by weight

Index	Weight	Company element	Uniform element
Cost index	0.50	0.50	0.50
Performance index	0.50	0.50	0.50
Total index	1.00	1.00	1.00

Table 1. The weight of the 'Company' and 'Uniform' elements of the cost and performance indices by weight.

Index	Weight	Company element	Uniform element
Cost index	0.50	0.50	0.50
Performance index	0.50	0.50	0.50
Total index	1.00	1.00	1.00

Table 1. The weight of the 'Company' and 'Uniform' elements of the cost and performance indices by weight.

Table 1/App. 3. Breakdown of 'company' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	1033	5040	1342	0	2591	10006 = Tc B
Equipment, depreciation, maintenance and running costs	1341	4666	531	0	326	6864 = Tc E
Labour, direct and supervisory costs	5599	4815	11401	0	6510	28325 = Tc L
TOTALS	8896·171 = Tc 000	16202·345 = Tc 310	14810·959 = Tc 500	0 = Tc 110	10518·525 = Tc 010	50428 = Tc

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 2/App. 3. Breakdown of 'company' weight performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·037	0·181	0·048	0	0·093	0·36 = $\frac{Tc\ B}{W}$
Equipment, depreciation, maintenance and running costs	0·048	0·168	0·019	0	0·012	0·247 = $\frac{Tc\ E}{W}$
Labour, direct and supervisory costs	0·201	0·173	0·41	0	0·234	1·018 = $\frac{Tc\ L}{W}$
TOTALS	0·320 = $\frac{Tc\ 000}{W}$	0·582 = $\frac{Tc\ 310}{W}$	0·532 = $\frac{Tc\ 500}{W}$	0 = $\frac{Tc\ 110}{W}$	0·378 = $\frac{Tc\ 010}{W}$	1·813 = $\frac{Tc}{W}$

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 3/App. 3. Breakdown of 'uniform' average annual costs

All values in £ sterling

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	2122	10279	2767	0	5377	20545 = Tu B
Equipment, depreciation, maintenance and running costs	1331	5042	790	0	395	7558 = Tu E
Labour, direct and supervisory costs	5077	4203	12440	0	7340	29060 = Tu L
TOTALS	9310·881 = Tu 000	21311·329 = Tu 310	17461·449 = Tu 500	0 = Tu 110	14312·341 = Tu 010	62396 = Tu

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Table 4/App. 3. Breakdown of 'uniform' weight performance indices

All values in £ sterling per cubic yard of goods throughput

Main cost centres	Unloading 000	Main storage 310	Order-picking 500	Packing and order assembly 110	Loading 010	TOTALS
Building, depreciation and allocated service costs	0·076	0·37	0·099	0	0·193	0·739
Equipment, depreciation, maintenance and running costs	0·048	0·181	0·028	0	0·014	0·272
Labour, direct and supervisory costs	0·183	0·151	0·447	0	0·264	1·045
TOTALS	0·335 = Tu 000 W	0·766 = Tu 310 W	0·628 = Tu 500 W	0 = Tu 110 W	0·514 = Tu 010 W	2·243 = Tu W

Notes: 1. Total control system costs are included and apportioned across equipment and labour costs (see p. 24).
2. The format is similar to that printed out by the computer.

Appendix 4

Categories of personnel employed in warehousing situations, with wage rates for 1967-68

Category		Wage rates			
1	General warehouse worker	1967	1968		
		1.00	1.05		
2	Warehouse worker - heavy	1967	1968		
		1.10	1.15		
3	Warehouse worker - light	1967	1968		
		0.90	0.95		
4	Warehouse worker - clerical	1967	1968		
		1.20	1.25		
5	Warehouse worker - supervisory	1967	1968		
		1.30	1.35		
6	Warehouse worker - maintenance	1967	1968		
		1.40	1.45		
7	Warehouse worker - specialized	1967	1968		
		1.50	1.55		
8	Warehouse worker - training	1967	1968		
		1.60	1.65		
9	Warehouse worker - management	1967	1968		
		1.70	1.75		
10	Warehouse worker - executive	1967	1968		
		1.80	1.85		
		Total		1967	1968
				1.00	1.05

Company code number:	1	2A	3	4
Normal base rate shillings/hour	7·5	8·0		8·16
Normal hours per week	40	40		40
Overtime rate	11·25	10·66 or 16·0*		11·25
Average number of hours overtime per week (nominally 1½ time)	4	—		—
Average number of hours overtime per week (nominally double time)	—	—		—
Average incentive bonus, shillings/hour	—	—		total rate 11·72
Shift allowances rate shillings/hour	—	0·835 (2-shift) 1·166 (3-shift)		—
Average number of hours shift allowances	—	40		—
Holiday pay rate shillings/hour	7·50	8		8·1
Company merit awards and long service awards	0·75 Merit	—		—
Gross earnings at base rate per week £	15	16		16·33
Gross earnings at base rate per year (48 weeks) £	720	768		783·84
Gross earnings at overtime rates per week £	2·25	—		—
Gross earnings at overtime rates per year (48 weeks) £	108	—		—
Gross earnings, incentive bonuses, per week £	—	—		—
Gross earnings, incentive bonuses, per year (48 weeks) £	—	—		—
Gross earnings, shift allowances, per week £	—	1·67 or 2·32		—
Gross earnings, shift allowances, per year (48 weeks) £	—	80·16 or 111·36		—
Gross earnings, holiday pay, per year (4 weeks) £	60	64		64·8
Gross earnings, merit awards, per week £	1·5	—		—
Gross earnings, merit awards, per year (48 weeks) £	72	—		—
Standardised employer's contribution, per week, shillings*	26	26		26
Standardised employer's contribution, per year £*	68	68		68
Employer's gross payments per working week £ (excluding holiday pay)	20·05	19·62		17·63
Gross payments per year (52 weeks) £	1028	1011		916

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 1/App. 4. STOREMAN

A blank column indicates that category of personnel was not employed

	7	8	9	10	11	12	13	14	2B
	9.5	9.167	6.45	6.75	12.27	8.208	7.75	6.75	7.25
	40	40	40	44	37.5	40	40	40	40
	12.66	13.751	9.67	11.34	18.5	12.01	11.63	10.1	9.417
is. 2s.	—	6.5	4	4	—	—	2.5	3.12	8
	—	—	—	—	—	—	—	—	—
	—	—	see below	—	—	—	1.25	2.75	—
	4.05†	—	—	—	—	10.944†	—	—	—
	40	—	—	—	—	40	—	—	—
	8.48	7.917	6.45	6.75	12.27	8.208	9	6.75	7.25
	—	—	—	—	—	—	—	—	—
	19	18.337	12.9	14.35	23	16.416	15.5	13.5	14.5
	912	880.17	620	712.8	1104	788	744	648	696
.8	—	4.468	1.93	2.26	—	—	1.45	1.57	3.96
.4	—	214.46	92.7	108.48	—	—	69.6	76.1	194.04
	—	—	5.42	—	—	—	2.5	5.56	—
	—	—	260	—	—	—	120	265.5	—
	8.10†	—	—	—	—	5.47†	—	—	—
	388.8†	—	—	—	—	263†	—	—	—
	67.8	63.34	51.6	59.4	92	65.6	72	54	58
	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—
6	26	26	26	26	26	26	26	26	26
3	68	68	68	68	68	68	68	68	68
9.1	$\frac{20.3}{28.4 \uparrow}$	24.1	21.55	18.41	24.3	$\frac{17.72}{23.1 \uparrow}$	20.8,	21.7	19.76
6	$\frac{1047.8}{1436.6 \uparrow}$	1226	1092.3	948.3	1264	$\frac{922}{1185 \uparrow}$	1073	1115	1016

†Nightshift.

Company code number:	1	2A	3	4
Normal base rate shillings/hour				7·3
Normal hours per week				40
Overtime rate				7·3
Average number of hours overtime per week (nominally 1½ time)				4
Average number of hours overtime per week (nominally double time)				—
Average incentive bonus, shillings/hour				—
Shift allowances rate shillings/hour				—
Average number of hours shift allowances				—
Holiday pay rate shillings/hour				7·3
Company merit awards and long service awards				—
Gross earnings at base rate per week £				14·6
Gross earnings at base rate per year (48 weeks) £				700·8
Gross earnings at overtime rates per week £				1·46
Gross earnings at overtime rates per year (48 weeks) £				70·08
Gross earnings, incentive bonuses, per week £				—
Gross earnings, incentive bonuses, per year (48 weeks) £				—
Gross earnings, shift allowances, per week £				—
Gross earnings, shift allowances, per year (48 weeks) £				—
Gross earnings, holiday pay, per year (4 weeks) £				58·4
Gross earnings, merit awards, per week £				—
Gross earnings, merit awards, per year (48 weeks) £				—
Standardised employer's contribution, per week, shillings*				26
Standardised employer's contribution, per year £*				68
Employer's gross payments per working week £ (excluding holiday pay)				17·36
Gross payments per year (52 weeks) £				897·28

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 2/App. 4. CHECKER

A blank column indicates that category of personnel was not employed

7	8	9	10	11	12	13	14	2B
	9·167	6·87	7·167		8·125	7·75	5·66	7·50
	40	40	44*		40	40	40	40
	13·751	9·67	12·04		12·187	11·63	8·5	9·417
8s. 12s.	6·5	4	4		—	2·5	—	8
	—	—	—		—	—	—	
	—	—	—		—	1·25	2·6	
	—	—	—		10·833†	—	—	
	—	—	—		40	—	—	
4·0	7·917	6·87	7·167		8·125	9	5·66	7·5
	—	—	—		—	—	—	—
	18·337	13·92	15·7		16·25	15·5	11·35	15
	880·17	668·16	753·6		780	744	544·8	720
·8	4·468	1·934	2·4		—	1·45	—	3·777
6·4	214·46	92·83	115·2		—	69·6	—	181·29
	—	5·687	—		—	2·5	5·1	—
	—	273	—		—	120	245	—
	—	—	—		5·42†	—	—	—
	—	—	—		260†	—	—	—
4	63·34	55·68	62·8		65	72	45·4	60
	—	—	—		—	—	—	—
	—	—	—		—	—	—	—
6	26	26	26		26	26	26	26
8	68	68	68		68	68	68	68
9·1	24·1	17·15	19·4		<u>17·55</u> 23·0†	20·8	17·5	20·08
6·4	1226	884·67	999·6		<u>913</u> 1173†	1073	903	1029·29

†Nightshift.

Company code number:	1	2A	3	4
Normal base rate shillings/hour	7·50	8·25		8·577
Normal hours per week	40	40		40
Overtime rate	11·25	*11·0 or 16·5		11·762
Average number of hours overtime per week (nominally 1½ time)	4	—		4
Average number of hours overtime per week (nominally double time)	—	—		—
Average incentive bonus, shillings/hour	—	—		—
Shift allowances rate shillings/hour	—	0·833 (2-shift) 1·166 (3-shift)		—
Average number of hours shift allowances	—	40		—
Holiday pay rate shillings/hour	7·5	8·25		8·373
Company merit awards and long service awards	0·75 Merit	—		—
Gross earnings at base rate per week £	15·0	16·5		17·154
Gross earnings at base rate per year (48 weeks) £	720	792		823·39
Gross earnings at overtime rates per week £	2·23	—		2·352
Gross earnings at overtime rates per year (48 weeks) £	107	—		112·89
Gross earnings, incentive bonuses, per week £	—	—		—
Gross earnings, incentive bonuses, per year (48 weeks) £	—	—		—
Gross earnings, shift allowances, per week £	—	1·67 or 2·32		—
Gross earnings, shift allowances, per year (48 weeks) £	—	80·16 or 111·36		—
Gross earnings, holiday pay, per year (4 weeks) £	60	66		66·98
Gross earnings, merit awards, per week £	1·5	—		—
Gross earnings, merit awards, per year (48 weeks) £	72	—		—
Standardised employer's contribution, per week, shillings*	26	26		26
Standardised employer's contribution, per year £*	68	68		68
Employer's gross payments per working week £ (excluding holiday pay)	20·03	19·47		20·81
Gross payments per year (52 weeks) £	1027	1006·16		1071·26 1

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 3/App. 4. FORK LIFT TRUCK DRIVER

A blank column indicates that category of personnel was not employed

	7	8	9	10	11	12	13	14	2B
	9.583	10.25	7	7.166	12.49	8.458	7.75	6.75	7.425
	40	40	40	44*	37.5	40	40	40	40
	12.77	15.37	10.5	12.04	18.75	12.687	11.63	10.1	9.667
8s. 12s.	—	5.5	9	4	—	—	2.5	4.44	15
	—	—	—		—	—	—	—	—
	—	—			—	—	1.25	1.75	—
	4.05†	—			—	11.275†	—	—	—
	40	—			—	40	—	—	—
	8.48	8.083	7	7.166	12.49	8.458	9	6.75	7.425
	—	—	—	—	—	—	—	—	—
	19.166	20.5	14	15.7	23.4	16.92	15.5	13.5	14.85
	919.97	984	672	753.6	1123	812	744	648	712.8
.8	—	4.226	4.72	2.40	—	—	1.45	2.2	7.25
.4	—	222.84	226.5	115.2	—	—	69.6	108	348
	—	—	7.87	—	—	—	2.5	3.4	—
	—	—	378	—	—	—	120	164.4	—
	8.1	—		—	—	5.63†	—	—	—
	38.9	—		—	—	270†	—	—	—
4	76.66	66.64	56	62.8	93.6	67.6	72	54	59.4
		—	—	—	—	—	—	—	—
		—	—	—	—	—	—	—	—
6	26	26	26	26	26	26	26	26	26
8	68	68	68	68	68	68	68	68	68
9.1	$\frac{20.47}{28.57 \uparrow}$	26.03	27.9	19.4	24.7	$\frac{18.22}{23.9 \uparrow}$	20.8	20.2	23.4
5	$\frac{1064.63}{1453.63 \uparrow}$	1341.4	1401	999.6	1285	$\frac{948}{1218 \uparrow}$	1073	1042	1188.2

†Nightshift

Company code number:	1	2A	3	4
Normal base rate shillings/hour		8·25		
Normal hours per week		40		
Overtime rate		10·6 or 16·0		
Average number of hours overtime per week (nominally 1½ time)		—		
Average number of hours overtime per week (nominally double time)		—		
Average incentive bonus, shillings/hour		—		
Shift allowances rate shillings/hour		0·833 (2-shifts) 1·166 (3-shifts)		
Average number of hours shift allowances		40		
Holiday pay rate shillings/hour		8·25		
Company merit awards and long service awards		—		
Gross earnings at base rate per week £		16·5		
Gross earnings at base rate per year (48 weeks) £		792		
Gross earnings at overtime rates per week £		—		
Gross earnings at overtime rates per year (48 weeks) £		—		
Gross earnings, incentive bonuses, per week £		—		
Gross earnings, incentive bonuses, per year (48 weeks) £		—		
Gross earnings, shift allowances, per week £		1·67 or 2·32		
Gross earnings, shift allowances, per year (48 weeks) £		80·16 or 111·36		
Gross earnings, holiday pay, per year (4 weeks) £		66		
Gross earnings, merit awards, per week £		—		
Gross earnings, merit awards, per year (48 weeks) £		—		
Standardised employer's contribution, per week, shillings*		26		
Standardised employer's contribution, per year £*		68		
Employer's gross payments per working week £ (excluding holiday pay)		19·47		
Gross payments per year (52 weeks) £		1006·16		1

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 4/App. 4. EQUIPMENT OPERATOR								
A blank column indicates that category of personnel was not employed								
7	8	9	10	11	12	13	14	2B
25	9.5	7.45	7	13.87	8.208	7.75	6.75	7.25
	40	40	44	37.5	40	40	40	40
87	13.75	11.17	11.76	27.3	12.312	11.63	10.1	9.417
25s. -87s.	5.5	2.5	4	—	—	2.5	4.44	8
	—	—	—	—	—	—	—	—
	—	—	—	—	—	1.25	1.75	—
	—	—	—	—	10.944†	—	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	40	—	—	—
25	7.917	7.45	7	1.248	8.208	9	6.75	7.25
	—	—	—	—	—	—	—	—
5	19	14.9	15.4	26	16.42	15.5	13.5	14.5
	912	715.2	739.2	1248	788	744	648	696
081	3.78	1.396	2.32	—	—	1.45	2.2	3.96
89	181.44	67	111.36	—	—	69.6	108	194.04
	—	—	—	—	—	2.5	3.4	—
	—	—	—	—	—	120	165	—
	—	—	—	—	5.47†	—	—	—
	—	—	—	—	263†	—	—	—
	63	59.6	61.6	104	65.6	72	54	58
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	26	26	26	26	26	26	26	26
	68	68	68	68	68	68	68	68
88	24.08	17.6	19.02	27.3	<u>17.72</u> 23.1†	20.8	20.2	19.76
	1224.7	909.8	980.2	1420	<u>922</u> 1185†	1073	1042	1016.8
†Nightshift.								

Company code number:	1	2A	3	4
Normal base rate shillings/hour	8·461	14·4		7·3
Normal hours per week	40	40		40
Overtime rate	12·69	—		7·3
Average number of hours overtime per week (nominally 1½ time)	4	—		—
Average number of hours overtime per week (nominally double time)	—	—		—
Average incentive bonus, shillings/hour	—	—		—
Shift allowances rate shillings/hour	—	—		—
Average number of hours shift allowances	—	—		—
Holiday pay rate shillings/hour	8·461	14·4		7·3
Company merit awards and long service awards	1·411 Merit	—		
Gross earnings at base rate per week £	16·922	28·8		14·6
Gross earnings at base rate per year (48 weeks) £	812·26	1382		700·8
Gross earnings at overtime rates per week £	1·935	—		—
Gross earnings at overtime rates per year (48 weeks) £	92·88	—		—
Gross earnings, incentive bonuses, per week £	—	—		—
Gross earnings, incentive bonuses, per year (48 weeks) £	—	—		—
Gross earnings, shift allowances, per week £	—	—		—
Gross earnings, shift allowances, per year (48 weeks) £	—	—		—
Gross earnings, holiday pay, per year (4 weeks) £	67·69	118		58·4
Gross earnings, merit awards, per week £	2·82	—		—
Gross earnings, merit awards, per year (48 weeks) £	135·36	—		—
Standardised employer's contribution, per week, shillings*	26	26		26
Standardised employer's contribution, per year £*	68	68		68
Employer's gross payments per working week £ (excluding holiday pay)	22·98	30·1		15·9
Gross payments per year (52 weeks) £	1176·2	1568		826·4

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 5/App. 4. CONTROL CLERK (MALE)

A blank column indicates that category of personnel was not employed

	7	8	9	10	11	12	13	14	2B
	9.50	10.167	7.75		11.47	8.208	7.75	6.75	8.5
	40	40	40		37.5	40	40	40	40
	12.66	15.25	11.6		17.2	12.312	11.63	10.1	11.75
3s. 12s.	—	6.5	8		—	—	2.5	7.71	8
	—	—	—		—	—	—	—	—
	—	—	—		—	—	1.25	1.1	—
	4.05 extra†	—	—		—	10.944†	—	—	—
	40	—	—		—	40	—	—	—
	8.48	8.083	7.75		11.47	8.208	9	6.75	8.5
	—	—	—		—	—	—	—	—
	19	20.334	18.21		21.5	16.42	15.5	13.5	17
	912	976	874		1032	788	744	648	816
.8	—	4.956	4.64		—	—	1.45	3.9	4.7
5.4	—	237.88	222.72		—	—	69.6	189	225.6
	—	—	—		—	—	2.5	2.15	—
	—	—	—		—	—	120	104	—
	8.1†	—	—		—	5.47†	—	—	—
	389	—	—		—	263†	—	—	—
4	67.84	64.66	72.84		85	65.6	72	54	68
	—	—	—		—	—	—	—	—
	—	—	—		—	—	—	—	—
3	26	26	26		26	26	26	26	26
3	68	68	68		68	68	68	68	68
9.1	$\frac{20.3}{28.4 \uparrow}$	26.59	24.15		22.8	$\frac{17.72}{23.1 \uparrow}$	20.8	19.6	23
5.4	$\frac{1047.8}{1436.8 \uparrow}$	1346.5	1237.5		1185	$\frac{922}{1185 \uparrow}$	1073	1063	1177.6

†Nightshift.

Company code number:	1	2A	3	4
Normal base rate shillings/hour	4·173			6·366
Normal hours per week	40			40
Overtime rate	6·26			8·4
Average number of hours overtime per week (nominally 1½ time)	4			4
Average number of hours overtime per week (nominally double time)	—			—
Average incentive bonus, shillings/hour	—			—
Shift allowances rate shillings/hour	—			—
Average number of hours shift allowances	—			—
Holiday pay rate shillings/hour	4·173			6·617
Company merit awards and long service awards	0·417 Merit			—
Gross earnings at base rate per week £	8·35			12·732
Gross earnings at base rate per year (48 weeks) £	400·8			611
Gross earnings at overtime rates per week £	1·25			1·68
Gross earnings at overtime rates per year (48 weeks) £	60			80·64
Gross earnings, incentive bonuses, per week £	—			—
Gross earnings, incentive bonuses, per year (48 weeks) £	—			—
Gross earnings, shift allowances, per week £	—			—
Gross earnings, shift allowances, per year (48 weeks) £	—			—
Gross earnings, holiday pay, per year (4 weeks) £	33·4			52·93
Gross earnings, merit awards, per week £	0·834			—
Gross earnings, merit awards, per year (48 weeks) £	40			—
Standardised employer's contribution, per week, shillings*	26			23
Standardised employer's contribution, per year £ *	68			61
Employer's gross payments per working week £ (excluding holiday pay)	11·53			15·51
Gross payments per year (52 weeks) £	602·2			805·6

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 6/App. 4. CONTROL CLERK (FEMALE)

A blank column indicates that category of personnel was not employed

7	8	9	10	11	12	13	14	2B
5 5s. 7·5s.	5·5	6·4	5·25	7·68	6·583	7·75	5·66	6·25
	40	40	44	37·5	40	40	40	40
	—	9·6	8·82	11·52	9·876	11·63	8·5	—
	—	Nil	Nil	—	—	2·5	0·66	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	1·25	—	—
	—	—	—	—	8·78	—	—	—
	—	—	—	—	40	—	—	—
	5·5	6·4	5·25	7·68	6·583	9	5·66	6·25
	—	—	—	—	—	—	—	—
·125	11	12·8	11·55	14·4	13·17	15·5	11·35	12·5
	528	614·4	554·4	691	632	744	545	600
	—	—	—	—	—	1·45	0·26	—
	—	—	—	—	—	69·6	14	—
	—	—	—	—	—	2·5	—	—
	—	—	—	—	—	120	—	—
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	44	51·2	46·2	57·6	—	72	45·4	50
	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—
	23	23	23	23	23	23	23	23
	61	61	61	61	61	61	61	61
·22	12·1	13·9	12·65		14·32	20·6	12·7	13·6
	633	726·6	661·6		746	1066	665	711

Standardised employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Company code number:	1	2A	3	4
Normal base rate shillings/hour	6·923	7·86		
Normal hours per week	40	40		
Overtime rate	10·38	10·48		
Average number of hours overtime per week (nominally 1½ time)	4	—		
Average number of hours overtime per week (nominally double time)	—	—		
Average incentive bonus, shillings/hour	—	—		
Shift allowances rate shillings/hour	—	—		
Average number of hours shift allowances	—	—		
Holiday pay rate shillings/hour	6·923	7·85		
Company merit awards and long service awards	0·417 Merit	—		
Gross earnings at base rate per week £	13·85	15·72		
Gross earnings at base rate per year (48 weeks) £	664·8	754·6		
Gross earnings at overtime rates per week £	2·076	—		
Gross earnings at overtime rates per year (48 weeks) £	99·65	—		
Gross earnings, incentive bonuses, per week £	—	—		
Gross earnings, incentive bonuses, per year (48 weeks) £	—	—		
Gross earnings, shift allowances, per week £	—	—		
Gross earnings, shift allowances, per year (48 weeks) £	—	—		
Gross earnings, holiday pay, per year (4 weeks) £	55·4	62·88		
Gross earnings, merit awards, per week £	0·834	—		
Gross earnings, merit awards, per year (48 weeks) £	40	—		
Standardised employer's contribution, per week, shillings*	26	26		
Standardised employer's contribution, per year £*	68	68		
Employer's gross payments per working week £ (excluding holiday pay)	18·06	17·02		
Gross payments per year (52 weeks) £	927·8	887		

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 7/App. 4. CLEANER (MALE)

A blank column indicates that category of personnel was not employed

7	8	9	10	11	12	13	14	2B
8.437			6.75	12.27	7.708	7.75		7.25
40			44	37.5	40	40		40
11.25			11.34	18.4	11.562	11.63		9.417
—			4	—	—	2.5		8
—			—	—	—	—		—
—			—	—	—	1.25		—
3.79†			—	—	10.277†	—		—
40			—	—	40	—		—
7.14			6.75	12.27	7.708	9		7.25
—			—	—	—	—		—
16.87			14.85	23	15.416	15.5		14.5
809.76			712.8	1104	740	744		696
—			2.26	—	—	1.45		3.96
—			108.48	—	—	69.6		194.04
—			—	—	—	2.5		—
—			—	—	—	120		—
7.58†			—	—	5.14†	—		—
363.84†			—	—	246†	—		—
67.48			59.4	92	56.6	72		58
—			—	—	—	—		—
—			—	—	—	—		—
26			26	26	26	26		26
68			68	68	68	68		68
<u>18.17</u> 25.75†			18.41	24.3	<u>16.72</u> 21.9†	20.8		19.76
<u>945.2</u> 1241.6†			948.3	1264	<u>865</u> 1111†	1073		1016

†Nightshift.

Instructions for the Employer to complete this form for the purpose of the Compensation Act 2006

Company code number:	1	2A	3	4
Normal base rate shillings/hour				
Normal hours per week				
Overtime rate				
Average number of hours overtime per week (nominally 1½ time)				
Average number of hours overtime per week (nominally double time)				
Average incentive bonus, shillings/hour				
Shift allowances rate shillings/hour				
Average number of hours shift allowances				
Holiday pay rate shillings/hour				
Company merit awards and long service awards				
Gross earnings at base rate per week £				
Gross earnings at base rate per year (48 weeks) £				
Gross earnings at overtime rates per week £				
Gross earnings at overtime rates per year (48 weeks) £				
Gross earnings, incentive bonuses, per week £				
Gross earnings, incentive bonuses, per year (48 weeks) £				
Gross earnings, shift allowances, per week £				
Gross earnings, shift allowances, per year (48 weeks) £				
Gross earnings, holiday pay, per year (4 weeks) £				
Gross earnings, merit awards, per week £				
Gross earnings, merit awards, per year (48 weeks) £				
Standardised employer's contribution, per week, shillings*				
Standardised employer's contribution, per year £*				
Employer's gross payments per working week £ (excluding holiday pay)				
Gross payments per year (52 weeks) £				

*Standardised at 28s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 8/App. 4. ORDER PICKER (MALE)

A blank column indicates that category of personnel was not employed

7	8	9	10	11	12	13	14	2B
8s. 12s.	10·167	6·45		12·27	8·208	7·75		
	40	40		37·5	40	40		
	15·25	9·67		18·4	12·312	11·63		
	6·5	3		—	—	2·5		
	—	—		—	—	—		
	—	see below		—	—	1·25		
	—	—		—	10·944†	—		
	—	—		—	40	—		
	8·083	6·45		12·27	8·208	9		
	—	—		—	—	—		
·8 ·4	20·334	12·9		23	16·416	15·5		
	976	620		1104	788	744		
	4·956	1·45		—	—	1·45		
	237·88	69·6		—	—	69·6		
	—	5·437		—	—	2·5		
	—	261		—	—	120		
	—	—		—	5·47†	—		
	—	—		—	263†	—		
	64·66	51·6		92	65·6	72		
	—	—		—	—	—		
0·1 ·4	26	26		26	26	26		
	68	68		68	68	68		
	26·6	21·09		24·3	$\frac{17·72}{23·1 \uparrow}$	20·8		
	1346·5	1070·2		1264	$\frac{922}{1185 \uparrow}$	1073		

†Nightshift.

Company code number:	1	2	3	4
Normal base rate shillings/hour				
Normal hours per week				
Overtime rate				
Average number of hours overtime per week (nominally 1½ time)				
Average number of hours overtime per week (nominally double time)				
Average incentive bonus, shillings/hour				
Shift allowances rate shillings/hour				
Average number of hours shift allowances				
Holiday pay rate shillings/hour				
Company merit awards and long service awards				
Gross earnings at base rate per week £				
Gross earnings at base rate per year (48 weeks) £				
Gross earnings at overtime rates per week £				
Gross earnings at overtime rates per year (48 weeks) £				
Gross earnings, incentive bonuses, per week £				
Gross earnings, incentive bonuses, per year (48 weeks) £				
Gross earnings, shift allowances, per week £				
Gross earnings, shift allowances, per year (48 weeks) £				
Gross earnings, holiday pay, per year (4 weeks) £				
Gross earnings, merit awards, per week £				
Gross earnings, merit awards, per year (48 weeks) £				
Standardised employer's contribution, per week, shillings*				
Standardised employer's contribution, per year £ *				
Employer's gross payments per working week £ (excluding holiday pay)				
Gross payments per year (52 weeks) £				

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 9/App. 4. ORDER PICKER (FEMALE)

A blank column indicates that category of personnel was not employed

7	8	9	10	11	12	13	14	2B
						6	5.75	
						40	40	
.5						9	8.6	
5s.						—	0.78	
7.5s.						—	—	
						0.18	1.1	
						—	—	
						—	—	
						6	5.75	
						—	—	
						12	11.55	
						576	554.4	
1.125						1.12	0.35	
4						53.7	16	
						2	2.25	
						96	108	
						—	—	
						—	—	
0						48	46.2	
						—	—	
						—	—	
3						23	23	
1						61	61	
2.22						16.2	14.15	
5						835	735	

Company code number:	1	2	3	4
Normal base rate shillings/hour Normal hours per week Overtime rate Average number of hours overtime per week (nominally 1 ½ time) Average number of hours overtime per week (nominally double time) Average incentive bonus, shillings/hour Shift allowances rate shillings/hour Average number of hours shift allowances Holiday pay rate shillings/hour Company merit awards and long service awards				
Gross earnings at base rate per week £ Gross earnings at base rate per year (48 weeks) £ Gross earnings at overtime rates per week £ Gross earnings at overtime rates per year (48 weeks) £ Gross earnings, incentive bonuses, per week £ Gross earnings, incentive bonuses, per year (48 weeks) £ Gross earnings, shift allowances, per week £ Gross earnings, shift allowances, per year (48 weeks) £ Gross earnings, holiday pay, per year (4 weeks) £ Gross earnings, merit awards, per week £ Gross earnings, merit awards, per year (48 weeks) £ Standardised employer's contribution, per week, shillings* Standardised employer's contribution, per year £*				
Employer's gross payments per working week £ (excluding holiday pay) Gross payments per year (52 weeks) £				

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 10/App. 4. PACKER (MALE)

A blank column indicates that category of personnel was not employed

7	8	9	10	11	12	13	14	2B
8s. 12s.			12·27		8·208	7·75	6·75	
			37·5		40	40	40	
			18·4		12·312	11·63	10·1	
			—		—	2·5	4·44	
			—		—	—	—	
			—		—	1·25	1·75	
			—		†10·944	—	—	
			—		40	—	—	
			12·27		8·208	9	6·75	
			—		—	—	—	
·8 ·4			23		16·416	15·5	13·5	
			1104		788	744	648	
			—		—	1·45	2·25	
			—		—	69·6	108	
			—		—	2·5	3·45	
			—		—	120	164·4	
			—		5·47†	—	—	
			—		263†	—	—	
			92		65·6	72	54	
			—		—	—	—	
			—		—	—	—	
			26		26	26	26	
			68		68	68	68	
9·1			24·3		$\frac{17·72}{23·1 \uparrow}$	20·8	20·3	
6·4			1264		$\frac{922}{1185 \uparrow}$	1073	1032	

†Nightshift.

EMPLOYER'S CONTRIBUTION

Employers must complete this form for each employee who is employed on 1 January 1992.

Company code number:	1	2	3	4
Normal base rate shillings/hour Normal hours per week Overtime rate Average number of hours overtime per week (nominally 1 ½ time) Average number of hours overtime per week (nominally double time) Average incentive bonus, shillings/hour Shift allowances rate shillings/hour Average number of hours shift allowances Holiday pay rate shillings/hour Company merit awards and long service awards				
Gross earnings at base rate per week £ Gross earnings at base rate per year (48 weeks) £ Gross earnings at overtime rates per week £ Gross earnings at overtime rates per year (48 weeks) £ Gross earnings, incentive bonuses, per week £ Gross earnings, incentive bonuses, per year (48 weeks) £ Gross earnings, shift allowances, per week £ Gross earnings, shift allowances, per year (48 weeks) £ Gross earnings, holiday pay, per year (4 weeks) £ Gross earnings, merit awards, per week £ Gross earnings, merit awards, per year (48 weeks) £ Standardised employer's contribution, per week, shillings* Standardised employer's contribution, per year £ *				
Employer's gross payments per working week £ (excluding holiday pay) Gross payments per year (52 weeks) £				

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 11/App. 4. PACKER (FEMALE)

A blank column indicates that category of personnel was not employed

7	8	9	10	11	12	13	14	2B
5 5s. 7.5s.					6.583	6		
					40	40		
					9.875	9		
					—	—		
					—	—		
					8.78†	0.18		
					—	—		
					—	—		
					6.583	6		
					—	—		
.125					13.17	12		
					632	576		
					—	1.12		
					—	53.7		
					—	2		
					—	96		
					—	—		
					—	—		
					52.6	48		
					—	—		
.22					23	23		
					61	61		
					14.32	16.2		
					746	835		

† Nightshift

Company code number:	1	2A	3	4
Normal base rate shillings/hour	8·658	10·6		8·577
Normal hours per week	40	40		40
Overtime rate	12·98	—		11·762
Average number of hours overtime per week (nominally 1½ time)	4	—		4
Average number of hours overtime per week (nominally double time)	—	—		—
Average incentive bonus, shillings/hour	—	—		—
Shift allowances rate shillings/hour	—	1·167		—
Average number of hours shift allowances	—			—
Holiday pay rate shillings/hour	8·653	10·6		8·373
Company merit awards and long service awards	0·865 Merit	—		—
Gross earnings at base rate per week £	17·31	21·2		17·154
Gross earnings at base rate per year (48 weeks) £	830·9	1017·6		823·39
Gross earnings at overtime rates per week £	2·59	—		2·334
Gross earnings at overtime rates per year (48 weeks) £	124·3	—		112·032
Gross earnings, incentive bonuses, per week £	—	—		—
Gross earnings, incentive bonuses, per year (48 weeks) £	—	—		—
Gross earnings, shift allowances, per week £	—	2·33		—
Gross earnings, shift allowances, per year (48 weeks) £	—	14·84		—
Gross earnings, holiday pay, per year (4 weeks) £	69·24	84·8		68·61
Gross earnings, merit awards, per week £	1·73	—		—
Gross earnings, merit awards, per year (48 weeks) £	83	—		—
Standardised employer's contribution, per week, shillings*	26	26		26
Standardised employer's contribution, per year £*	68	68		68
Employer's gross payments per working week £ (excluding holiday pay)	22·93	24·83		26·79
Gross payments per year (52 weeks) £	1175·4	1282·2		1072

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 12/App. 4. ASSISTANT FOREMAN/CHARGEHAND

A blank column indicates that category of personnel was not employed

6	7	8	9	10	11	12	13	14	2B
		11		7·5		9·208		10	
		40		44		40		40	
		—		12·6		13·812		15	
		—		—		—		5·02	
		—		—		—		—	
		—		—		—		—	
		—		—		†12·277		—	
		—		—		40		—	
		11		7·5		9·208		10	
		—		—		—		—	
		22		16·5		18·416		20	
		1056		792		884		960	
		—		—		—		3·75	
		—		—		—		181	
		—		—		—		—	
		—		—		—		—	
		—		—		6·14†		—	
		—		—		294†		—	
		88		66		73·6		80	
		—		—		—		—	
		—		—		—		—	
		26		26		26	26	26	
		68		68		68	68	68	
		23·3		17·9		$\frac{19·72}{26·0†}$		25	
		1212		926		$\frac{922}{1154†}$	1250‡	1389	

†Nightshift. ‡Range: Female: £750–£1240; Male: £948–£1632.

Company code number:	1	2A	3	4
Normal base rate shillings/hour	14·106	14·4		
Normal hours per week	40	40		
Overtime rate	—	—		
Average number of hours overtime per week (nominally 1½ time)	—	—		
Average number of hours overtime per week (nominally double time)	—	—		
Average incentive bonus, shillings/hour	—	—		
Shift allowances rate shillings/hour	—	—		
Average number of hours shift allowances	—	—		
Holiday pay rate shillings/hour	14·106	14·4		
Company merit awards and long service awards	1·411 Merit	—		
Gross earnings at base rate per week £	28·21	28·8		
Gross earnings at base rate per year (48 weeks) £	1354·1	1382		
Gross earnings at overtime rates per week £	—	—		
Gross earnings at overtime rates per year (48 weeks) £	—	—		
Gross earnings, incentive bonuses, per week £	—	—		
Gross earnings, incentive bonuses, per year (48 weeks) £	—	—		
Gross earnings, shift allowances, per week £	—	—		
Gross earnings, shift allowances, per year (48 weeks) £	—	—		
Gross earnings, holiday pay, per year (4 weeks) £	112·84	118		
Gross earnings, merit awards, per week £	2·82	—		
Gross earnings, merit awards, per year (48 weeks) £	135·36	—		
Standardised employer's contribution, per week, shillings*	26	26		
Standardised employer's contribution, per year £*	68	68		
Employer's gross payments per working week £ (excluding holiday pay)	32·33	30·1		
Gross payments per year (52 weeks) £	1670·3	1568		

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 13/App. 4. FOREMAN/SUPERVISOR

A blank column indicates that category of personnel was not employed

5	7	8	9	10	11	12	13	14	2B
1·54	11·4	14·76	12·5		19·49	12			
0	40	40	40		37·5	40			
—	15·2	—	—		—	18			
—	—	—	—		—	—			
—	—	—	—		—	—			
—	—	—	—		—	—			
—	4·86†	—	—		—	16†			
—	40	—	—		—	40			
1·54	11·4	14·76	12·5		19·49	12			
—	—	—	—		—	—			
23·08	22·8	29·52	25		36·54	24			
17·84	1094·4	1416·96	1200		1754	1152			
—	—	—	—		—	—			
—	—	—	—		—	—			
—	—	—	—		—	—			
—	—	—	—		—	—			
—	—	—	—		—	8†			
—	—	—	—		—	384†			
92·32	91·2	118·08	100		146	96			
—	—	—	—		—	—			
—	—	—	—		—	—			
26	26	26	26		26	26	26		
68	68	68	68		68	68	68		
24·4	24·1	30·82	26·3		37·84	$\frac{25·3}{33·3 \uparrow}$			
68·1	1253·6	1608	1368		1968	$\frac{1316}{1784 \uparrow}$	1850†		

†Nightshift.

‡Range: Second Line Supervisors (All Male): £1545-£2284.

Company code number:	1	2	3	4
Normal base rate shillings/hour				
Normal hours per week				
Overtime rate				
Average number of hours overtime per week (nominally 1 ½ time)				
Average number of hours overtime per week (nominally double time)				
Average incentive bonus, shillings/hour				
Shift allowances rate shillings/hour				
Average number of hours shift allowances				
Holiday pay rate shillings/hour				
Company merit awards and long service awards				
Gross earnings at base rate per week £				
Gross earnings at base rate per year (48 weeks) £				
Gross earnings at overtime rates per week £				
Gross earnings at overtime rates per year (48 weeks) £				
Gross earnings, incentive bonuses, per week £				
Gross earnings, incentive bonuses, per year (48 weeks) £				
Gross earnings, shift allowances, per week £				
Gross earnings, shift allowances, per year (48 weeks) £				
Gross earnings, holiday pay, per year (4 weeks) £				
Gross earnings, merit awards, per week £				
Gross earnings, merit awards, per year (48 weeks) £				
Standardised employer's contribution, per week, shillings*				
Standardised employer's contribution, per year £*				
Employer's gross payments per working week £ (excluding holiday pay)				
Gross payments per year (52 weeks) £				

*Standardised at 26s. (male) or 23s. (female) per week, equivalent to £68 and £61 per year respectively, which includes employer's contribution to Social Security, National Insurance and Graduated Pensions, but excludes SET, REP and Training Levy.

Table 14/App. 4. WAREHOUSE MANAGER

A blank column indicates that category of personnel was not employed

	7	8	9	10	11	12	13	14	28
	19	19			20·51	15			19·2
	40	40			37·5	40			40
	—	—			—	—			—
	—	—			—	—			—
	—	—			—	—			—
	—	—			—	—			—
	—	—			—	20†			—
	—	—			—	—			—
9	19	19			20·51	15			19·2
	—	—				—			—
3	38	38			38·45	30			38·4
4	1824	1824			1845	1440			1843·2
	—	—			—	—			—
	—	—			—	—			—
	—	—			—	—			—
	—	—			—	—			—
	—	—			—	8†			—
	—	—			—	384†			—
2	152	152			153	120			153·6
	—	—			—	—			—
	—	—			—	—			—
6	26	26			26	26			26
8	68	68			68	68			68
9·3	39·3	39·3			39·75	$\frac{30·0}{39·3} \uparrow$			39·7
4	2044	2044			2066	$\frac{1628}{2012} \uparrow \uparrow$			2065

†Nightshift. ‡Range: Third Line Supervisors (All Male): £1890–£3120.

Appendix 5

Method for transforming capital charges into annuities over the life of the assets

The recommended rate of discount for transforming the capital sum into an annuity is 8 %, which is the figure mentioned in the White Paper on Nationalised Industries – A Review of Economic and Financial Objectives, Command 3437 (1967), as representing a minimum test rate of discount for use in low risk projects or the opportunity cost of capital.

This figure represents a return on capital after corporation tax and investment grants and allowances have been taken into consideration, but before income tax, which will depend on a particular company's policy. It may be that a higher rate would be more appropriate to today's economic climate, say 10%. The choice of a particular rate should properly be the result of careful assessment by each company board based on its present and future financial policy coupled with its future commercial and technical planning and forecasting.

In using the annuity approach to standard costing of warehousing systems, it is necessary to use a uniform figure and it is proposed to use 8 % in future analyses.

Example

Capital sum £1000. 8 % annuity over 20 years.

The present value of £1 p.a. for 20 years at 8 % is £9.81815. Therefore, £9.81815 spent now on an 8 % annuity will buy £1 p.a. for 20 years. If £9.81815 buys £1 p.a. for 20 years, then our capital sum of £1000 buys $\frac{£1000}{£9.81815}$ p.a. = £101.852 p.a. for 20 years.

This figure of £101.8 measures the income which is given up in the course of a decision to buy a conveyor, for example, with a life of twenty years.

Appendix 6

Examples of details of survey of Company No. 9

FORM 1. Company code No. 9

Period covered 1967–68

Explanatory comments		Combined operations																					
		011 Take goods off trailers and load into containers																					
		018 Check contents of goods whilst loading into containers																					
Main selected or sub cost centres	000	002	004	100	103 104	Repalletise 106	200	Goods inwards control clerks 201 203	Storekeepers 202	Despatch clerk 204	205	300	304	320	324	500	502	340	342	010	011	017	018
Selected primary expense items	201		101	†	101	101		101	101	101			101	201	101	201	101		101	201	101	101	101
	202		102		102	102		102	102	102			102	202	102	202	102		102	202	102	102	102
	204		104		104	104		106	104	106			104	204	104	204	104		104	204	104	106	104
	206		106		106	106		107	106	107			106	206	106	206	106		106	206	106	107	106
	207		107		107	107			107				107	207	107	207	107		107	207	107		107
	501	402	402								305		402	432	402	432	442		442	301		412	
	502		403										403		403								
	503		404										405	452	405		452						
	505		405										407		407								
	506		406										408	501	408	501			501				
	516		407										409	502	409	502			502				
	517		408											503		503			503				
			409											505		505			505				
														506		506			506				
														516		516			516				
														517		517			517				

†Costs under heading 100 included in 000.

COMPANY 9

27 818 – Weight (tons)

108 800 – Volume (cubic yards)

Cost centre	Code No.	Primary expenses	
		'Company' £	'Uniform' £
000	501	422	469
320	501	1817	2020
500	501	594	661
010	501	1057	1176
000	505	242	992
320	505	1050	4282
500	505	343	1401
010	505	611	2495
000	502	54	140
320	502	233	600
500	502	76	220
010	502	136	360
000	503	195	170
320	503	840	760
500	503	275	240
010	503	489	430
000	506	28	280
320	506	177	1770
500	506	23	230
010	506	74	740
000	517	22	11
320	517	93	47
500	517	31	15
010	517	54	26
000	516	70	60
320	516	830	800
010	516	170	150
002	402	45	45
004	402	484	452
004	403	42	42
004	405	650	650
004	407	25	25
004	408	89	111
004	409	6	6
304	402	484	452
304	403	42	42
304	405	650	650
304	407	25	25
304	408	89	111
304	409	6	6
324	402	968	904
324	403	84	84
324	405	1300	1300
324	407	50	50
324	408	178	222
324	409	12	12
320	432	508	508
320	452	270	676
500	452	129	322
500	432	242	242
502	442	144	206
342	442	16	20
010	301	47	47
017	412	279	348
000	201	500	500
000	202	49	49
000	204	87	87
000	204	34	34
000	207	42	42
004	101	672	770
004	102	227	260
004	104	378	1
004	106	68	68
004	107	56	65
103	101	659	790
103	102	247	300
103	104	273	1
103	106	68	68
103	107	55	65

Cost centre	Code No.	Primary expenses	
		'Company' £	'Uniform' £
106	101	1238	1490
106	102	187	230
106	104	520	1
106	106	136	136
106	107	103	120
201	101	1228	1228
201	102	369	369
201	106	110	110
201	107	102	102
202	101	1266	1266
202	102	185	185
202	104	520	520
202	106	136	136
202	107	105	105
204	101	744	744
204	102	278	278
204	106	68	68
204	107	62	62
205	305	60	60
304	101	672	770
304	102	227	260
304	104	278	1
304	106	68	68
304	107	56	65
320	201	500	500
320	201	49	49
320	204	87	87
320	206	34	34
320	207	42	42
324	101	1344	1540
324	102	454	520
324	104	756	1
324	106	136	136
324	107	112	130
500	201	500	500
500	202	49	49
500	204	87	87
500	206	34	34
500	207	42	42
502	101	5573	6350
502	102	625	720
502	104	2348	2348
502	106	612	612
502	107	463	530
342	101	619	700
342	102	69	80
342	104	260	260
342	106	68	68
342	107	52	60
010	201	500	500
010	202	49	49
010	204	87	87
010	206	34	34
010	207	42	42
011	101	1977	2400
011	102	222	240
011	104	780	780
011	106	194	194
011	107	165	200
017	101	143	170
017	102	60	70
017	106	13	13
017	107	12	15
018	101	1318	1580
018	102	148	180
018	104	520	520
018	106	136	136
018	107	110	130

COMPANY 9

Allocated services

Apportionment factors, based on maximum usable volumes of main cost centres:

000	0.108424
320	0.466997
500	0.152824
010	0.271853

Expenses to be apportioned:

501 *Building depreciation*: Building cost £164 750 in 1963. Current equivalent price £194 500 or 3.85 shillings/cu ft.

Average annual depreciation expenses $\frac{£194\ 500}{50} = £3890$ p.a. company

and $\frac{£194\ 500}{45} = £4325$ p.a. uniform

505 *Rates*: £2250 p.a. company or £9170 uniform (2.37 shillings/sq ft)

502 *Building maintenance*: £500 p.a.

503 *Building cleaning*: £1800 p.a.

506 *Insurance*: £260 p.a. (building and fire but not including value of goods stored)

516 *Janitor service*: See other notes

517 *Telephone service*: £200

COMPANY 9

Labour: All daywork only

004 1 male fork lift truck driver (includes labour used for 3 hand pallet trucks used on casual movement in the unloading bay).

103 }
104 } 1 male checker

106 2 male goods inwards warehousemen (storemen)

304 1 male fork lift truck driver (have no data at present, to distinguish between (a) transport from 000 to 320 and (b) Lifting loads to upper 4 levels of storage in 320).

324 2 male fork lift truck drivers (includes loading into 'Floracker' part of main stores).

502 9 male order-pickers

342 1 male order picker (transports stillages to loading bay).

011 3 male checker/loaders (manually loading goods into vehicle 'containers')

018 2 male checker/loaders (checking goods into vehicle 'containers').

017 5 crane operators (equipment operator)

Control system

201 } 1 female goods inwards control clerk
203 } 1 female movement control clerk

202 2 male storekeepers (male control clerks)

204 1 male despatch clerk (male control clerk)

Supervision

516 1 foreman and 1 assistant manager, apportioned equally into cost centres 000, 320, 500, 010
Janitor service is included and represents about 2% of all warehousemen's time and 7% of all order-pickers' time. To simplify transfer of this time to janitor service, have deducted equivalent time of one order-picker from 502 and established 516 as 2½% of all direct labour = £1070.

COMPANY 9

Unit loads

Unit load 1. Input

Cardboard cartons on a standard 40" x 48" wooden pallet. Maximum height 3 ft. Width 3.33 ft. Depth 4 ft. Average volume 35 cu ft. Average weight 1790 lb (nominal 1 ton load).

Unit load 2. Output from order picking

'Package' wrapped in brown paper, variable in shape and volume

$$\begin{aligned} \text{Total weight of throughput} &= 51\,000 \times 48 \text{ tons per year} \\ \text{(based on 88 packages per ton)} &= \frac{88}{27} \\ &= 27\,818 \text{ tons per year} \end{aligned}$$

$$\begin{aligned} \text{Total volume of throughput} &= 51\,000 \times 48 \times 1.2 \text{ cu yds} \\ \text{(based on volume per 'package' = 1.2 cu ft)} &= \frac{27}{108\,800} \text{ cu yds} \end{aligned}$$

$$\text{Density} = 573 \text{ lb/cu yd}$$

FORM 3A

Description of storage area 77 390 sq ft. (Refer to drawing SKY 1)

Period covered 1967-68

Main cost centre	Description of area	Length ft	Width ft	Maximum usable height ft	Volume cu ft
000 Unloading (including 100)	Vehicle standing enclosure	104	50	20.5	103 200
320 Main storage		223	132	15.5	455 000
500 Order picking		223	132	5	147 000
110 Packing (or order assembly)					
010 Loading	'Container' loading bay, despatch assembly area and repack area	150 180	50 25	24 21	180 000 94 300
020 Auxiliary services	Vehicle maintenance, bay (a) pallet buffer store o/s (b)	47 20	27 20	20 10	25 400 4 000

Re-apportionment of auxiliary services, 020, back into the other main cost centres 000, 310/320, 500, 110 and 010. Method and reasons for re-apportionment:

020(a) apportioned back into 000, 320, 500 in approximate proportion to truck activity (i.e. labour)
1:2:1 or = 6200:13000:6200.

020(b) apportioned back into 320, 500 in approximate proportion to cubic capacities i.e. 3:1 or = 3000:1000

Main cost centre	Re-apportionment of 020	Total corrected volumes, cu ft	Grand total volume, cu ft
000	6200	109 400	
310/320	13 000 + 3000	471 000	
500	6 200 + 1000	154 200	
110			1 009 000
010		274 300	

*Only ground floor racks used for order-picking.

Date: August 1968

COMPANY 9

Equipment

- 017 **Gantry Crane** for loading 'containers' on to vehicles 1963, £6100; current equivalent price £6965. Maintenance and power usage small and not measured.
- 002 **3 hand pallet trucks**
Current equivalent price $3 \times 105 = £315$
- 320/500 **Racking**
1963, £8740; current equivalent price £9980.
Apportioned between bulk store 320 and order picking activity as a function of volume, since order picking occupies lower two shelf levels of 5 in the racking system or 0·3226 of cost apportioned to 500 (order-picking).
- 502/342 **Trailers** (90 stillages and 16 skid jacks) to collect and take order-picked goods to loading. Total current equivalent price £1130.
Apportioned 10 :1. in proportion to the time they spend in the two sub cost centres. Maintenance negligible.
- 320/500/022 **Wooden pallets** (40" × 48") Total number in use 3250. @ £1·3 each = £4200.
Treated as annual expense for tax purposes, but expected life = 5 years therefore average annual expense £840 and apportioned in ratio of number of pallets in cost centres :

000 }	Negligible – moving through
100 }	
320 }	1965
500 }	935
020 }	350

Pallet maintenance carried out by goods inwards warehousemen in their slack time. Materials £15 p.a. Labour 40 hours/year. These small amounts have been included in direct labour costs.

COMPANY 9

Fork lift trucks

- August 64 3 Conveyancer electric fork lift trucks Type E4RS4 £2500 each, including batteries. (4500 lb at 20")
3 charger units £640. Delivery £28
2 battery charging platforms £28 each
1 spare battery £330.
- August 66 1 similar fork lift truck £2840, including battery
1 charger unit £213. Delivery £17
1 battery charging platform £30.
- After August 66 1 battery replacement £340.

Overall expenses apportioned in proportion to estimated fork lift truck activity in sub cost centres 004, 304 and 324

Maintenance

- 403 Internal labour 6 hours/week at $1\frac{1}{4}$ times (11/5d per hour)
Carried out by 2 fitters = £170 p.a.
- 404 Materials (spares). internal. Negligible
- 405/406 Labour/Materials by outside Firm(s)

Aug. 64 – Dec. 64	None	Average £780
Jan. 65 – Dec. 65	£240	
Jan. 66 – Dec. 66	£430	
Jan. 67 – Dec. 67	£950	

Jan. 68 – June 68 £1500 includes two major overhauls at £500 each. These figures do not include battery maintenance and battery replacement expenses which are capitalised.
No separate data available for 407 Power, taken as 10s per week per truck.
- 408 Batteries expense, based on average life of 4 years.
- 409 Tyre replacements based on £128 p.a. but subsequently found to be £60 p.a.

COMPANY 9

Cost of documents 205/305

Average 51 'packages' per set of documents (GRA's)

1000 sets of documents per week @ 23/2d per 1000 pallet cards

Average annual cost = £60

Miscellaneous wrapping

Approx. 200 out of 1400 lines are too small to be sent out without wrapping or are pilferable.

Cost per 'package' = 4½d (one secondhand carton) × 2500 cartons p.a. = £47.

Published by

HER MAJESTY'S STATIONERY OFFICE

To be purchased from

49 High Holborn, London WC1V 6HB

13a Castle Street, Edinburgh EH2 3AR

109 St Mary Street, Cardiff CF1 1JW

Brazennose Street, Manchester M60 8AS

50 Fairfax Street, Bristol BS1 3DE

258 Broad Street, Birmingham B1 2HE

80 Chichester Street, Belfast BT1 4JY

or through booksellers