INFORMATION FLOW IN HOUSE BUILDING ORGANISATIONS

by

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SUMMARY

This research describes an investigation into the information flows within the technical and commercial functions of house building organisations. It was initiated because of the evidence of poor data transfer and communications within the construction industry as identified by previous research. Little previous research had addressed the particular problems of the house building industry which accounts for up to a third of total new construction output in the UK. The organisational and information structures of six house building companies were examined and a typical organisational model developed. This model highlighted the importance of the technical and commercial functions of estimating, purchasing, valuations and cost monitoring/comparisons and the need for effective transfer of information between them.

The information flows between these functions were studied and modelled using systems analysis techniques of data flow diagrams and entity-relationships models.

The requirements for a computer-aided management system to improve and rationalise the information flows were identified and an integrated system, known as DEVELOP, was developed.

The system was installed into a collaborating company and its advantages and disadvantages monitored over time.

The main outcomes of the research are:

(a) an organisational model for a typical house building organisation;

(b) data flow and entity-relationship models for the functions of estimating, purchasing, valuations and cost monitoring/comparisons; and

(c) an operational integrated management system for house builders that provides:

  (i) faster throughput of information (for example the time required to aggregated dwelling quantities for a typical development is reduced from three man days to one hour);

(ii) greater consistency of information (by the provision of a company data library); and

(iii) better communications between the functions (due to the integrated nature of the system and the adoption of a common coding system).

CERTIFICATE OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in the acknowledgements or in footnotes and that neither the thesis nor the original work contained therein has been submitted to this or any other institution for a higher degree.

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CHAPTER 1

1. INTRODUCTION

1.1 Background.

1.1.1 *Information flow in construction companies*

The effective management of construction relies upon the manager receiving accurate, timely and relevant information on which to base decisions (Tenah,1986). This information is provided by the company's communication systems at personal, departmental and organisational levels (Guevara and Boyer,1981).

Munday (1979) presented data showing that construction managers spend almost 50% of their working time on tasks devoted exclusively to the transmission of information and suggested that the flow of information is particularly important to construction companies due to the unique nature of each project. Despite this, the communication systems within construction companies are often poorly defined and the double-handling of data is common-place. The same information, in different guises, may be created or captured many times by several separate departments (Ndekugri and McCaffer,1988). This can be due to departments being insular and unaware of the data available in other departments, but more usually results from a mistrust of data which they have not created or captured themselves, or the fact that the data may not be in the form which they can readily use (Ogunlana and Thorpe,1987).

These problems of information sharing and communication within the U.K. construction industry were originally highlighted in a number of reports in the early 1960's (Emmerson,1962; Banwell Committee,1964; Higgin and Jessop,1965) and have received considerable attention since (see Chapter 2). Similar problems have also been reported in the United States (Business Roundtable,1982; Ibbs,1985).

Whilst studies of information flow have been undertaken in general building and civil engineering contractors (for example McCaffer and Pasquire,1987; Ndekugri and McCaffer,1988) there is no evidence of similar work in house building organisations.

Work undertaken as part of this research highlighted the dynamic nature of house building projects. These rely heavily on market information from inception to completion. Even during the construction phase of a development projects are frequently re-planned and recosted in the light of feedback from the sales staff as to which house types are selling and the prevailing demand. Thus a house building company needs:

i) an efficient information and communication system; and
ii) the ability to quickly revise and recost developments to produce more financially attractive schemes.

This is in contrast to normal contracting where the final product is clearly defined and specified at the tender (costing) stage and variations from this are kept to a minimum.

Hence there is a need to study information requirements and flows within house building companies to complement the existing work. This research provides part of that study.

1.1.2 *The house building Industry*

The joint forecasting committee for the construction industries of the National Economic Development office divides Construction output into three broad categories (NEDO,1990):

housing;
non-housing; and
repair and maintenance.

These are further sub-divided as follows:

housing divides into public and private;
non-housing divides into other public, private industrial and private commercial; and
repair and maintenance is not sub-divided.

It is difficult to differentiate between the volumes of work undertaken by civil engineering and building contractors because of the format in which

these statistics are gathered and reported. In contrast the volume of work undertaken by house builders is easier to identify.

In 1989 the output for both public and private housing (at 1985 prices) was £5073 million (NEDO,1990). This represented 26% of all new construction work and in 1988 this figure was 33%. Thus house building is a major element in the U.K. construction industry. It is also a very volatile sector and changes in interest rates, wage rates, rates of inflation, taxation and the subsequent changes to mortgage payments have dramatic effects on consumer demand (Stokdyk,1990) and hence on supply.

Fig 1.1 shows the growth of the housing sector from £3000 million in 1981 to £5500 million in 1988. This buoyant market attracted general contractors (both civil engineering and building) to compete with the established house-builders/developers. In the 1986 edition of "Investment in construction" (Green and Co., 1986) nine of the top ten most profitable construction companies, as measured by pretax profit/turnover, were either specialist house-builders or had a strong house-building content.

This resulted in the former largest house-builders being ousted in volume production terms by large general contractors. For example Tarmac completed 11,200 homes in 1990 compared to 5,800 by the largest specialist house-builder Barratt Developments (Cooper, 1991). This migration between various sectors of the industry by general contracting companies, according to demand, has previously been identified and described by McCaffer, McCaffrey and Thorpe (1981), whilst Hillebrandt and Cannon (1990) report civil engineering contractors made "strenuous attempts" to replace infrastructure work with privately funded projects and house building in the mid 1980's.

Whilst changing sectors is a viable option for large general contractors the opportunities for specialist house builders are limited. Hence house builders require efficient and effective management systems to remain competitive and profitable.

The end of the growth in the housing market was marked in July 1988 by the removal of dual tax relief on mortgages. This move had been announced by the then Chancellor of the Exchequer in April of the same year which

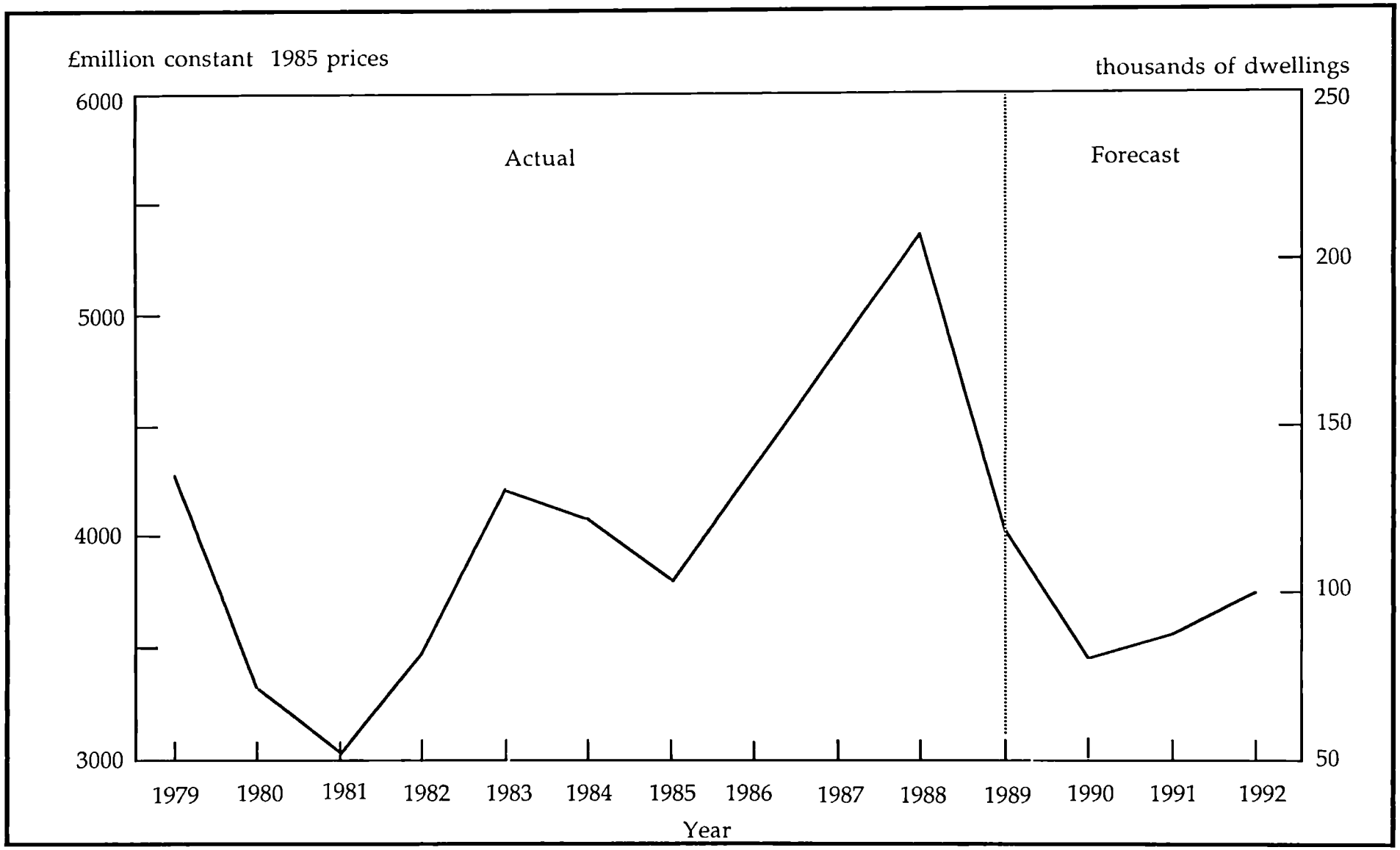

Fig. 1.1 Private housing output

produced a "panic-buying" boom, inflating volume output, land prices and hence new house prices. The removal of dual tax relief together with rising interest rates and the worsening general economic situation, precipitated a recession in house building with 1990 being called "the worst year for private housebuilding in 50 years" (Building, 1991a).

This has forced many specialist house builders into receivership and general contractors have drastically reduced their house building operations (Building,1991b).

The changing fortunes of housebuilders over the last 3 years is clearly shown in the following extracts from the Business news section of Building magazine:

"Persimmon, the Yorkshire-based house builder, last week reported a 132% rise in pre-tax profit" (10th March 1989);

"CALA, reported a 134% rise in pre-tax profit to £3.6m last week" (10th March 1989);

"Barratt last week reported an 81% hike in profits to £32.5m for the half year to the end of December" (31st March 1989);

"Tarmac became the first housebuilder to make profits greater than £100m in 1987. But 1988 was twice as good with housebuilding contributing £209m to a 48% boost in group profits to £393m" (28th April 1989);

"West Midland housebuilder Bryant saw profits dive from £14.7m to £9.3m in the six months to the end of November" (15th February 1991);

"Crest Nicholson, the Surrey housebuilder suffered a profits collapse from £37.1m to £8.1m in the year to October 1990" (22nd February 1991);

"Alfred McAlpine has started a withdrawal from housebuilding in the London region after disastrous losses in its homes division caused annual group profits to slump by more than 60%. A drop from £18.6m profit to a £1.9m loss in the housebuilding division is the main cause of the nosedive in the overall group profit" (1st March 1991);

"John Laing's homes division profits plunged from £33.3m to £5.8m in 1990" (5th April 1991); and

"In the year to the end of February, Westbury saw a profit of £28.1m turn to a loss of £8.1m" (May 1991).

Specialist housebuilders need efficient and effective management to survive these "boom or bust" fluctuation in the housebuilding market and to resist competition from general contractors. This management is fuelled by information on land availability, land prices, market demand, local structure plans, dwelling build costs, selling prices, work in hand and a mass of other technical and commercial information. It is this information, and the decisions that are taken because of it, that provide the company with its "competitive advantage" (Porter and Millar, 1985) and which determines the success or otherwise of the company. The information is gathered and distributed within the company by the corporate information and communication systems which are thus vitally important to the well being of the company (Tenah,1986; Guevara and Boyer,1981).

1.1.3 *The use of computers*

The use of computers in construction has risen steadily since the introduction of small, cheap micro computers (Howard,1989). The scale and use of computers in the various sectors of the construction industry have been well documented by the Construction Industry Computing Association (CICA,1987; CICA,1990), and others (for example Sidwell and Cole,1986; Atkin,1990). This increase in use has corresponded with the relative drop in hardware prices and the increasing number of software packages available. However due to the diversity and complexity of construction work many software products have found few if any users, the products too often being unsuitable for the company, the application or both. Thus the use of computers in construction still lags behind other industries (Crow,1990).

Software products which have found a reasonable market have tended to be large, generalised single function packages. Examples of this type would be network planning packages or estimating packages which are 'stand-alone' (ie. they do not receive or pass-on data to other systems) and which

encompass many of, if not all, the desirable features for their particular purpose and thus will satisfy personnel in many different companies. Even these packages may require modifying or ' tailoring' to suit individual modes of practice.

Limited integration of packages across functions has been achieved in some instances but total integration remains an unrealised goal for most companies although the benefits of integration are recognised. Howard et al (1990) for example, suggest integration can offer significant levels of improvement in productivity, quality and overall efficiency whilst Baxendale (1990) proposes the more modest benefits of better utilisation and consistency of information.

The house building industry has received little attention from software developers (Ewin, Oxley and Poole,1990). At a conference entitled "Get your House-Building Systemised" in January 1990 (CIOB,1990), concern was voiced by the delegates as to the dearth of available systems specifically designed for house building organisations. Three systems were identified which did satisfy some of the house builders requirements. These were:

Gamma 2000 (Redland Software);
BRICS (Sydney Ltd); and
Homemanager (PCL Ltd).

Subsequently the latter two systems were withdrawn from the market. BRICS due to a change in management strategy by its owners David Wilson Homes; and Homemanager due to PCL withdrawing from the construction software market.

Thus most house builders have had to design and develop their own management systems in-house, relying on their own skills or employing outside software houses or consultants.

1.1.4 *The Hypothesis*

The hypothesis of this research is that more efficient management of house builders organisations is achievable by streamlining and integrating the information flows between the various management functions.

This gain in efficiency would evident in terms of :

i) faster throughput and use of information;

ii) greater consistency of information between the functions; and

iii) the establishment of more structured communications between the functional departments.

The obvious method of streamlining and integrating data transfer between the various departments is by means of a computerised or computer-aided system. The development of such a system requires a study of the information flows within house building organisations identifying the source, use and destination of the data in addition to a study of the organisation itself.

The developed system should be able to provide management with relevant, accurate and timely information on which to base corporate decisions thus providing the opportunity for efficient and effective management necessary for surviving the volatile housing market.

1.2 Objectives

Against this background the objectives of this research are:

i) to examine the organisational structure of house-building companies to identify the key technical and commercial functions;

ii) to examine and model the flow of information between these functions identifying where data is captured, stored, used and shared within the system;

iii) to develop, in conjunction with a co-operating house-builder, a computer-aided management information system to improve the flow of management information; and

iv) to install the system and monitor over time the advantages and disadvantages offered by it over existing manual systems.

1.3 Methodology and Work Undertaken

The work undertaken to meet the requirements of the objectives outlined in section 1.2 is described below:

i) A number of house building firms were contacted and one agreed to collaborate with the research and to act as the reference site for the modelling and system development phases.

ii) A literature review of previous similar works was undertaken. This revealed very little work relating specifically to house builders. Considerable research in the areas of construction information flows and the development and use of computer systems in construction had however been reported. A total of 16 research reports and papers were reviewed to provide the framework for this research. In particular data flow and logical data models were identified from the literature review as useful and viable techniques in describing and modelling an organisation's information flows.

iii) Six house building companies (the collaborating company and five others) were contacted and their methods of operation and organisational structures studied. These studies took the form of personal interviews with senior management in the companies and discussions with department heads such as the chief estimator or chief buyer. This enabled comparisons to be drawn between organisations and methods of working and a typical organisational structure was developed.

iv) The organisational structure highlighted the importance of the technical and commercial functions of estimating, purchasing, valuations and cost monitoring/comparisons and their interdependence. Data was gathered from the collaborating company and data flow and logical data models constructed to examine the exchange and use of data by these functions.

v) The requirements of a computer-aided management system for the functions of estimating, purchasing, valuations and cost monitoring/comparisons were identified and agreed with the staff of the collaborating company.

vi) An integrated system, known as DEVELOP, was designed and developed to meet the requirements outlined in v) above. This was written in FORTRAN on a micro computer and comprised 64 linked programs including approximately 125,000 lines of code. A user manual was also produced.

vii) The system was installed into the collaborating company and the company staff trained in its operation. This involved running training courses and also providing one to one tuition on the workings of the system.

viii) Finally the advantages and disadvantages of the system were monitored over a six month maintenance period. This was achieved by holding discussions with the personnel involved and by recording the changes in working practices that the system brought about.

1.4 Achievements and findings

The major achievements and findings of this research are:

the production of a typical organisation structure for housebuilding organisations;

the development and implementation of the DEVELOP house builders management system; and

an improved and accelerated flow of management information within a house building company.

1.4.1 *Study of organisations*

Six house building companies were studied and a typical organisational structure was produced for the purposes of examining the flow of information between the various departments.

The typical organisational structure was constructed using guidelines produced by Arthur Anderson and Co (Arthur Anderson,1985). This divides the activities and departments into a matrix as shown in fig 1.2. The full organisational structure produced is presented and described in Chapter 3.

A study of all data flows within an organisation was not feasible within the time scale of this research and so the research focussed on the flows at the processing level of the technical and commercial functions.

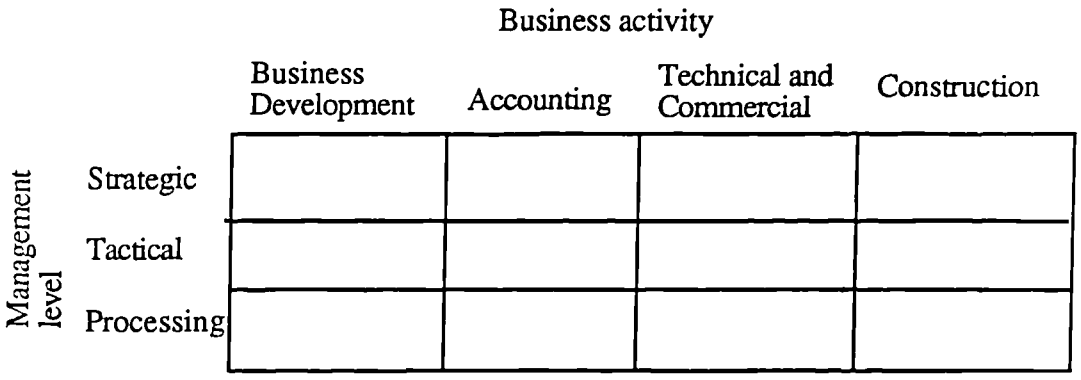

Fig. 1.2 Matrix template for house-building organisations (after Arthur Anderson and Co)

These were estimating, purchasing, valuations and cost monitoring/comparisons. These functions were chosen as the development of the organisational schematic had highlighted their interdependence and in particular their reliance on data supplied by the estimating function. Previous research in general contracting companies by McCaffer and Baldwin (1986) and Marchant (1987) had also identified the estimating function as a major source of management information for the company.

These functions are briefly described below:

i) *Estimating*

Just as in general contracting each housing project must be priced and a "tender figure" or cost budget calculated for consideration by the client or the developer. This occurs even if the 'client' is an associated company or

even a different division of the same company (as in the case of a developer/building company). This budget figure must be produced quickly, accurately and competitively and this responsibility lies with the house builder's estimating staff.

ii) *Purchasing*

Once the budget has been agreed by the house builder and developer the materials and labour can be ordered. Sub-contract labour is predominantly used by house building companies and direct labour is usually confined to site managers (agents, foreman etc.).
Before placing any orders the buyer must determine:

a) the material and labour content of the works;
b) the availability of materials, labour or suitable alternatives;
c) the staging of the work;
d) the amount of storage on site; and
e) any wastage assumptions and conditions imposed by the site.

iii) *Valuations*

The valuations function was not well developed in the companies studied due to them being developer/builders. However in the companies which had divided the development and building activities the method of payment to the builder by the developer once the contract was underway was by means of monthly valuations. This involves a site inspection each month by the builder's surveyor who measures and records the progress of the work under predefined cost categories. These progress figures are compared with the previous months certificate to determine the amount of work completed that month. By referencing the cost categories to items of work in the original estimate, rates for the cost categories are produced and the value of the months work on site calculated. This provides both a cost and progress monitoring system.

iv) *Cost Monitoring/Comparisons*

At the end of a project and frequently during its duration a cost comparison analysis will be undertaken by the building company's senior management. The benefits of this are:

a) to highlight the parts of the project which made or lost money; and
b) to check the accuracy of the estimate/estimating data.

For a project which has produced the expected profit this exercise may be quite brief. However on a project which has only 'broken-even' or made a loss then the cost comparison analysis will be more detailed and involves comparing the estimated price for each item with the actual cost of that item to the builder. Usually the amount of data is such that only the major cost significant items are compared.

The study of these functions enabled two forms of data model to be produced for each function:

data flow models which illustrate the physical flow of data through a process; and logical data models which are used to identify the data elements into 3 categories (entities, attributes or relationships).

These models were used to identify and document the data flows and as the basis for designing the computer-aided system DEVELOP.

1.4.2 *The DEVELOP system*

The requirements for a computer based management system for house builders were defined from a study of existing manual systems within the collaborating company and from examination of the data models.

The system, named DEVELOP, was developed on a micro computer and installed into the collaborating company. The main features of the system are:

the ability to create, store and amend a library of company standard data which forms the basis for all new projects. This data includes standard

house details, lists of suppliers and subcontractors, standard specifications, standard dwelling items, valuation centres, addendum dwelling details and phase (or project) details; and

sub-systems for the functions of estimating, purchasing, valuations and cost monitoring/comparisons. The facilities offered by these sub-systems include the calculation of phase (or project) budgets on a plot by plot basis; the creation and maintenance of the buyers records; the calculation of monthly interim valuations; and the production of cost/value reconciliations.

DEVELOP was installed into the collaborating company and company personnel were trained to use it.

1.4.3 *Improved information flow*

The development of the computer-based system, DEVELOP, provided the collaborating company with the opportunity to rationalise and formalise the flows of information between its technical and commercial functions.

This, together with the speed and flexibility offered by the computer system, enabled the information flows to be accelerated and improved and the information to be presented in a consistent and uniform style.

Specific improvements included:

- the creation of a library of company standard data enabling quick and easy access for all the functional staff;

- a decrease in the time taken in aggregating costs and quantities for developments saving approximately 5 man days for a typical 30 dwelling development;

- the ability to quickly change unit rates, overheads or dwelling details to achieve a target budget figure or to redesign a phase in response to marketing information;

- a faster and more uniform method of producing monthly valuations saving approximately half a man day for a typical 30 dwelling phase;

and

- more detailed cost comparisons than were previously possible providing better information for management control.

1.5 Guide to the thesis

This thesis is structured as follows:

Chapter 2 contains a review of previous research work in the areas of:

i) Organisation and Communication in the construction industry;
ii) Information flow and data co-ordination in the construction industry; and
iii) The impact and use of integrated management systems for the construction industry.

Chapter 3 describes a typical organisational structure for a house building organisation developed from interviews with six house building companies. Data flow and logical data models are developed for the technical and commercial functions of estimating, purchasing, valuations, and cost monitoring/comparison. Chapter 4 presents the system requirements for an integrated system to fulfil the needs outlined in Chapter 3.

Chapter 5 describes the development and main features of the software, its implementation and the staff training undertaken.

Chapter 6 presents the findings of the system in use - its benefits and shortcomings.

Chapter 7 summarises the conclusions of the research and suggests areas of further work.

A pictorial representation of the thesis is contained in fig 1.3.

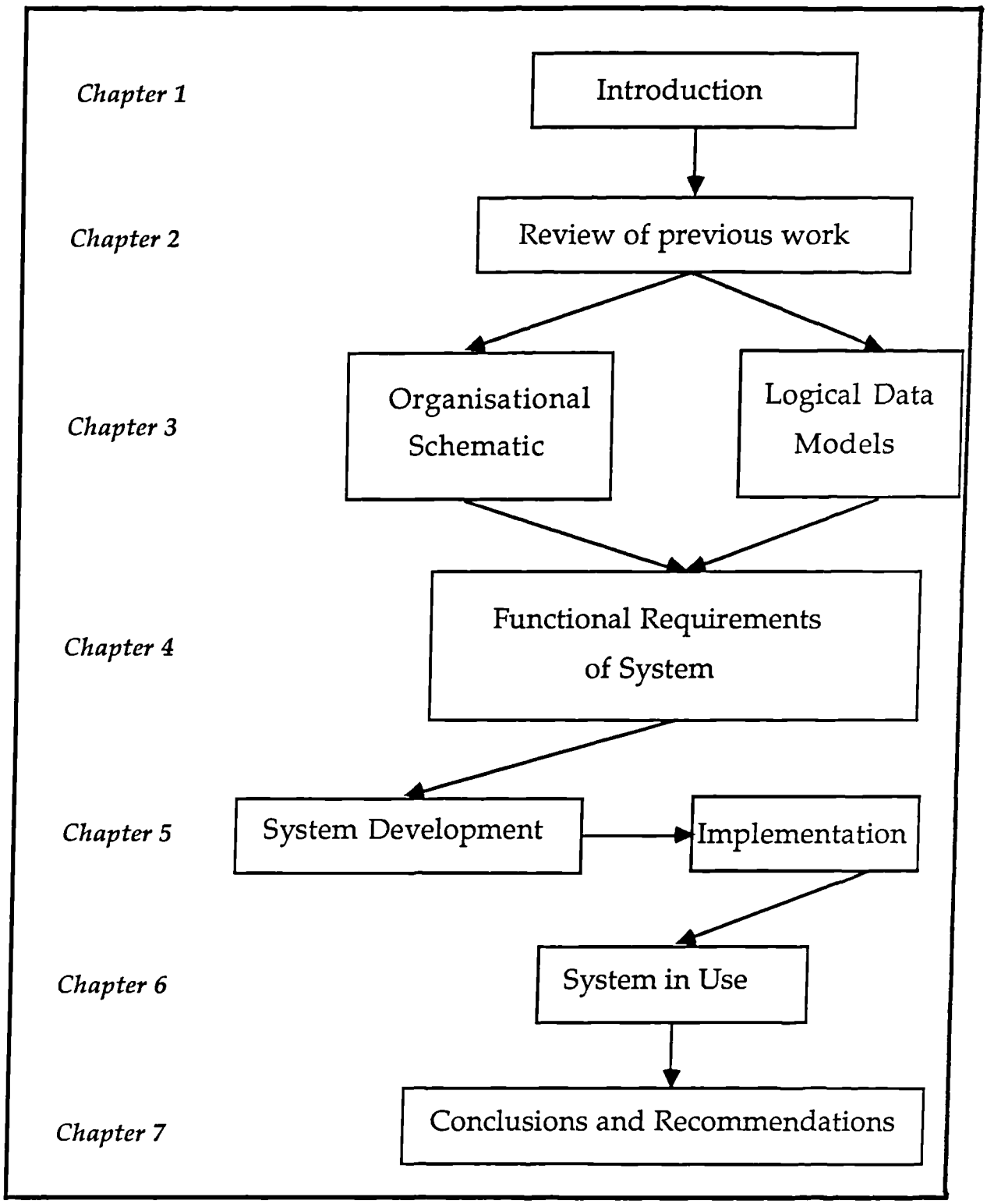

Fig. 1.3 Thesis layout

CHAPTER 2

2. REVIEW OF PREVIOUS WORK

2.1 Introduction

This chapter summarises the findings of 16 research reports and papers which addressed problems germane to the objectives of this project although only one directly addresses house building. The summaries are arranged in three sections:

i) Organisation and Communication in the construction industry;
ii) Information flow and data co-ordination in the construction industry; and
iii) The impact and use of integrated management systems within the construction industry.

2.2 Organisation and Communication in the construction industry

2.2.1 *Higgin and Jessop (1965) : The Tavistock Report*

The Tavistock Institute of Human Relations was commissioned in the early 1960's by the National Joint Consultative Committee for Architects, Quantity Surveyors and Builders to undertake a study of the organisational structure and communication processes of the Building Industry. A report of this study was published in 1965 by Higgin and Jessop entitled "Communications in the Building Industry". Although the study was completed in only 3 months over twenty-five years ago it is still a relevant document today mainly due to the lack of comparable studies in the intervening period.

The study was primarily concerned with macro level communications (ie. interprofessional) rather than micro level (ie. interfunctional). It was initiated because of dissatisfaction with the existing systems of communication between the members of the building team namely the Client, Architect, Quantity Surveyor, and Builder and in particular the apparent inappropriateness of the Bill of Quantities as the main medium of contract communication. These disatisfactions are still present today despite

numerous attempts to introduce more informative documents such as Operational Bills (Skoyles,1965; Skoyles,1968; Bishop,1966) or the more recently tried BPF system (British Property Federation,1983; Pasquire and Tyler,1987).

The Tavistock report split the building process into 8 distinct phases and examined the communication processes within and between each phase. The phases are:

Phase 0	Client decides to build;
Phase 1	Client consulting building team sponsor;
Phase 2	Sponsor investigating and preparing brief;
Phase 3	Preparing and gaining clients acceptance for sketch plans. Obtaining outline approval;
Phase 4	Preparing contract documents. Obtaining final approvals;
Phase 5	Preparing and agreeing contract. Setting up construction team;
Phase 6	Construct to completion; and
Phase 7	Handing over and settling final account.

The communications used by the various parties were examined during the 8 phases for various contracts.

The study distinguished formal and informal communication:

formal included written communications;
informal included unrecorded oral communications.

The researchers who were not building professionals identified the need for continuous intercommunication between the members and noted the conflict of interests between them. Similar recent studies (Guevara and Boyer,1981; Day, Faulkner and Happold, 1986) have revealed the same needs and conflicts.

The development of the principal formal communication medium the bill of quantities (together with drawings, specifications, conditions of contract etc.) was examined and the researchers observed that the bill was of limited use for a contractor in planning or controlling the construction phase. This

was later confirmed in a separate study by Skinner (1979) who undertook a detailed examination of the role of bills in the management of building contracts. This prompted the study team to suggest a further investigation of inter departmental or intercompany communications but sadly this was not undertaken.

The study also examined the roles and relationships in the building team and conducted a survey of attitudes to other members in the same team. This section of the study was later repeated by researchers from Bath University (Day, Faulkner and Happold,1986) and is reported in Section 2.3.3.

The Tavistock study presented 5 problems of communication within the building team. The most relevant of these for the purposes of this research is that:

"Control of Construction requires:

a) effective communication within the construction team; and
b) effective communication between the construction team and others"

The report concludes:

"On many occasions members of the construction team could, but do not, ease this problem (of insufficient information) by supplying the data that would facilitate the preparation of fuller and more useful information by others."

The Tavistock study concentrated on macro level (ie. inter professional) communications. Other researchers (Ndekugri and McCaffer,1988; McCaffer and Pasquire, 1987) examining communications and information flows at a micro (ie intercompany) level have reported similar problems of insufficient and ad-hoc flows of information. Without a structured communication system the scope of efficient management is reduced to those areas where the relationships of departmental personnel allow adequate communications to occur. From observations made during this research these findings are also true with regard to house building companies (see chapter 3) although no previous work has been reported.

2.2.2 *Guevara and Boyer(1981): Communication problems within construction*

Guevara and Boyer (1981) presented the findings from a study of communications within construction companies. This extended the earlier work of Guevara (1979).

The authors examined the causes of poor communication, specifically the problems of:
distortion (the partial corruption of information);
gatekeeping (the withholding of information);
overload (the supply of too much information); and
underload (the supply of too little information).

It was found that when overload exists there is not enough feedback or face to face communications or interactions between staff. Gatekeeping, the intentional withholding of information occurs when there is insufficient feedback or staff are not satisfied with communication flow or both. Distortion occurs when there is inadequate feedback, insufficient interaction and underload. The authors stress the need for further work in the areas of information transfer and communication and note that "power, leadership and decision-making rely on the communication process, either explicitly or implicitly, since these processes would be meaningless in the absence of adequate information flow".

The authors conclude that to function efficiently a construction company must have communication systems of different types: inter-personal, inter-departmental, inter-organisational and that communication systems are the vehicle by which construction personnel co-ordinate their efforts and skills towards a common goal in an integrated and orderly way.

These findings are unsurprising, and it could be argued that the communication systems required by construction companies, and the problems associated with these systems are little different from other industries. However the authors emphasize that effective and efficient management, of construction in particular, requires adequate flows of information. The authors did not explicitly demonstrate changes in

managerial efficiency by varying communication levels and hence this argument remains a proposition.

2.2.3 *Tenah (1986): Construction Personnel role and information Needs*

Tenah, building on the earlier work of Guarara and Boyer (1981), states that a manager can not manage efficiently without proper information on which to base decisions. He maintains that in the construction industry there is a severe lack of information regarding functions, responsibilities and information needs of construction personnel which hampers the understanding of the management processes.

He presents the finding of a survey of 16 construction companies, all based in Texas, in which the functions and responsibilities of key construction personnel, their information needs and reporting structures were studied.

26 levels of key personnel were identified. These are:

1. Board of Directors and Chairman
2. President
3. Vice-president: operations
4. Vice-president: finance
5. Vice-president: administration
6. Procurement director
7. Chief Accountant
8. Operations manager
9. Chief Estimator
10. Divisional Engineer
11. Procurement manager
12. Construction manager
13. Labour relations manager
14. Project manager
15. Resident project manager
16. Assistant Estimator
17. Planning engineer
18. Cost engineer
19. Estimator
20. Purchaser
21. Accountant
22. Safety engineer
23. Field office engineer
24. General superintendent
25. Superintendent
26. Foreman.

The primary functions and primary information needs of each of these 26 categories was examined and described. This work is not reported in detail here but is similar to the analysis undertaken in section 3.2.3 of this thesis.

Tenah's survey showed that:

i) management functions and responsibilities are inextricably linked to information needs;

ii) each manager or supervisor cannot perform his or her functions efficiently without accurate, timely and relevant information on which to base decisions; and

iii) given appropriate information managers are likely to make decisions that:

- reduce or maintain project durations;
- make better use of resources;
- increase productivity; and
- decrease cost.

Tenah also observed that construction companies seldom change information systems after undergoing changes in the organisation and that some construction companies buy "packaged" information systems without studying the information needs of the personnel. He concludes that both these approaches are incorrect and that only by studying organisational structures, personnel roles and information needs can efficient information systems be adopted.

Tenah's work is important because it identified in detail the typical individual personnel roles or functions within, albeit, U.S. construction companies and briefly described their information needs. This work indicated the need for a clear understanding of the organisational structure within house building companies as reported in chapter 3, in order to develop an appropriate information system.

2.3 Information flow and data co-ordination in the construction industry.

2.3.1 *Bishop and Allsop(1969): A study of coding and Data Co-ordination for the Construction Industry*

In May 1966 the then Minister of Public Building and Works set up a committee on the Application of Computers in the Construction Industry. Its brief was to foster the effective use of computers in the industry and in particular to improve communications and facilitate access to data on

materials, products, commodities, regulations, standards, costs etc. This committee decided that in order to achieve its objectives, a system of coding and data co-ordination was required suitable for the industry as a whole. This aspect was entrusted to the Building Research Station who produced their report in December 1968.

The study examined the data flow between functions within various construction organisations, the object being to formulate a set of rules governing data in general, rather than in any one particular sector of the industry.

The outcome of the study was a proposed framework for an industry wide information system.

The proposed framework was to comprise :

i) A preferred vocabulary that would consist of the descriptors used in other parts of the framework;

ii) Classification categories to allow information to be filed, retrieved and sorted in ways useful to the industry. The following categories were recommended:

Building Type;
Functional Space and system;
Building Element;
Technical Solution;
Commodity;
Construction method;
Work Section;
Work Element;
Operative occupation;
Plant and equipment;
Conventions for feedback; and
Performance data, for procedures and production information.

iii) A central commodity file in which information about materials, products and components would be systematically made available;

iv) Procedures for formalising many of the functions performed in the building process as a prelude to the wider use of computers; and

v) Codes to make the transmission of information more reliable and more economical.

The study is important in terms of developing a new approach to the classification of construction project data and by recognising the fact that a framework of classification systems is necessary as a precursor to system development. However what the work failed to do was to show how different classifications might be interrelated to allow appropriate information to be shared by a number of users as is required in an integrated approach.

The major achievement of the report was the sitting up of the Co-ordinating Committee for Project Information (CCPI) which has had direct influence in the development of a set of conventions which give comprehensive guidance on the preparation of co-ordinated project documents.

Unfortunately although many of the recommendations made in the report were sound, the fragmented nature of the industry has meant that they have never been realised. Indeed it is only in the last 5 years that the computing technology has been available on an affordable scale to make them possible.

A re-appraisal of this work was made by one of the original team, Bishop, in 1984 and this is presented in the next section.

2.3.2 *Bishop (1984) : Information needs and data co-ordination : a reappraisal*

Bishop undertook a reappraisal of the work described in section 2.3.1 in 1984. Having described the background and aims of the study he considered its impact on the industry, its outcomes and its relevance.

He reports that the study was over-optimistic about the pace of development of computer applications in the industry. The report was intended to act as a template to allow computer applications to proceed in an orderly and structured manner. This was confidently expected to have the incidental effect of removing barriers between the various professional parties within

construction thus aiding and improving communications. However Bishop reports that this has not occurred and progress has been slow in developing alternative contractual relationships.

The area where most progress has been made is the work of the Co-ordinating Committee for project information (CCPI) which has produced the definitive guides on co-ordinated project information (CCPI,1987) and SMM7 (RICS,1988). Bishop concedes that this was achieved by largely ignoring the influence of computers. He concludes by stating that much of the framework then devised is still valid and the priorities (as identified in 2.3.1) are also still valid. Whilst Bishop maintains that the framework and priorities of the original study are still valid, the need for an industry-wide coding system has been eliminated by the proliferation of small, cheap, single activity systems which are now widely available. Recently, renewed interest has been shown in common coding systems with the advent of EDI (Electronic Data Interchange) and the development of standard product (or STEP) models.

2.3.3 *Day, Faulkner and Happold (1986) : Communications and Computers in the Building Industry*

Day, Faulkner and Happold of Bath School of Architecture and Building Engineering undertook a study in 1986 which set out to repeat and update some of the work of Higgin and Jessop in the light of increasing use of new technology (ie. computers) by the members of "the building team".

In particular they studied the impact of CAD systems by architects on the interprofessional communication processes. This was done partly by a series of case studies of live building projects where there had been a significant use of new technology and partly through conducting a survey into the pattern of relationships in the building team. As with Higgin and Jessop the main focus of the work was the effect new technology was having on relationships between different organisations. Also investigated were the ways in which new technology was being used, and the problems arising in individual organisations. The main findings relating to this work were:

i) the attitudes of the main building team occupations towards each other have changed little since the study of Higgin and Jessop;

ii) the use of in-house computer systems affects the timing, quality, quantity and content of information transferred between organisations. This can lead to "binding" of information around target programme dates and a sporadic information flow;

iii) the effect of computer-aided techniques on relationships between members of the building team depends upon project characteristics such as complexity, uncertainty and constraints on time and cost. Where these factors are important the impact of the computer on communication is secondary to the impact of contractural and organisational influences;

iv) the volume and frequency of communication between team members was found to increase and improve due to a number of factors. The most important of these were the completeness of the building design, the level of clients involvement and participants familiarity with each others working methods;

v) introduction or development of a new computer-assisted system was seen as much a question of skill level, staffing and organisation as of technical innovation. It was stated that software design and organisational design should be considered as "two sides of the same coin"; and

vi) finally the report concluded that the major advantages of new technology currently perceived by practitioners in the industry lie in the in-house processes of information production, rather than in its communication amongst other members of the building team.

The report showed that despite the increased communication potential offered by computer systems, it is within organisations rather then between organisations that this potential can fully be realised. Communication between different organisations still depends on organisational and contractual influences.

The report suffers form a lack of quantitative or case study data which supports these findings. In spite of this the report once again highlights the links between communication and organisational structure.

2.3.4. *McCaffer and Pasquire (1987): The Interchange and Use of Data by Contractors Management Functions*

This paper reports on an investigation into the use of data in building contractors organisations. The authors identify the data interfaces between the management functions and establish which data is used in its original form, which data is amended to suit the task to be undertaken which is ignored altogether, whether there is any repetition of the data generated and the extent to which new data is created by each of the management functions.

This work formed part of a larger project studying the management rules for contracts without bills of quantities which was reported separately by Pasquire and Tyler (1987).

Three case studies were undertaken within medium to large contracting organisations. These organisations were studied over a period of 12 months and the tasks performed by each management function recorded. This aspect of the work is similar to that of Tenah(1986) reported in section 2.2.3.

The data used to perform these tasks and its source was also recorded.

The standardised list of tasks performed by each management function is reproduced in table 2.1.

The data used by each of the management functions in support of these tasks is then described in terms of :

data received;
data generated, regenerated or transformed;
data passed on; and
data not used.

Table 2.1 Standardised Management Function Tasks
(Source: McCaffer and Pasquire)

	Task performed	Management function
(1)	Measure the quantities for tender purposes (i) to supplement quantitative tender documentation; (ii) to provide quantitiative data where none supplied by client, e.g. design/construct specification/drawing tenders	
(2)	Obtain quotes from sub-contractors	Estimating
(3)	Price the quantities to produce the tender	
(4)	Price preliminary items, PC and provisional sums	
(5)	Assess percentage addition for profit and overhead	
(6)	Schedule the materials for ordering	
(7)	Place sub-contract orders	Purchasing
(8)	Order materials in line with programme	
(9)	Compile time-based programme for the works	Planning
(10)	Prepare target costings and monitor profitability	
(11)	Prepare interim valuations	Surveying
(12)	Prepare final account	
(13)	Allocate labour resources in line with programme	Site manager
(14)	Monitor progress on site	
(15)	Accommodate variations	All management functions undertake this task

An analysis of the data flows revealed the following:

i) large quantities of data are passed within and between the management function groups of construction organisations;

ii) much of this data has to be reworked or regenerated by functions receiving the data to enable their tasks to be performed;

iii) there are two main sources of construction management data, the estimator and the site;

iv) the purchaser , planner and surveyor are heavily reliant on the estimators data; and

v) the amount of reworking of the data could be reduced if the estimators data was in a more appropriate form for subsequent reuse.

The conclusions of the work were that more research effort was required to define the form the estimators initial data should take, to allow other management functions to more easily use this data. The authors also stressed that more feed back to the estimator from the other management functions was required and that the management of contracts could become more streamlined if the need to rework or regenerate data could be reduced.

Although the formal techniques of data flow diagramming (as described in section 3.3) were not used to illustrate the observed data flows, the work of McCaffer and Pasquire is important as it is one of the few attempts at analysing the data flow patterns and needs within contracting organisations. The main findings relating to the exchange and flow of information were also found within the study of house building organisations undertaken as part of this research.

2.3.5. *Ndekugri and McCaffer(1988): Management Information flow in Construction Companies*

Ndekugri and McCaffer highlighted the problems of sharing information between various management functions within the construction industry. They contend that the introduction of computer technology has not improved the situation because too often stand alone, single activity systems have been purchased leading to what they describe as a "Tower of Babel".

They argue that an appropriate way forward for the industry is via totally integrated construction project management information systems. However such systems need careful consideration of the existing information flows and needs of the construction management functions. Thus the following six management functions were studied to elicit the flow of data between them:

- planning
- estimating
- cash flow forecasting
- valuations
- cost control
- accounting.

The study involved literature reviews, consultation with contractors and expert opinion. The outcome of the study was the construction of simple input output models of the flow of information for each of the six functions.

The specific diagrams produced do not relate directly to the housebuilding industry and therefore they are not described here. However some of the features of the information flows are common with the flows in house building organisations.

These features include:

- the information used or produced by management functions is frequently ill defined;
- the production of data is duplicated in some cases;
- there is a high level of use of common data;

- some functions provide data for others.

Many of these problems are blamed on the high level of informality of communication in the construction industry. Another problem cited is that the data is generalist in nature and ill defined.

Because of this latter problem the authors suggest that traditional data-bases are ill equipped to handle such data particularly in transactions between functions. Further, in regard to the transfer of data from one function to another, they state "In the majority of cases the nature of the data as well as the format in which it is to be received is ill-defined. Hardly ever is the data structured with the convenience of the receiving parties in mind. The obvious result is that a lot of manipulations have to be done with further time-consuming contacts for amplification or explanation. Indeed some receiving parties find the information of so little use that they either re-extract or make up their own data".

This strongly aligns with the findings of Higgin and Jessop (1965) as reported in section 2.2.1.

To overcome these problems the authors advocate the development of integrated systems, integrated that is, in the sense that any information once stored is available to any other function. However they acknowledge that total integration is a "gargantuan task" which is only achievable in stages over a long period.

The work of Ndekugri and McCaffer confirmed and extended the work of Higgin and Jessop (1965) and McCaffer and Pasquire (1986). As well as describing the problems of data exchange they also offer a solution in the form of integrated management systems. The work described in this thesis developed these proposals into the design and development of an integrated management system for housebuilders as described in Chapter 4.

2.3.6 *Betts (1987) : A co-ordinated system of information retrieval for building contractors tendering*

Betts presented a study on the problems of the classification and interrelation of construction project data for the purposes of communication

between and within the functions of design and construction with detailed consideration being given to the tendering process. This built on and continued the earlier work of Betts, Howes and Skinner (1986).

The author states that most construction project information within the tendering process is communicated by use of documents. The format of these documents is limited by the purposes for which they are primarily designed and insufficient attention is given to other potential users of such documents and the alternative formats they may require. This has led to different people involved in the construction management process needing to re-quantifying or re-classifying information to present it in an appropriate form for their purposes. This prevents the smooth transfer of information between different tasks and prevents adequate feed back of information for management control.

His research involved the examination of the individual tasks that are executed as part of the tendering process. The data used within the process was analysed, conceptually modelled and constructed into a physical database design which allowed a common store of data to be interrogated for information in a format that was specified by the user. This work is similar in concept to that of Carter(1987) reported in section 2.3.7.

The model consisted of process flow charts of tendering procedures derived from structured personal interviews. This process flow model was then analysed to extract and define the flow of data through the model. This aspect of the work is important because use was made of the formal data modelling techniques proposed by Chen (1976) in addition the more common data flow models advocated by DeMarco (1978) and Gane and Sarson (1979).

The result of this data modelling process was the conceptual design of a tender information data base. This conceptual design was translated into a physical system using the relational database dBASE III on an IBM PC. When reported this system was still at a prototype stage. However preliminary results using the system suggested that such an approach was efficient in terms of adequate information provision and overcame many of the problems outlined earlier.

The relevance of this work (and that of Carter described in the next section) is that formal data modelling techniques were used to describe and map the information flows between construction personnel. These models were then used to develop software to provide rapid access to information and exchange of information between the personnel.

This approach was adopted in this research in the analysis of the information flows occurring in house building organisations.

2.3.7 *Carter (1987) : The use of Structured Information Systems in Building Contract Administration*

Carter studied the information flow from site to supervising officer, (Architect) on a number of hospital building contracts. The study used the techniques of data flow diagrams originally developed by DeMarco (1978) and Gane and Sarson (1979) but which have seldom been used in a construction information context.

Although the study of information flows from site to Architect is not directly relevant to this study many of the observed problems in the data flow are similar to those reported by Ndekugri and McCaffer (1988) and McCaffer and Pasquire (1986).

The study collected the various documents used to transmit information from site to the Architect. A flow diagram showing the routing of each individual document was then drawn and when all documents had been traced an integrated document flow diagram was produced.

Examination of this flow diagram revealed a number of short comings. There was considerable duplication of information flow and storage. Many of the physical files and documents contained information on more than one topic dictating the need to consult numerous documents to obtain complete information on one topic. The data collection was often haphazard or ad-hoc resulting in incomplete information. Finally the transmission of information on paper using postal or messenger delivery resulted in delays and it was not unusual for information to be "overtaken by events".

Having analysed the existing systems a logical system was proposed that overcame many of the observed drawbacks. The proposed system consists of a set of data stores into which information is fed from the site and from which information is extracted by the architect and others.

The proposed system was then developed into a working prototype using a micro computer. The perceived advantages of this system were:

i) staff could collect and use specific items of information;

ii) there would be quicker transmission, storage and retrieval of data;

iii) tighter control could be imposed on the data flows; and

iv) intervention of senior staff could automatically be called by the system when required.

Whilst the data flow modelling was considered successful the development system was unable to be tested in parallel with manual systems on a live project (Carter,1988) and so the benefits claimed by the author were never proved. The major achievement of this work therefore was that the techniques of data modelling were shown to be capable of identifying and mapping existing physical data flows. These techniques were adopted to analyse the data flows occurring in house builders organisations, as described in chapter 3 of this thesis.

2.4 The impact and use of computer-aided management systems in construction

2.4.1 *Wroe (1986): Contractors and computers, Why systems succeed or Fail*

Wroe undertook a study of 10 small construction companies between 1980 and 1985 during the period in which they were selecting, implementing and using computer-based management information systems. A model of MIS (Management Information Systems) development and implementation in small construction companies was developed from the observations of these

companies and a strategy for the successful implementation of micro-computer based MIS proposed.

The ten companies ranged from sole traders with a turnover of £100,000 to small general contracting organisations with a turnover of £5 million. Both building and civil engineering contractors were included in the sample.

The study involved the collection of qualitative data from the time of the initial management decision to investigate the possibility of developing a micro-computer based MIS through to its live operation or abandonment. This data was used to assess the degree of success or failure of each development phase, based on several criteria.

A table of the development phases and the associated criteria are shown in table 2.2.

Wroe assessed the success of each company at each phase in fulfilling the prescribed criteria. Table 2.3. shows the results of the study.

The results show that four companies proceeded to a successful live operation of the MIS during the 5 year period of the study. Five companies abandoned the MIS either during the selection or implementation phase. One company continued to try to achieve live operation but experienced serious difficulties. The main research findings were the identification of those factors which contributed to the success or failure of the selection, implementation and live operation of the MIS as listed below:

1. Organisational Context

a) Economic stability of work
b) Management orientation and decision style.
c) Administrative slack
d) Internal skill and support level
e) Formality of administrative practices
f) Level of management boundary spanning activity

Table 2.2 A Template for Evaluation of Functional Stages in the MIS Implementation (Source: Wroe)

1. SELECTION

a) Determination of requirements:
   - identification of problem area and system objectives
   - assessment of mandatory and desirable information needs
   - sizing of data storage

b) Selection of system:
   - location of potential systems
   - evaluation of alternaives
   - negotiation with supplier
   - selection time (in relation to plan)

2. SELECTION JUDGEMENT
3. IMPLEMENTATION

a) Installation of system
b) Implementation of time (in relation to plan)
c) Training:
   - general system appreciation
   - routine operating skills
   - non-routine operating skills

d) System conversion:
   - data capture/encoding
   - master/library file creation
   - establishment of working system

e) System testing:
   - trial processing
   - reconciliation with requirements

4. IMPLEMENTATION JUDGEMENT
5. LIVE OPERATION

a) Abandonment of former system
b) Evaluation/tuning of system operation
c) Management use of information
d) Enhancement of system facilities

6. LIVE OPERATION JUDGEMENT
7. OVERAL PROJECT JUDGEMENT

Table 2.3. Analysis of companies success rating at each phase (Source: Wroe).

	Selection	Implementation	Live Operation	Overall
Successful	3	4	4	4
Partially Successful	4	1	-	1
Unsuccessful	3	4	1	5
Abandoned	1	3	1	-

2. Application Context

a) Functional systems gap (degree of change from the old system to the new).
b) Functional simplicity/complexity of requirements
c) Technological simplicity/complexity
d) System support base (Hardware and Software)

3. Systems Development Process

a) MIS Strategy
b) Use of outside advisor
c) Involvement of user staff
d) Transitional Strategy

This work contains two potentially useful elements to anyone undertaking systems development and implementation work:

i) a template for implementation evaluation; and
ii) a checklist of factors which should be considered in the development/ implementation process.

Unfortunately many of the factors included in these elements were found to be too general or too vague to be of great use in the development/implementation process. Indeed many of the development/implementation factors are dealt with by using a standard system design methodology (such as SSADM(N.C.C.,1986)). A modified

version of Wroe's evaluation template was used in the evaluation of the DEVELOP system as described in chapter 6.

2.4.2 *Studies at Loughborough*

Over the last 10 years a number of research projects and studies have been undertaken at Loughborough University pertaining to the topic of integrated computer systems for construction companies. This research forms part of that continuing theme. Two of the studies are reported in sections 2.3.4 and section 2.3.5 and four other relevant reports are described here. These reports are the work of :

W.D. Sher (1981);
A.N. Baldwin (1982);
I.E. Ndekugri (1986); and
R.Z. Abdullah (1988).

a) Sher (1981): Interactive Estimating for Building Contractors.

Sher undertook a study of commercially available estimating systems for building contractors in the early '80's. He concluded that none fully met the needs of building estimators and embarked upon the development of a computer aided estimating system designed specifically for building contractors.
The system, known as INTEREST BUILD, was developed in association with four practicing estimators. The main features of the system are:

the storage of performance data;
the utilization of these data to price bill items;
the pricing of items where no data is stored;
the updating of resource costs;
the automatic completion of arithmetical calculations;
the retrieval of item build-ups; and
the addition of tender mark-ups.

A major problem at the time, was the development or selection of a classification system suitable for the storage and retrieval of building estimators data. Five classification systems were examined but none proved

suitable for a computer-aided system and so a new classification system based on the Standard Method of Measurement of Building Works: 6th Edition (RICS,1979) was developed.

The benefits accruing from the use of the system were reported as:

- the ability to commence the preparation of the estimate without having to wait for materials and sub-contract quotations;
- the ability to plan the estimating work load thus providing more time for the simulation of different construction methods;
- the ability to quickly and easily update resource costs;
- the production of numerous management control reports;
- increased accuracy and speed of arithmetical calculations;
- enhanced adjudication facilities; and
- the standardisation of the format of the estimate and the manner in which they are produced.

These benefits may be regarded as being typical in scope for single function computer-aided management systems.

b) Baldwin (1982): Computer-aided Estimating for Civil Engineering Contractors.

In parallel to Sher's work Baldwin undertook a similar study and development, but this time for civil engineering contractors.
He reviewed previous research in the area and critically examined six existing estimating systems. The estimating and tendering process was investigated by interviewing eight estimators from three different contracting companies and a specification for the computer aided estimating system was produced. A computer based system known as INTEREST CE was developed from this specification, installed, and tested by six estimators. The dissemination and demonstration of this system has been cited as a major influence on the development of other similar systems for the construction industry (McCaffer,1987).

As well as providing a comprehensive estimating system, Baldwin also proposed that such a system could form the basis of a linked suite of construction management programs. This is shown in fig 2.1

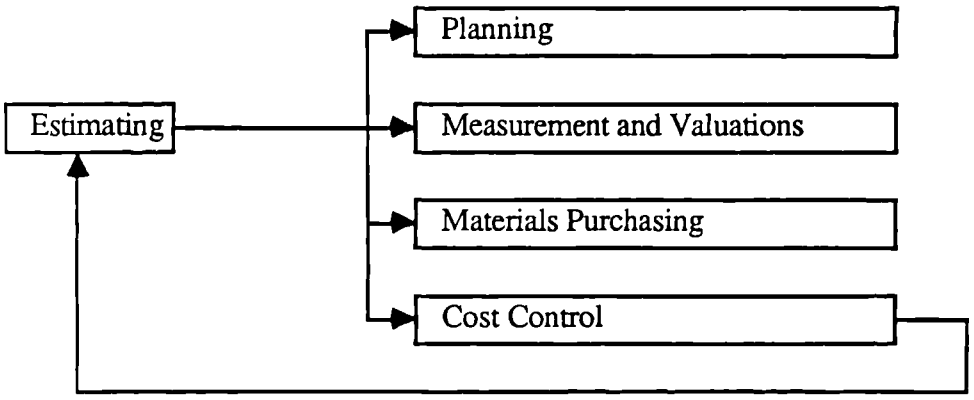

Fig 2.1 A linked suite of construction management programs (source: Baldwin)

This proposal was a major advance at the time as it highlighted the need for data exchange between functions and the advantages to be derived from this.

The development of these linked programs was initiated by Allsop (1980), Bowman (1984) and Furness (1984) and continued by Ndekugri (1986) and Abdullah (1988) as reported in the following sections.

c) Ndekugri(1986) : Construction contract information management : An integrated systems approach.

Ndekugri continued the work of Allsop, Furness and Baldwin by investigating and developing a suite of programmes to support contractors, valuations, purchasing management and cost control in an integrated manner. The developed system was named PLUS-VAL and provided:

- facilities for valuations, materials control and the control of sub-contractors;
- the integration of estimating, valuations, purchase management and cost control;
- reduced costs of data capture;
- reduced times of data processing;

- increased data consistency; and

- increased flexibility.

The work provided a rigourous examination of essentially contractors valuations and cost control procedures. The software system, PLUS-VAL was developed to assist in these functions. However the greatest achievement was the practical integration of a number of different management functions all accessing a common store of data, largely derived from the estimator.

Ndekugri listed the advantages offered by integration as:

i) reduced data capture costs;
ii) better turn around times (faster throughput of information);
iii) better management of computer resources;
iv) greater consistency of information; and
v) greater flexibility.

Ndekugri's work carried forward the proposals made by Baldwin (1982) and demonstrated that computerised integration between functions was possible although his system proved too cumbersome in practice to be adopted by industry.

d) Abdullah (1988) : Integrated Systems for Site Management.

Abdullah took the concepts of integrated systems proposed by Baldwin and Ndekugri and continued them through to site control systems. He surveyed the requirements of efficient site control systems and the feasibility of linking such a system to other management systems (Estimating, Planning, Cash flow forecasting and Valuation).

The system he developed, PLUS-COST, enabled the production of site control reports for management control and the provision of feed back to the estimating department thus completing a further link in the chain of integration.

The relevance of the studies undertaken at Loughborough is in the demonstration that the development and integration of computer-aided management systems for construction is both possible and can offer significant benefits in terms of data access and data exchange. None of these studies, however, addressed the house building sector and none of them attempted the scale of integration undertaken in this research.

2.4.3 *Ewin, Oxley and Poole(1990): Advanced applications software for Speculative housing companies*

Ewin, Oxley and Poole report the development of an advanced prototype software development system known as DB4GL. Using this system an integrated estimating and cost control system was produced for speculative housing companies. This system was named Spec-Build. Whilst much of the paper considers the necessity and importance of producing a general software development tool the information flows for a speculative house builders estimating and cost control functions are also described, hence the relevance to this study.

The authors state that the shortage of suitable specialist applications packages has limited the utilisation of computers in small and medium sized building contractors and particularly in house building companies. Estimating systems, for example, designed for general contractors are not applicable to speculative house builders. Whilst general contractors estimating packages are designed to produce competitive tenders from client's bills of quantities, speculative house builders produce their own "bills" designed mainly as an aid to decision making and control. These bills are used:

i) to estimate the cost of developing a new site, which, when compared to the estimated site revenues, indicates the site potential;

ii) to estimate the cost of new house types, which can be compared with the estimated selling price and other similar designs to show whether the design is cost effective; and

iii) to provide information to enable accurate cost control during construction.

The authors studied the estimating and cost control procedures of a medium sized speculative house building company. The study involved extensive interviewing, the development of a logical data model and model verification by the company.

Having produced the logical data flow model, the software development tool DB4GL was used to create an integrated estimating and cost control system. The resulting system Spec-Builder enables:

i) the estimator to build up a hierarchical bill of quantities for each house type;

ii) the compilation of site estimates by combining house type bills of quantities with similar bills of quantities for general site costs;

iii) the production of estimates for site and house types;

iv) the entry of cost details, whether actual or provisional, into the system interactively;

v) the comparison of estimated and actual costs; and

vi) the identification of the sources of deviant cost.

Spec-Builder remains a prototype and the authors acknowledge that it does not possess many features which would be needed in a commercial package. It was developed mainly as a vehicle to demonstrate the potential of DB4GL as a development tool. The system was developed in an impressive five weeks and is currently being improved further.

Whilst this article is important, as it is one of the few studies of speculative housing companies procedures, a major discrepancy between it and this research is the method of estimating adopted.

The creation of bills of quantities within house building organisation as described by Ewin, Oxley and Poole was uncommon in the companies studied during this research. Rather schedules of "items" (materials, plant,

labour and subcontracts) were maintained and the estimating process involved the allocation of rates to these items. The only exception to this was in the estimation of site works (roads, drainage, landscaping etc) where occasionally more traditional hierarchical resource-based bills were produced.

Similarities between Spec-Builder and the system developed as part of this research include:

the adoption of a common estimating and cost control coding structure to allow the integration of these two functions;

the consideration of cost on a plot by plot basis;

the need to allocate non-plot costs (such as access roads, drainage and general landscaping) to plots; and

the comparison of actual cost against estimated cost as a means of cost control.

2.5 Summary

The research reports and studies reviewed in this chapter highlight a number of salient points which form the underlying basis for this research. These are:

i) Systems of communication and information flow are vitally important for all companies' management and decision making functions(Guevara and Boyer, 1981; Tenah, 1986);

ii) Communication systems and organisational structures are inexorably linked(Tenah, 1986; Day, Faulkner and Happold, 1986);

iii) Communication systems within construction companies are not well defined (Guevara and Boyer, 1981);

iv) There is considerable duplication, regeneration and loss of information between the management functions within construction

organisations (Ndekugri and McCaffer, 1988; McCaffer and Pasquire, 1987);

v) The formal methods of data analysis can help in identifying information flows with a view to improving and streamlining information transfer (Betts, 1987; Carter, 1987);

vi) The development of computer-aided management systems can aid the process of information flow (Bishop and Allsop, 1969; Ndekugri and McCaffer, 1988; Baldwin, 1982);

vii) To capitalize on the full potential benefits of computer-aided management systems, systems should be integrated(Ndekugri and McCaffer (1988); Baldwin, 1982; Ndekugri, 1986);

viii) Computer-aided management systems, particularly integrated systems, rely heavily on the adoption of a common coding system (Bishop and Allsop, 1969; Ndekugri, 1986);

ix) There are numerous problems to be overcome in developing and implementing computer-aided systems within construction firms (Baldwin, 1982; Wroe, 1986);

x) Finally few studies have considered the information needs of house-building organisations (Ewin, Oxley and Poole, 1990).

CHAPTER 3

3. HOUSE BUILDERS ORGANISATIONAL AND DATA MODELS

3.1 Introduction

This chapter presents the findings from a study of house builders organisations and the flow of information between their major technical and commercial functions. This study provides the framework within which the integrated data management system, described in Chapter 5, was developed.

Both Carter (1987) and Fisher (1984, 1990) have demonstrated the use of data flow models in describing the transfer of information between construction functions. Betts (1987) used the technique of entity-relationship modelling (or logical data modelling) to identify the key data items and their constituent properties from the data flows as described in section 2.3.6. However it is first necessary to determine the organisational structure in which the functions operate in order to document the exchange of information between them. This approach is advocated by Tenah (as reported in section 2.2.3) and Carter and Silverman (1980) who state "Since we know how important accurate and timely information is for effective decision making, the establishment of the organisation's needs for information enable us to design a system which will efficiently meet the requirements".

In this research three forms of model are used to describe the information needs of house building organisations. These are:

i) an organisational schematic;
ii) functional data flow diagrams; and
iii) logical data models.

These are described in detail in the following sections.

3.2 The organisational model.

3.2.1 *Study of Organisations*

The study of the organisational structures of companies, large and small, has produced a wealth of literature over the years (for example Mintzberg, 1979; Galbraith, 1972; Sofer, 1973). Similarly the study of construction organisations has also been widely reported (for example Harris and McCaffer, 1989; Fryer, 1990; Newcombe, Langford and Fellows, 1990).

Whilst the terminology used by these authors vary, the basic organisational structure of a construction firm is agreed to be what Fryer (1990) describes as a "functional line and staff organisation". In this form of organisation the line managers are responsible for production. They pass instructions and information down the hierarchy to the functional specialists or "staff". Some of these specialists may be departmental heads and therefore have both line and staff responsibilities. A basic line and staff organisational schematic is shown in fig 3.1.

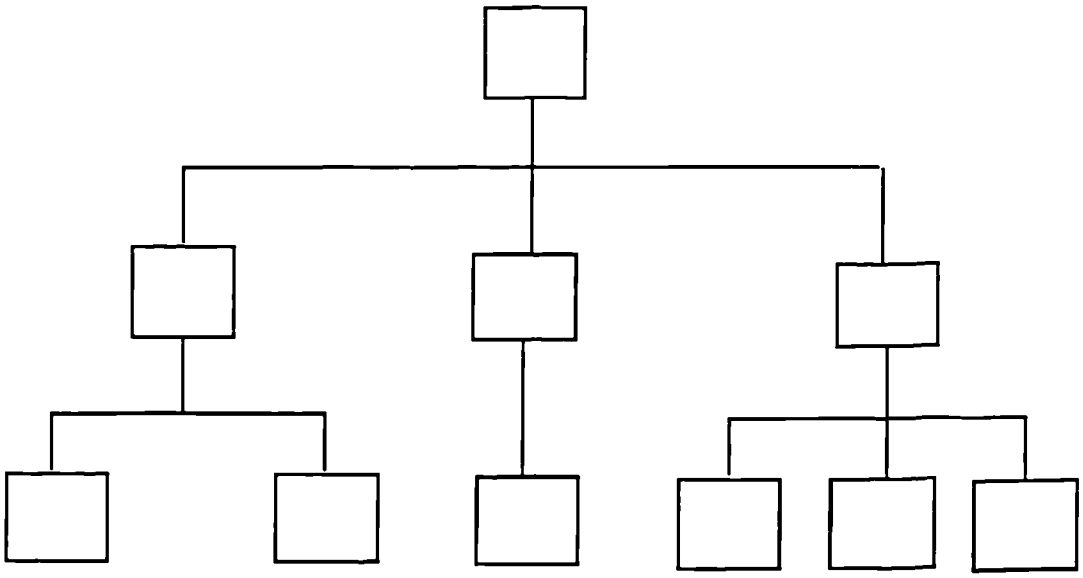

Fig 3.1 Basic line and staff organisation.

An organisational model comprises of a schematic showing the organisational levels and spans of management responsibility for each member of the organisation (Koontz and Weihrich, 1988). Where

individual job titles are company specific the functional activities of the individuals may be used when comparing similar organisations.

3.2.2 *Study of house building organisations*

A study of six medium-sized regionally based house building companies was undertaken to enable the development of a typical organisational model or schematic. The study comprised initial detailed interviews and discussions with senior managers and staff within the collaborating company followed by interviews and discussions with various senior personnel in five other house building companies. A total of 21 people were interviewed.

The initial interviews provided the basic organisational schematic which was then used for discussing and highlighting organisational or managerial differences in the other companies. As differences were identified the structure was amended to include them. After all the companies had been visited the schematic was rationalized and sent back for confirmation.

The interviews revealed that although company organisational structures varied due to size, history of growth and details of ownership, the same functions were undertaken, with differing emphasis, by all the companies. The major difference observed was in the degree of division between the "development" and "building" activities. In the collaborating company and one other these two activities were split into separate operating divisions whilst in the other four companies this corporate division did not occur. The organisational schematic developed is shown in fig 3.2 and described in the next section.

3.2.3 *Organisational Schematic*

In developing the organisational schematic it quickly became apparent that it was difficult to reconcile the job/position titles of the staff in different organisations. Their functional roles and responsibilities were easier to identify and used a more standard terminology and these were therefore used in the schematic.

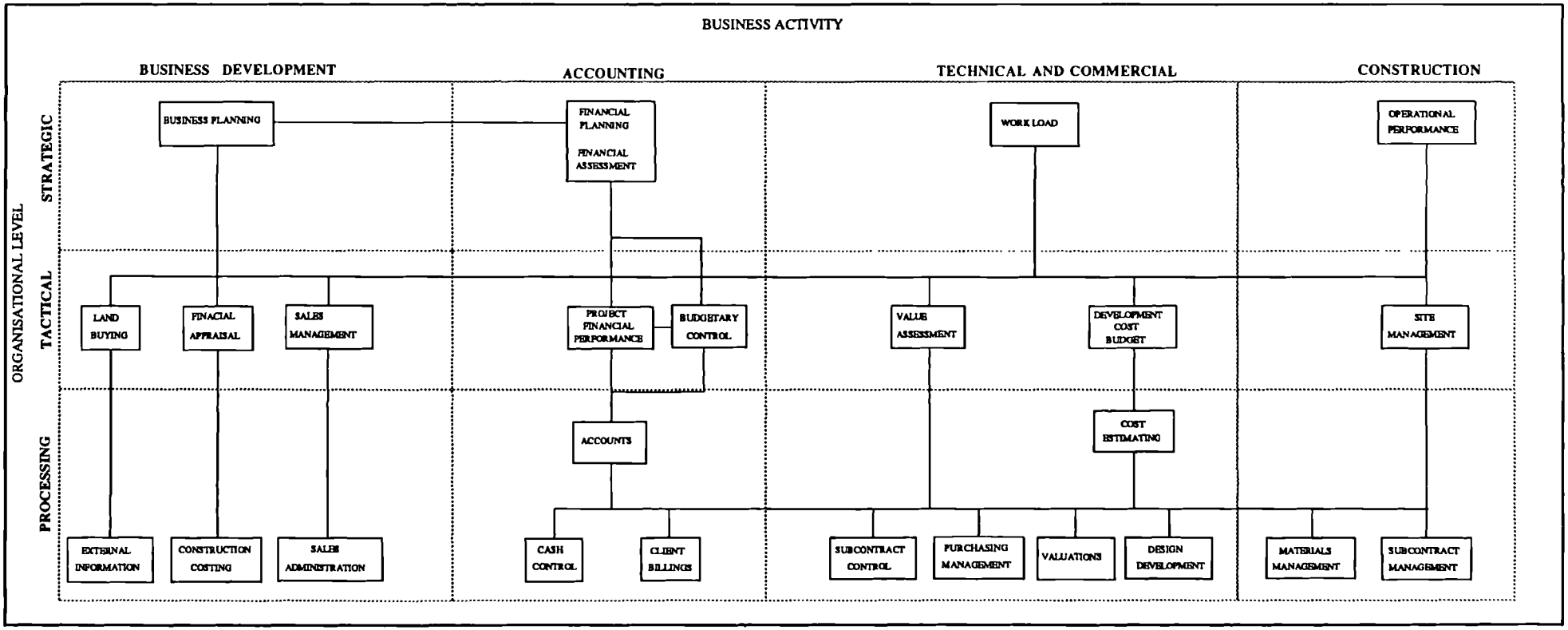

Fig. 3.2 Organisational schematic for a typical house building company

Four key business activities were identified through discussions within the house building companies:
business development;
accounting;
technical and commercial; and
construction.
These activities overlay the basic line and staff hierarchy as depicted in fig. 3.1 and formed sub-hierarchies within it. Parsons (1960) suggests that there are three levels in the structure of any organisation:
the technical or production level;
the organisational or managerial level; and
the institutional or community level.

Arthur Anderson and Co (1985) have refined this idea into strategic, tactical and processing levels within an organisation. These three organisational levels and the four business activities formed a matrix into which the line and staff relationships were allocated. The developed organisational schematic is shown in fig 3.2 and described below:

1. *Business Development*

The business development functions form part of the "development" aspect of a house building organisation. In particular they are concerned with land buying, house sales and financial appraisals of proposed projects.

The business development functions are shown in fig. 3.3 and described below

a) *Strategic*

i) Business planning. This responsibility usually rests at board of directors/M.D. level. In one company a single director was nominated as development director. The function involves assessing market potential (and new markets); authorising overall development appraisals and agreeing sales budgets with the sales manager.

b) *Tactical*

i) Land buying. The land buying function usually consists of a small team (of say 3 people) or a single person who report to the board/development director. In the smaller companies interviewed the roles of land buyer and development director were combined. The function involves identifying and monitoring possible future sites; buying land by negotiation or at auction; negotiating options on so-called "white land" (ie land without planning approval); initiating services (electricity, gas, water, telephone) enquiries; submitting outline scheme proposals; and monitoring competition activity.

ii) Financial appraisal. This overlaps with the land buying function and involves the same staff. The function comprises calculating land cost ranges and timings; preparing outline scheme proposals (see i); planning build and sale stages; estimating likely build and site costs; assessing likely fees incurred; estimating likely sales revenue; preparing cash flows on estimated income/expenditure; and estimating probable margins and amounts of capital employed.

iii) Sales management. This is undertaken by the sales manager which was a common position in all companies interviewed. It involves setting sales targets; monitoring actual sales; recording construction progress against the planned progress; authorising sales releases; co-ordinating advertising; and organising incentive schemes for the sales personnel.

c) *Processing*

i) External information. This is the responsibility of all company staff and as such there is no one individual or team responsible for it. However all the companies interviewed stressed the importance of external or "market" information for both the land buying and competition activity roles. Information cited as being particularly useful included planning applications; demographic information; competitor activity and maintaining local contacts. Two companies interviewed reported that they paid estate agents a fee for providing

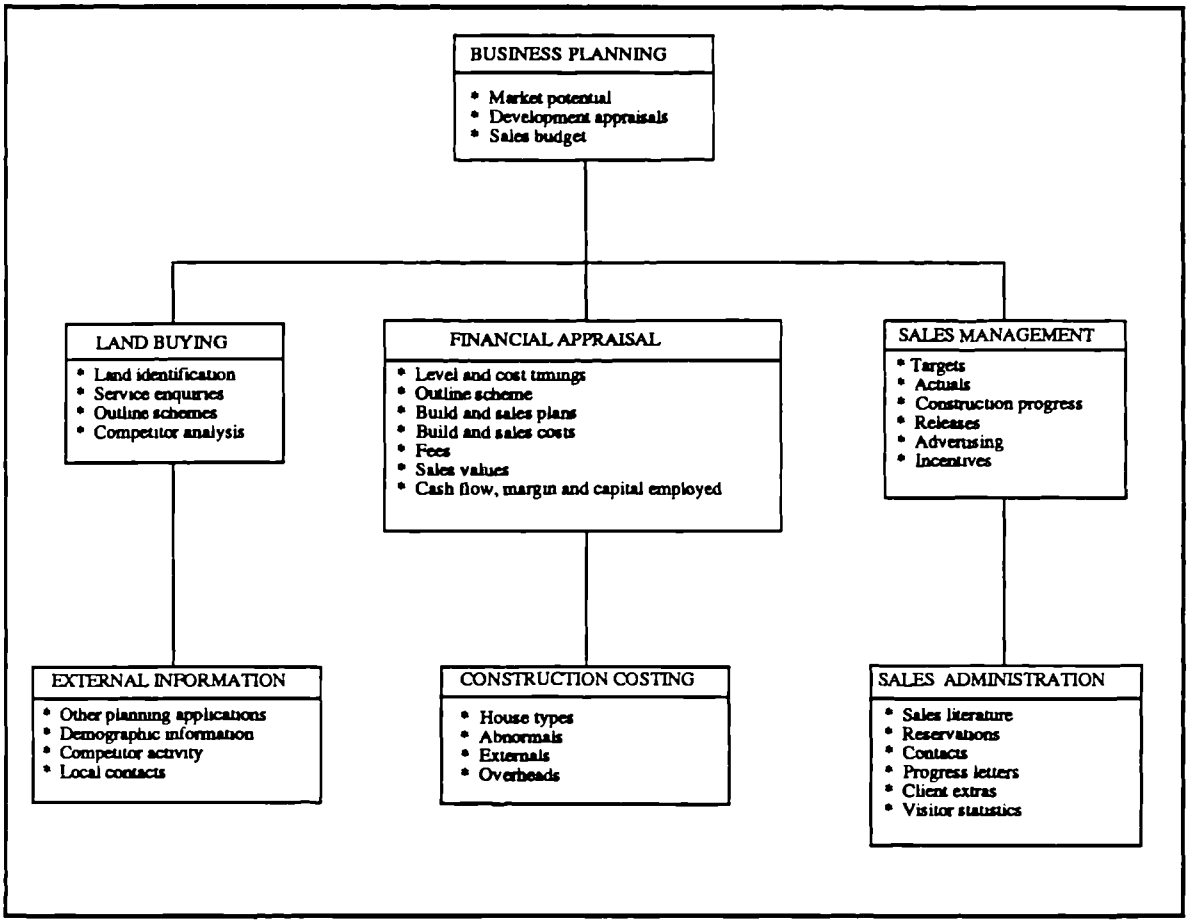

Fig. 3.3 The Business Development Functions

information on available land and new planning approvals. This information is fed back into the land buying function

ii) Construction Costing. This is usually the responsibility of the estimating department which provides concise information and costs on house types, abnormals, external works and overheads for producing financial appraisals.

iii) Sales Administration. This is the responsibility of the sales staff who usually occupy a show house on the development. It involves the day to day sales administration including producing sales literature, taking

reservations and signing contracts, sending progress letters to clients; organising 'extras' required by the clients and producing visitor and sales statistics. The analysis of these sales statistics strongly influences the mix of dwelling types on subsequent or adjacent phases. This information is relayed back to the sales management/ financial appraisal functions and schemes may be re-designed and re-submitted if a more financially attractive scheme can be devised.

2. *Accounting*

The accounting functions together with the business development functions comprise the "development" side of house building organisations. The accounting functions comprise corporate financial planning, budgetary control and project financial performance. The individual functions are shown in fig. 3.4 and described below.

a) *Strategic*

i) Financial Planning/Assessment. All companies interviewed had a single point of responsibility for this function, either the finance director or company accountant. The function involves analysing, monitoring and reporting sales, overheads, margins, capital employed, cash flows and orders.

b) *Tactical*

i) Budgetary control. This is the responsibility of senior accounts staff. It involves preparing and maintaining annual budgets and company accounts.

ii) Project Financial performance. This is the responsibility of line/project accounts staff. It involves analysing and monitoring original and final sales values on individual projects. It also includes the calculation of margin, interest, and capital employed project by project.

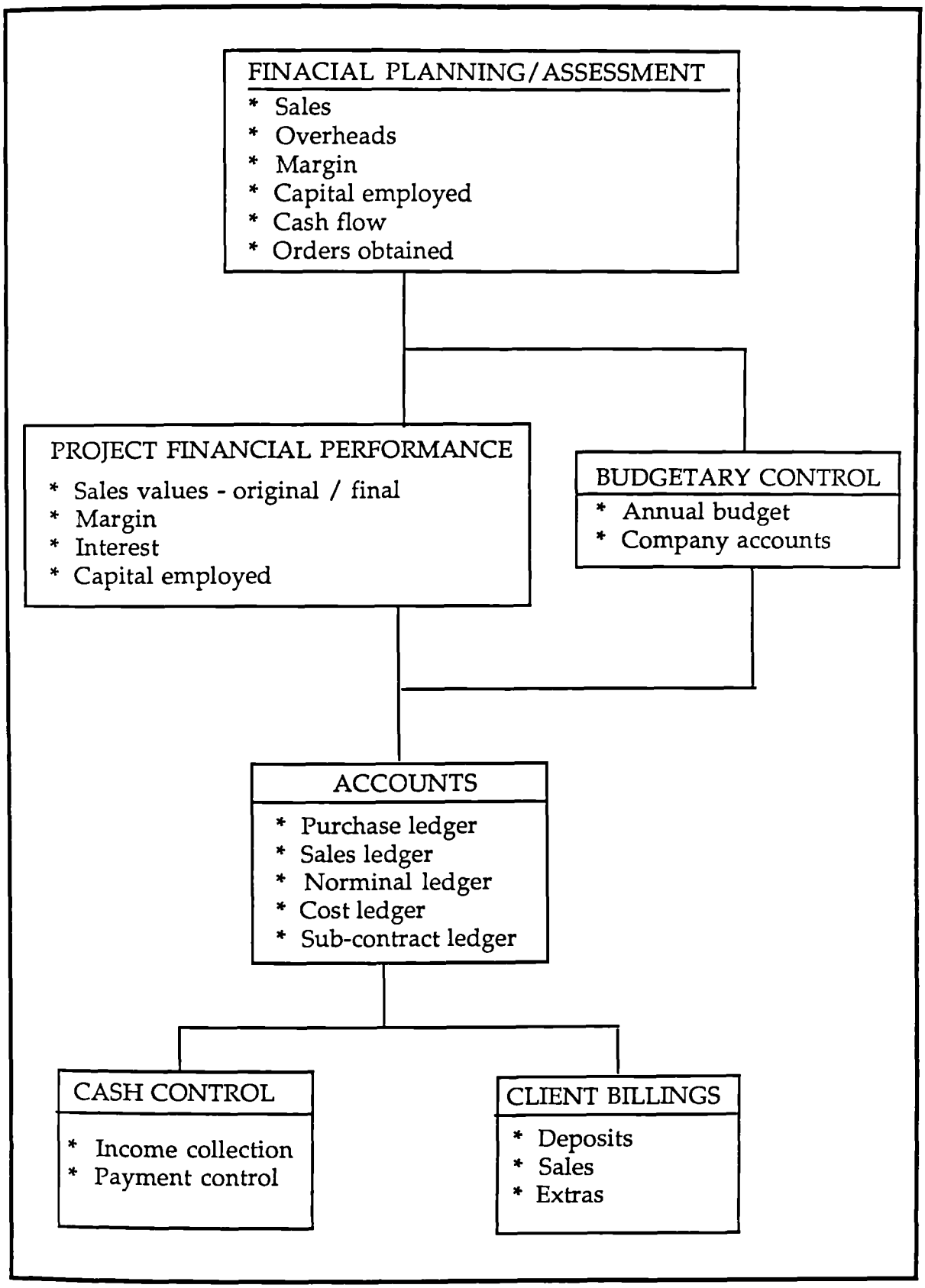

Fig. 3.4 The Accounting Functions

c) *Processing*

i) Accounts. This is the responsibility of the account clerks. It involves the day to day maintenance of the purchase ledger, nominal ledger, sales ledger, cost ledger and subcontract ledger.

ii) Cash control. This forms a sub-section of the accounts dept. and involves income collection and payment control.

iii) Client billings. This is a further sub-section of the accounts dept. It collects the client deposits, sales monies and extras.

Further information for the accounts staff is provided by the subcontractor control and purchasing management sections (See 3c(i) and 3c(ii))

3. *Technical and Commercial*

The technical and commercial functions together with the construction functions form the "building" part of a house building organisation. The technical and commercial functions are those necessary for designing, costing, buying and measuring the actual house building work. The functions are shown in fig. 3.5 and described below.

a) *Strategic*

i) Work load. This is the responsibility of the senior technical director and may form part of the business planning function. It involves the assessment of the work load secured, possible opportunities and predicted resource requirements.

b) *Tactical*

i) Value assessment. This is the responsibility of the contracts managers. It involves individual project progress assessments and forecasts of cost to complete. This function was only undertaken regularly by two of the six companies interviewed. In the other four companies it was either not undertaken at all or combined

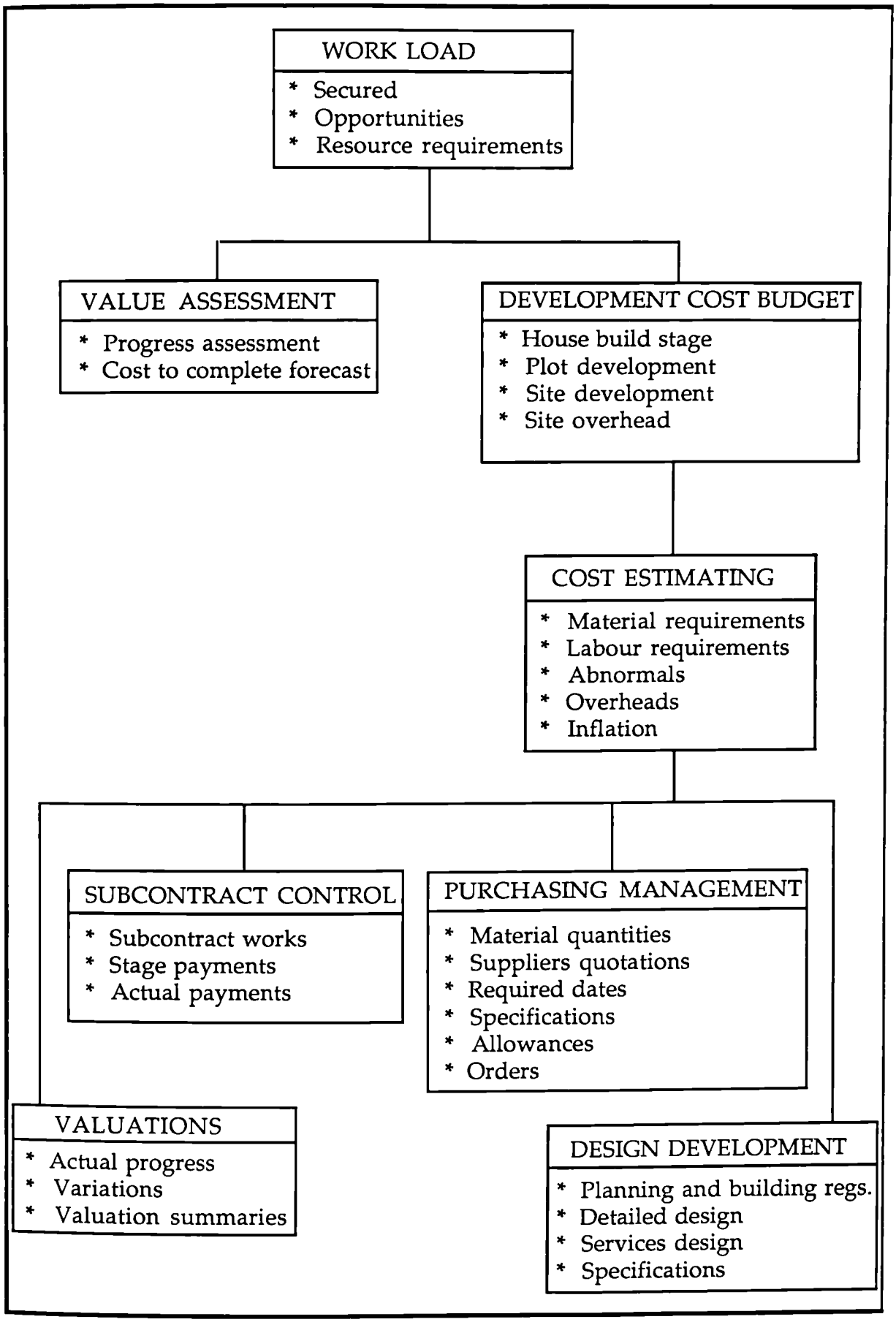

Fig. 3.5 The Technical and Commercial Functions

with the valuations function. The reason given for not undertaking a value assessment was that the company knew how much the development was going to cost in total and hence an intermediate value assessment was unnecessary. The two companies who did undertake this were those (including the collaborating company) which had a strong development/building divide in the company.

ii) Development Cost budget. This is the responsibility of the estimating director. It involves planning the construction schedule, considering plot and site development costs and site overheads.

c) *Processing*

i) Cost estimating. This is the responsibility of the estimators. It involves assessing labour and materials requirements, assessing abnormals and overheads and allowing for inflation. The estimators report to the chief estimator and the contracts directors. The cost estimating function provides information to the business development functions for financial appraisals, to the buyers for materials and subcontractor enquiries and to the surveyors for measurement and valuations functions. It hence has a key role in the information flow of the company and this is described in detail in section 3.3.3.

ii) Subcontract control. This is the responsibility of the subcontract 'buyer'. It involves negotiating and hiring subcontract tradesmen agreeing stage payments and actual payments.

iii) Purchasing management. This is the responsibility of the buyer. It involves aggregating material quantities from the development or the parts of a development, obtaining quotes from suppliers, checking specifications and prices and placing orders.

iv) Valuations. This is the responsibility of the surveyors. It involves measuring actual monthly progress, assessing the value on variation

orders and claims against allowances and preparing monthly valuation summaries.

This function occurred in all six companies but was strongest (with up to 6 staff) in the two companies with a distinct development/building divide.

v) Design development. This is the responsibility of the company architects/surveyors. It involves obtaining detailed planning permission and building regulations on new developments and the design of new standard house types and specifications. It also involves any special services designs. Interestingly in none of the six companies interviewed was there a senior architect function.

4. *Construction*

The construction functions in the six companies interviewed were mainly site based and overlapped the technical and commercial functions. The functions are shown in fig. 3.6 and described below.

a) *Strategic*

i) Operational performance. This is the responsibility of senior contracts managers who report to a construction director or managing director. It includes monitoring budgets, costs, variances and sales on the on-going developments.

b) *Tactical*

i) Site Management. This is the responsibility of the site agents. It involves maintaining the construction programme, assessing actual progress, scheduling resources, implementing clients requirements, site engineering and the health and safety of the work force.

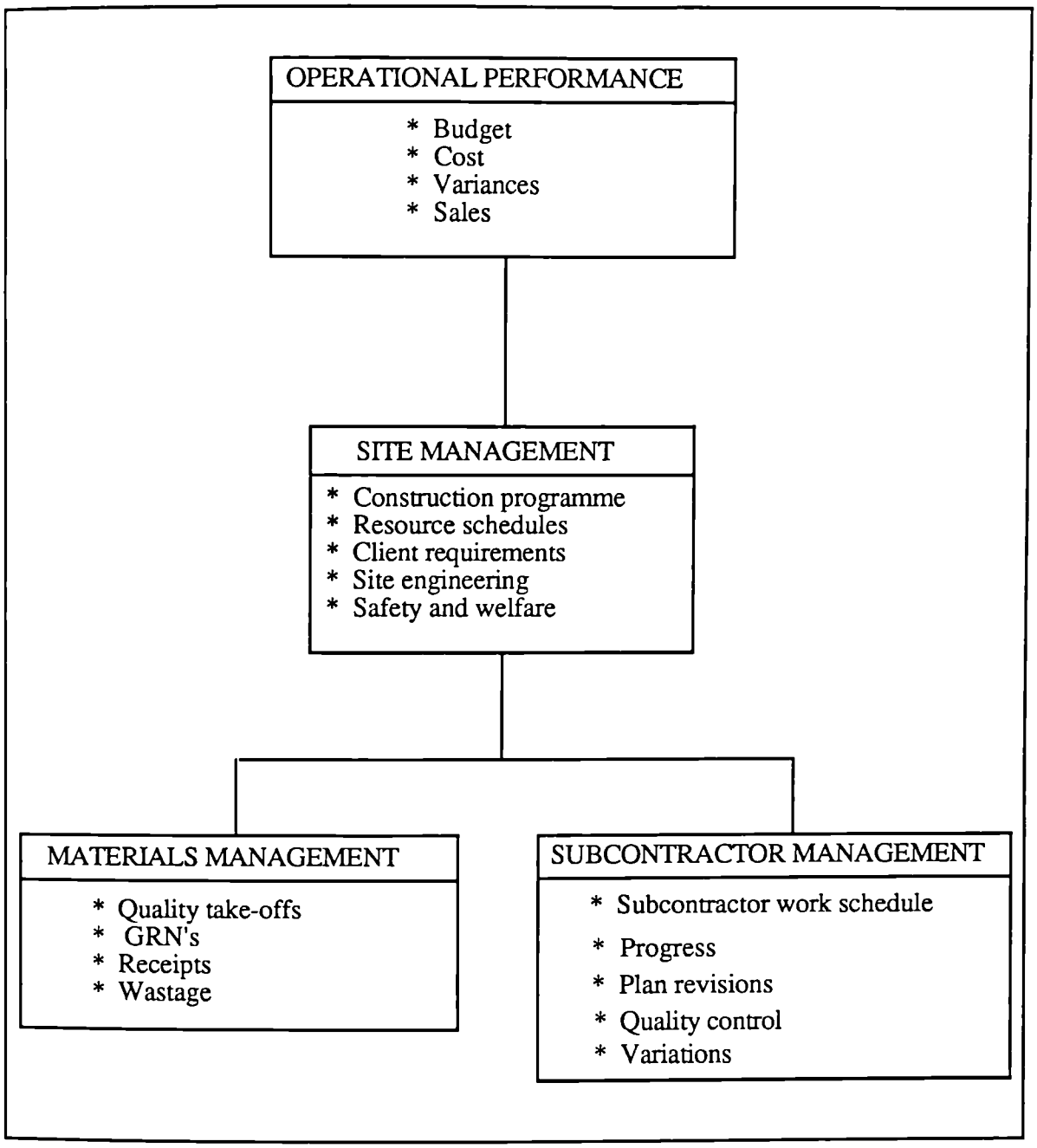

Fig. 3.6 The Construction Functions

c) *Processing*

i) Material Management. This is the responsibility of the site agents staff. It involves quantity take-offs for non-standard items, passing requirements back to the buyer and receipts to accounts, monitoring and controlling wastage.

ii) Subcontract Management. This is the responsibility of the site agents staff. It involves planning sub-contractors work schedules, maintaining progress, quality control and recording variations to plan.

3.3 Function Processes and data flows.

3.3.1 *Introduction*

The development of the organisational schematic as shown in figure 3.2 highlighted the fact that the estimating department is a prime source of data for other related technical and commercial functions.

This confirmed the findings of McCaffer and Pasquire (1987) and Merchant (1987). It was agreed that the greatest benefit to the collaborating company would be in examining the data requirements and flows at the processing level for the technical and commercial functions of cost estimating, purchasing management and valuations. In addition a further function of cost monitoring/comparison was included. This complements the function of value assessment at the tactical level.

The technique used to identify and model the exchange of data between the functions is that of data flow diagramming which was introduced by DeMarco (1978) and Gane and Sarson(1979).

Although the basic concepts of this technique are outlined in the following sections, a full description can be obtained in Parkin (1987), Skidmore and

Wroe (1988) and Jackson (1983). The use of this and similar techniques in construction have been described by Stephenson and Oxley (1985), Barton and Heath (1985), Carter (1987), and Fisher (1984,1990). These authors have used these techniques to describe and identify information flows but none have carried the work through to full system development.

The methodology adopted for the development of the data flow models was to interview the departmental head of the estimating, purchasing and surveying departments to determine the processes involved in their particular function and the source and destination of information used in these processes. Data flow diagrams were then produced and confirmed with these departmental heads. The cost monitoring/comparisons data flow model was produced in consultation with a company contracts manager responsible for this function.

3.3.2 *Definitions and Terminology*

A data flow diagram depicts the passage of data through a system by using four basic symbols. Different authors have suggested alternative notations and the one presented here is that adopted by the National Computer Centre (1986).

The symbols are shown in fig 3.7 and described below.

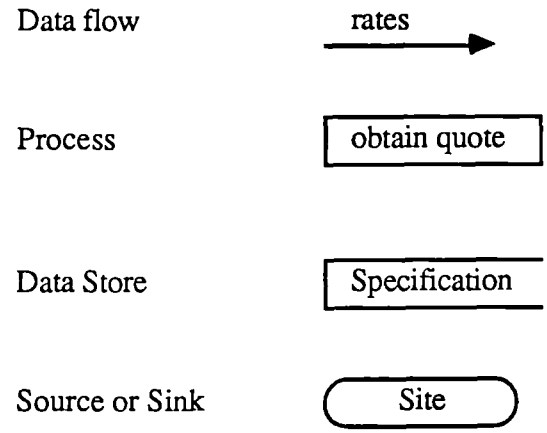

Fig 3.7 Notation used in data flow diagrams.

i) Data Flow. A data flow is a route which enables packets of data to move from one point to another. Data may flow from a source to a process, from a data store to a process etc. The direction of flow is indicated by an arrow. Data flows should be named unless moving in and out of data stores where the store name is sufficient to describe them.

ii) Process. A process represents a transformation changing incoming data flows into outgoing data flows. Processes should be named but no physical arrangement should intrude into the process description and they should be as terse as practical.

iii) Data Store. A data store is a repository of data. It may be a card index, a database file, a wastepaper basket etc. The physical representation is irrelevant, only the logical connections being of importance. Stores should be named and may be included more than once to simplify the presentation.

iv) Source and Sink. A source or sink is a person or part of an organisation which enters or receives data from the system but is outside the context of the particular data flow model under considerations.

Various levels of data flow diagram can be constructed but only the primary level diagrams are presented in the following sections as these are sufficient for producing the entity-relationship models described in section 3.4.

3.3.3 *The Estimating process*

The house builder/developer purchases land either by negotiation or in open competition at auction and then develops the land with an appropriate mix of dwelling types to give maximum return on the initial capital investment. Hence the developer acts as both client and contractor and so the requirement to produce competitive tenders (as for general contracting) is removed. However in order to remain competitive with other developers and to maintain effective control of projects the developers organisation is often divided, albeit informally, into a development section and a building

section. This division may be formalized by creating separate companies under a holding company.

This division of interests ensures that the building company produces budgets (in effect estimates) of the work to be undertaken. These are agreed with the development section or company and are then used to monitor progress and control costs. They also act as a vehicle for staged payments in a similar manner to the use of bill rates for monthly valuations in normal contracting. Thus the need to estimate the work to be undertaken, and for the estimate to be agreed before the work starts still exists.

McCaffer and Baldwin (1986) identified the following steps in producing an estimate for a contracting organisation:

programming the estimating task;
preliminary project study;
materials and sub-contractor enquiries;
detailed project study;
calculating labour and plant costs;
estimating the direct costs of the project;
calculating on-costs; and
preparing reports for tender adjudication.

The steps involved in producing an estimate for a housing development are :

project study;
estimating the site development budget;
breaking down the dwelling units into their constituent elements;
obtaining material and sub-contractor quotations;
estimating the direct costs of the dwelling units;
estimating abnormal costs;
calculating on-costs; and
preparing reports for agreement.

These are described below:

i) *Project Study*

The first stage of the estimating process is the project study. The estimating department may already have been involved in preparing the original outline scheme which is used to determine the maximum land price payable in securing an area of building land, and the optimum mix of dwellings to maximise return. These decisions are taken at developing manager/ managing director level with advice from the land buying/financial appraisal functions.

Whether or not the estimating department has prior knowledge of the scheme they will be presented with a set of documents relating to the development. These consist of site plans showing plot layouts, dwelling types to be erected identified by numbers and proposed road and drainage lines. If it is available, or thought advisable, site borehole data may also be included. These will be accompanied by standard dwelling specifications amended to suit the local conditions, planning requirements or other special constraints. A planned schedule of completions or key dates (such as the completion of a show house) may also be included.

Having received this information the chief estimator will assign the project to one or more estimators depending upon the size and urgency of the project. A walk over survey will then usually be undertaken. This walk-over survey enables the estimators to confirm the information supplied and also to identify problem area's particularly with regard to site development (ie any site levelling required, positioning of roads and drains) and with regard to abnormal foundations.

At this stage a more detailed site plan may be produced either by the estimators or jointly by the estimators and the financial appraisal staff. A planned sequence of work will also be developed.

ii) *Site development budget*

The site development budget contains all work which can not be allocated to a plot. This will include site road installation, drainage, service links and any preparatory site works. It may also include provision of site offices etc. or those may be covered in a general overhead element.

Estimating these works relies heavily on traditional estimating techniques as described by McCaffer and Baldwin (1986). Much of this work is sub-contracted thus sub-contractor quotes plus markup often forms the estimate. The site development may be kept as a separate estimate or may be apportioned to the plots. This may be done on a total area basis or a frontage basis. This latter approach may be taken if the cost /metre of frontage and the revenue/metre of frontage are used as performance indicators by the company.

iii) *Dwelling unit breakdown*

The information supplied to the estimators contains the plan of the plot layouts with an indication of the dwelling type to be built on each plot. These dwelling types will be one of a standard range of dwellings offered by the company. Each company will have its own range of types which may contain between 30 to 100 standard dwellings. Barratt Homes, Britains largest specialist house-builder was reported as having 54 standard designs in 1985 (Spring, 1985).

The items of work (including labour, plant and materials) which make up these standard house types will be known and documented. Hence a standard type 'A' dwelling built in London will contain the same items and amounts of labour, plant and materials as a standard type 'A' dwelling in Aberdeen. However the cost of building the two dwellings will depend on local variation in material suppliers, sub-contractors etc. This comparison only includes the fabric and fittings of the structure. The cost of the plot itself and any foundation works required will vary from site to site and will need to be estimated separately. Thus the breakdown of standard dwellings into their constituent items is a relatively straightforward task.

However due to local constraints such as planning requirements, special customer requirements or company decisions to offer either a more basic or more comprehensive standard specification these standard dwelling types are often amended to produce one-off or site specific designs. In this case the estimator must ascertain the differences from the standard and break them down accordingly.

Once this has been achieved the estimator will have a complete "parts-list" for all dwellings on the development.

iv) *Material and sub-contractor quotations*

The majority of the building work is subcontracted therefore quotes are required for all major (ie cost significant) items. These may be obtained by the estimator directly from the supplier or from the buyer who places orders and who is therefore 'in tune' with current rates. This latter approach is adopted for the less cost significant items.

v) *Estimating the direct costs*

Once the quotations have been obtained unit rates can be calculated and these can be applied to the work item quantities abstracted in iii) above to give a cost for each work item and thus a cost for the whole dwelling. The costs are usually recorded on a plot by plot basis and summed for the whole development.

vi) *Estimating abnormal costs*

Any non-standard items are estimated separately. These may include non-standard foundations, or abnormal external works.

vii) *Calculating On-costs*

On costs include allowance for site management and supervision, site accommodation, miscellaneous labour etc. Much of the requirement for detailed calculation of on-costs is minimised by the extensive use of sub-contractors hence the on-cost and the allowance for profit and risk is usually a lump sum percentage added to the total cost for each dwelling. This method is rudimentary when compared to the calculations undertaken by contracting organisations but it appears to be satisfactory.

3.3.4 *Estimating data flow*

The data used by the estimating department to undertake its work is shown in fig 3.8 and is defined as follows:

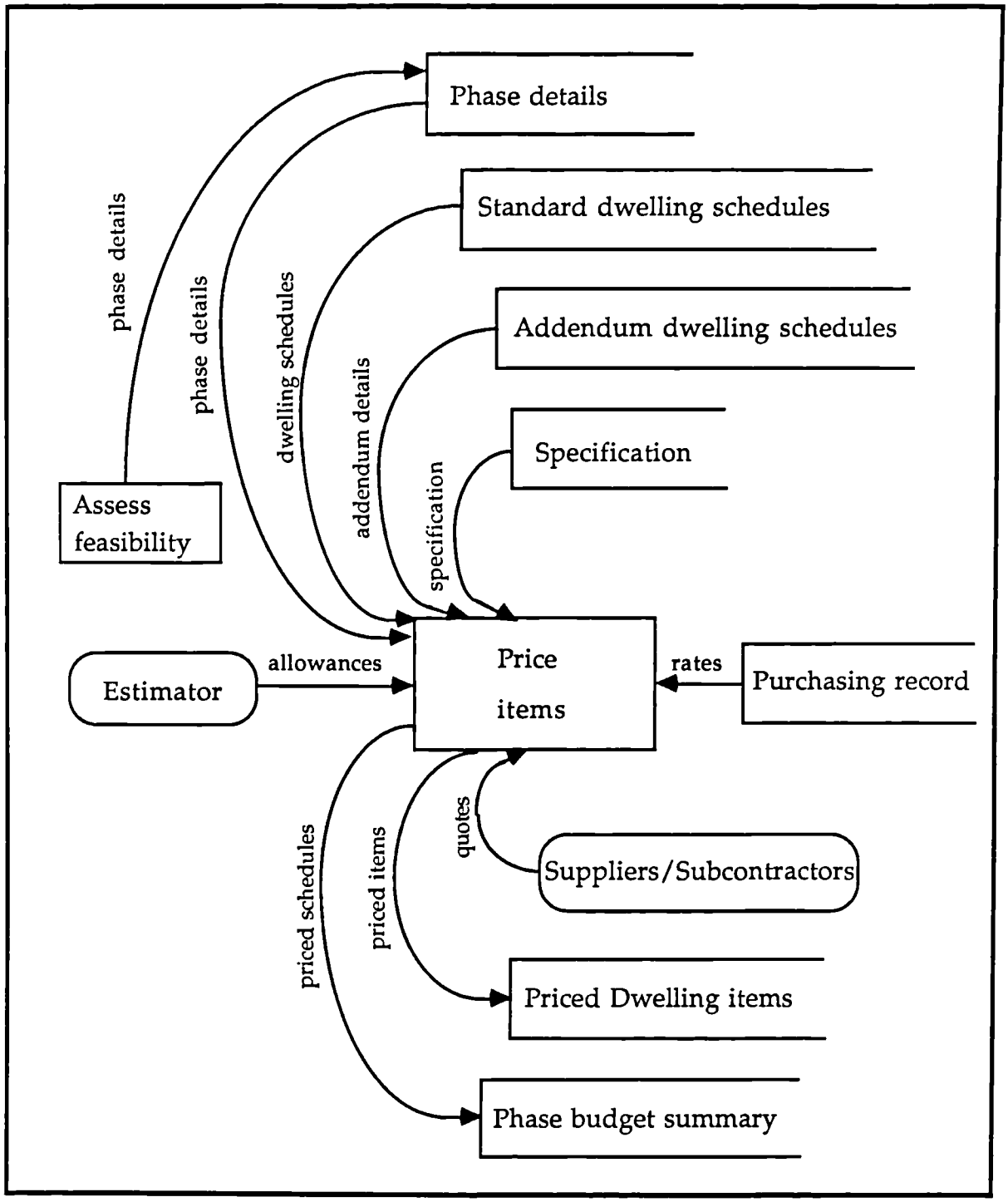

Fig. 3.8 Estimating data flow

Data Received

Site plans and layout: This may take several forms from very brief sketch details to fully annotated plans. The estimating department may already be familiar with the project if they collaborated in the formation of the preliminary proposals.

Plot layouts and details: the plans will usually be divided into the proposed plots and the dwelling unit decisions for each plot will be shown. These decisions may later be reworked in the light of the overall budget estimate to reduce costs, increase revenue or to alter the character of the development.

Dwelling addenda details: details of any non-standard dwelling features will be included

Specification changes: details of any known changes to standard specifications will be included.

All of the above information is received from the financial appraisal/land buying functions responsible for originally assessing the potential of the development.

Material/Sub-contractor rates: These will be obtained either directly from suppliers/sub-contractors or from the purchasing department who are familiar with the up to date rates.

Data available

Standard dwelling schedules: for each of the companies standard dwelling units the estimator will have a standard dwelling schedule. This schedule list under various headings the individual items and their quantities which make up the dwelling.

Standard addenda schedules: some modifications may be so common as to become "standard" addendums. These addenda schedules hold details on the changes to the items in the standard schedules.

Standard specification: each item used within the dwelling units will have a standard specification. This standard specification will be amended by the estimator to suit the prevailing site condition. In particular changes may be required to suit local planning regulations etc.

Data generated or transformed

Priced dwelling schedules: for each plot on the development the estimator prices all the items within each dwelling schedule to produce a total cost of the dwelling.

These dwelling schedules may include addendum schedules of non-standard items, schedules of abnormal costs usually including non-standard foundations and the cost of external site works allocated to the individual plots or priced separately.

Preliminary costs: the estimator calculates the required preliminary costs of the site (site establishment, supervision and transport etc.). These costs may be apportioned back to the individual plots or priced separately.

Project-specific specification: the estimator amends the company-standard specification to suit the particular requirements of the project.

Budget cost estimate: by combining all costs associated with the development the estimator produces the budget cost estimate for the project.

Data passed on

To the purchaser:	The priced schedules for each plot The project specific specification
To the surveyor:	The priced schedules for each plot The project specific specification
To senior management:	The budget cost estimate.

3.3.5 *The Purchasing process*

The purchasing of sub-contractor services and materials for sites and indeed obtaining quotes for such services is undertaken by an independent purchasing department or function. This department is usually small compared to the estimating department or purchasing functions within general building or civil engineering contractors. This is due to the restricted and specialised nature of the house-building industry. England(1970) has identified the following steps in the purchasing process:

- ascertainment of the need;
- an accurate statement of the character and amount of the article to be purchased;
- negotiation of possible sources of supply;
- transmission of the purchasing requisition;
- vendor selection and placing of orders;
- the follow-up of the order;
- checking the invoice;
- delivery of the goods; and
- completion of the records.

These are similar for the house-building buyer whose duties may be summarised as :

aggregating total quantities of materials for all house types within a development or part development;

aggregating sub-contract trade requirements within a development or part development;

sending out sub-contractor and material schedules and obtaining competitive material and sub-contract quotes;

placing material and sub-contract orders;

checking material and sub-contract invoices against orders before passing them to the accounts department for payment;

maintaining a purchasing record (a simplified purchase ledger); and

maintaining lists of names and addresses of suitable material suppliers and sub-contractors.

These are described in detail below.

i) *Aggregating material and sub-contractor quantities*

In order for quotes to be obtained for materials and sub-contractors the buyer must first abstract like items from each house type and aggregate (ie add together) their quantities. Given that each house type may contain several thousand individual items this process can be both tedious and time consuming even if only the larger cost-significant items are considered. This process is further complicated where addendum or non-standard dwelling units are involved as standard schedules may not exist for these.

ii) *Obtaining quotes*

Having aggregated the item quantities, quotes are obtained from suppliers and sub-contractors. These are initially taken informally via telephone but official schedules are then sent to the suppliers for pricing. Several suppliers may be approached for the major cost significant items (bricks, blocks, bricklaying, plastering etc.) but single quotes are often sufficient for less important items.

The suppliers to contact are selected from the lists maintained by the buyer. Often the same suppliers are used as for previous projects, providing their service or workmanship is satisfactory, but for projects in new locations or for new materials, new suppliers are found either from trade directories or catalogues, from the yellow pages or by recommendation. On the successful completion of the order or work they may be added to the buyers approved list.

iii) *Placing orders*

Official orders for materials or sub-contractors are placed after receiving notification from the suppliers or sub-contractors of rates and discounts. Orders are usually awarded to the supplier offering the lowest rate for the particular task but occasionally other factors such as location, previous record, etc. are taken into account.

It should be noted that for large developments the total quantity required may not be ordered at once. Usually the order is "staged" to coincide with the development on-site. This both reduces the storage requirements (and wastage) on site and also achieves a better cash flow for the project.

iv) *Invoice checking*

Once the work or order is complete the supplier or sub-contractor submits an invoice for the required amount. This invoice is checked against the order either by the accounts dept. or more usually by the buyer who is more familiar with the original order details and any subsequent changes which have occurred. Having approved the invoice it is passed onto the accounts department for payment. If the invoice does not agree with the order it is the buyers task to determine where and how the discrepancy has occurred and to decide on what action to take.

v) *Maintaining a purchasing record*

In performing his duties the buyer obviously needs to maintain a record of his transactions so that the current purchasing position for each item on each active development is readily available.

The format of this on-going record varies greatly from company to company from brief rough notes informally recorded by the buyer to more formal sheets and forms filled in by the buyer as a matter of course. From the observations of this research it is recommended that the following information should be recorded on the purchasing record:

- item number or description of item;
- aggregated quantity;

- total quantity to order;
- quoted rate;
- total quantity ordered to date;
- date of last order;
- discount details;
- cumulative total spent (or committed) to date; and
- supplier number, name and address.

vi) *Maintaining supplier/sub-contractor lists*

As previously described, the buyer maintains a list of approved suppliers or sub-contractors. This is a list of names, addresses, telephone numbers and details of materials/services offered and perhaps a brief note on past performance.

3.3.6 *Purchasing Data Flow*

The data used by the purchasing department to undertake its work is shown in fig 3.9 and is defined as follows:

Data received

i) From the estimator : Priced dwelling schedules for each plot. Project-specific specification

ii) From material suppliers and sub-contractors : Material and sub-contractor quotes. Material and sub-contractor invoices.

Data available

Supplier and sub-contractor lists: the purchaser will maintain lists of approved material suppliers and sub-contractors.

Data generated or transformed

Purchasing schedules: from the priced dwelling schedules supplied by the estimator the buyer aggregates the item quantities to produce purchasing

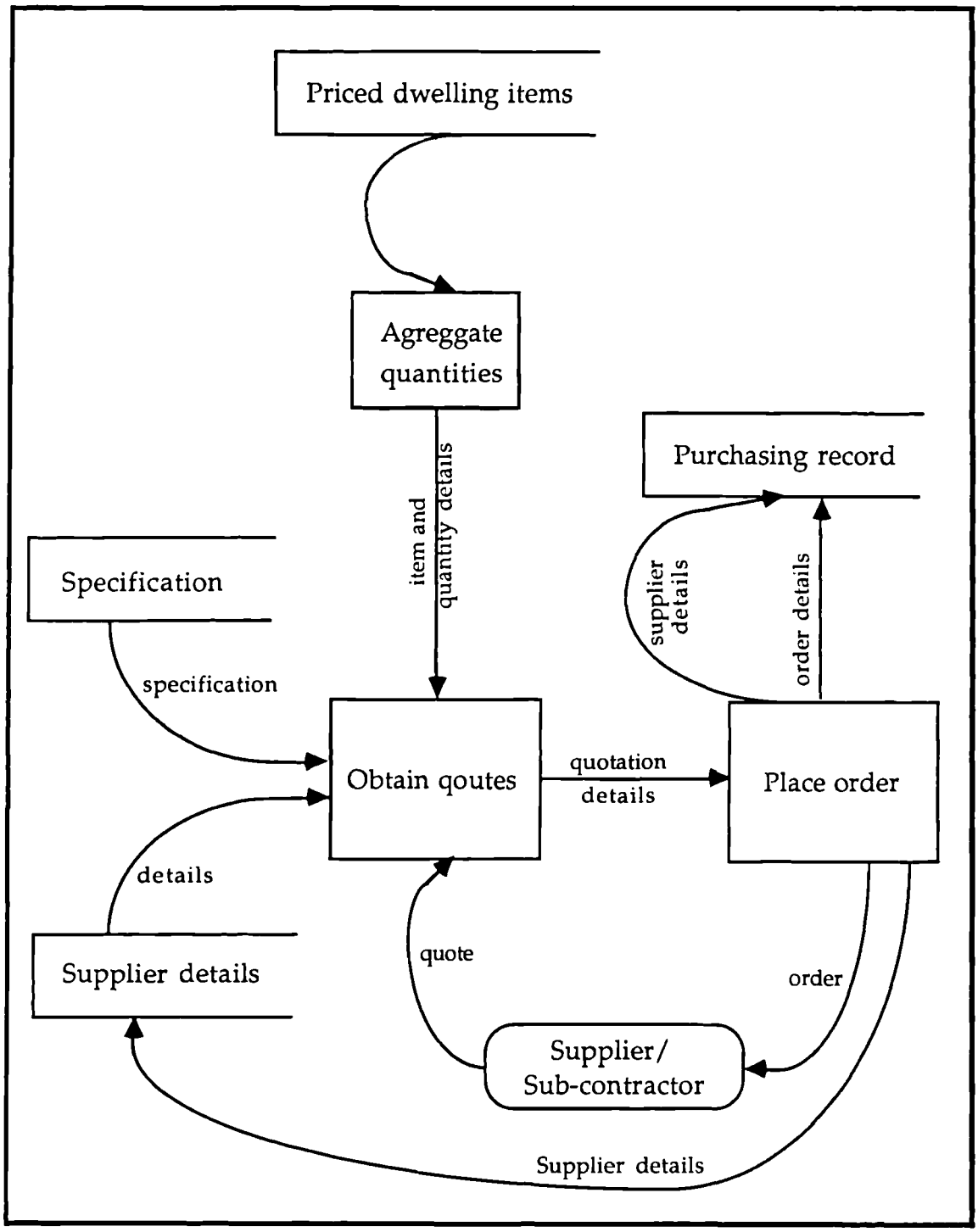

Fig. 3.9 Purchasing data flow

schedules. Whilst aggregating the quantities the buyer also makes wastage allowances and assumptions.

Purchase orders: from the purchase schedules, specification and the supplier/sub-contractor lists the buyer obtains quotes for the required items and places the appropriate orders.

Purchasing record: a record of the aggregated quantities, amounts ordered, purchasing rates, dates and supplier details forms the purchasing record.

Data passed on

To the estimator:	the latest material and sub-contractor quotes
To the accounts dept:	orders and invoices for checking and payment
To senior management:	the purchasing record for cost reconciliation at the completion of the project.

Data not used

The estimators rates are not used by the purchaser.

3.3.7 *The Valuations process*

During construction the house builder invoices the developer (or client) on a monthly basis for payment. The basis of this invoice is the monthly valuation of the work undertaken by the builder and agreed by the developer (or client). The monthly valuation may be undertaken by the senior site staff or the estimators but is more often undertaken by the quantity surveying staff of the company.

Preparing the monthly valuation sheets involves the following:

aggregating the item costs into cost centres;

measuring the work done against these cost centres and calculating the value to date;

comparing the current progress figures with the previous months figures to obtain the value of work done;

agreeing and recording any variations in work and charging the appropriate portion thereof;

producing valuations summaries to be passed to the accounts dept. for actioning and senior management for information; and

producing cost/value reports for management.

i) *Aggregating items into cost centres*

Monthly payments to contractors can be based on several different methods. In civil engineering all work is usually subject to re-measurement whereas building is usually assessed on the billed quantities (Ndekugri, 1986). House building valuations are similar to the latter.

The individual items for each dwelling are collected in to global cost centres (usually between 20 - 50 cost centres are sufficient whilst there may be several thousand different items). These cost centres include the major materials and labour items used during construction eg. bricks and blocks, concrete, plasterer etc. The cost centres are further sub-divided into cost stages. These stages usually coincide with identifiable stages of physical progress for example foundations, first lift, externals etc.

The rates for the individual items which make up the cost centres are aggregated into global rates for the centres and stages thus allowing the work to be valued on the global cost centres rather than on an individual item basis. This aggregation is usually done on a plot by plot basis. Where costs are not plot based ie. site roads, drainage etc. these items are apportioned to plot costs on a total area basis or some similar method

ii) *Measuring work done*

Each month the surveyor will determine the amount of progress on site in order to prepare the monthly valuation. This is normally assessed on a "percentage complete" basis as opposed to a measured value.

A total cost for each cost centre stage will have been calculated as described in i) above for each plot. The surveyor visits each plot and notes the percentage complete for each stage for example:

Concrete in foundations - 100% complete
Brickwork in foundations - 50% complete

The importance and total cost of the stage largely determines the required accuracy of these observations. Increments of 10% are usually sufficient.

Having obtained the progress figures from site these can be multiplied by the cost centre/stage rate to give the value to date for that stage on that plot. Aggregating the plot values gives a total value to date for that development.

iii) *Comparison with previous figures*

By comparing the total value to date with the same figure for the previous month the value earned for the current month is calculated.

iv) *Other additions*

In addition to the measured progress on site the surveyor will assess the proportion of direct site costs to be recovered and any inflationary adjustments to be made.

v) *Preparation of valuation summary sheets*

By combining iii) and iv) above the total monthly valuation to be submitted to the client can be calculated. The build-up of this claim is usually summarised on a valuation summary sheet. This is used by the accounts dept. to instigate payment and by senior management for information on actual progress and cash flow.

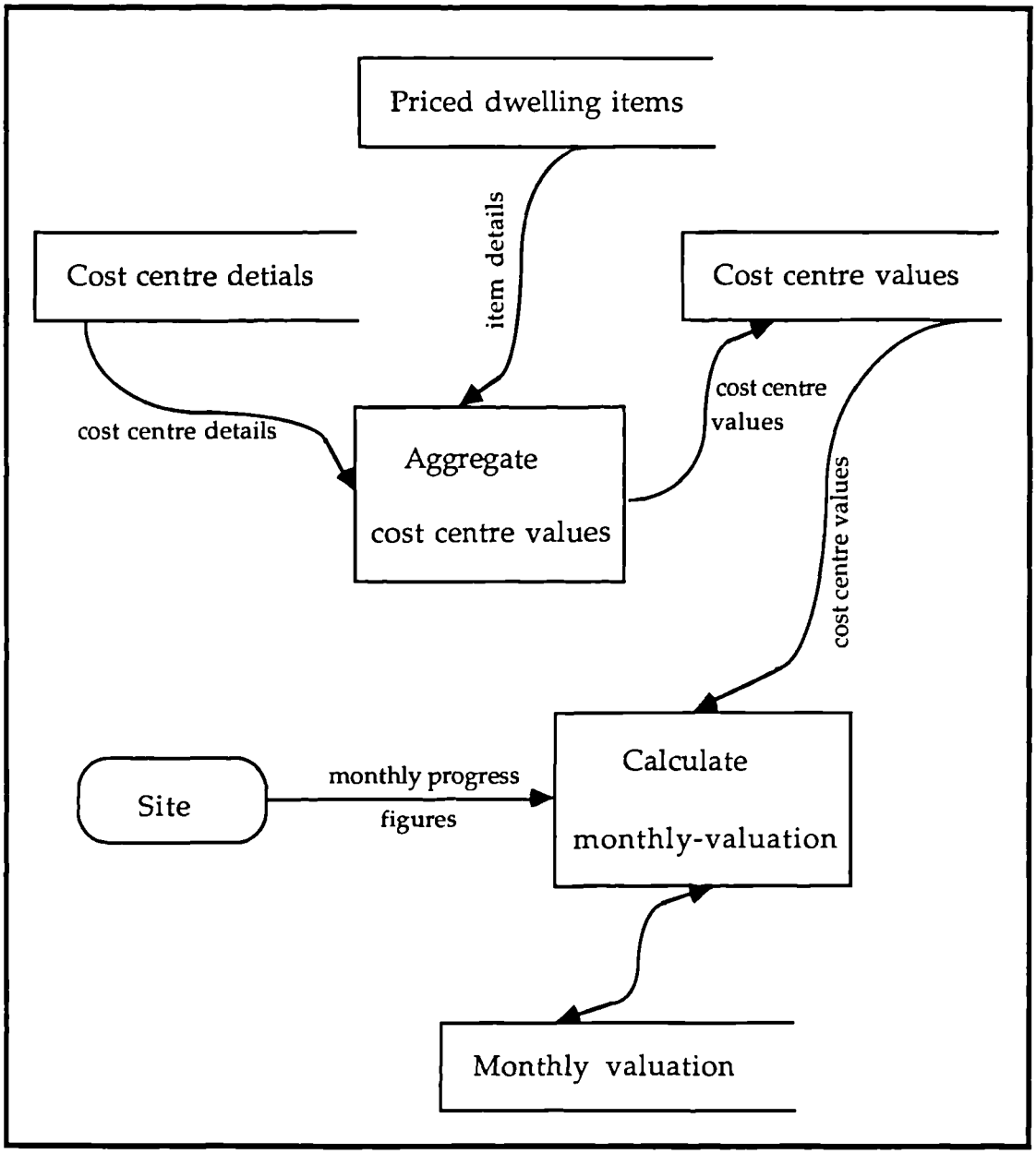

Fig. 3.10 Valuation data flow

3.3.8 *Valuations data flow*

The data used by the surveyors to undertake their work is shown in fig 3.10 and is defined as follows:

Data received

From the estimator : Priced dwelling schedules for each plot
Budget estimate

Data Available

Cost centre details: the surveyor maintains a company standard list of cost centres and stages.

Data generated or transformed

Cost centre rates: from the priced dwelling schedules supplied by the estimator, the surveyor aggregates the item rates into global cost centre rates and stages.

Monthly progress figures: from the site the surveyor assesses the monthly progress for each of the cost centre stages.

Monthly valuation summaries: by combining the monthly progress figures, the cost code rates and the value of any variations the surveyor is able to produce monthly valuations for payment purposes and valuation summaries for senior management to enable monitoring of progress and profitability.

Data passed on

To the client: monthly valuation amounts

To senior management: monthly valuation summaries

To the accounts department: monthly valuation summaries to allow cost/value reconciliations.

3.3.9 *The Cost monitoring/comparison process*

Two types of cost monitoring/comparison techniques were observed in the collaborating company.

The first was undertaken by the accounts department and consisted of comparing the invoiced amounts from suppliers and sub-contractors against the value earned on the various cost codes. This allowed for a typical cost/value report to be prepared.

The cost centre values were readily obtained from the monthly valuation sheets but the invoices had to be sorted and similarly coded if meaningful comparisons were to be made. This was not always undertaken due to the time consuming nature of the task.
The second method was an item by item comparison between the estimated rate, quantity and hence total value and the actual purchasing rate, purchasing quantity and hence total cost. Only the major cost significant items were compared in this way and it enabled the performance of the estimating department to be monitored and rogue items (ie. an item which has cost significantly more or less than expected) to be identified. This type of information was particularly useful in the final overall financial assessment of a projects performance.

3.3.10 *Cost Monitoring/comparisons data flow*

The data used to facilitate cost monitoring/cost comparisons is shown in fig 3.11 and defined as follows:

Data Received

From the estimator : Priced dwelling schedules for each plot.

From the purchaser : The purchasing record containing current item rates and quantities.

From the surveyor : Up-to-date valuation details against cost centres.

From the accountant : Up-to-date payment and commitment details against cost centres.

Data generated or transformed

Cost/Value reconciliation between valuation and payment details.

Purchasing/Estimating reconciliation between estimated rates and purchasing rates.

Data passed on

To senior management : cost/value reconciliation

To senior estimator : purchasing/estimating reconciliation.

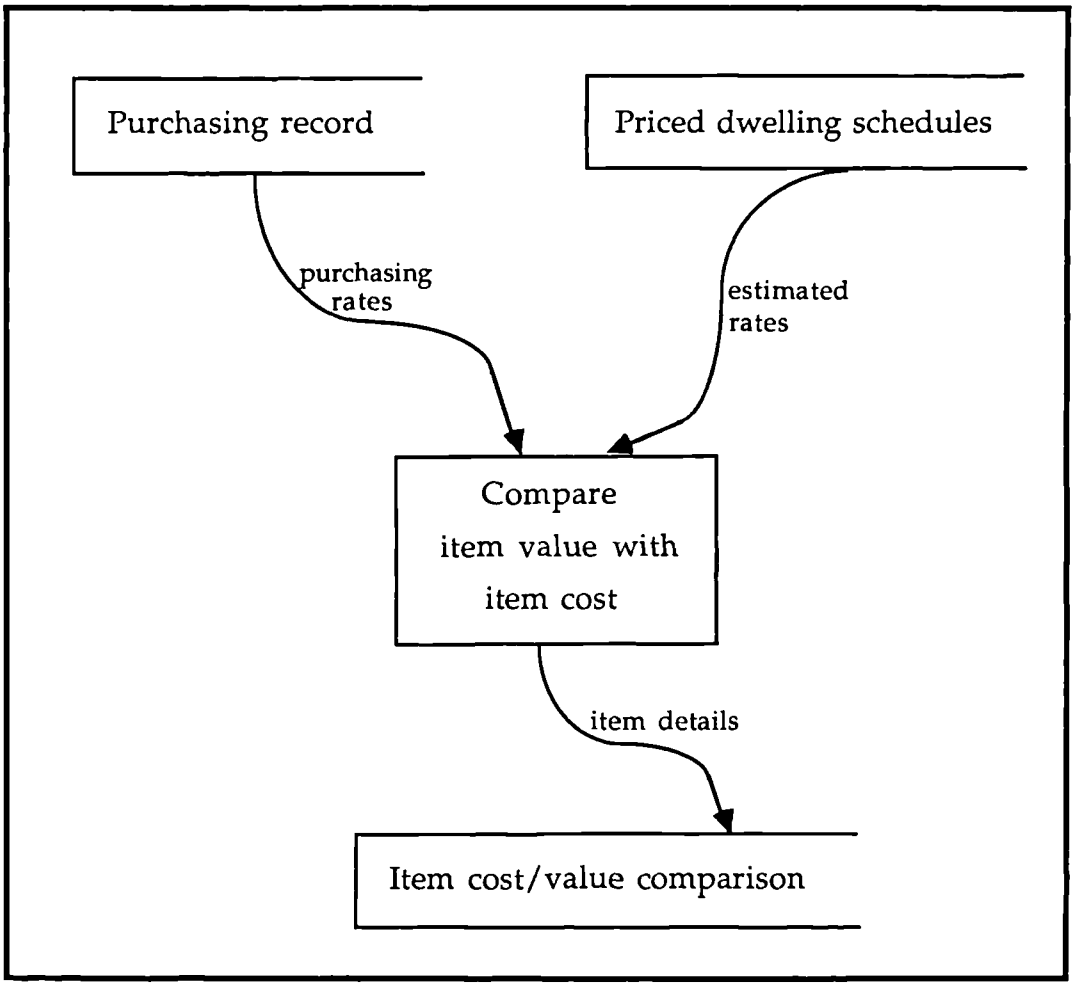

Fig. 3.11 Cost Monitoring/Comparisons data flow

3.4 Logical data modelling.

3.4.1 *Introduction*

Logical data models were constructed having identified and mapped the flow of information between the commercial and technical functions with the aid of data flow diagrams. Logical data models or entity-relationship models as they are also known are used:

to identify the key items of data and their sources (the entities);

to establish and verify the connections between them (the relationships);
and
to identify their main distinguishing features (the attributes).

Having identified these features of the data flow a system design can be undertaken.

The technique involves building models of observed phenomena (data flows) and from these proposing logical models of an improved system (Checkland, 1981). By modelling the data in the way, duplications and redundancies can be identified and eliminated, and enables a system design to be undertaken (as described in Chapter 4).

A full description of the technique can be obtained in Chen (1976), Howe (1983), Date (1986) and Benyon (1990). The use of this technique in modelling construction information systems has been reported by Betts (1987), Blackwood (1988) and Tah (1989).

For the sake of clarity the membership class of the relationships (mandatory, optional, involuted etc.) is not shown.

3.4.2 *Definitions and Terminology*

Logical Data Modelling is a method used to understand, analyse and document a complex environment in terms of its data resources. The emphasis is to analyse the pure state of the data, unconstrained by organisational functions. The analysis identifies entities, their attributes and

the possible relationships between entities all of which is summarised in a logical data model diagram(entity-relationship diagram).

i) *Entities*

An entity is something of fundamental importance to an organisation. It is something about which data will be kept in an information handling system (eg. FACTS, ABSTRACTIONS and EVENTS).

ii) *Attributes*

An attribute is a basic unit of information which describes an entity. Within the organisations environment an attribute cannot usefully be sub-divided into other units of information.

iii) *Relationships*

A relationship is an association between entities. Several different types of relationship exist (one to one, one to many , mandatory, optional, involuted etc.)

iv) *System rules*

Each component in a data system environment must be classified as either being an entity , an attribute or a relationship .

A component cannot be classified in more then one way.
Each entity must have a unique identifier and at least one other attribute.
Relationships exist only between entities.

The notation adopted is shown in Fig 3.12

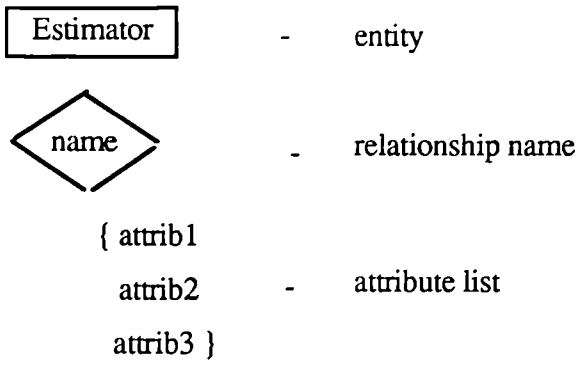

Fig 3.12 Entity-relationship model notation.

3.4.3 *Basic data used by functions*

Despite the different roles and needs of the technical and commercial management functions within the house building organisation their processes are based upon a common unit of data. This data unit may be amended or aggregated (summed) for particular purposes but it consists essentially of:

i) a description of a work item (a dwelling schedule item);
ii) a unit of measurement;
iii) a quantity; and
iv) a unit rate for undertaking the work (which may incorporate an element for overhead recovery and profit).

This basic unit of data is passed between the functions where other data may be appended, abstracted or aggregated. Surrounding this basic data is the mass of supporting data, site details, programme dates, market conditions, company workload, material specifications, supplier details etc. which enables the organisation to estimate, purchase and measure its various potential and on-going projects.

Within civil engineering and building contracting organisations this base data originates from the bill of quantities (Marchant,1987; Braint,1984) which normally has been prepared on behalf of the client by his quantity surveyors. However in house building organisations this base data is generated in-house from the original outline plan and dwelling unit mix decisions and is identified as a dwelling schedule item. It is therefore less

ambiguous and more easily verified than bill of quantities data. However it is equally more readily changed and amended due to changing market conditions or company strategies. It is this basic data that provides the link between the functions and thus enables an integrated approach to be adopted.

3.4.4 *Estimating Data Model*

The entity-relationship model for estimating is shown in fig 3.13, tabulated in table 3.1 and briefly described below.

Table 3.1 Entities, attributes and relationships for estimating

Entity	Attributes	Related to	Relationship
Development	Code Name Location Agent Budget cost	Dwelling Type	contains
Dwelling type	Code Plot number Description Area Dwelling cost	Dwelling Schedule Development	comprises is contained
Dwelling Schedule	Code Name Schedule cost	Dwelling Item Dwelling Type	comprises is contained
Dwelling Item	Code Description Quantity Rate Estimated cost	Dwelling Schedule Estimator	forms is priced
Estimator	Code Name	Dwelling Item	prices

Each development is made up from ('contains') a number of dwelling types. These may be either standard or addendum types. Each dwelling type on the project contains a code number identifying it, a description, its habitable

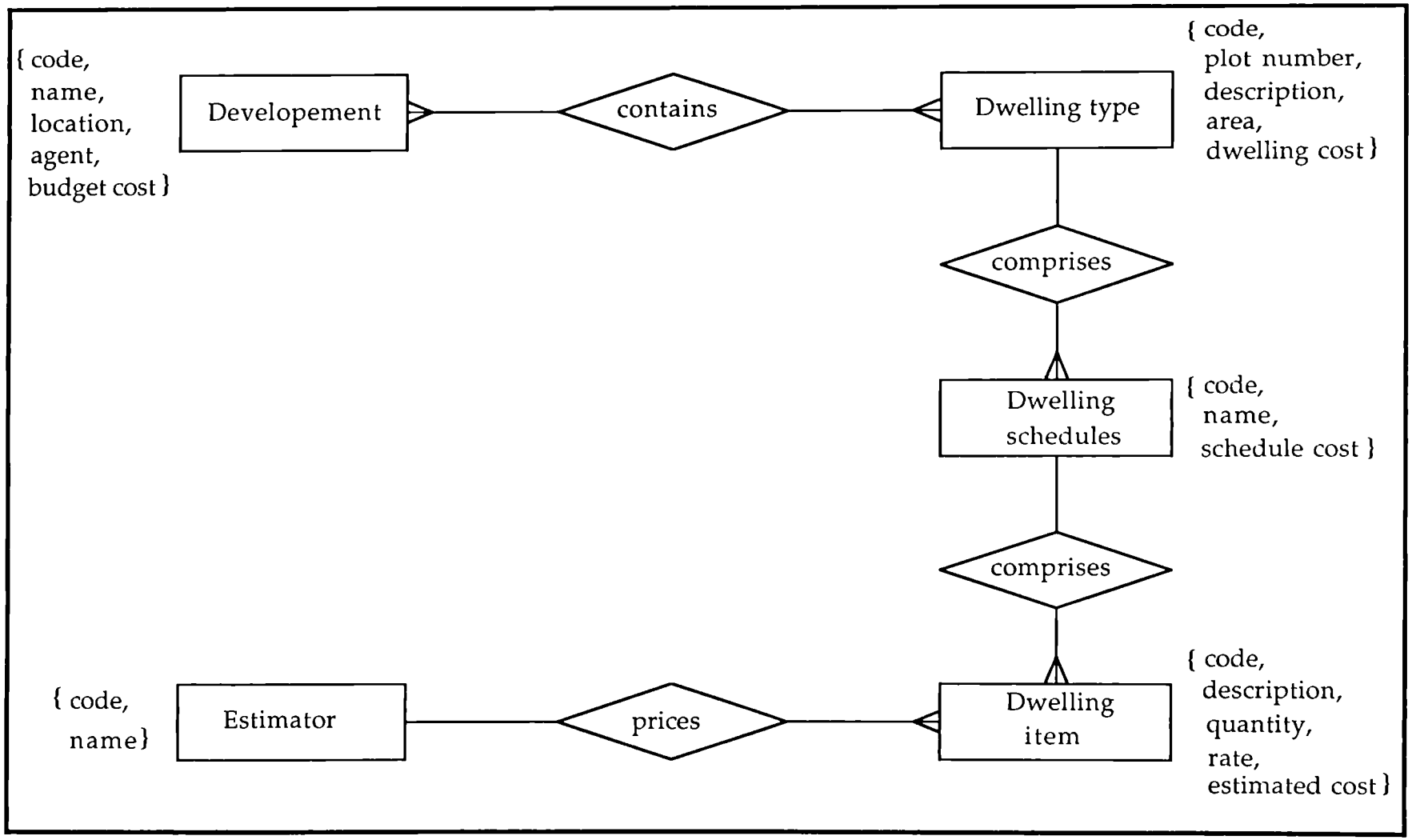

Fig. 3.13 Entity - Relationship Model for Estimating

area and estimated dwelling cost. The dwelling type comprises 80 standard dwelling schedules. Each schedule has a code, name and total estimated schedule cost. The sum of these schedule costs is the estimated dwelling cost.

The dwelling schedules contain a number of dwelling schedule items. Each item has a code, description and quantity. The estimator prices each item by entering a rate. When multiplied by the quantity this produces the estimated

dwelling schedule item cost. The sum of all the individual item costs within a dwelling schedule is the estimated schedule cost.

The estimator is identified by a code and a name.

The Development has a code, name, location, agent name and budget cost. The budget cost is the sum of all the individual estimated dwelling costs.

3.4.5 *Purchasing Data Model*

The entity-relationship model for purchasing is shown in fig 3.14, tabulated in table 3.2 and briefly described below.

Each dwelling on a development contains dwelling schedules. Between different dwellings these schedules will contain many of the same items but with differing quantities. Total quantities for each dwelling schedule item may thus be aggregated from all the dwelling schedules.

The aggregated dwelling item is identified by a code and description and has a total aggregated quantity. This quantity therefore represents the amount of that item required for the whole development.

The purchaser (identified by a code and name) places orders with suppliers for the dwelling items. The supplier is identified by a code, name and has an address.

The details of all orders form the purchasing record for that phase and it is maintained by the purchaser. The purchasing record is identified by the development code and date.

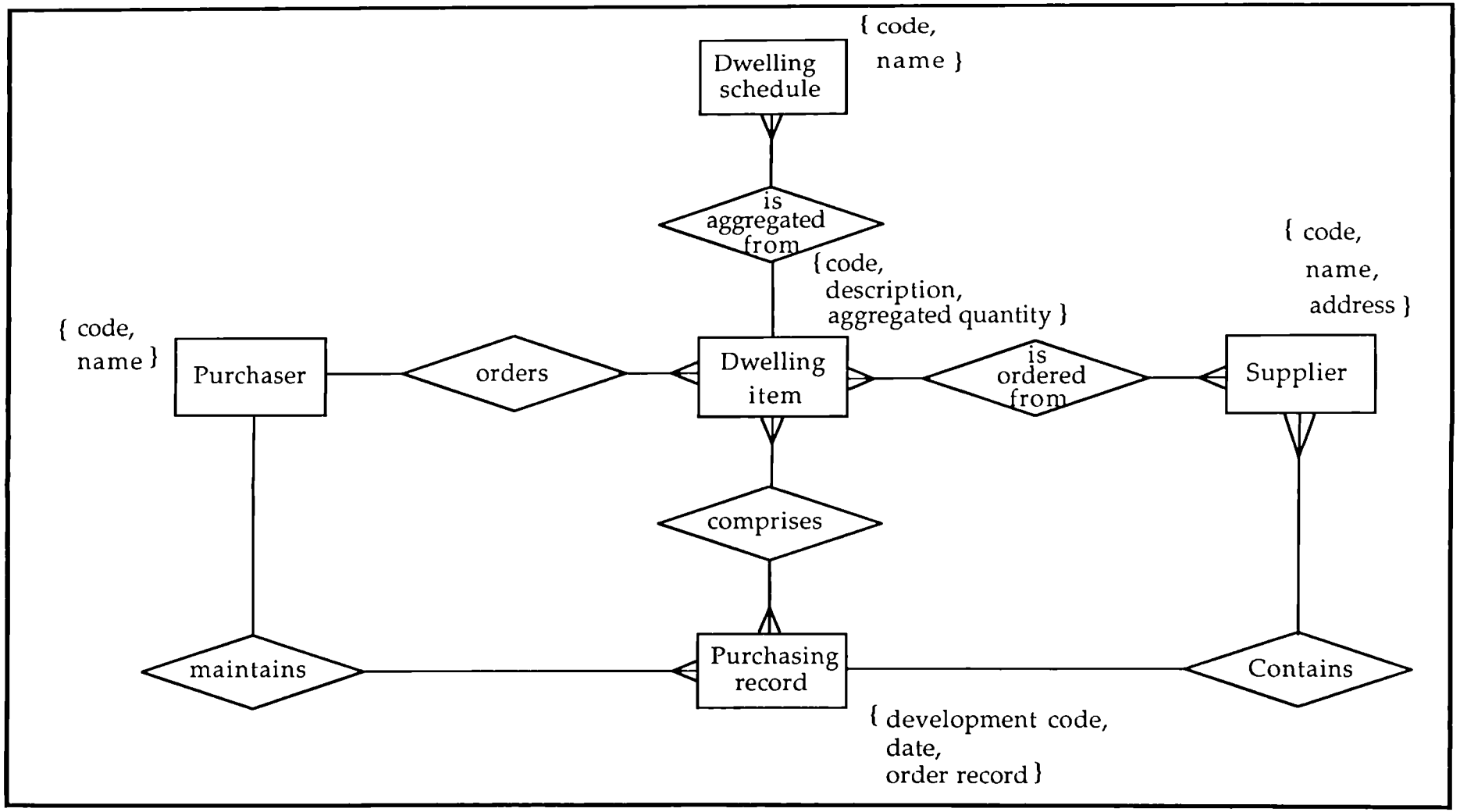

Fig. 3.14 Entity - Relationship Model for Purchasing

Table 3.2 Entities, attributes and relationships for purchasing

Entity	Attribute	Related to	Relationship
Dwelling Schedule	Code Name	Dwelling item	aggregates to
Dwelling item	Code Description Aggregated Qty	Dwelling Schedule Purchaser Supplier Purchasing Record	aggregated from ordered by ordered from forms
Purchaser	Code Name	Dwelling Item Purchasing Record	orders maintains
Supplier	Code Name Address	Dwelling Item Purchasing Record	supplies is recorded
Purchasing Record	Dev. Code Date Order Record	Dwelling Item Purchaser Supplier	records maintained by contains

3.4.6 *Valuations Data Model*

The entity-relationship model for valuations is shown in fig 3.15, tabulated in table 3.3. and briefly described below.

Each dwelling schedule item has an estimated cost and quantity. These items for each development are gathered together ('aggregated') into cost centres. Each cost centre is identified by a code and description and contains an aggregated quantity and aggregated rate for a number of

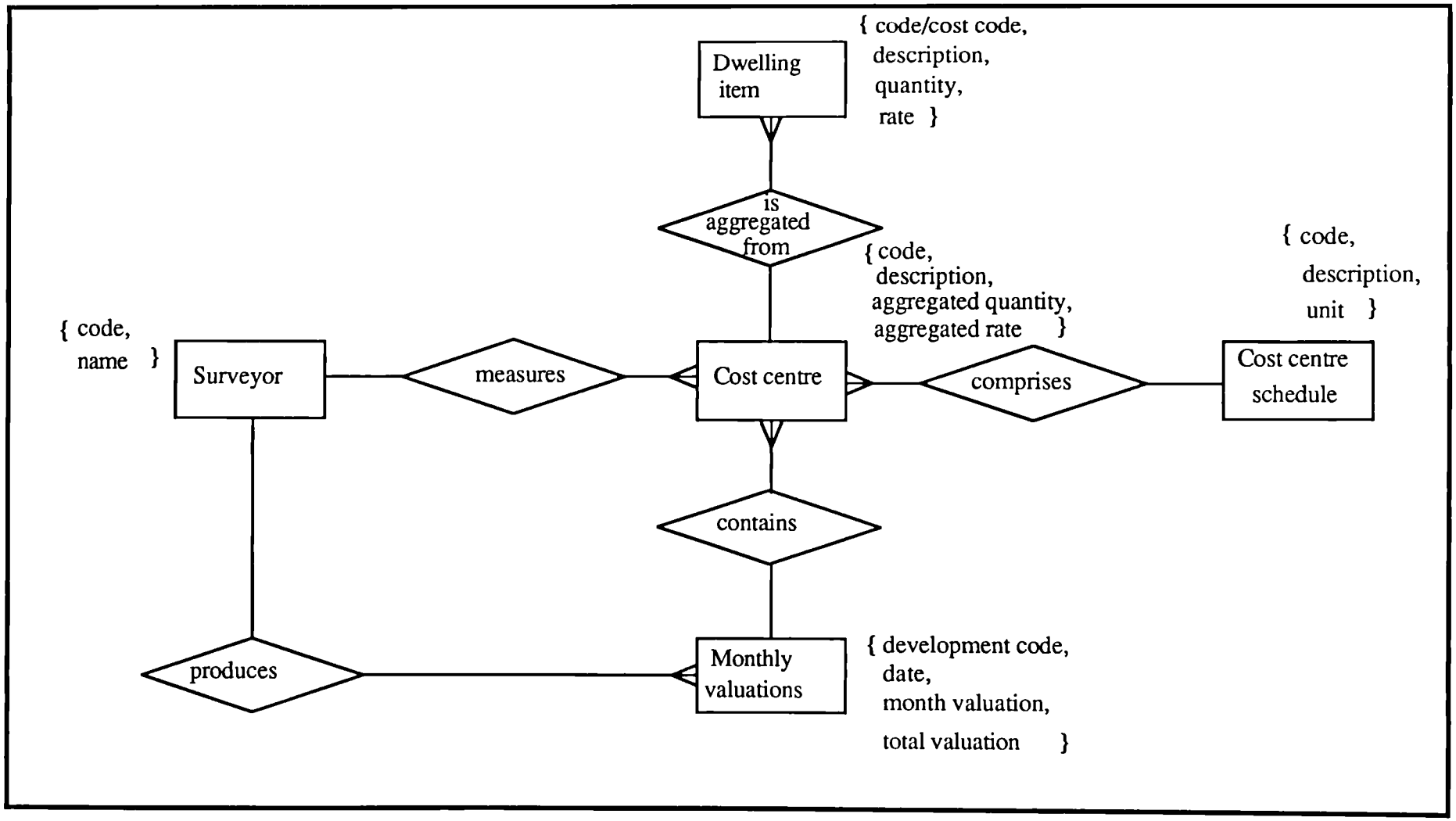

Fig. 3.15 Entity - Relationship Model for Valuations

Table 3.3 Entities, attributes and relationships for valuations

Entity	Attribute	Related to	Relationship
Dwelling Item	Code/Cost Code Description Quantity Rate	Cost Centre	aggregated to
Cost Centre	Code Description Aggregated Qty Aggregatdd Rate	Dwelling Item Surveyor Cost Centre Schd Monthly Valuation	aggregated from measured by contained forms
Surveyor	Code Name	Cost Centre Montly Valuation	measures produces
Cost Centre Schedule	Code Description Unit	Cost Code	comprises
Monthly Valuation	Development Code Date Mthly Valuation Total Valuation	Cost Centre Surveyor	contains produced by

dwelling items. The individual cost centres are held in a cost centre schedule. Each schedule is identified by a code and description, and hold the unit of measurement of the schedule. The surveyor measures progress on site against these cost centres and records the quantity of work done to date. This, when multiplied by the aggregated rate, gives the value to date of that cost centre. The sum of all the values to date for each cost centre forms the monthly valuation. This is identified by the development code and date, and holds the total valuation to date and the monthly valuation.

3.4.7 *Cost Monitoring/Comparisons data model*

The entity-relationship model for cost comparisons is shown in fig 3.16, tabulated in table 3.4 and briefly described below.

At the end of each month a member of the senior management collates the monthly account details for each development. The account details are identified by a development code and contain cost centre amounts (ie. invoices and accruals). These are compared with the monthly valuation figures for the corresponding development (ie. cost code values).

At the end of each development (or occasionally at any time during a development) a member of the senior management collates the purchasing record for a development and compares it to the dwelling item estimates for the corresponding development.

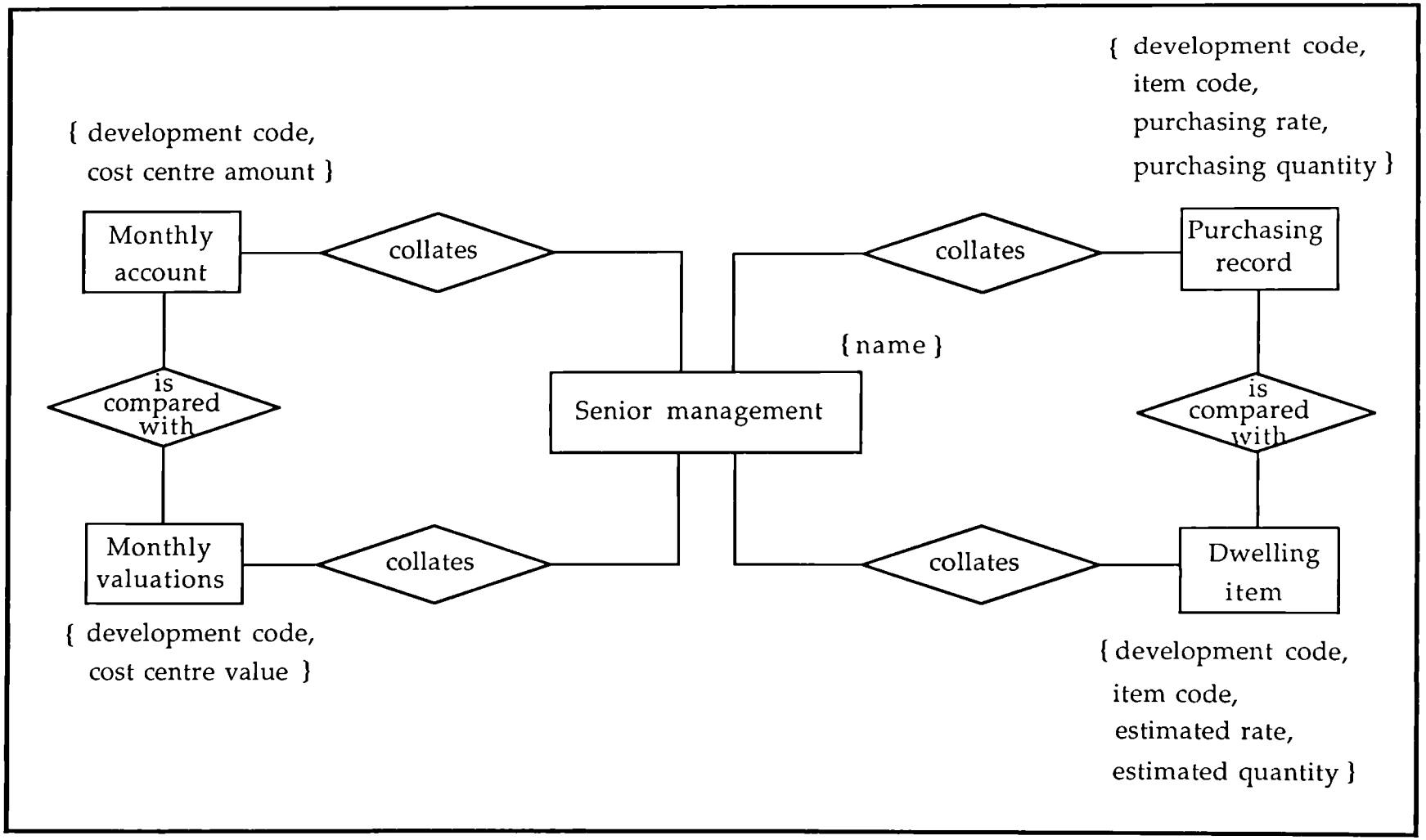

Fig. 3.16 Entity - Relationship Model for Cost Comparisons

Table 3.4 Entities, attributes and relationships for cost monitoring/comparisons

Entity	Attribute	Related to	Relationship
Senior Management	Name	Monthly Account Monthly Valuation Purchasing Record Dwelling Item	collates collates collates collates
Monthly Account	Development Code Cost Centre Amount	Senior Management Monthly Valuation	collated by compared with
Monthly Valuation	Development Cost Centre Value	Senior Management Monthly Account	collated by compared with
Purchasing Record	Development Code Item Code Purchasing Rate Purchasing Qty	Senior Management Dwelling Item	collated by compared with
Dwelling Item	Development Code Item Code Estimated Rate Estimated Qty	Senior Management Purchasing Record	collated by compared with

3.5 Summary

The study of the collaborating company and the five other house building organisations enabled the development of a typical organisational schematic. This schematic was divided into the business activities of: business development; accounting; technical and commercial; and construction. It was also layered into the management levels of strategic; tactical; and processing.

The development of the schematic highlighted the importance of the processing level technical and commercial functions and in particular the estimating function. A more detailed study of estimating, purchasing, valuations and cost monitoring/comparisons was therefore undertaken.

This study involved the development of data flow and logical data models for the four selected functions. The data flow models enabled the identification of the data used, received and passed on by the functions whilst the logical data models categorised these data flows into one of three types: entities; relationships; and attributes. The logical data modelling was important in describing at the most basic level the data required to undertake the four functions. This then enabled the computer-aided management system to be designed and developed to assist in these processes as described in the next section.

CHAPTER 4

4. SYSTEM REQUIREMENTS

4.1 Introduction

This section describes in both general and detailed terms the requirements of the developers computer-aided management system. These requirements were defined from the study of existing manual systems in use in the co-operating companies and from the data modelling exercises described in chapter 3.

Much information exists (Keen, 1981; Ginzberg, 1981; Benjamin and Scott Morton, 1988) regarding the organisational impact and problems brought about by the introduction of new computer systems into offices. All these authors emphasise that the successful implementation of a new system requires organisational as well as technical considerations. Wroe (1986) and Rounds and Warning (1987) specifically studied the problems and pitfalls of the small construction company in this area. Wroe produced a checklist of factors to be considered during the development and implementation of a management information system, and Rounds and Warning stressed the need for top-level management commitment to the development.

The computer system must fulfil various basic criteria to minimise the inevitable problems which ensue during installation and these are outlined in section 4.2.

As well as these basic criteria the system must be able to undertake the specified requirements and functions. For this system these were identified as :

estimating;
purchasing;
valuations; and
cost monitoring/comparisons.

Section 4.3 describes in detail the specification methodology and the system requirements for each of these functions.

4.2 General system requirements

The general requirements of the system cover those aspects which:

i) enable the system to be quickly and easily installed;
ii) enable the users to quickly understand and use the system and to further promote its use;
iii) present the user with an understandable and helpful dialogue mode (the user interface); and
iv) facilitate the effective control of the system by a member of the senior management designated the system manager.

Cusack (1987) has identified the following five general criteria which should be considered when designing a computer-based management information system:

i) The system must meet the requirements of the potential users and the temptation to design and implement a sophisticated system which is not understandable must be avoided;

ii) The system should make as much use as possible of the exception principle, highlighting deviations from expected behaviour thus keeping the amount of routine information to an absolute minimum; although this must be available for checking if required. Different outputs are required to satisfy the needs of the various users, who should be consulted as to the most appropriate formats;

iii) The computer provides information only by transforming the data input. The accuracy of this information is dependant on the availability of pertinent data, which must normally be input in a specified format. Accordingly, the technique used to enter the data must be accurately described with a general data validation procedure which will check and reject unsuitable information. Thus the system should request the operator to re-enter incorrect data items or enter missing data. It is important to ensure that existing data is not inadvertently destroyed when new data is entered;

iv) The system should be designed to allow additional modules to be added at a later date; and

v) The levels of skill, quality, potential and responsibility of the ultimate users should be taken into account, particularly in an interactive system, in that the user will have to retrieve information from the system and input new or modified information.

These factors were considered and incorporated when developing the specification for the system as described in section 4.3.2.

4.2.1 *Scope of system*

In keeping with Wroe's criteria for success (see section 2.4.1) and following discussions with the company management it was decided that the system would as far as was possible, reflect the existing in-house manual system but would include improvements where possible. In order to make the system familiar to the users the computer system was designed around existing practices, procedures and forms. This would have the benefit of minimising the disruption and learning times for the users.

The improvements envisaged over the manual systems where in the areas of data transfer, data capture and analysis of the available information. The more ordered structure that the computer system imposed would additionally standardise hitherto ad-hoc procedures and reports.

4.2.2 *Ease of use*

For any system to be successful it must be used. To be used the system must satisfy the expectation of the user, which may be realistically small or ambitiously large! Also in meeting these expectations the system must fulfil numerous criteria which collectively determine how "user-friendly" the system is.

In this context "user-friendly" is taken to mean:

an understandable dialogue mode;
meaningful error messages, traps and checks;
thorough validation of data entry;
sufficient control on access to protect data;

adequate back-up facilities to restore data in case of a system failure or mistake; and
thorough and understandable user documentation.

These features taken together determine how easy the system is to learn and use for the potential user.

Much work has been undertaken in studying the design of the user interface (for example Shneiderman, 1987; Vassiliou, 1982). Most indicate that there is some trade-off between ease of use and speed of operation (Walker, 1985; Wison, Barnard and MacLean, 1985). Often the more 'user-friendly' the system is, the more ponderous it is in operation, with each stage asking for confirmation of commands etc. This suits the novice user but the more experienced user often finds this frustrating and time consuming. However a system designed for an experienced user would quickly loose and disillusion the inexperienced user.

For this development it was decided to use a system of menus for the user interface. This perhaps errs towards the inexperienced user but as the personnel who would be using the system were all novice users it was felt that the time penalties involved were outweighed by the benefits of simple operation.

An example of a typical system menu is shown in fig. 4.1 below.

MAIN SPECIFICATION

AD . . . Add a New Specification
CH . . . Change an Existing Specification
DE . . . Delete an Existing Specification
RE . . . Refer to a Specification
PC . . . Print the Complete Specification
QU . . . Quit

Enter Command >

Fig 4.1 Typical system menu.

4.2.3 *Security and accessibility*

One of the main worries for management in introducing a widely available corporate information system is in the integrity and security of its data (Otter,1985; Rounds and Warning, 1987).

The data within a company is regarded as the vehicle by which work is won and controlled. If this data is compromised (ie lost to a competitor) then the strategic competitive advantage of the company is lost (Porter and Millar,1985). This produces an overly protective attitude towards the company data and results in limited access to parts of the system for users.

The second concern is the willful corruption of data by an employee. This may be due to dismissal or other circumstances but the problem is one which was particularly emphasised by the management of the house building company.

Finally and perhaps most likely to occur is the problem of unintentional data corruption. This happens when users or data preparation personnel inadvertently access a part of the system that either they should not use or which they have not used before. This can result in data loss or corrupted data entry. Again the solution is by limiting access.

a) *User Numbers and Access rights*

The solution to the problems of data security and user access is by means of user numbers and passwords. The method adopted in this development is described below.

The system manager maintains a file of users. This file contains the following information:

i) User Number;
ii) User Name; and
iii) Access control list.

Each new user is given a 2 digit number and his name is added to the user file.

The system manager can then set the access control list for the user. The access control list works at 3 levels for the 5 main subsystems ie;

company;
estimating;
valuations;
purchasing; and
cost monitoring/comparisons.

The 3 levels of access are:
refer;
edit; and
print.

The system manager can therefore set the required access rights for each particular user.

For example an estimator would be allowed to refer to company data (and perhaps to print it) but not to edit it. He would be able to refer, edit and print information in the estimating subsystem (ie. his function). He would be allowed to refer to the purchasing information (and perhaps to print it). He might not be allowed any access within the valuations and comparisons sub-systems.

This system allows sufficient flexibility without causing resentment amongst the personnel because they have less access rights than other users.

b) *Passwords*

In order to protect the access rights of users their user number was associated with a password. Experience has shown that users prefer to choose and manage their own passwords rather than be given a meaningless password by the system manager.

The users were therefore given full responsibility for choosing and changing their passwords. This was hidden from the system manager and if a password was forgotten the user had to be deleted and re-entered on the current user file.

4.2.4 *Speed and Accuracy*

Two other important criteria for the system are its speed and accuracy. These are two of the main perceived benefits for any computer system - ie. you are able to do work more quickly and more accurately.

i) *Speed*

The speed of computer systems often disappoints inexperienced users. They expect to be able to enter the data press a button and be presented with an answer immediately as with a pocket calculator. This unfortunately is often not the case, the speed of response depending on numerous factors such as:

number of users;
size of machine; and
operation being performed.

Generally numerical calculations are performed rapidly whilst filing operations (ie. reading and writing data) take considerably longer. Whilst all operations take a fraction of the time taken manually, the user is often presented with either a blank screen or a 'wait' message whilst the computer performs its allotted task. Even delays of a few seconds frustrate the user and lead to complaints of the system being slow. This requires the user to be educated to understand what the computer is doing and to appreciate its limited power. The greater the understanding the user has of the computer, the more likely he is to be satisfied with its performance.

ii) *Accuracy*

To be effective the system must give consistent accurate results. The accuracy of the system depends upon:

the accuracy of the input information; and
the correctness of the computing procedures.

The first parameter is the domain of the user and is typified by the expression "rubbish in, rubbish out". The second is the responsibility of

the software writer. This can only be verified by running tests on trial data and checking the results by hand. It is vital that the computational procedures are accurate. Nothing causes a greater loss of faith in the system than the discovery that basic calculations or assumptions built into the system are wrong.

4.2.5 *User documentation*

Any system must be supported by informative documentation. This enables the user both to further his understanding of the system and provides immediate support and explanation should problems arise with using the system. Lee and Rao (1985) suggest that the user document should contain a description of assumptions, the adopted solution, input and output facilities and the required hardware configuration. The user document produced for the house builders system is contained within Appendix 1.

4.3 Specific System requirements

4.3.1 *Introduction*

The examination of the organisational and information models developed in Chapter 3 led to the proposal to develop a system that would integrate the functions of estimating, purchasing, valuations and cost monitoring/ comparisons. These four commercial and technical functions offer the greatest potential for the exchange of data.

For each of the four functions identified the basic requirements were:

the estimating sub-system should allow the estimator to price a phase, plot by plot and produce a summary for each phase;

the purchasing sub-system should allow the buyer to extract aggregated quantities for the purchasing function from the estimate and maintain purchasing records;

the valuations sub-system should allow the surveyor to capture monthly site progress figures on a tick sheet and, using data from the estimate, produce monthly valuation figures which can be compared to invoiced accounts; and

the cost monitoring/comparisons sub-system should allow purchasing rates to be compared to amounts allowed in the estimate.

The methodology adopted in defining the specific requirements of the system, and the individual requirements of each sub-system is described below.

4.3.2 *Specification methodology*

The methodology used to identify the individual requirements of each function involved a combination of instruction, observation and discussion.

The management of the collaborating company had already formulated ideas on what the system should provide in the functional areas. It was these ideas that had provided the impetus for the development and these therefore formed the minimum basic requirements as stated in section 4.3.1.

A company contracts manager, who was familiar with the technical and commercial functions, was put in charge of the development, provided the necessary access to the individual departments and personnel, and agreed decisions on behalf of the company.

The estimating, purchasing and surveying (valuations) departments were visited and the work of these departments observed and discussed with their personnel. The collection of, and familiarisation with, the standard forms used by the departments was a particularly important aspect of these visits. Typical examples of these standard forms are included in appendix 2. These forms provided the basis for the design of the inputs and outputs of the system:

These visits also provided the opportunity to discuss in detail the requirements of the eventual users of the system. These unsurprisingly aligned to the generally stated requirement of the management but often had different emphasis. For example the management of the company wanted the purchasing sub-system to allow the buyer to maintain the purchasing records, but the buyer saw the greatest benefit to himself being the aggregation of unit quantities from a development or part development.

The requirements culled from these discussions and observations were written up, agreed with the personnel in the individual departments and then agreed with the nominated contracts manager. Any changes or additions were included and then this became the specification for that particular function.

The requirements for the cost monitoring/comparisons sub-system were obtained from discussions with the contracts manager and agreed with him.

The requirements for each function are briefly outlined in the following sections.

4.3.3 *Estimating*

The estimating process for a house building organisation is described in section 3.3.3 and the data flows presented in section 3.3.4.

In order to produce the phase budget estimate for a particular development the estimating sub-system must provide:

- the ability to specify the phase details, in particular the types of each dwelling to be constructed on each plot;
- access to the company standard dwelling schedules;
- the ability to edit and amend the dwelling schedules and to allow for any unusual or abnormal conditions or requirements of the development;
- the collection and input of current labour and material rates;
- the calculation of the site development costs;
- the ability to allow for overheads and inflation.

a) *Phase Details*

The estimator should be able to collect and create the general details required for a development. These details will include:

- a phase identifier or name;
- a phase code (to align with the accounting code for the phase);
- the number of dwellings;
- the key dates for the development (budget date and start date);
- Agents name;
- delivery address;
- telephone number;

and for each plot:

- the plot number;
- the dwelling type;
- the key plot dates (inspection date, completion date);
- postal address (when known); and
- purchasers name (when known).

Once this information has been created it is used as a reference by the other function sub-systems.

b) *Standard dwelling schedules*

As previously noted each company maintains a number of standard dwelling types. These standard dwellings comprise a large number (typically up to

4000) standard dwelling items. These are the individual material and labour items that make up the dwelling.

Because both the items and the dwellings are specific to the company and not to any particular development a company specific library of these details can be compiled and maintained. This concept of data being associated either to the company or to a particular development is central to most computer-aided management systems. The company specific data library is described in section 5.2.2.

The estimator must be able to select the standard dwelling schedules for each of the dwelling types to be constructed on the development. This information is obtained from the phase details.

c) *Edit and amend*

Once the standard dwelling schedules have been assembled they can be amended to suit the specific development.

For example the planning authorities may insist on a particular type or colour of roof tile which is not the standard for that dwelling. The sub-system must therefore allow the estimator to delete the standard tile item and substitute the new details. If the tile is a different size or shape this will include changes to the item quantity. It may also change the lath spacing and quantities and the labour quantity for fixing the tiles. Having made such a change the dwelling schedule becomes specific to that particular development as it now differs from the company standard.

d) *Labour and material rates*

When the estimator has completed all the changes to the standard dwellings he then has to price their constituent items. This involves obtaining rates, either directly from the supplier or subcontractors, or from the buyer and applying them to the item quantities. The sum of all the item quantities gives the estimated dwelling cost.

e) *Site Development Costs*

The estimator needs to estimate the site development costs. These are often formed into a schedule which applies to the whole development and not to any particular dwelling. This schedule will contain standard items but the quantities of these items will require measuring or estimating for each new development. Quotes for these items are obtained from suppliers and subcontractors as in d) above.

The sum of the site development costs and the dwelling costs gives the total cost of the development.

f) *Overhead and Inflation allowance*

Finally the estimator must allow a monetary amount for overheads and inflation. This is usually a percentage of the total estimated cost. This amount added to the estimated total cost, gives the budget estimate for the phase.

4.3.4 *Purchasing*

The purchasing process for a house building organisation is described in section 3.3.5 and the associated data flows presented in section 3.3.6.

The sub-system to assist the buyer in his duties must provide:

- a facility to aggregate total quantities of dwelling schedule items (both material and labour items) for a development or part development;
- a library of suppliers and subcontractors details; and
- a mechanism for keeping an up-to-date record of the purchasing transactions for a particular development.

a) *Aggregating quantities*

The buyer needs the aggregated quantities of all the items in the development before he can start to place orders for materials or

subcontractors. This involves summing the quantities of all like items for all dwellings in a development. This is both a tedious and time consuming process undertaken manually. However a computer-aided system can perform this task rapidly presenting the buyer with the quantities either for the whole development, or part of a development where the construction is to be staged.

b) *Suppliers library*

The company will normally maintain a library (or list) of material suppliers and subcontractors with whom it has previously placed orders and received a sufficiently good service. This library is created and maintained by the purchasing department and will be extended and modified for each new development. The purchasing sub-system should allow rapid access to this library and the information needs to be structured in such a way, that suppliers can be chosen either by trade or geographical location.

c) *The purchasing record*

In order to allow the buyer to maintain a record of all purchasing transactions for a particular development, the purchasing sub-system must include the facility to record the following information for each dwelling item:

- item description;
- total aggregated quantity;
- the total to order (including any wastage assumptions);
- the total ordered to date;
- the purchasing rate;
- the date of the last order;
- the discount allowed;

- the cumulative total cost of the item; and

- the name of the supplier.

This information will be constantly edited and amended during the construction phase.

4.3.5 *Valuations*

The valuations process is described in section 3.3.7 and the associated data flows presented in section 3.3.8.

The valuations sub-system must provide:

- the ability to aggregate the value of the dwelling items in the estimate, into cost codes;

- a method of recording the physical progress on site against these cost codes; and

- the production of monthly valuation summaries.

a) *Value aggregation*

The first process to be undertaken by the surveyor is the aggregation of the dwelling items values from the estimate into cost centres. This requires a list of cost centres to be maintained by the surveying department.

Aggregating these values manually is tedious and time consuming and so the sub-system must perform this task.

b) *Work measurement*

Having aggregated the code centre values the physical progress on site can be recorded. The sub-system should produce standard data capture forms to enable this to be structured in a format suitable for inputting directly into the computer . This form should contain for each dwelling type:

- the development name;
- the valuation month;
- the plot numbers on which the dwelling occurs;

and for each plot:

- the cost centre and stage;
- the total value;
- the amount of work completed (in percentage terms); and
- the amount of materials on site.

The surveyor takes this form onto site to record the new monthly values. It then forms the input document for calculating the monthly valuation summaries.

c) *Valuation Summaries*

In the manual system only one valuation summary was produced. This listed the valuation totals by cost code for each dwelling type. In order to compare valuation totals with invoiced amounts from the accounts system a new summary sheet was required. This form (summary sheet B) is described in section 5.2.5.

4.3.6 *Cost Monitoring/Comparisons*

Two forms of cost monitoring/comparisons are identified in section 3.3.9.

The first is the comparison of monthly valuations cost code totals with similarly coded invoice accounts. This can be facilitated using the monthly valuation summaries described in section 4.3.4 (d) above and the accounts information.

The second involves comparing estimated dwelling item rates with the corresponding purchasing rates held in the purchasing record. The cost monitoring module therefore has to make this comparison, printing the results so that a check on the estimating accuracy can be made.

4.3.7 *Problems encountered*

Few problems were encountered in observing or recording the work of each department. Difficulties that did arise were caused largely by the negative attitudes and lack of enthusiasm for the system by a small number of the potential users.

These difficulties included:

a reluctance to divulge information on methods and procedures;

excuses of being "too busy" to discuss detailed requirements; and

a lack of foresight or interest in new facilities or changes in working practice which the proposed system could provide.

Fortunately these difficulties were overcome because other personnel were available who co-operated fully and enthusiastically.

Attitudes did not remain static during the development process and some sceptical personnel during the specification phase, became competent and committed users.

CHAPTER 5

5. SYSTEM DEVELOPMENT, IMPLEMENTATION AND TRAINING.

5.1 Introduction.

This chapter describes the integrated computer-aided system, which was developed to fulfil the functional requirements outlined in chapter 4. The development methodology, the system details and the training and implementation procedures adopted are all discussed.

The system was given the name DEVELOP (short for Developers Data Management System) and comprises 5 modules or subsystems:

* Company data sub-system;
* Estimating sub-system;
* Purchasing sub-system;
* Valuations sub-system; and
* Cost monitoring/comparisons sub-system.

The data input required by each sub-system, the operations performed on the data and the output produced are briefly discussed together with the coding system developed to facilitate the exchange of information between the modules. The individual options available within each sub-system and the method of operation of the system are described in detail in the user manual contained in appendix 1.

5.1.1. *Development Methodology*

The development of the total system took approximately 18 months from inception to operational system. The development methodology was refined and improved during this period from an informal, ad-hoc system to a more structured, formal and comprehensive approach. The experience gained during this period of the problems and pitfalls associated with software development led to the formulation of the structured development methodology proposed in chapter 7.

The system development process commenced as a routine technical operation which involved liaising with the nominated contracts manager and writing programs to capture and manipulate data based on the specific requirements identified in chapter 4. However whilst this provided the basic structure to the system, further information was needed to achieve the required level of detail and integration. This involved discussing the development work with the target users. Initially this was achieved by holding meetings with individual users as required, but eventually developed into a more formal arrangement whereby a group of users was formed which met regularly to advise and comment on the development. In retrospect this group was formed too late in the development, however it still imparted considerable benefits to the whole development particularly in the areas of training and implementation. This is discussed in more detail in section 5.4.

5.1.2. *Development Environment*

The system was designed to support the functions of estimating, purchasing, valuations and cost monitoring/comparisons. These activities occur in physically separate offices and the computer system therefore had to allow for this. Similarly the ability for more than one person to use the system at any one time was seen as a vital requirement. These requirements dictated the need for a multi-user system. At the time of the system specification the purchase of a mini computer was discounted as being too expensive. The company therefore chose and purchased a multi-user micro computer which would run upto 8 terminals. This computer (a BCD system) was based on a Z80 8-bit processor and used the MP/M operating system (the multi-user version of the CP/M operating system). It was equipped with a 20mb hard disk (This was subsequently upgraded to 60mb and eventually to 120mb).

The system routines were written in Micro Soft FORTRAN 4 using the word processing package WORDSTAR as a development tool.

5.2 Introduction to the DEVELOP system

The requirements of the DEVELOP system are identified in chapter 4. These are to support the functions of:

- Estimating;
- Purchasing;
- Valuations; and
- Cost monitoring/comparisons.

From a systems view point each of these functions required a separate sub-system within the total data management system. In addition to these four sub-systems a further sub-system was required, to create, edit and maintain a set of company - specific data. Fig 5.1 shows the relationship between the company data sub-system and the four phase - specific sub-systems.

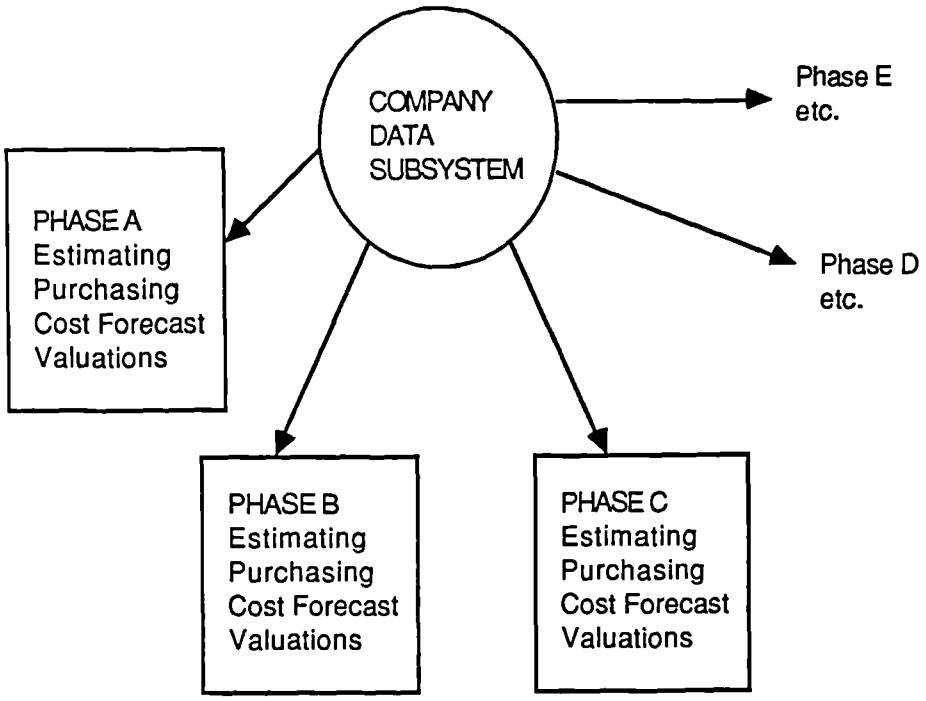

Fig. 5.1 Company and Phase - specific sub-systems

5.2.1 *The coding structure*

All computer based information systems rely heavily on some form of coding system or structure to allow information to be stored and retrieved quickly and efficiently. Coding systems have also been a common feature of construction work for many years. Crisp (1966), Gilchrist and Gaster (1969), Bradburn (1976), Moyles (1973) and Scoins (1980) have all studied the problems of defining short, unique and usable classification and

coding systems for construction work. The important criteria in developing a coding system based on their work includes:

unique identification;
length of notation;
recognizability of notation;
level of detail; and
expandability of notation.

The basic unit of data common to the functions is identified and described in section 3.4.3. This is the dwelling item, ie. the constituent components of each dwelling constructed. The importance of the dwelling item to the individual functions is highlighted in the entity-relationship diagrams Fig 3.13, 3.14, 3.15 and 3.16. Like items, for example all items connected to brickwork and blockwork are gathered together into a number of schedules. Each item can therefore be referenced by its schedule number, and its position (or number) within that schedule.

In the DEVELOP system, all the dwelling items were collated into 54 schedules with 26 spare schedules for future use giving a total of 80. The schedule headings are shown in Table 5.1. Within each schedule, a maximum of 500 individual items could be stored. Thus the code 01.003 refers to the third item in Schedule 1 (brick, blocks etc.) as shown in fig 5.2.

Whilst this is sufficient for the estimator to identify and price the items it is insufficient for the buyer and surveyor who need to cross reference the item with other information such as specification details and cost codes.

When inviting quotations for items and placing orders the buyer needs to specify the item in greater detail than the brief description held in the item schedules. To achieve this a company specification is maintained which describes the standard and quality of the items required in detail. Each item needs to be linked to this specification although it should be noted that many items may be adequately described by a single specification. The specifications are collected into 99 main headings with up to 300 sub-headings. To reference a particular specification the heading number and sub-heading number is given

Table 5.1 The 80 Schedule Headings

01	Bricks, Blocks, etc.	41	(Spare)
02	Stressline lintols	42	"
03	External Frames	43	"
04	1st Floor Construction	44	Materials in Std. Foundation
05	Main Roof Construction	45	L.O. Groundwork
06	Porch & Bay Roof Construction	46	L.O. Brickwork
07	Finishing Timbers	47	(Spare)
08	Stairs	48	"
09	Partitions and Plasterboard	49	"
10	Internal linings & frames	50	Materials in Std. Gar.
Found.			
11	Internal Doors	51	L.O. Groundwork
12	External Doors	52	L.O. Brickwork
13	Kitchen Units & Worktops	53	(Spare)
14	Ironmongery	54	"
15	Sanitaryware	55	"
16	(Spare)	56	Mats. in Std. Gar. Superstr.
17	"	57	L.O. S/C
18	"	58	L.M. S/C
19	"	59	(Spare)
20	"	60	"
21	Subcontract Brickwork	61	"
22	Subcontract Scaffolder	62	Act. Mats. in DW/Gar.
Found			
23	Subcontract Carpenter	63	Actual L.O. Groundworks
24	Subcontract Tacker	64	Actual L.O. Brickwork
25	Subcontract Plasterer	65	(Spare)
26	Subcontract Roof Tiler	66	"
27	Subcontract Felt Roofer	67	"
28	Subcontract Plumber	68	Mats. in Foul Drainage
29	Subcontract Electrician	69	L.O. S/C
30	Subcontract RP Insulation	70	Mats. in Storm Drainage
31	Subcontract Wall Tiler	71	L.O. S/C
32	Subcontract Floor Tiler	72	(Spare)
33	Subcontract Glazier	73	"
34	Subcontract Painter	74	Ext. Works Turf
35	Subcontract Artexer	75	Ext. Works paths and drives
36	Subcontract Mastic Point	76	Ext. Works Services
37	Subcontract Cleaner	77	(Spare)
38	Subcontract Heating Engineer	78	"
39	(Spare)	79	Preliminaries
40	"	80	Summary

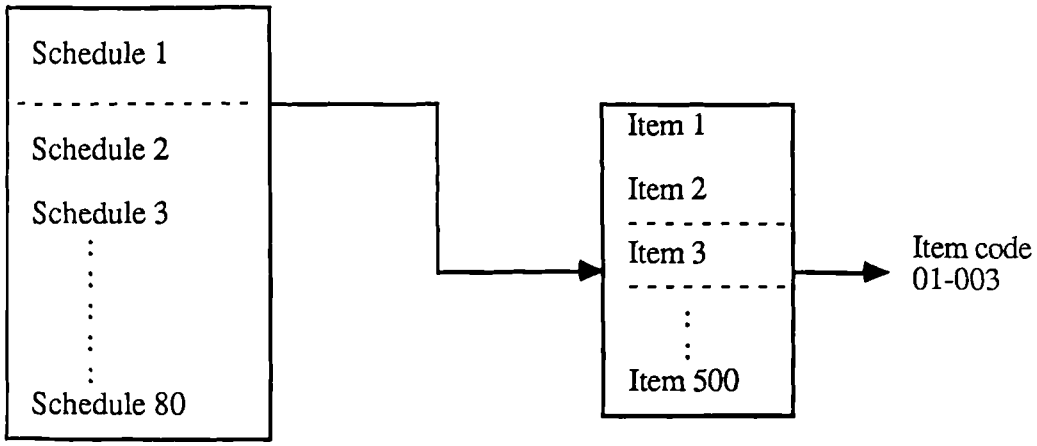

Fig. 5.2 The dwelling schedule item coding structure

separated by a point (.). The code is prefixed by an 'S' to show it is a specification code. Hence S12.05 refers to the fifth item of specification heading 12 and reads "DOORS: Internal Flush Doors: Crosby Crown Teak/Sapele hardwood.". Extracts from the company standard specifications are contained in appendix 3.

When the surveyor measures the monthly progress on site to produce the valuations he does not do so on an item basis but on a cost centre basis. A cost centre is an aggregation of the values of a number of items to allow the surveyor to measure a composite item. The cost centre or cost stage into which each item is aggregated therefore has to be defined. In the DEVELOP system a total of 30 cost centres were identified with each centre containing up to 30 individual stages. A particular cost centre was referenced by means of two 2 digit numbers separated by a point and prefixed by 'C'. Hence C04.01 refers to the first stage of cost centre 04 which is "1st lift". Thus the full reference code for a dwelling item becomes:

01.003/S04.01/C04.02

where

01 is the schedule: Bricks, Blocks etc.

003 is the schedule item : Facing in 225 x 225 isolated piers

S04 is the specification heading: Load Bearing Walls

01 is the specification clause: Cavity walls: 265mm facings and Hemelite U1 blocks or 250mm of two block skins. Tile hung walls always cavity construction. Plus 50mm Rockwool batts in cavity.

C04 is the cost centre: Bricks

01 is the cost stage: 1st lift

The full item reference is not required for all functions. However it is this code that enables the transfer of information between functions and thus facilitates integration.

5.2.2 *The company data sub-system*

The company data sub-system comprises the company standard data which forms the basis and starting point for all calculations and processes within the other functional sub-systems. This ensures that:

i) all phases start with the same base data;
ii) the integrity of the company data is not lost due to different requirements on many on-going sites;
iii) changes in materials, costs or company policy need only be input into the company data sub-system and all subsequent phases will automatically be furnished with the most upto date data.

The company data sub-system comprises 7 main data files:

- the specification file;
- the suppliers file;
- the items file;
- the standard dwellings file;
- the dwellings addenda file;
- the phase details file; and
- the valuation stages file.

The content of these files is described below:

i) The specification file contains specifications for each item used in a dwelling unit (eg. work below D.P.C.; drainage services; load bearing walls; sanitary fixtures and fittings etc.) . A total of 99 main

categories with upto 300 sub-headings are available. The following example is typical of an entry from the company's main specification file:

Specification: S04.01

LOAD BEARING WALLS
Cavity Walls: 265mm facings and Hemelite U1 blocks or 250mm of two block skins. Tile hung walls always cavity construction. Plus 50mm Rockwool batts in cavity.

ii) The suppliers file contains names, addresses and telephone numbers of materials suppliers and sub-contractors. This is split into three groups: labour only; labour and materials; and material only suppliers with up to 400 of each contained in the file.

iii) The items file contains a library of 80 schedules with up to 500 items within each schedule. Examples of schedules are: bricks and blocks; stressline lintels; main roof construction; external doors; etc. Examples of items within the schedule 'Bricks and Blocks' are :- facings in half brick skin; 100mm blocks in internal walls; 225 x 225 air grills; etc. Each item code has an associated specification and cost code. An extract from the items file is shown in figure 5.3.

iv) The Standard dwellings file contains details of the standard dwelling units which are represented by a group of item codes together with the quantities of each item. A total of 99 standard types can be accommodated.

v) The dwellings addenda file contains details of amendments in the form of additions and alterations to standard dwelling types. These comprise extra or replacement items and quantities.

vi) The phase details file contains details for each active development phase. These comprise general phase details such as: site address; start and finish dates; agents name; together with a list of plot numbers, their associated dwelling types and purchasers name.

Schedule Ref. 01.000 BRICKS, BLOCKS ETC.

Item Code	Description	Units
01.001/S04.01/C04.00	FACINGS IN HB SKIN	TH
01.002/S04.01/C04.00	FACINGS IN HB GARAGE PROJECTIONS	TH
01.003/S04.01/C04.00	FACINGS IN 225 x 225 ISOLATED PIERS	TH
01.004/S04.01/C04.00	FACINGS IN 225 X 328 ISOLATED PIERS	TH
01.005/S04.01/C04.00	FACINGS IN 328 X 328 ISOLATED PIERS	TH

Fig. 5.3 Extract from Typical Item Schedule

vii) The valuation stages file contains 30 cost centres such as: ready mix concrete; bricks; frames; etc. Within each cost centre there are up to 30 cost stages. Each dwelling item is allocated to a cost centre and stage to enable the monthly valuation to be undertaken.

The user has the facilities to add, change, delete, refer and print any of the information held in these files. Examples of the data held in these files are contained in Appendix 3.

5.2.3 *The Estimating Sub-system*

The purpose of the estimating sub-system is to produce a budget estimate for a phase using data from the company standard data files and inputs from the estimator. The estimator is first required to amend and adjust the company standard data to meet the particular requirement of the phase. The estimator must then price each dwelling schedule item. Rates for these items may be obtained via quotations from suppliers, directly from the company buyer or by reference to the purchasing record of recently completed (or still on-going) projects. Once a dwelling schedule item is priced, the rate is subsequently automatically applied to the same item in all other dwelling units in the phase. The estimator is also required to enter allowances for overheads, inflation and profit. Fig 5.4 shows the estimating sub-system process.

The estimating sub-system produces priced dwelling schedules for each dwelling and these are collected together into the phase budget summary.

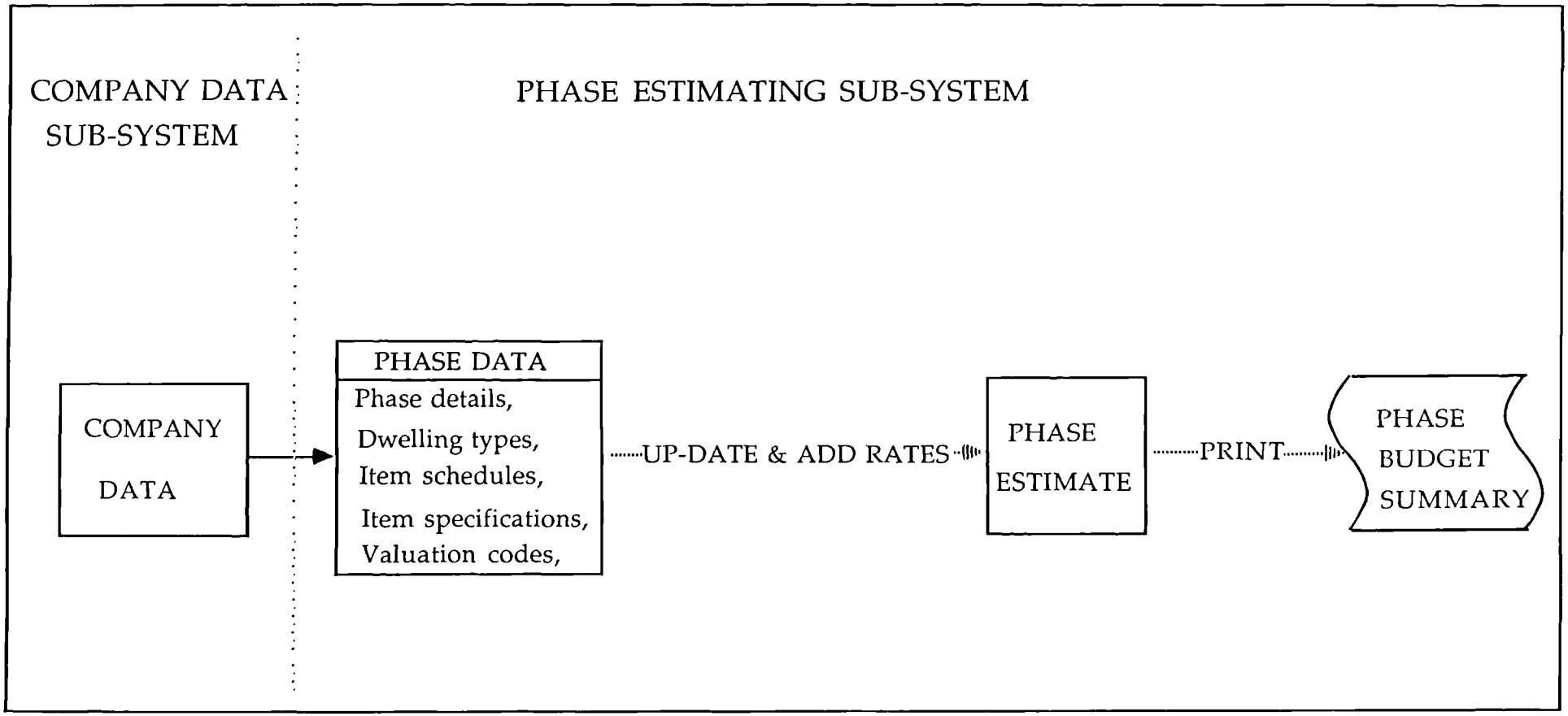

Fig. 5.4 The Estimating sub-system process

BUDGET SUMMARY - LOUGHBOROUGH 5A

	Plot Numbers	10, 14	11, 12, 13	15, 17	Cummulative
	House Types	365	222	374	Total
A	Tot. Materials				
B	Tot. Subcontractors				
C	Std. Hse. Foundation				
D	Std. Gar. Foundation				
E	Gar. Superstructure				
F	Plastered Shell				
G	Fittings				
H	Drainage				
J	External Works				
K	Preliminaries				
L	Basic Cost				
M	Abnormals				
N	Inflation				
P	Tot. for Develop. Budget				
Q	Margin				
R	Tot. for Works Order				
	Number of Units	2	3	2	
	Habitable Area				
	Cost/m2 Plastered shell				
	Cost/m2 Basic cost				
	Cost/m2 Dev. Budget				
	Cost/m2 Works order				
	Building Programme	Start:	End:	Duration:	
	Date of Estimate				

Fig. 5.5 Representation of Phase Budget Summary

Fig 5.5 is a diagrammatic representation of the phase budget summary whilst a completed phase budget summary is contained in appendix 4.

5.2.4 *The Purchasing Sub-system*

The purpose of the purchasing sub-system is to calculate the aggregate quantities of both material and labour items required on a phase and to maintain the phase purchasing record. The purchasing record is used:

by the buyers as an on-going record and account of material ordered and delivered, outstanding orders, dates of order, rate and supplier;

by the estimators as a source of suppliers and rates for estimating new phases; and

by senior management in the cost monitoring phase when purchasing rates are compared with estimated rates for dwelling schedule items.

Fig 5.6 shows the purchasing sub-system process.

Once the estimate is complete the purchasing sub-system aggregates similar item quantities to produce totals to be ordered together with the purchasing specification. This provides the basis for sending out enquires. The buyer is required to enter against each schedule item:

the total amount to order (usually the aggregated quantity plus an allowance for wastage);
the amount ordered;
the purchase rate;
the discount(if any);
the date of order; and
the supplier or subcontractor reference.

The buyer has the facilities to amend the purchasing specification, items details and supplier file. However changes to specifications or item details would be

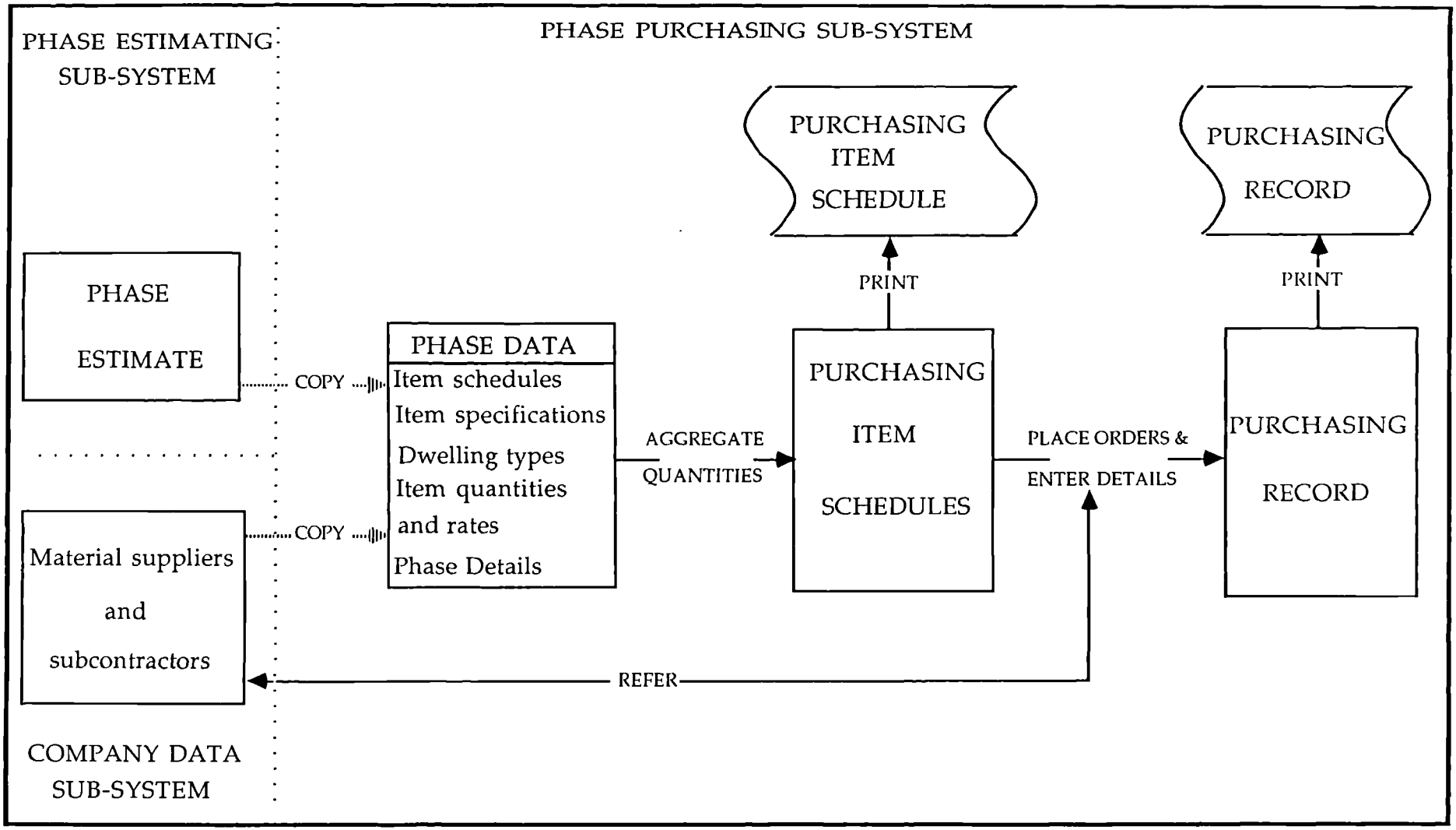

Fig. 5.6 The Purchasing Sub-System Process

undertaken in consultation with the estimator to ensure that cost implications are allowed for.

The output the buyer can obtain includes:

aggregated quantities for all items within a phase;

aggregated quantities for all items within selected combinations of dwelling types within a phase; and

the phase purchasing record comprising:
a list of all items in a phase;
the associated aggregated quantities;
the total amount of each item the buyer will order
(and hence the wastage allowance);
the latest purchase rate for the item;
the date of the last order/rate;
the amount ordered to date;
the item discount allowed by the supplier;
the cumulative item cost; and
the supplier code for the item.

Fig 5.7 shows a diagrammatic representation of the phase purchasing record whilst a complete phase purchasing record is contained in appendix 5.

5.2.5 *The Valuations Sub-system*

On completion of the phase budget estimate the valuation sub-system can be used to aggregate the value (ie. the estimator's rates, overheads and profit) of the items within each cost division, using the third part of the item code (see section 5.2.1). Many items may be aggregated into a single cost code. This produces a table of plot numbers against the cost codes showing the value of each code within the estimate. This is known as the Monthly Valuation sheet and its use is twofold:

firstly it is used by the surveyor as a "tick-sheet" to record progress on site; and

PURCHASING - SCHEDULE PRICING

Schedule 01 - Bricks, Blocks, etc. Page 1

Item Code 01.015 100mm Blocks in internal walls

Wastage : 10.5 % Units : m2

Code	Ag. Quant	Tot. Ord.	Rate	Ordered	Date	Disc.	Cum. Tot.	Supplier
01.001	128.3	130.0	115.00	130.0	02.03.90	0.0	1460.0	MA12345
01.002	20.5	20.0	112.00	20.0	06.03.90	0.0	2240.0	MA12345
01.003	22.5	22.0	112.00	22.0	06.03.90	0.0	2464.0	MA12345
01.004	10.8	11.5	110.00	0.0	-	-	-	-
01.005	3.1	3.5	2.50	0.0	-	-	-	-
*								
*								

Fig. 5.7 Representation of phase purchase record

secondly it produces the totals of Value of Work Done (VWD) and Value of Materials on Site (VMOS) which are carried forward into the Valuation Summary sheets.

Fig 5.8 shows the valuations sub-system process, and fig 5.9 a diagrammatic representation of a monthly valuation sheet. A completed valuation sheet is contained in appendix 6.

On completion of the monthly valuation sheet the valuations sub-system produces two summary sheets known as summary sheet A and B.

Summary sheet A is used as a check on progress to date and as the basis of reimbursement to the house building company and includes allowances that are not measured by the surveyor on site. These include:

site setting-up allowance;
miscellaneous site bills;
supervisory wages;
plant hire charges; and
variation orders.

A diagrammatic representation of summary sheet A is shown in fig 5.10 and a completed sheet is contained in appendix 7.

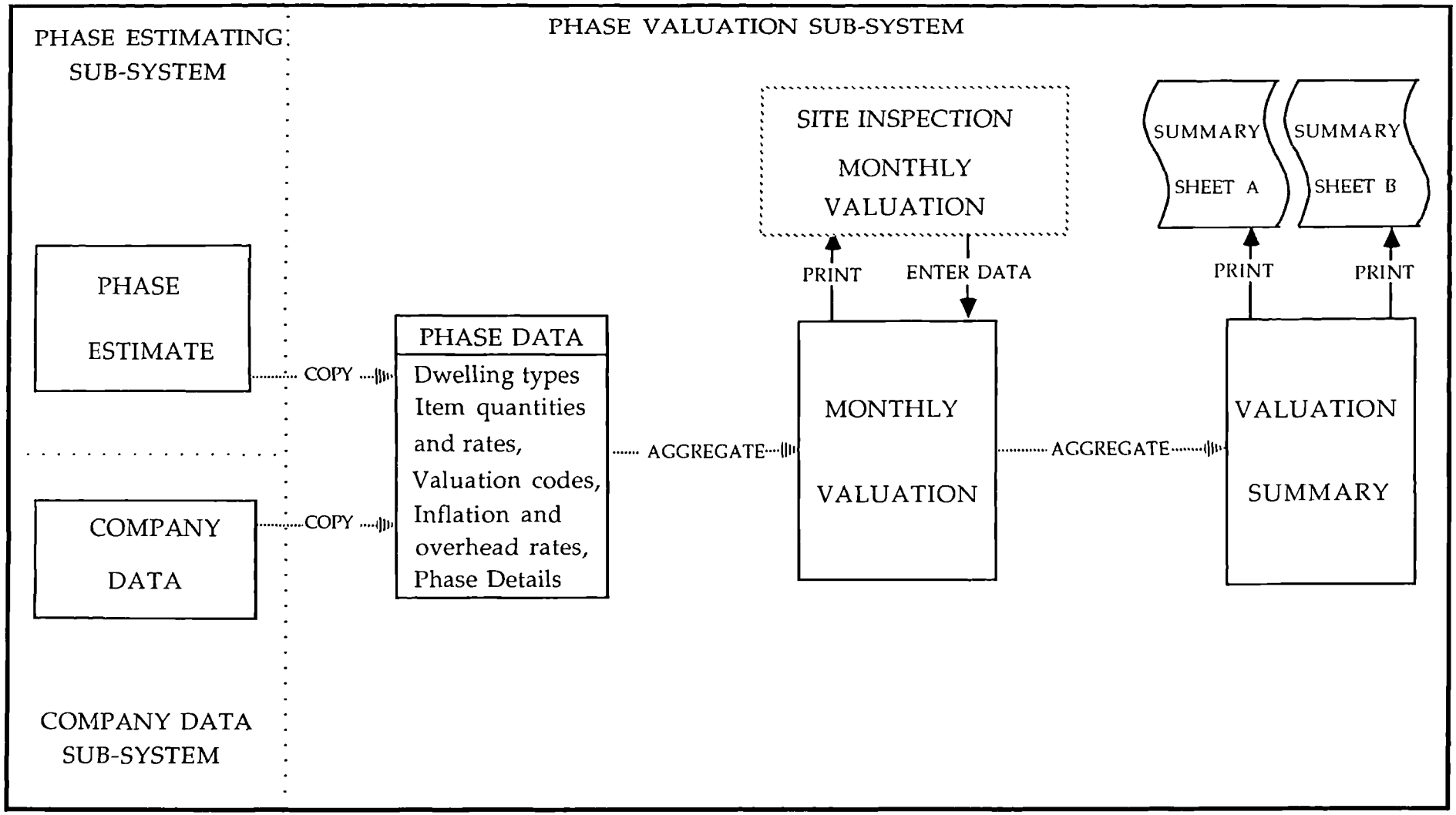

Fig. 5.8 The Valuation Sub-System Process

Development		Valuation		Type: 365			
Phase : LOUGHBOROUGH		Month : JAN90		No. of Units: 3			
04.00 BRICKS		Plot Nos.					
Cost Code	Value	100	106	210	VWD	MOS	VMOS
01 foundation	846	100	100	100	2538	0	0
02 1st lift	1500	100	100	75	4125	0	0
03 2nd lift	1376	50	100	0	2064	1	1376
04 3rd lift	1574	0	0	0	0	2	3148
05 4th lift	1311	0	0	0	0	0	0
06 top out	384	0	0	0	0	0	0
07 externals	794	0	0	0	0	0	0

Fig. 5.9 Representation of Monthly Valuation Sheet for 1 cost code

Summary sheet B is used to compare the value of the cost codes with the invoiced amounts from suppliers and subcontractors for the same codes. The invoiced amounts are manually entered after extraction from the mainframe accounts system. This enables a check to be made at a cost code level on the profitability of the project.

Development		Valuation	SUMMARY A
Phase : LOUGHBOROUGH		Month: JAN90	
Type	Work Done	VMOS	All Sums
374	1450	250	exclude OHP
365	3295	326	
222	1335	214	
	7080	790	

V. O.	0
MoS	790
Tot. of Est. Work	7080
TOTAL	7870

Code 19	Site Setting-Up Value	400
Code 20	Site bills	200
Code 21	Wages	1750
Code 9.02	Plant	550
Code 22	Capital Cost Contrib.	350
Code 23	Maintenace provision	300
Inflation		0

Total Excl. OHP	11428
Total Incl. OHP	12113

Fig. 5.10 Representation of Valuation Summary Sheet A.

A diagrammatic representation of summary sheet B is shown in fig 5.11 and a completed sheet is contained in appendix 8.

5.2.6 *The Cost monitoring/comparison sub-system*

At any time after the completion of the estimate a cost comparison may be produced. This compares the estimated rates with purchasing rates and produce an analysis of the difference. The data for this is drawn from the phase budget summary and the purchasing record. The cost monitoring/comparison sub-

Development Phase: LOUGHBOROUGH						Valuation Month: JAN90				SUMMARY B
Cost Code	Types		VMoS	Vord	Total	Supp. Accrue	S/C Accrue	Build Cost	Total Cost	Difference
	365	374								
1 2 3 4 5 6 - - 18										
Total										

Fig. 5.11 Representation of Summary Sheet B

system aggregates these values item by item to produce the cost forecast comparison and no additional input is required from the user.

Fig 5.12 shows the cost monitoring/comparison sub-system process.

Fig 5.13 shows a diagrammatic representation of the cost forecast comparison and contains:

the dwelling item code;
the current purchasing rate;
the current purchasing forecast(a forecast of the likely total cost although not yet ordered);
the estimated rate;
the estimated forecast;
the estimated forecast plus the inflation allowance; and
the differences.

A completed cost forecast comparison is shown in appendix 9.

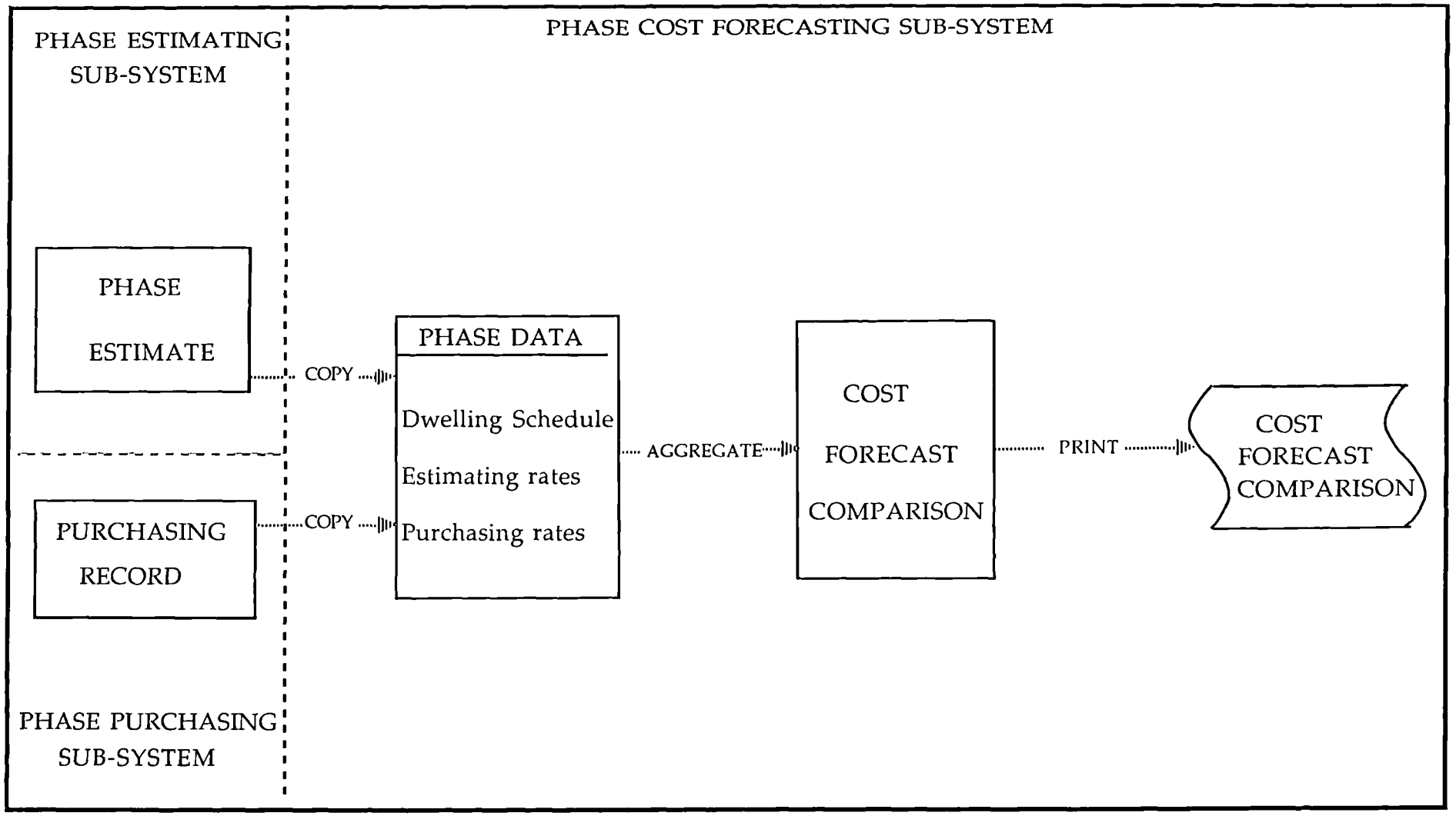

Fig. 5.12 The cost monitoring/comparison sub-system process

Phase : LOUGHBOROUGH				Cost Forecast/Comparison			
Schedule 01.000				Inflation = 3.0 %			
Item Number	Current Purchase Rate	Current Purchase Forecast	Estimated Rate	Estimate Forecast	Estimate Forecast + Intl.	Diff (Est - Forecast)	Diff (Est+Intl. - Forecast)
01.001 01.002 01.003 01.004 01.008 01.009 01.010 01.011							
Total							

Fig. 5.13 Representation of Cost Forecast Comparison for 1 schedule

5.2.7 *The integrated system*

The DEVELOP system integrates the five sub-systems described in the previous sections. It facilitates the accurate and timely transfer of information between the various functional activities of estimating, purchasing, valuations and cost monitoring/comparisons. These transfers are achieved using files of common data that are shared or passed between functional departments where information is added or amended as dictated by the particular requirements of that section. The basis for this information sharing is a coding structure which cross references the various diffuse items of information used by the company, as described in section 5.2.1.

Fig 5.14 shows a diagrammatic representation of the whole DEVELOP system.

5.3 Implementation and Training

The implementation and training phases of a computer system development are of vital importance if the system is to be adopted and used by the company personnel quickly and efficiently. Unfortunately it is often overlooked or underestimated by the staff responsible for overseeing the development. The requirements of systems

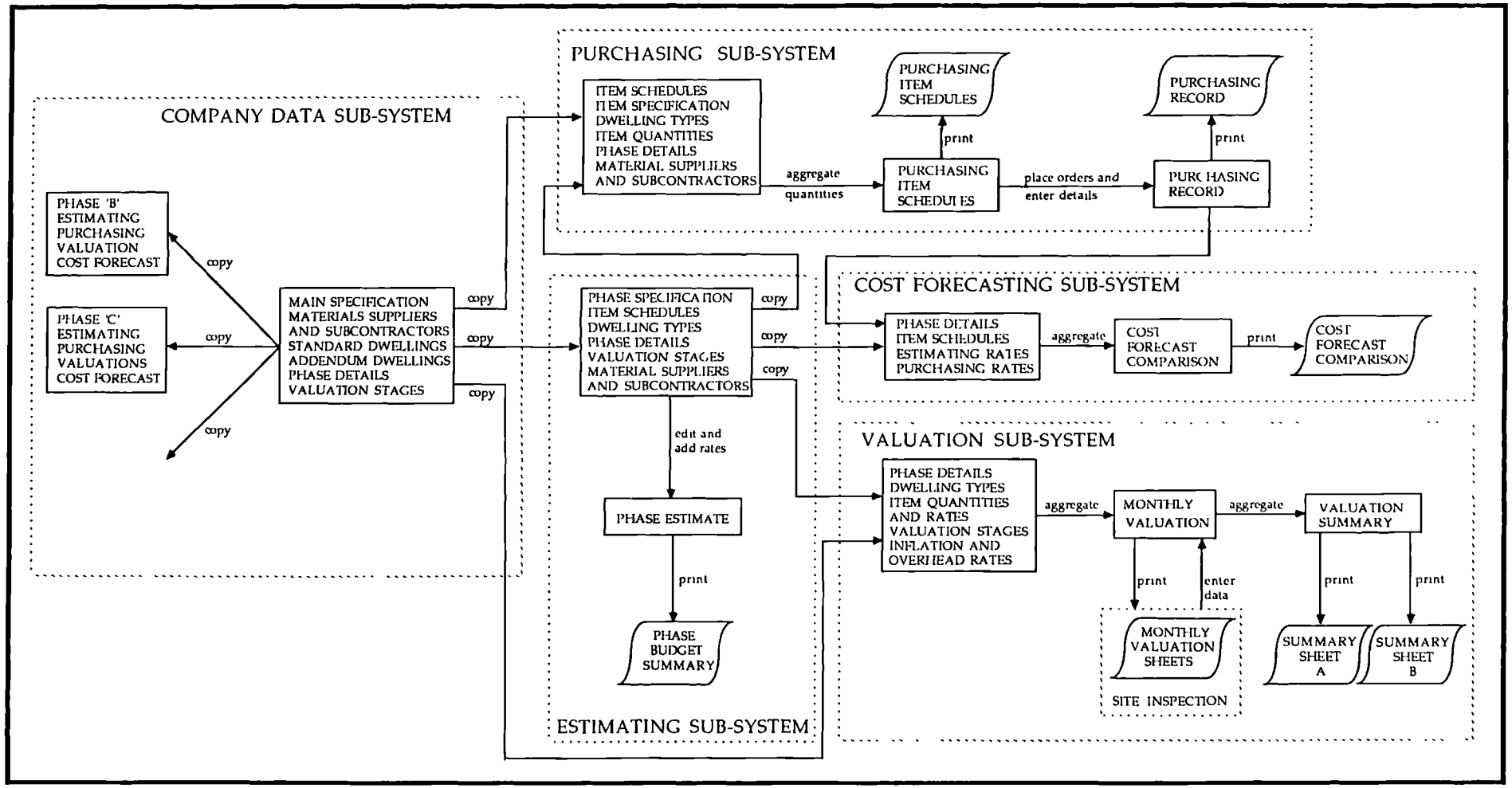

Fig. 5.14 The DEVELOP system

training and implementation have previously been highlighted by Baldwin (1982) and Hall (1981) who suggested that user training depends upon the type of user, the users individual needs and the stage of the users development within the system. Eason (1986,1988) emphasises the role of the local expert or "user champion" in the training and implementation process.

When installing a large system, as in the case of DEVELOP, which will be used by a number of staff from different departments and therefore with different needs, it is important to tailor the training to met these specific needs. In addition the training should dove-tail into the implementation programme so that the two activities are complementary.

The training and implementation procedures adopted for the DEVELOP system are described in the following sections.

5.3.1 *Implementation Procedure*

The various strategies which may be adopted when implementing a new computer system are shown in Fig 5.15.

For the DEVELOP system an incremental implementation was considered most appropriate as it allowed:

i) the company data sub-system to be established before the other sub-systems were implemented;

ii) training to proceed each sub-system before it was implemented;

iii) the company to minimise disruption which might have occurred if implementing the total system at once.

5.3.2 *Personnel and Training required*

Initially eight members of the company staff were selected for training in the operation of the DEVELOP system. These staff were chosen on the basis of their functional role within the company and their involvement in the specification of the system. The staff comprised:

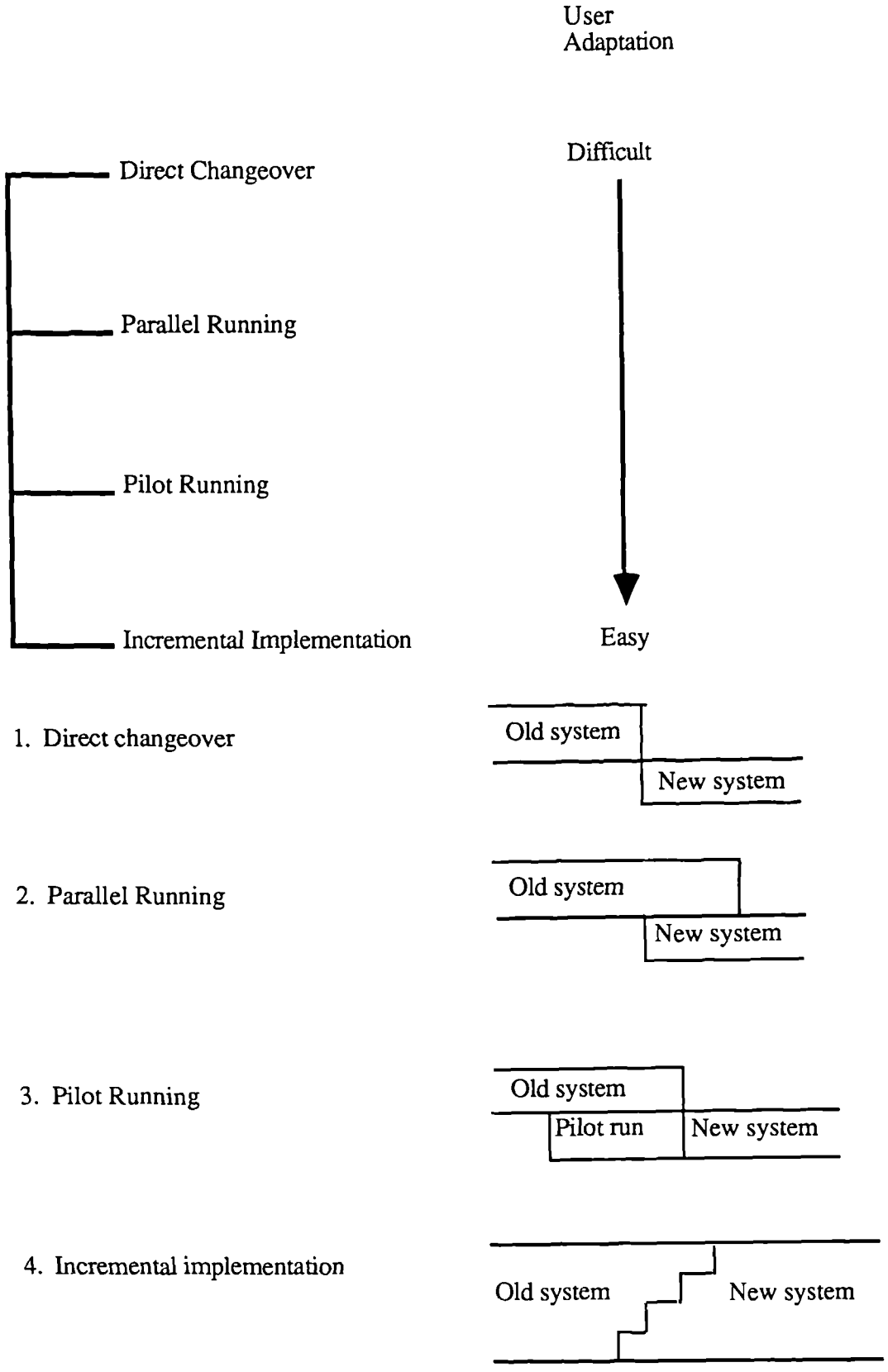

Fig. 5.15 Implementation Strategies

2 contracts managers;
2 estimators;
2 buyers (1 materials, 1 subcontractors); and
2 surveyors.

These staff represented approximately half the staff in each of the functional areas. The reasons for training 2 staff from each section were:

i) they would act as 'local experts' and train the other staff over a prolonged period;

ii) training 2 staff from each area ensured that sickness and holiday periods would be covered by at least 1 member of staff with a knowledge of the system; and

iii) whilst the training was undertaken other staff were still available within the functions to continue their normal work.

The training required was divided into four sections. These sections were:

i) an introduction and overview of the system, its role and importance within the company;

ii) a description and demonstration of the company data sub-system. This also demonstrated the basic 'hands-on' skills required; selecting menu options, inputting numbers etc;

iii) a detailed description and demonstration of the specific sub-system of most interest to the staff (ie the sub-system with which they would be working); and

iv) a brief description and demonstration of the other relevant sub-systems.

Items (i) and (ii) above were presented to the group as a whole whilst items (iii) and (iv) were undertaken on a one to one basis.

5.3.3 *Attitudes of staff*

The importance of the attitude of the staff in the successful implementation of a computer system have been well documented by Argyris (1970), Otway and Peltu (1984) and Carey (1988).

These authors emphasise the mistrust and resentment felt by employees who have new systems forced upon them with little regard for the dramatic changes these systems bring about. Otway and Peltu(1984) make this comment on the effect of office automation:

"News of an impending reorganization heralds the start of an agonizing period of uncertainty in organizational life. There is a pervasive fear of the unknown: some managers will emerge as winners; others will be losers; power balances will change; long standing work relationships may be disrupted; new communication channels will open, others will close; the context of jobs and working practices will be different. New office technology implicitly brings with it these kinds of far reaching changes".

The only way to reduce and remove these fears is by a process of education and training. Disruption can also be minimised by designing the system around existing practices and forms. This was the policy adopted for the DEVELOP system.

The initial attitudes of the staff ranged from committed enthusiasm to cynical opposition. All but one of the staff selected for training were novice users with no prior experience of using computers. Similarly all but one had been involved in the specification process.

Six of the eight members of staff quickly overcame their initial hesitancy and problems with using the system. Within a period of eight weeks they became competent users, able to access their sub-system and use all the available facilities without the need for supervision or the user manual.

One of the surveyors seemed unable to grasp the concepts of the computer system despite a high level of supervision. Whilst he was able to enter monthly valuation figures obtained from site he had no overall view of what they were used for and had little perception of the scope of the system. He

was subsequently moved to a more traditional area of surveying practice within the company.

One of the contracts managers whilst being proficient in the systems use, emphasised the omissions and limitations of the system rather than its benefits. This was believed to be because he had not personally been involved in the specification and development of the system as had the other contracts manager. He therefore did not wish the company to see the system as an unqualified success which might show the other contracts manager in a better light than himself. This contracts manager subsequently left the company.

5.3.4 *System Testing*

The purpose of system testing is to satisfy the users and company management that the system functions as expected and produces consistent and accurate results. Much of this testing for the DEVELOP system was undertaken during the development process itself but this testing only used small samples of real data, or in many cases data was created for the sole purpose of testing new routines.

Full system testing can thus only be satisfactorily undertaken using a complete set of real, though not necessarily live, data and by one or more of the actual users.

In the case of DEVELOP the contracts manager undertook this task during the period the other users were being trained. The rational behind this was:

he was the most familiar with the system and was already a competent user;
he had actively participated in the specification and design development of the system and hence fully understood its facilities; and
he was to make the final recommendation on when to abandon the existing system to the company.

The system testing was achieved in the short time scale of two weeks with only small modifications being required to the system.

Although the system testing achieved its objective of proving the robustness and reliability of the system no opportunity was taken to involve the other users. They could have benefited from this as an addition to their training.

5.4 Discussion

The main achievements of this phase of the research were the development of the house builders data management system DEVELOP and its successful implementation into the collaborating company.

The main lessons learned were in the development methodology used and implementation/training strategies adopted. Both these factors are related and the method of development known as prototyping was found to give significant benefits at the implementation/training stage.

The method of prototyping involves developing small sections of the whole system and then demonstrating it to its potential users for evaluation and comment. The feedback from the users is incorporated before the next section is started and the process is repeated.

The main benefit from this method of development is that the users have direct involvement in the development process thus ensuring that the system fulfils their requirements.

It also helps to overcome many of the initial fears and suspicions of the users. This was observed with one user in particular who was openly critical of the proposed system at the specification stage, but who became an enthusiastic advocate of the system by the time it was installed.

Prototyping also exposes the system to the users over a prolonged period thus reducing the need for familiarisation and training once implemented.

The disadvantages of this method of development are that it is slow and it can be difficult to achieve a concensus view on common system features (ie those required by several users). Nevertheless the experiences gained during this development suggest that the benefits offered by prototyping greatly outweigh the disadvantages.

CHAPTER 6

6. THE SYSTEM IN USE

6.1 Introduction

The performance of the system was monitored over a 6 month period as part of the maintenance and de-bugging phase after the system was installed and the staff trained in its operation, . The system development and implementation were then evaluated against a set of criteria modified from Wroe (1986). This evaluation and the advantages of the system in each of the four functional areas are described together with the general benefits derived by the company from the development. The limitations and short comings of the system are also presented.

6.2 Evaluation of DEVELOP

Keen and Woodman (1984), Ndekugri (1986) and CICA (1990) have all commented on the difficulties of quantifying the benefits of a new computer-aided management system. Whilst time savings can be measured and costed, more intangible benefits such as greater accuracy and consistency, more detailed analyses and the standardised presentation of information can only be notionally costed. This makes evaluating the deliverables of a new system rather subjective. However the actual time savings achieved by each sub-system of the DEVELOP system are presented in section 6.3.

The evaluation of the development and implementation phases of a Management Information System pose similar problems but Wroe (1985) suggested a template for evaluation (see table 2.2). Because DEVELOP was written "in-house" in contrast to the systems studied by Wroe, not all of the evaluation stages are relevant. Others which are relevant are not present in her template. Thus a modified version of Wroe's template is presented in table 6.1 showing the criteria against which the development and implementation of DEVELOP is based. It should be noted that this is a subjective assessment of the author and the company's contracts manager who co-ordinated the development.

i) Specification. The identification of the problem area and system objectives and the determination of mandatory and desirable information needs were judged to have been undertaken successfully. The sizing of the data storage

Table 6.1 The evaluation criteria of DEVELOP (after Wroe)

Specification	
identification of problem area and system objectives	S
determination of mandatory and desirable information needs	S
sizing of data storage	P
selection of hardware configuration	P
Design and Development	
design and provision of easily usable interface	S
development of mandatory requirements	S
provision of new facilities	P
provision of documentation	S
Implementation	
installation of system	S
training of users	P
creation of company data library	S
system testing	P
Live Operation	
abandonment of manual system	S
enhancement of system operations/facilities	S
management use of facilities	S

Key: *S* = *successfuly achieved*
P = *partially successful*
U = *unsuccessful*

and the selection of the hardware configuration were only partially successful and these are discussed more fully in sections 6.4.1 and 6.4.2.

ii) Design and Development. This phase was considered successful with the exception of the provision of new facilities which was only considered partially successful. This was due to intentionally mirroring the company's existing practices and the restrictions imposed by the company on the overall scope of the system. Whilst some new facilities (such as the provision of Summary Sheet B) were provided, others were not developed. Some of these further facilities are discussed in section 7.6.2.

iii) Implementation. The installation and the creation of the company data base was considered successful despite encountering some problems as discussed in section 6.4.2. The training of the users and the system testing were considered only partially successful as discussed in section 5.3.

iv) Live Operation. The live operation of the system was successfully achieved with the abandonment of the former manual system. The system facilities were enhanced in the light of operational use as described in section 6.4.2(c) and the management use of the system facilities is discussed in the remaining sections of this chapter.

The Specification, Design and Development, Implementation and Live Operation phases of the system are regarded as successful when evaluated against this set of criteria modified from Wroe(1986).

6.3 Advantages of the system

This section considers the advantages offered by the DEVELOP system over the previously used manual methods. The advantages are listed under the following headings:

general;
company-data sub-system;
estimating sub-system;
purchasing sub-system;
valuations sub-system; and
cost monitoring/comparison sub-system.

6.3.1 *General*

a) *Presentation of Information*

One of the major benefits of the DEVELOP system development was the formalisation and structuring of the company's information. This resulted from the rationalisation which occurred as part of the analysis and design phases of the development. By examining the use of the company's data, the forms that were used to capture, record and transmit data, and the structure of the data itself new data formats were proposed and adopted. For example the coding of suppliers and sub-contractors had not been previously used and they had been filed alphabetically by name. By allocating them a seven digit code the suppliers and subcontractors could be stored and identified both by trade and geographical region. Similarly it was discovered during the specification phase that the senior management of the company used various ratios derived from the budget summary for control and comparison purposes. However these ratio's (such as cost/m2 of plastered shell) were not automatically produced on the existing budget summary. The incorporation of such changes produced more streamlined and efficient procedures in terms of reduced time and effort required for retrieving, amending and using the data. This process would have had benefits to the company even if a computer-aided system had not been developed.

b) *Improved Integration*

Improved integration of the functional departments of estimating, purchasing and surveying together with senior contract management staff was achieved by creating a common company-specific library of information, by providing easy access to data from other functions and by formalising the transfer of data from one function to another. This integration enabled a faster throughput of management information and ensured a greater consistency than had been possible with the manual methods. The computer-system not only achieved the integration of the data flows between different departments but also highlighted their interdependence. This was demonstrated by the interest shown by the staff in the workings of functional sub-systems other than their own, particularly those which supplied data to, or received data from, their function.

c) *Staff training and company image*

All companies need to recruit and retain good quality staff. This is achieved through a combination of remuneration, job satisfaction, career prospects and a myriad of other factors. One of these factors is staff training and development programmes which equip the staff with new skills and make them more valuable to both their current and potential future employers. The introduction of a new computer systems presents a perfect opportunity for staff training and in the case of the DEVELOP system the staff were keen to learn about the system and computers in general. The introduction of the DEVELOP system and the training of staff therefore had two unforeseen advantages to the company although the evidence of this was only anecdotal:

i) firstly the company was seen as confident and forward looking by investing in new technology. This gave them a "high tech" image amongst its own staff and reputedly by its suppliers and competitors;

ii) secondly the staff who were trained felt they had personally gained new and valuable skills and that their potential had been recognised and rewarded by the company.

6.3.2 *Company data sub-system*

The system enabled the creation and maintenance of a library of company specific data on :

current projects or phases;
standard and addendum dwelling types;
dwelling items;
material and subcontract suppliers;
standard specifications; and
valuation cost centres.

The system provided a more formalized and structured system for recording, storing, retrieving and presenting this company information than had previously been possible. The senior management of the company considered it was this data that gave them their competitive advantage over

other similar companies hence its efficient management was of paramount importance to the company.

6.3.3 *Estimating sub-system*

The primary function of the estimating sub-system is to produce phase budget estimates quickly and accurately. This the system achieves, with a reduction in time for the pricing of a typical 30 dwelling phase from 2 mandays to a 1/2 man day (4 man hours), whilst providing a greater level of detail on the phase budget summary.

However it is the ease and speed with which the phase details can be changed and repriced, at any stage during the development which offers the greatest benefits. This enables new dwelling types and dwelling configurations to be evaluated following feedback from sales staff.

This feature was commonly used to replan and estimate developments after the system was implemented. In discussions with the estimating staff it was estimated that two thirds of the developments were re-worked in this way compared to one third prior to the introduction of the system.

6.3.4 *Purchasing sub-system*

The purchasing sub-system offers three advantages over the manual methods:

firstly the aggregation of the quantities from a typical development of 30 dwellings is reduced from approximately 3 man days to 1 hour.

secondly it allows the creation and maintenance of a file of material suppliers and subcontractors. This enables the rapid retrieval of suppliers and subcontractors details either by supplier type (ie labour only, materials only or labour and materials) or by geographical area; and

finally it enables a purchasing record to be maintained. Whilst this involves the same amount of time and effort on behalf of the buyer as the manual purchasing record, it was available on-line to the estimators and therefore reduced the amount of queries regarding current item rates;

6.3.5 *Valuation sub-system*

The valuation sub-system provides advantages over the manual methods in three areas:

firstly the aggregation of the item estimates into cost centres for a typical development of 30 dwellings has been reduced from approximately 2 man days to 30 minutes;

secondly it enables monthly valuations to be produced more quickly. This is due to the monthly valuations sheet (as shown in fig 5.9), on which the monthly progress figures are recorded, being used directly as the input sheet for the monthly valuations program thus reducing clerical time in transposing the figures into a form from which the monthly valuation totals can be calculated. This process saves approximately half a day for a typical 30 dwelling phase. The sheet also contains more information than had been possible previously, such as cost centre totals; and

thirdly the valuation sub-system allows the valuations data to be analysed and compared directly against costs derived from the accounts system. This comparison was difficult and tedious in the manual system. This analysis is Summary Sheet B as shown in fig 5.11 and is used to provide cost control information to the senior management.

6.3.6 *Cost monitoring/comparisons sub-system*

The cost monitoring/comparison sub-system provides a comparison between the estimated and actual costs for all material and labour items. Only the most cost significant labour items had previously been compared due to the time consuming nature of the task. A complete analysis is now possible providing useful feedback to the estimators on errors or mistakes in their data or assumptions.

Senior management also use the system to provide cost forecasts as it is possible to perform the analysis at any time after the completion of the estimate as there are no additional inputs required other than the budget estimate and the purchasing record.

6.4 Shortcomings of the system

Whilst the DEVELOP system can be regarded as successful in terms of the criteria as listed in table 6.1 there remained several aspects of the system which posed difficulties for the company or the system users. These difficulties were caused by two major factors:

i) inadequacies in the system configuration ; and

ii) new company requirements brought about by the introduction of the system.

6.4.1 *System configuration*

As stated in section 5.1.2 the initial system configuration comprised a multi-user micro computer with a 20mb hard disk. This provided an excellent platform on which to develop the system.

However from the outset it was realised that 20mb would be insufficient disk space to store the system programs, the company data library and the phase specific data for the proposed 20 active developments and an upgrade to 60mb was made when the system was installed in the company offices. Once the company data library was compiled it proved to be much larger than originally calculated and this together with the system programmes occupied approximately 10mb. Each phase occupied another 5mb thus only 10 active phases could be stored.

To overcome this a further 100mb disk was installed giving the capacity for 25 active phases. However the speed of response of the machine diminished as the disks became full prompting concern and criticism from the users.

In the short term this problem was reduced by instigating regular back-up procedures which removed redundant files from the disk. This proved effective until more fundamental changes to the system could be effected.

These changes involved porting the system to more modern, and powerful, 16 bit computers and changing the mode of operation from a multi-user to a

networked Pc system with a central file server. This overcame the problems of disk space and response time.

6.4.2 *Company requirements*

a) As stated in 6.4.1 above the company data library proved to be larger than originally envisaged due to the company increasing its stated requirements several times during the specification and development phases. This created a problem for the company in terms of capturing and coding the data in the first place and then maintaining and updating it once the data files had been created. The time involved in this aspect of the system had been under estimated by the company who had made one of its contracts manager's responsible for this aspect of the project. However eventually the company employed a new staff member as a "data scheduler" to undertake this work.

b) The purchasing sub-system did not provide the buyers with some of the facilities they wanted. These facilities included the preparation of enquiry letters giving full specification details and the preparation of orders.

   These omissions resulted from the buyers not participating fully in the functional specification phase and the company wishing to limit the overall scope of the system.

c) The company's method of working changed with the introduction of the DEVELOP system thus removing the need for some elements of the system and introducing new requirements. Many of the changes were slight with no apparent impact on the system however two of these changes did have significant implications.

These were:
the method of estimating dwelling types; and
the creation of addendum dwelling types.

i) *Dwelling estimating*

The method of estimating incorporated into the system involved the estimator entering rates against each item in a dwelling. The rate was automatically multiplied by the item quantity to give the total estimated item cost. As the estimator entered rates against items in one dwelling type, all similar items in other dwelling types were automatically priced. Hence the estimator priced one dwelling and then when pricing the next dwelling only needed to price the items which had not occurred in the first. Thus the number of items needing to be priced in subsequent dwelling reduced until only the items specific to that particular dwelling needed pricing.

Whilst this method worked perfectly well, with the creation of a company standard item file as described in Section 5.2.2 it became possible to hold "standard rates" against these items. Thus as each dwelling was created, a standard dwelling cost was also created with it.

The facility to store standard rates was strongly opposed by the company contracts manager during the development of the system as it was felt it would remove to some extent the estimators responsibility for producing an estimate which would therefore not receive the amount of attention deemed necessary.

Also the creation and maintenance of standard rates was thought to put the company's competitive advantage at risk.

However after the system had been used on several developments the advantages of storing standard rates became attractive because:

phase budgets could be produced very rapidly; and
the estimating sub-system still allowed the estimator the flexibility to edit and amend rates to reflect the particular site requirements and conditions.

Software was developed to enable this and estimators were thus able to concentrate more effort on unique or one-off items and features of the development whilst the standard items were automatically priced. Item details and rates held on the company standard item file were regularly reviewed and updated (every 2 weeks).

ii) *Addendum Dwelling Types*

In the manual system standard dwelling types were amended, usually in terms of visual finishes, to produce addendum dwelling types. These amendments comprising new items and/or different item quantities were stored in an addendum schedule to the standard dwelling details.

The facility to create, store and manipulate addendum dwelling types and details was therefore seen as being important in mirroring the company's practices, one of the stated objectives of the system.

However because of the ease with which standard dwellings could be created, once the system was in use the creation of new addendum dwellings practically ceased. This had two important knock-on effects:

the number of company standard dwellings increased from approx 35 to 60 ; and
the disk space required to store the company data library increased leading to the problems discussed in section 6.4.1.

By the end of the 6 month monitoring period the concept of addendum dwelling types was abandoned completely. All dwelling types became company standards and were amended if required for particular developments and then became phase-specific dwelling types.

CHAPTER 7

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The objectives of this research as stated in section 1.2 were:

i) to examine the organisational structure of house-building companies to identify the key technical and commercial functions;

ii) to examine and model the flow of information between these functions identifying where data is captured, stored, used and shared within the system;

iii) to develop, in conjunction with a co-operating house builder a computer-aided management information system to improve the flow of information; and

iv) to install the system and monitor over time the advantages and disadvantages offered by it over existing manual systems.

The findings in relation to these objectives are discussed in the following sections.

7.2 Organisational structure and information flow

A study of 6 house-building companies revealed similar management functions and responsibilities. This resulted in the development of a typical organisational schematic as shown in fig 3.2 and described in section 3.3.2.

The discussions involved in producing the schematic highlighted the importance of the technical and commercial functions and their interdependence and in particular the estimating function as the major source of data for the other functions. The detailed data flow analyses were therefore focused on the estimating and associated functions and this is described in sections 3.4 and 3.5.

The data flow and entity-relationship models produced identified the dwelling schedule item as the basic element of data shared by the functions of estimating,

planning, valuations and cost monitoring/comparisons. The structure and coding of this data was therefore central to the design of an improved management information system.

7.3 Information Management

At the time of the original study in 1985 all the companies involved were reappraising their management information systems. None of them had a formal, explicit strategy with respect to computers and information management and the responsibility for formulating and implementing such a strategy had, in most instances, not been entrusted to a senior director. This had resulted in some managers "going it alone" and buying a variety of stand alone personal computers and software for their own departments requirements and preferences. Others had yet to be convinced of the need for, and benefits to be gained from, a computer-aided system.

The flow of information between the functions was usually easily discernible. The medium of communication involved standard forms, specifications and drawings, both formal and informal meetings, a large use of the telephone, informal written correspondence and even shouting from office to office. The result of this was an informal ad-hoc system of communications which whilst appearing to operate satisfactorily, could not offer uniform consistency of information. Indeed it was reported that in times of high workload the information flows became erratic which meant that the receivers had to persistently prompt for the required information instead of being presented with it in an orderly and timely manner.

Since that time all the companies have developed some form of corporate computing strategy and the larger companies have nominated an IT manager or director responsible for overseeing all computing purchases and developments. The use of computers has naturally increased with the growing availability of low cost systems and the systems used have become more refined. Only 2 of the six companies studied started with bespoke systems (ie. systems written to their own requirements) with the others taking general purpose systems (spreadsheets etc.) or industry standard software (such as Redlands Gamma 2000). However with increasing experience of using general purpose software, the companies have been better able to articulate their own requirements and therefore initiate in-house or 3rd party bespoke developments.

Total integration of systems, to enable automatic transfer and transformation of data from system to system has generally been adopted as the ultimate goal of the companies. However this has largely remained unrealised due to rapid technological developments in both hardware and software which has not created the stable conditions necessary for total integration. Partial integration has been achieved in some cases usually based around the estimating function as described in this research.

Currently one of the companies is embarking on a major development, which will involve the integration of the technical and commercial functions but which will be based around the CAD module as opposed to the estimating module. This will be based on the UNIX operating system using open system architecture thus ensuring a high degree of flexibility and the ability to link further modules as they are developed.

7.4 System development

A computer-aided management system for a house building company was developed. It comprised 64 linked FORTRAN programs and approximately 125,000 lines of code
The main features of the system are:

- the creation, storage and retrieval of standard and unique dwelling details;
- the storage and retrieval of dwelling items and rates;
- the storage and retrieval of phase development information;
- the storage of suppliers details;
- the calculation of phase budgets on a plot by plot basis;
- the creation and maintenance of the buyers records;
- the aggregation of total and partial phase quantities;
- the aggregation of cost code values;

- the production of monthly valuation sheets;
- the calculation of monthly interim valuations;
- the production of cost/value reconciliations; and
- the production of estimated rate/actual cost reconciliations.

7.5 System in use

The system was installed in a collaborating company's head-office. A total of eight staff were trained to use the system and the performance of the system was monitored over a six month period.

The benefits of the system were observed to be:

- a consistent and uniform presentation of information ensuring that all information was recorded and reported to the company-defined standard;
- an improved and accelerated flow of information required for estimating, purchasing, valuations and cost comparisons due to the removal of the clerical work involved in abstracting information required by the function;
- the creation of a library of company standard data enabling quick and easy access for all the functional staff;
- a decrease in the time taken in aggregating costs and quantities for developments saving approximately 5 man days for a typical 30 dwelling development;
- the ability to quickly change unit rates, overheads or dwelling details to achieve a target budget figure or to redesign a phase in response to marketing information;
- a faster and more uniform method of producing monthly valuations saving approximately 1/2 man day for a typical 30 dwelling phase; and

- more detailed cost comparisons than were previously possible providing better information for management control.

In addition the system:

- introduced company personnel to computers and systems thereby increasing their skills and making them aware of the potential for computer-aided systems; and

- reputedly gave the company a 'high tech' image amongst its competitors and clients.

The disadvantages or problems encountered and observed included:

- the creation and management of the company standard data was a major problem for the company. Initially it was envisaged that the nominated contracts managers would be able to create the library and then maintain it. However the abstraction of the company data necessary to create the library proved to be a long and laborious task and a new member of staff was engaged solely to undertake this work. Over time the amount of data stored increased as a 'throw nothing away' mentality emerged. This in turn meant that the computer disks were constantly full and the machine worked considerably slower than it could. Also during the creation of a new phase the machine often ran out of disk space causing disillusionment and frustration amongst the users. The solution was to instigate regular back-up and house keeping routines to purge the machine of outdated or redundant data.

- One of the results of the above was that the company requirements quickly outpaced the capabilities of the initial hardware configuration. The machine was upgraded with extra disk storage. The system was ported from 8 bit to 16 bit machines which involved a partial rewrite and finally the system was rewritten in the C language to speed up processing and to add new facilities. This system then operated on a number of networked PCs.

- The initial specification for the system was undertaking in consultation, with the eventual users of the system and a company contracts manager. Whilst this contracts manager was familiar with all the technical functions

addressed by the system his detailed knowledge was better in some areas then in others. In particular, once developed, it was felt that the purchasing system did not provide the buyers with as many facilities as they would have liked. Indeed apart from saving them approximately 3 days for each development by aggregating quantities the system required them to input information for use by others. This resulted in the buyers being more reluctant to use the system as it provided them with fewer facilities than the other users.

- As in most construction companies the company accounts, wage roll, invoices etc. were undertaken on a separate computer run from the accounts department. Initially the companies computing facilities had fallen under the jurisdiction of the Financial Director and this had led to the slow development of technical computing within the organisation. Whilst the DEVELOP system was never intended to integrate with the existing accounts systems it was necessary to extract information from the accounts system to enable meaningful cost/value comparisons to be made. This involved both technical and managerial difficulties. The former due to the computers being incompatible and the latter due to a reluctance on the part of the financial staff to divulge the required information. Fortunately this was resolved and a manual transfer of information adopted. This involved printing out the required information from the accounts computer and re-inputting it into DEVELOP.

- The implementation of the system and training of the users took longer than anticipated. This was mainly due to an overly ambitious training programme which did not allow users to become familiar with the basics of the system before being introduced to more complex procedures. In hindsight insufficient time was given to system testing by the users which would have enabled them to become familiar with the system using real data but without the pressure to get everything right first time.

- One of the problems voiced by the management over the development was to actually quantify the benefits in monetary terms to the main board of directors. Whilst time savings could be measured and costed, more intangible benefits such as greater accuracy and consistency, more detailed analysis and more uniform presentation of information could only be notionally costed. This made arguing for more development funds difficult

and funds were often granted in the belief that they 'improved efficiency' without quantifying the improvements expected.

- The company found that computer literate staff were a valuable commodity and 2 of the original 8 staff who were trained left the company within 2 years to work for competitors. One of the reasons cited was the fact that they were familiar with computer developments within their area of expertise and could advise on the purchase and development of such systems.

7.6 Recommendations and Observations.

The recommendations and observations are divided into two sections.
The first section contains general observations, and the second section contains proposed improvements and enhancements to the DEVELOP system.

7.6.1 *General Observations*

A number of points emerged from this research which are of relevance to any systems analysis/development/implementation project.

These observations are in the areas of :
Corporate I.T. strategy;
Hardware and software configuration;
Integration of systems;
Development methodology; and
Implementation and Training.

i) *Corporate I.T. Strategy*

One of the key elements in any systems project within an organisation must be a cohesive and comprehensive corporate I.T. strategy. Many writers on management information systems have identified the need for a clear policy on I.T. emanating from the top management of the company (for example Lucas and Turner, 1982; Senn, 1990). Unfortunately it is only recently that construction companies have recognised the importance of an explicit policy regarding computers and the situation within some companies is confused (Turk,1985).

The adoption of an IT strategy also requires a senior member of the company to take on the responsibilities of IT Director. If no one is suitably qualified (or enthusiastic) a professional IT manager should be appointed. This should ensure that individual developments within the company fit into the overall strategy of the company thus enabling compatibility and integration between different systems. A corporate policy, with a number of approved suppliers can also ensure that maximum discounts (up to 45%) are obtained.

ii) *Hardware and Software configuration*

Hardware and software must be chosen with expansion and flexibility in mind. Hardware technology has advanced rapidly in the last 10 years with micro's moving from 8 bit to 16 bit to 32 bit machines with 64 bit machines already entering the market.

Software has developed less rapidly due to the operating systems being ported onto the larger machines without exploiting their full potential. This is particularly true of the industry-standard MS-DOS operating system.

Newer operating systems such as OS/2 and UNIX appear to offer greater scope for future expansion.

Similarly traditional programming languages such as FORTRAN or COBOL are slowly being replaced by fourth generation environments such as FOCUS or ORACLE which enable programmers to develop and tailor systems to user requirements much more rapidly.

iii) *Integration of systems*

As previously stated, the total integration of all corporate computer systems is often seen as being the ultimate aim of company systems development. This would, in theory, link together all commercial, managerial and technical systems around a corporate database which would allow quick and efficient data transfer, analysis and use.

Unfortunately this situation is rarely achieved, and indeed it is questionable as to whether this scale of integration is desirable.

Only in areas where data is reasonably stable, and the transformations of the data required between functions small, is large scale integration feasible and beneficial.

Three areas are particularly affected once modules are integrated. These are:
- training;
- program maintenance/de-bugging; and
- data integrity and transformations.

Training: more detailed planning and more extensive training is needed for an integrated systems which is wider in scope than a stand alone package.

Program maintenance/de bugging: the problems of program maintenance and de-bugging are exacerbated in a large integrated system. The concept of 'referred pain' is well known to software staff!

Data Integrity and Transformation: the larger the scale of integration, the harder it is to maintain data integrity as the same basic data blocks are used for a variety of different (and sometimes conflicting) purposes.

iv) *Development Methodology*

A modified version of the methodology adopted for the development of the DEVELOP system can be taken as a good working template for any future systems development. Basically the method is that described by Yourdon (1982), Olle et al (1988) or Downs et al (1988) and comprises:

- development of a Functional Specification;
- development of a System Design;
- prototyping with system design reviews;
- validation using historical data;
- staged training and implementation; and
- monitoring and modifying.

Functional Specification: This document sets down the requirements of the system in terms the user can understand and agree. It includes typical examples of input data and resulting output. It explains how the data is to be analysed and the calculation processes required. This document should be circulated widely in the company to elicit comments and criticisms which can be incorporated into the system.

System Design: The system design document forms the basis from which the actual computer programs are developed. It is devised from the Functional Specification and contains the scope of the individual programs, the files and records required, the calculation and manipulation routines and input and output forms. Where possible methods or procedures to be followed should be specified.

Prototyping: The method of prototyping with end user input is slow but has many advantages. The method involves forming a cross section of the users into a system design revue group. A section of the system is produced and demonstrated to this group and their comments recorded. The section is amended and the process repeated.

The two main advantages of this type of development are:

a) the system development team can resolve problems or clarify queries with the potential users of the system. This enables the development to remain on the correct path; and

b) the eventual users of the system can both have input into the development and also become familiar with the software over the whole development phase. This reduces the orientation and training required significantly and also helps to promote the use of the system in the user departments.

Validation: Where possible the system should be validated using historical data before being used on a live project. Constraints of time and data availability in the required form often mean this is not possible. In these cases parallel running of the system in tandem with the existing manual

system should be adopted. The manual system should not be abandoned until the system has been proved to be reliable.

Staged Training and Implementation: This is vitally important and is discussed in the next section.

Monitoring and Modifying: After the system has been implemented and is in use the development team should monitor the performance of the system and make any modifications required. This is best achieved by maintaining the System Design Review Group and meeting at regular intervals for upto a year after the implementation.

v) *Implementation and Training*

The implementation and training phase of a development is often given less time, planning and effort than any of the others. However it is central and vital to the success of any computer system development and is what Eason (1988) describes as the "acid test".

As outlined in the previous section the orientation and training of the eventual users starts with their contributions to the functional specification. This is continued and refined via the System Design Review Groups. Finally properly planned training sessions should be held as the system is implemented.

For large integrated systems the implementation should be on a staged basis with users being introduced and trained on a few modules at a time. Implementation and training should proceed in tandem allowing sufficient time for the users to become familiar with one section before being introduced to further modules.

7.6.2 *Enhancements to the DEVELOP system*

There are several modifications/enhancements which could be made to the DEVELOP system to increase its usefulness and applicability.

These modifications are in the areas of :

purchasing;
land appraisal;
CAD; and
site-based data capture.

These proposed extensions are discussed below.

i) *Purchasing*

As described in section 7.5 the purchasing sub-system of the system fell short of the expectations of the users. The purchasing sub-system should be extended to include the production of material and subcontractor enquiry letters, using standard specifications drawn from the Company Standard Specification file and also produce written orders for such materials and services. This would involve linking the system to a standard word processing package and would overcome the criticisms of the buyers that they did not receive enough benefit from the system.

ii) *Site Appraisal*

As described in section 3.3, a site appraisal is usually undertaken as a precursor to the decision to buy or develop an available site. A likely mix of dwelling types is decided, their approximate costs and revenues estimated and a cash flow and profit forecast calculated.

These figures need to be easily and quickly adjusted and recalculated so that the optimum cash flow or profit can be realised. This type of application is ideally suited to a spreadsheet and provision should be made to link a standard spreadsheet module to the system. A feasibility study has already been undertaken on this aspect (Aberra, 1988). Once the appraisal had been undertaken the details could automatically transfer into the Phase Details file thus removing the need for this to be initialized at a later stage.

iii) *Computer-Aided Design*

A computer-aided design (CAD) module could be used in two areas:

site appraisal/layout ; and

dwelling design.

During the site appraisal a preliminary site layout is often developed. This will include site roads, drainage lines and proposed plot layouts. As can be imagined the possible permutations are huge and a balance needs to be achieved for profit optimisation.

A CAD system is now often used to try various site layouts. The advantages of a CAD system are that company standard 'plan' libraries of dwelling types can be stored thus allowing the planner to arrange these to achieve the desired outcome. This can be done quickly allowing many different layouts to be examined. A feasibility study investigating the use of AUTOCAD for housing site layouts has been reported by Hurst(1988).
The second use for a CAD module would be for designing new company standard dwelling units. A growing trend amongst house builders is to design new developments to reflect the character of the surrounding area. This, together with the ability to store many more details then was previously possible, has resulted in house-builders developing far more standard house types then before. This trend was noted with the DEVELOP system where a number of previously 'one-off' dwellings became company standards due to the ease with which they could be manipulated.

The development of new designs is usually undertaken by inhouse architects. Occasionally it is let to external architectural practices. The proliferation of low cost PC-based CAD packages (Richens,1990) has enabled these architects to utilize the benefits offered by such packages. One of the main benefits is the breakdown of new designs into building material items and the aggregation of these items into schedules thus eliminating the need to 'take-off' the items from drawings (Gilleard, 1990). The labour items naturally still need to be estimated and formed into schedules as before.

Direct integration of a CAD system with the DEVELOP system would be difficult due to the format of stored graphical information. However a 'loose integration' would be possible with the .DXF graphical files being translated for use by the DEVELOP system. This type of transformation is becoming more common and has been described by Wix and McLelland (1986) and NEDO(1990).

iv) *Site-based Data Capture*

One of the problems of construction computing is whilst the data processing power (in terms of hardware, software and data prep staff) is based in the head office, much of the data required is generated at the site. This data therefore needs to be captured and transmitted to head office, usually in the form of paper records, to enable the systems to run. The data is therefore recorded by site personnel which renders its quality and completeness variable.

The development and adoption of site-based computers for data capture overcomes some of these problems. Firstly the data is captured in a structured manner which avoids omissions and duplications. Error checking routines ensure that the data is validated, as far as possible, before being stored. Finally the information can be transmitted to the head office either electronically (via telephone lines) or manually (via diskettes) thus removing the need for data preparation staff to retype the data.

The ideal medium for site-based computers on housing projects is the portable lap-top computer. This would enable the peripatetic site manager, with several sites to control, to easily transport the computer from site to site to record progress, material deliveries, variations to plan, etc. These machines are battery operated and can therefore be used on sites before mains electricity has been supplied.

The use of such systems has been described by Quinnan (1987), James and Thorpe (1989) and James, McCaffer and Thorpe (1990) and significant savings in costs and time have been reported.

7.7 Summary

The volatile nature of the house building market as discussed in section 1.1.2 and the need to respond to changing demands dictate the need for efficient and effective management systems which can design, cost and monitor housing developments quickly and easily. These management systems rely implicitly on the information and communication systems of the organisation. Traditional manual systems are

often informal, ad hoc and inefficient and hence improved computer aided systems are required.

The unique nature of house building within the construction industry has meant that existing systems designed for general contracting companies are inappropriate and thus house building specific systems are needed.

The research described in this thesis provides an insight into the likely needs of such systems. Having been designed and implemented with only one collaborating company it is not intended as a panacea for all house building companies but hopefully provides an indication of the way forward for the industry.

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APPENDIX 1

User document for the DEVELOP system

A USER'S GUIDE TO THE DEVELOP SYSTEM

Antony Thorpe

DEVELOP - USER DOCUMENTATION

CONTENTS

7 ESTIMATING SUB-SYSTEM

A description of the files and facilities that provide a basis for creating a phase estimate.
An example of interrogating and updating a file; input of item rates; and producing a 'phase budget summary'.

8 PURCHASING SUB-SYSTEM

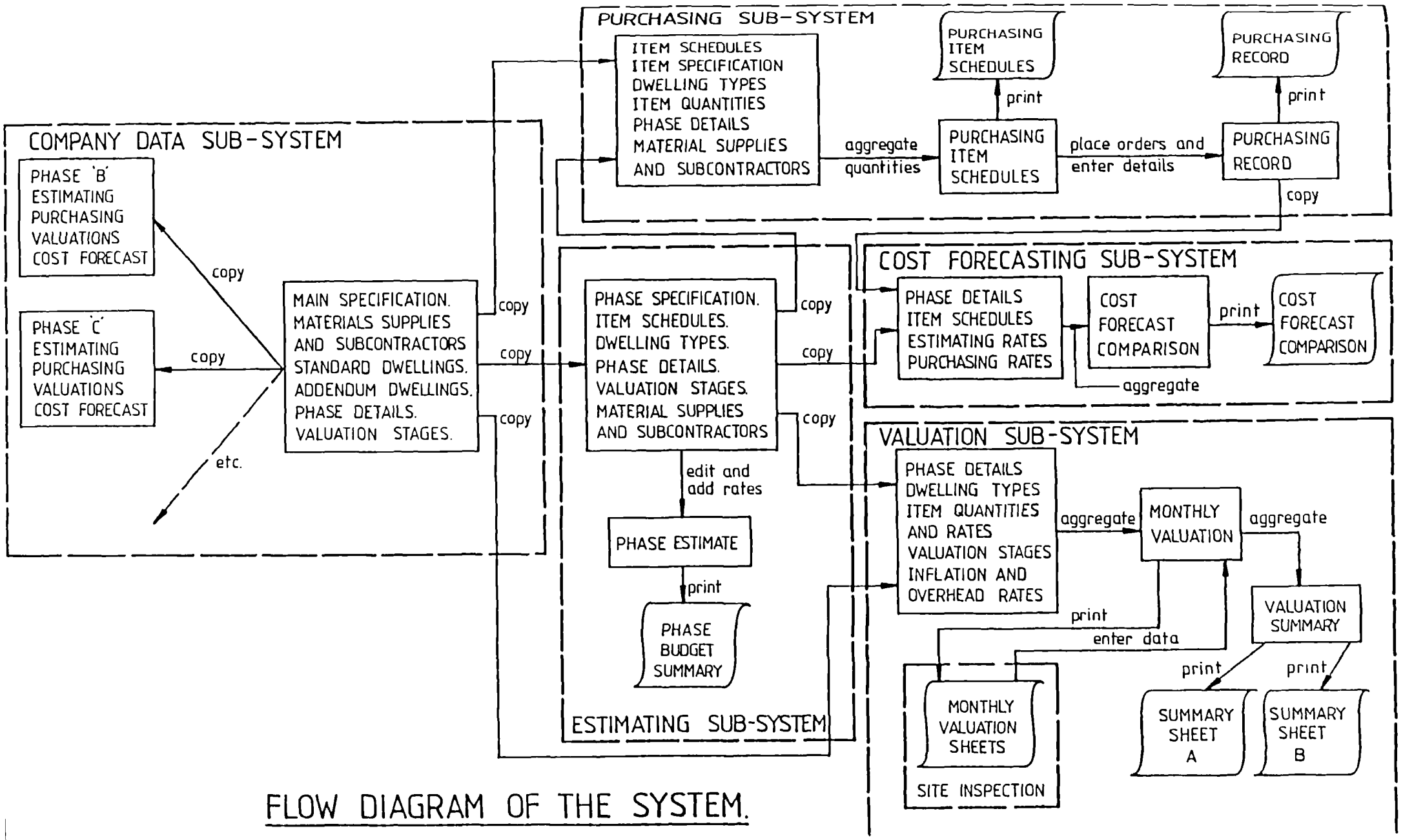
A description of the files and facilities that provide the basis for creating purchase orders.
An example of aggregating item quantities; input of order details; and producing a 'purchasing item schedule'.

9 COST FORECASTING SUB-SYSTEM

A description of the files and facilities that provide the basis for creating a phase cost forecast/comparison.
An example of aggregating for a cost forecast and printing the results.

10 VALUATIONS SUB-SYSTEM

A description of the files and facilities that provide the basis for producing monthly valuations and valuation summaries.
An example of aggregating values from the phase estimate; input of data following site inspection; and producing a monthly valuation.
An example of variation order input; aggregating for summaries; and producing summary sheets 'A' and 'B'.



FLOW DIAGRAM OF THE SYSTEM.

DEVELOP - USER DOCUMENTATION

1. SYSTEM OVERVIEW

The Develop computer system is a comprehensive data management system. It is designed to store and process all the company's data relating to the building of dwellings. The phase related functions of Estimating, Purchasing, Valuations and Cost Forecasting each refer, and in turn, add data relating to specific building phases into the system. Information relating each function with others in the phase is consequently up-to-date and readily accessible, stressing their interdependence; and phase cost analysis and control made easier thereby benefitting the company's cost effectiveness.

The Develop system is divided into 5 sub-systems; these are

(i) Company Data Sub-system
(ii) Estimating Sub-system
(iii) Purchasing Sub-system
(iv) Valuations Sub-system
(v) Cost Forecasting Sub-system

COMPANY DATA SYSTEM

Central to the design of the Develop system is a store of Company Data. This data store or library contains computer files of all information relating to the company's recent and current building projects or 'phases'. It will therefore contain details of the dwelling types being built in each phase; all the resource items such as materials and sub-contractors that contribute to their construction; details of all the suppliers and sub-contractors used, etc. (Refer to fig. 1).

This information provides the basis from which the Estimator and Purchaser for each individual phase start to build-up their phase data. The creation and regular maintenance of this Company Data is therefore a matter of extreme importance to the company and should be the subject of continued security.

The Develop system is designed to provide all users with the facility to refer to the Company Data, but the facility to amend or add to this data is limited to key personnel within the company. This limitation is controlled by a system of user registration numbers and passwords.

ESTIMATING SUB-SYSTEM

The estimating sub-system, like the remaining sub-systems, is "Phase Specific". This means that the operator of the sub-system only works with data relating to one building phase at any one time. Access to data regarding a specific phase is controlled by user registration numbers and passwords.

This phase specific data includes a description and details of the phase, the types of dwellings to be built, together with copies of the company data regarding material and sub-contractor

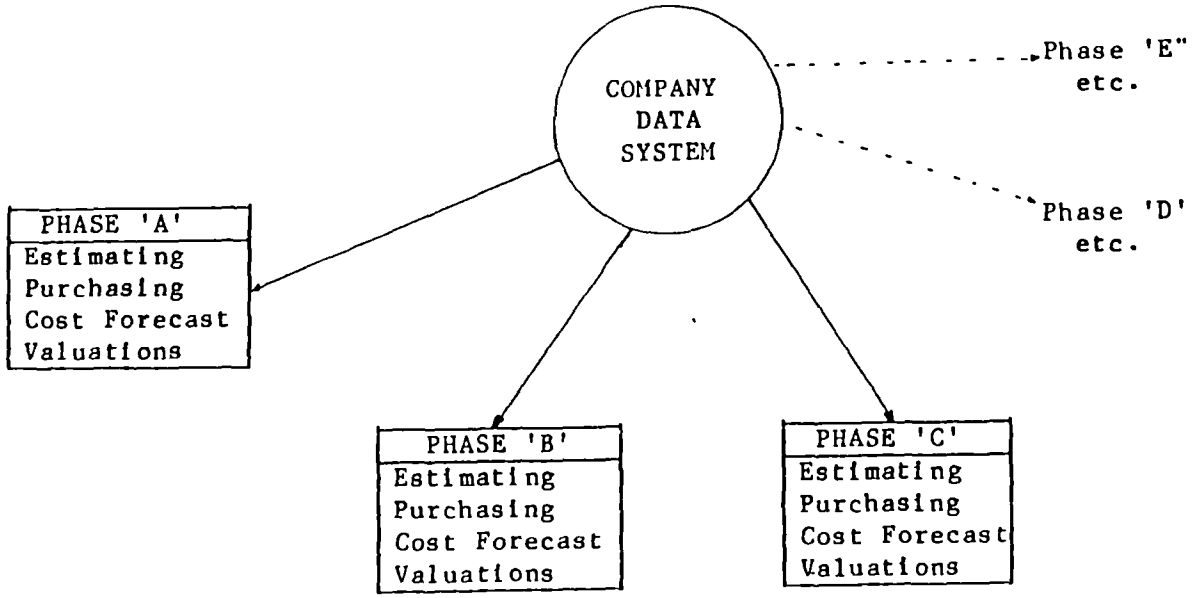


Figure 1 COMPANY DATA AND PHASE SPECIFIC DATA

items and their specifications. This data is transferred in the form of duplicate copies of whole or part of files held in the company data system. This enables the estimator to effect changes to the company standard data to reflect particular contract requirements without compromising the integrity of the original files. (Refer to fig. 2).

The estimating task is facilitated by the provision of a break-down of those items and quantities which specifically contribute to the construction of each type of standard dwelling within the phase. The estimator will exercise his judgement in amending this information in the light of contract conditions and then enter into the system a rate against each item involved. The results are held in a file called the Phase Estimate from which the estimator can print a phase budget summary.

PURCHASING SUB-SYSTEM

The buyer given responsibility for a 'phase' will obtain a copy of the phase details transferred from the company data files. In addition, he will be provided with copies of the computer files containing details of the phase dwellings, the items to be used, and their specifications. These are copied from the phase estimate in order to reflect any amendments to company standards that the estimator may have specified. (Refer to fig. 3).

The buyer's initial task is to aggregate the quantities required of each type of item that occurs in the phase estimate in order to prepare purchasing orders. This aggregation is carried out by the computer to produce a printed report. Individual items are grouped together within 'schedules' such as bricks and blocks, standard frames etc. enabling the buyer to aggregate and print the results in groups of related items. These printed reports are referred to as purchasing item schedules. The buyer may choose to aggregate items for a single dwelling, a number of dwellings, (selective aggregation); or aggregate the entire phase estimate.

By reference to the company data file containing the details of material suppliers and sub-contractor details, the buyer is able to select appropriate sources as the basis for building-up purchasing orders for each aggregated item. As a purchasing record, the buyer enters onto the computer the total quantity of each item to be ordered; the rate and quantity of the most recent interim order with date, and records the cumulative total ordered to date against the supplier's details.

COST FORECASTING SUB-SYSTEM

Within each phase, the facility is provided to quickly produce a report comparing a forecast of costs based on rates within the phase estimate against a forecast based on the purchasing costs. This comparison is done for each item, and provides totals for each schedule of items throughout the phase. Additional totals are provided illustrating the effects due to an adjustable

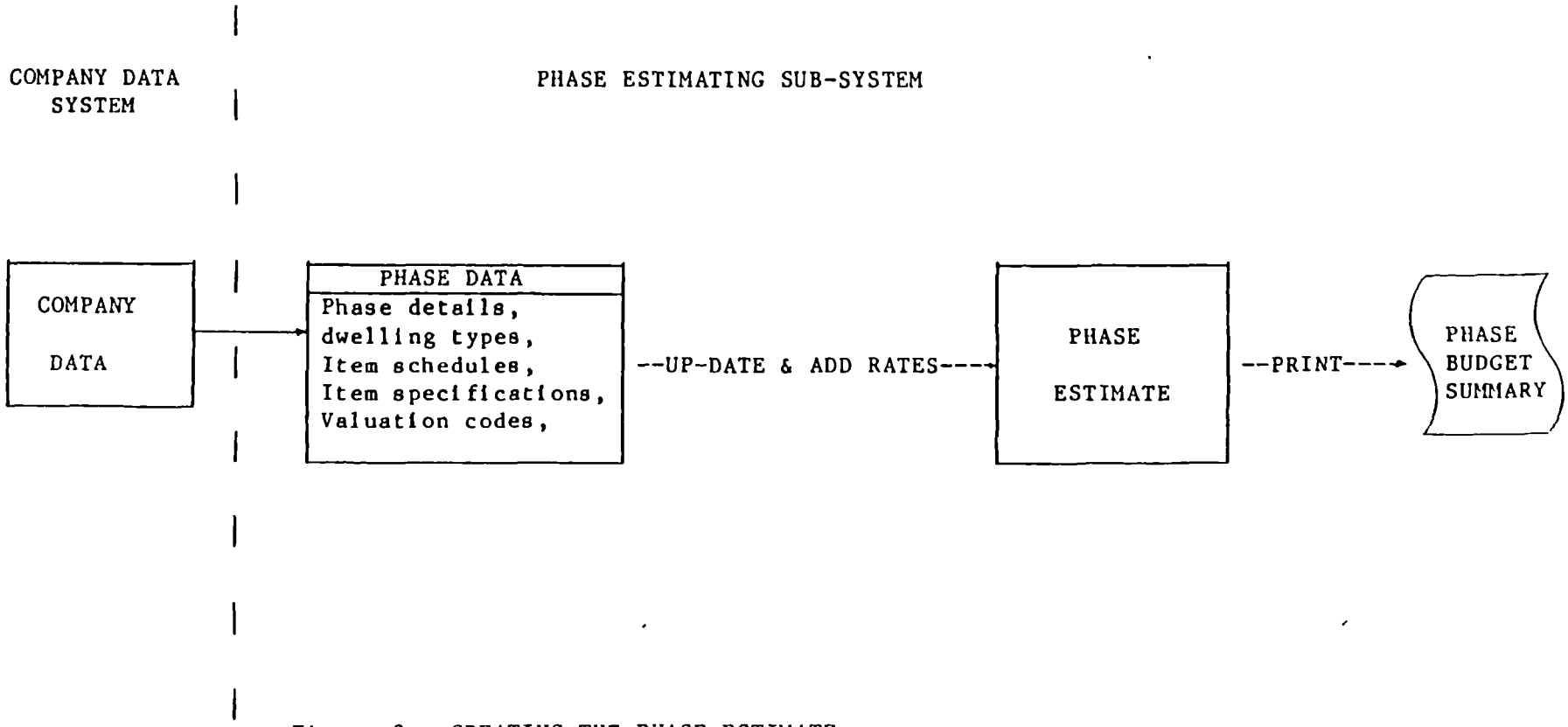


Figure 2 CREATING THE PHASE ESTIMATE

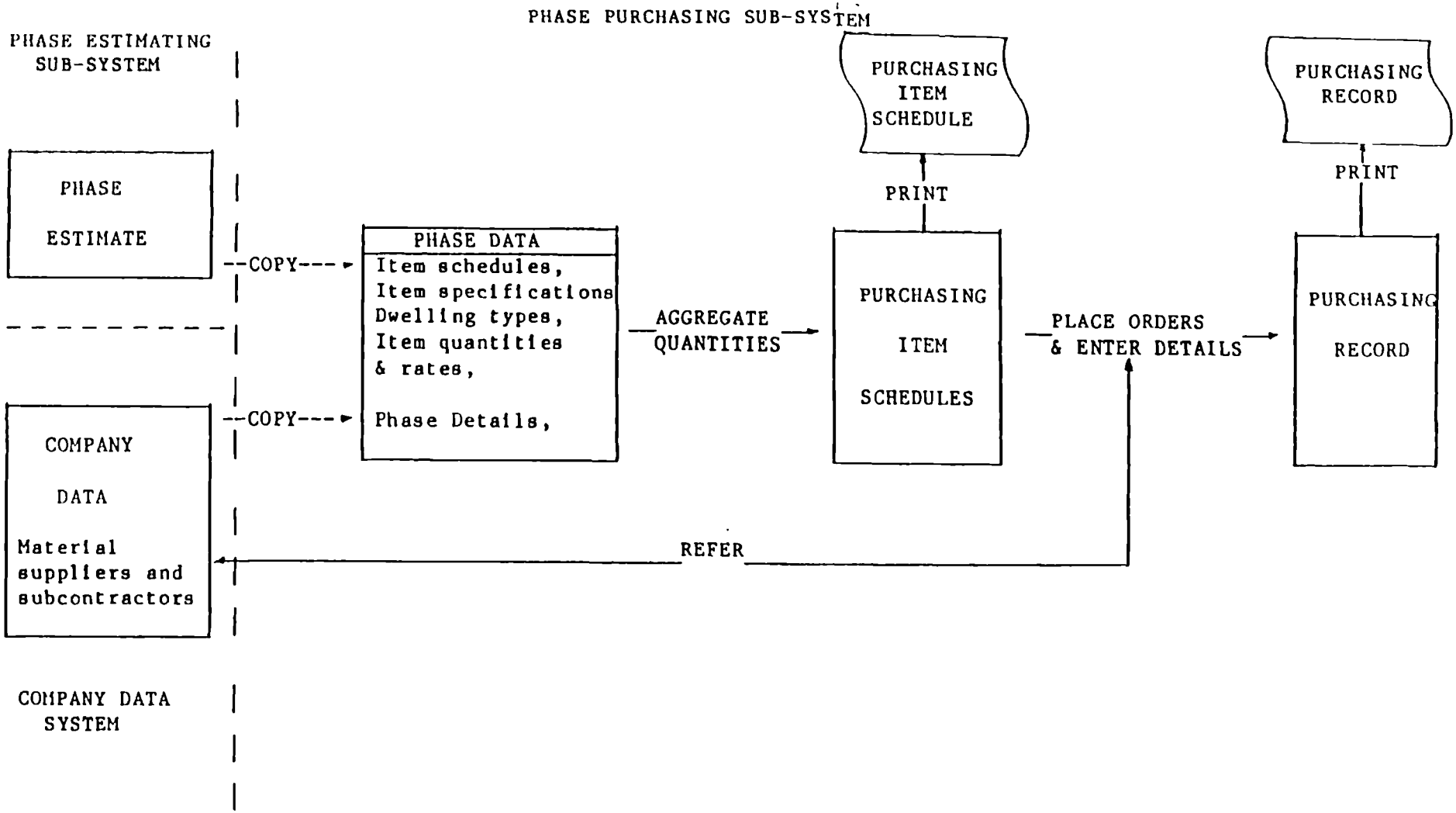


Figure 3 PREPARING PURCHASE ORDERS AND PURCHASING RECORD

inflation rate and also including any discounts involved. (Refer to fig. 4).

VALUATIONS SUB-SYSTEM

For the purposes of valuations, items on the company data files are also classified within cost code categories, such as drains, bricks, frames, brickwork, roofing, etc. This enables the surveyor to perform an aggregation of item totals from the phase estimate to arrive at a value that each cost category contributes to the estimated cost of each dwelling type.

From this aggregation, a monthly valuation sheet is produced to accompany site inspections of work done to date.

The monthly valuation sheets will subsequently display totals for work done within each cost category, dwelling by dwelling, when these have been entered into the system, following site inspection.

Provision is also made for recording in the system any variation orders emanating from the phase site. These are added along with valuations of preliminary works, allowances for inflation and overheads, to provide for valuation summaries. Two types of valuation summaries are available from the system providing alternative levels of analysis of the phase valuation data. Refer to fig. 5).

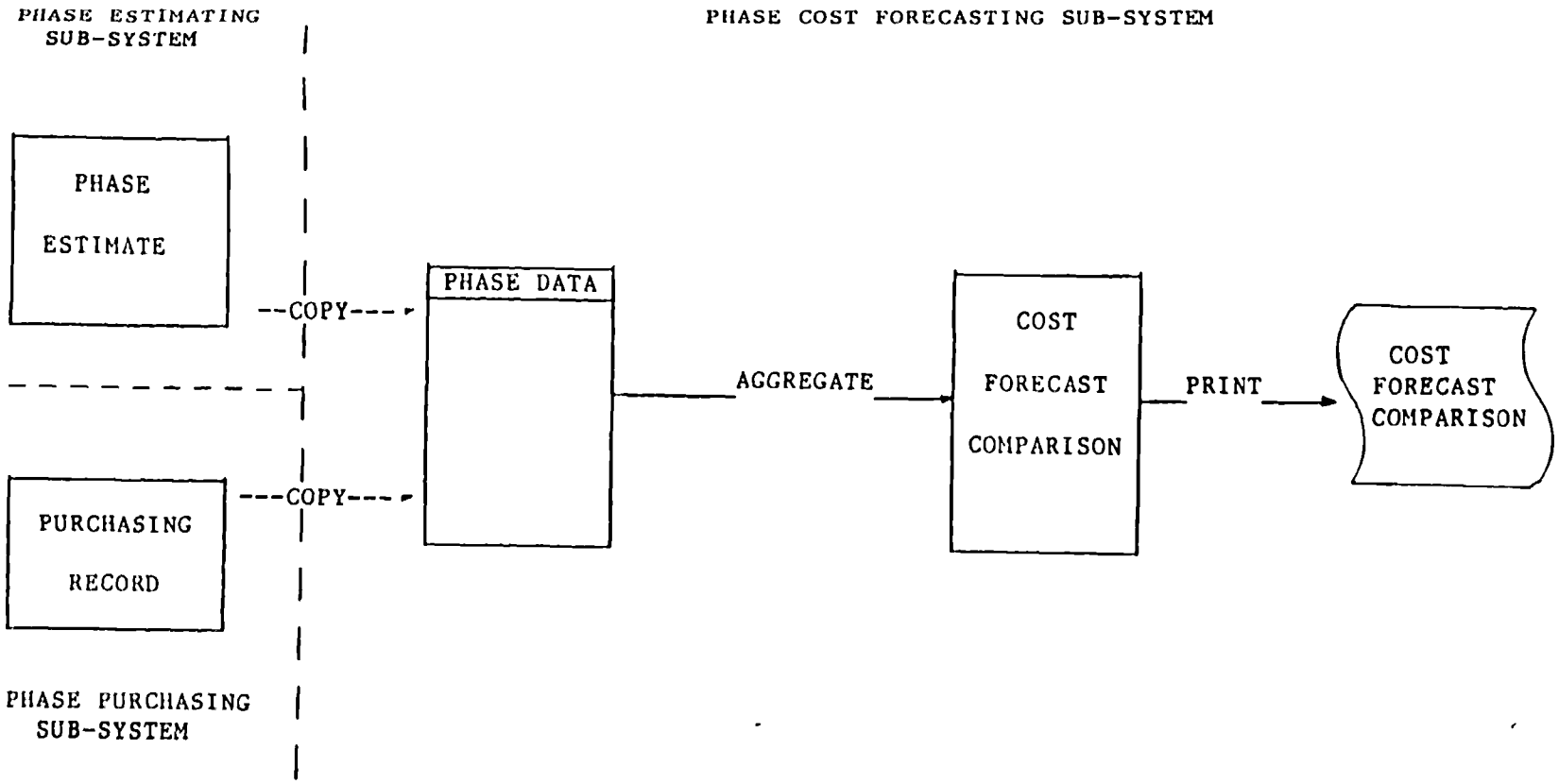


Figure 4 CREATING THE PHASE COST FORECAST COMPARISON

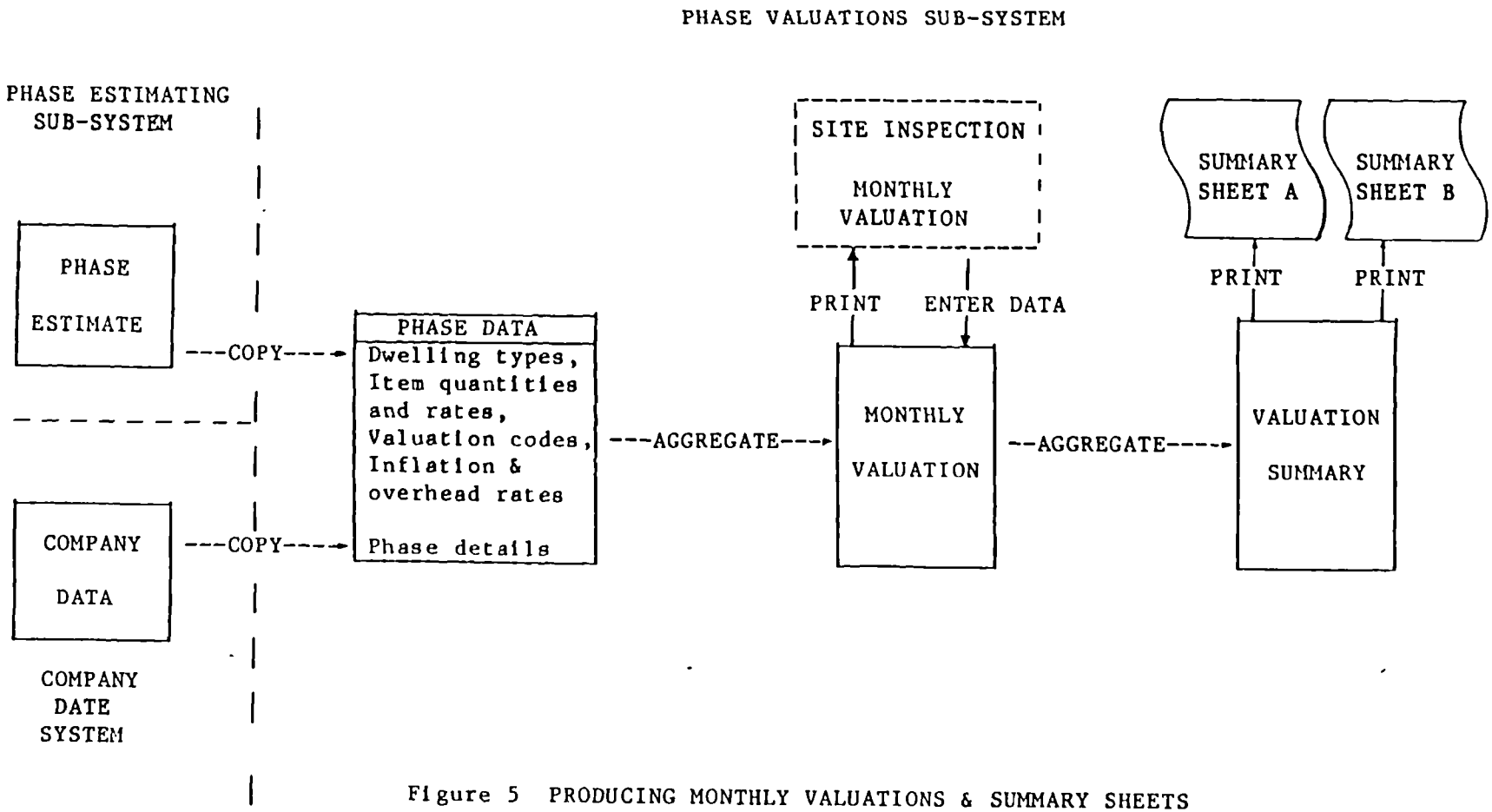


Figure 5 PRODUCING MONTHLY VALUATIONS & SUMMARY SHEETS

2. FILES AND FACILITIES

The Develop system has been designed to exploit the advantages that computers can provide over manual methods of data management, and yet leave the operator free to exercise his judgement and creativity in performing the all important decision making. This section examines what part the computer plays in supporting the operator of the Develop system.

Basically, computers provide for 3 main functions :

* they store information
* they perform calcuations
* they print reports

Regardless of which Develop sub-system you will operate, these three functions are all provided by the computer. They are each examined in turn below :

STORING INFORMATION

For each of the four sub-systems that deal with a single phase, i.e. estimating, purchasing, valuations, and cost forecasting, the computer provides files of stored data as a starting point. These files originate from the company data sub-system but are processed and changed within each sub-system in turn before handing on to the next.

It may be instructive at this point to clarify just what is meant by a computer file :-

Much like a file of information in a typical office filing system, a computer file contains related data, organised in some systematic way so that you can quickly retrieve the information you require. For example :

* a file may contain details of all the different material items that the company uses to construct dwellings. These may be grouped under headings such as bricks and blocks, standard frames, etc.

* another file may contain details of precisely which items are used to construct a particular standard dwelling type, and the quantities required.

For effective filing, each key item of data in the file must be provided with a unique identifier. In the Develop system, the identifiers are codes made up of letters and numbers. These codes are used for the following important reasons :

* to provide a unique location in the file so that the computer can quickly locate the information you require via an indexing system.

* to classify items so that the operator may organise and

identify them more readily.

* to provide classification such as cost centres for subsequent phase analysis.

For those users who are not yet accustomed to handling files within the Develop system, it is important to emphasise the following points :

* where files of data are transferred from one sub-system to another for subsequent processing, the Develop system is designed to transfer a duplicate copy thereby ensuring the continued integrity of the original file.

* when the originating file itself is processed as in the case of up-dating a company data file or a phase estimate, the amendments made will be reflected in any subsequent copies but NOT in copies that were transferred prior to the up-date.

These points have important implications for the operator. For example, the file containing the results of the phase estimate provides the basis for the purchasing and cost forecasting sub-systems. If the phase estimate is to be up-dated to reflect some changing contract conditions then consideration will have to be given as to whether to rework the purchasing schedules and consequently the cost forecast for the phase based on the new phase estimate file.

PERFORMING CALCULATIONS

Within each phase sub-system the computer provides for the required processing of data. Typically this involves the aggregation of figures, for example :- totalling item rates for all dwellings of a certain type within the phase. Calculations which are time consuming when performed by manual methods and subject to human error and performed by the computer with astonishing speed and accuracy. Calculations such as these are initiated by simply keying-in a single command at the computer keyboard.

In order to prepare data for calculations, the provision is made for the operator to enter any required figures into the system. For example: estimated item rates, or cost rates for purchasing. Any information entered into the system can be subsequently changed or deleted if required and this also applies to data provided from the company data sub-system. Collectively, the operations of adding, changing and deleting data are referred to as edits and these are performed using the computer keyboard and display screen so that the operator is able to see the effects of edits as these take place.

For security purposes, the ability to edit data must be limited to those given specific responsibility for the phase data. This limitation is controlled by a system of user registration numbers

and passwords. The computer will then automatically restrict editing facilities within each sub-system to authorised personnel.

PRINTING REPORTS

The results of all edits and calculations are stored on the computer in files specifically set aside for the purpose. Within each phase sub-system the facility is provided to print reports from these files summarising the results. These reports may be based on all the calculations performed or only those calculations that affect a particular portion of the building phase, i.e. a selective report. A typical example of a printed report would be a monthly valuation sheet which may be used to accompany a site inspection. Revised figures for work done to-date would be entered onto the sheet for subsequent input onto the computer.

In a similar manner to that of calculations, printed reports are initiated by simply keying-in a single command at the computer keyboard.

3. SYSTEM CONTROL AND SECURITY

The Develop system is designed to provide facilities to aid the tasks performed by a number of personnel at different levels and with differing roles within the company. In any multi-user system such as this there is an ever present danger of data being corrupted, accidentally or otherwise, resulting in time consuming repetition of work. In extreme cases, data of vital importance to the company may be lost, or fall into the wrong hands if the system is not managed effectively. There is therefore a requirement to limit access to both data and system facilities to authorised personnel, maintain a careful watch on the current status of all system data files, and establish an effective system of back-up duplication as a routine task in the event of data loss or equipment failure.

ACCESS TO SUB-SYSTEMS

Provision is built into the Develop system for the contracts manager or whoever has responsibility for the day to day management of the system to exercise control over access to data and system facilities. This is achieved by a system of user registration numbers.

Each operator of the system will require a unique registration number designated by the system manager. Against each registration number the system manager will specify those sub-systems and data to which that person will require access in the normal performance of their tasks. Access may be at three levels :-

* reference only
* facility to print
* facility to edit

The manager may designate merely one or any combination of the three levels of access to each sub-system, although the ability to edit would normally imply access at the other levels.

USER PASSWORDS

In addition to the registration number, each operator of the system will require a user password. The user password is used in conjunction with the user's registration number to limit access to the system. However, by virtue of its personalised nature, the user password differs in effect from that of the registration number :-

Each operator allocates his/her own password and enters it into the system where it is recorded against the user's registration number. A user's password is never displayed on the display screen and cannot be ascertained by interrogation of the system. Provided that the user does not disclose his/her password either to the system manager or colleagues then the user is assured that access to the system via their registration number is denied to

all but themselves.

Maintenance of a user's personal password is the sole responsibility of the user in question. The password may be changed at any time and as frequently as required provided the current password is not forgotten! In the event of the password being forgotten, the system manager will have to issue the user with a new registration number.

SYSTEM STATUS

The Develop system is designed to enable the company to process a number of phases concurrently. However, with limited storage space available for phase data, care must be taken when adding a new phase onto the system. In anticipation of insufficient space remaining, the system manager may wish to delete an existing phase to create the additional space required. Should this phase require further processing at a later date a copy of the phase files should be taken prior to deletion. This copy should be created on an external storage medium such as magnetic tape. The tape can then be used subsequently to reinstate the files on the computer.

DATA BACK-UP

The establishment of a regular procedure for creating back-up copies of data files is crucial in the event of possible computer failure or data corruption. Although unlikely, the speed at which any data can be restored and work resumed following a breakdown will naturally depend upon the extent to which files have been changed following the most recent back-up operation. The frequency at which copies must be taken should therefore correspond to the frequency at which files are up-dated.

The responsibility for maintaining system status and initiating back-up operations will probably rest with the system manager. Detailed procedures for these operations are not therefore provided in this document.

4. DRIVING THE DEVELOP SYSTEM

The Develop computer system is an INTERACTIVE system. The term 'interactive' refers to a style of working that the computer system provides for the operator. There are two key elements in an interactive system:-

* Flexibility of use - having access to a range of facilities which you can quickly locate and exploit.

* Speed of response - immediate feedback of results to any up-dates and calculations.

The Develop computer system is therefore designed to provide the operator with a choice of facilities to suit his purpose and the freedom to work at his own pace. The operator uses a keyboard to enter commands for action to which the computer will respond with almost no perceptible delay and yet will display unending patience while you decide what your next move will be!

COMMAND MENUS

For technical reasons the Develop System is designed to recognise only a limited choice of commands by the operator at any one stage in their 'interaction'. In most cases the computer will actually display this choice of commands in the form of a list. This is referred to as a MENU of commands. The following figure illustrates a typical command menu.

```
                    BUDGET SUMMARY


        RC . . . Refer/Input/Change Percentage Constants
        AG . . . Aggregate Budget Summary
        PB . . . Print Budget Summary
        QU . . . Quit

        Enter Command >-
```

Selection of a desired facility from the command menu merely requires the operator to key-in the appropriate two letter command from the left hand side of the menu.

SYSTEM REQUESTS

In some circumstances the Develop System will ask the operator for a specific piece of information by displaying a request on the display screen. This is called a SYSTEM REQUEST and an example is shown below :-

In those cases where the request demands a YES/NO decision, it is sufficient to merely key-in 'Y' for YES, or 'N' for NO. In other cases such as a request for a password or a dwelling code, the system will examine the operator's response to check that it is valid. An unrecognised response will result in a repeat of the question!

EDIT MODE

The Develop System is designed to allow the operator to effect changes to data that appear on the display screen by moving a cursor in much the same way as you would use a pencil and eraser on a piece of paper. Changes such as additions, deletions and up-dates are collectively referred to as edits, and this method of editing by use of the cursor is called 'EDIT MODE'.

Edit mode is provided automatically by keying-in certain commands at appropriate points in the interaction. When in the edit mode, the operator can move the cursor about the screen, for example, down a column of figures until the desired figure for editing is located. The precise nature of your edit, whether it is deletion, a change, or otherwise is then specified by keying-in a further single character command. These commands do not appear on a menu and therefore must be memorised. You should note however, that in the present version of the Develop System, the edit mode within the Valuations Sub-System is of a more advanced design. The edit mode for this, and other sub-systems is dealt with in greater detail elsewhere in this manual.

USING THE RETURN KEY

All commands or information keyed-in by the operator at the keyboard must be concluded by pressing the 'RETURN' key. The computer will not act upon the command or information until this is done. The advantage of this procedure is to allow the operator to correct keying errors before sending the information to the central processing unit for action.

On screen displays illustrated in this manual, those characters that are keyed-in by the operator are shown underlined. The 'RETURN' key is always pressed after these characters although this is not indicated in the display.

The only exception to this rule occurs when editing within the valuations sub-system. The valuations edit mode is of an advanced design where key strokes are spontaneously acted upon by the computer thus dispensing with the need to operate the 'RETURN' key.

5. GETTING STARTED

This section examines the procedure for switching-on and loading the Develop System onto your computer from where you can select the appropriate sub-system and proceed to work. Switching-off the system is also explained in detail since it is equally important to follow the correct closing down procedure to avoid data corruption.

MULTI-USER EQUIPMENT

It is vital to appreciate that the Develop System is designed to operate in a multi-user situation. This demands particular caution when starting-up and closing down equipment.

The diagram overleaf illustrates the computer equipment in the Develop installation. The central feature of this 'hardware' is the computer itself. This provides the storage facilities and processing power for each user terminal.

User terminals comprise of a visual display unit and a keyboard. In the Develop installation one of the user terminals is the Primary Terminal; all other terminals are subsidiary to it. For starting-up and closing down it is essential to identify which is the primary terminal. Usually it will be the terminal located nearest to the computer unit.

Other items of hardware include a printer, and a tape unit for back-up purposes.

SWITCHING-ON PROCEDURE

1. Ensure that the computer equipment is connected to the mains electricity supply and that the current in 'ON'. This will be indicated by the illumination of the red 'standby' light on the right of the terminal keyboard.

2. Switch-on the primary terminal. The red 'standby' light should be replaced by a green 'ON' light. If you are in any doubt as to which is the primary terminal you should refer to the system manager. Check to see that the cursor appears in the top left corner of the display screen.

3. Switch-on the computer unit. The switch is situated on the bottom left of the unit. The computer will automatically 'boot-up'. This is indicated by the display of miscellaneous data on the display screen accompanied by a loud shrilling noise. Check to see that the 'boot' is complete. This is indicated by the following display on the screen:

```
A >
```

4. The 'A prompt' display above indicates that the computer is only booted-up for single-user operation. To boot-up for multi-user applications such as the Develop system, key-in

the following command on the terminal keyboard :

MPMLDR

5. Press the 'RETURN' key. The computer will automatically boot-up for multi-user operation. Check to see that the 'boot' is complete. This is indicated by a 'zero A prompt' on the screen:

0A>

SUBSIDIARY TERMINALS

5a. Other subsidiary terminals may now be switched-on by use of their respective keyboard ON/OFF switches. There is no need to 'boot-up' the computer again for a subsidiary terminal since the display screen will immediately indicate a multi-user operation prompt, e.g.:

1A>

5b. To change a subsidiary terminal to display the 'zero A prompt' you must now key-in the following command on the subsidiary terminal keyboard:

USER 0

5c. Press the 'RETURN' key.
Check to see that the subsidiary terminal now displays the 'zero A prompt', e.g.

0A>

PRIMARY AND SUBSIDIARY TERMINALS

6. To load the Develop system you should first check to see that your terminal screen displays the 'zero A prompt' (see above). Key-in the command:

RUN

7. Press the 'RETURN' key.
A successful load will be indicated by the title display followed by the system request :-

Please enter your Registration No. >

8. Key-in your registration number followed by the 'RETURN' key. This will result in the following system request :-

Please enter your Password >

9. Key-in your password followed by the 'RETURN' key. Remember that the display of this password will be suppressed. If you

have not allocated yourself a password then merely press the 'RETURN' key.
(To allocate yourself a password refer to page 16).

10. Following the entry of a valid registration number and associated user password the terminal screen will display the main menu of the Develop System which provides the company sub-system options. This is illustrated below:

COMPANY SUB-SYSTEM OPTIONS

CD . . . Company Data System
ES . . . Estimating System
PU . . . Purchasing System
VA . . . Valuations System
CF . . . Cost Forecasting System
QU . . . Quit

Enter Command >-

To select a sub-system, merely key-in the appropriate two character command from the left hand side of the menu, followed by the 'RETURN' key.

CLOSING DOWN PROCEDURE

PRIMARY AND SUBSIDIARY TERMINALS

1. Close all files and return to the main menu of the Develop System by keying-in the command 'QU' to quit from each sub-system menu.

2. Unload the Develop System by keying-in the command 'QU' to quit from the main menu.

3. Ensure that each terminal displays the 'zero A prompt' before switching-off their respective terminal ON/OFF switches.

4. It is essential that ALL terminals in the installation are switched-off BEFORE the computer unit is switched off.

5. Switch-off the computer unit.

WARNING

It is crucial to comply with the above procedure to ensure the

security of system data. Any other method of closing down cannot be guaranteed to avoid data corruption and at worst may seriously damage both software and hardware.

ALLOCATING A USER PASSWORD

Each operator of the Develop System is advised to take the opportunity to use a personal password. It is used in conjunction with the user's registration number to ensure that access to the system files and facilities provided by your registration number will be denied to all but yourself.

Once allocated, a user may change his/her password as often as required. The procedure is similar to that of initial allocation:-

1. Obtain the 'zero A prompt' on your user terminal by either following steps 1 to 5 of the switching-on procedure, or steps 1 and 2 of the closing down procedure if you have already loaded the Develop System.

2. Key-in the command:

   NEWPASS

3. Press the 'RETURN' key.
   The screen will display the following system request:

   Enter user registration number >

4. Enter your registration number and press the 'RETURN' key.

   USERS WITHOUT A PASSWORD

5. The screen will display the following system request:

   Enter new user password >

   USERS WITH EXISTING PASSWORD

5a. The screen will display the following system request:

   Enter existing user password >

5b. Key-in your existing password. Remember the display of this password is suppressed.
   Provided the existing password is keyed-in correctly the screen will display the following system request;

   Enter new user password >

   ALL USERS

6. Key-in a new password followed by the 'RETURN' key. Remember that the display of this password is suppressed.

Passwords can be a maximum of six characters in length. Each character may be a number, letter, a space, or a punctuation mark.

WARNING

Do not reveal your password to anyone else, and do not forget it! Remember, a new password can only be allocated provided you can recall the existing password.

6. COMPANY DATA SUB-SYSTEM

The company data sub-system comprises seven computer files. These store all the company's information relating to the building of dwellings, and details of both current and recent building phases.

To locate the company data sub-system, first load the Develop System and obtain the main menu of company sub-system options. This is described in section 5.

From the main menu, select the command 'CD' - Company Data System. This will result in the following display of commands:

C O M P A N Y D A T A F I L E S

MS . . . Main Specification
SU . . . Materials Suppliers and Subcontractors
IT . . . Materials, Preliminaries and Subcontractor Items
DW . . . Standard Dwelling Types
AD . . . Addendum Dwelling Types
PH . . . Phase Details
VA . . . Valuation Codes
QU . . . Quit

Enter Command >-

The commands displayed in the menu permit the operator to refer to any one of seven files within the company data sub-system. The table overleaf summarises the files which comprise the company data sub-system and provides page references where a more detailed description can be located:-

TABLE 1. SUMMARY OF COMPANY DATA FILES

COMMAND	DESCRIPTION	PAGE
MS	MAIN SPECIFICATION - contains a detailed specification of each item which the company may use to construct a dwelling. Each item has a specification code.	20
SU	MATERIAL SUPPLIERS and SUBCONTRACTORS - contains details of suppliers and sub-contractors used by the company. Each has an identifying code.	34
IT	MATERIALS,PRELIMINARY and SUBCONTRACTOR ITEMS - contains the description of all items which contribute to the construction of company dwellings.These are coded and grouped into schedules.	24
DW	STANDARD DWELLING TYPES - contains a list of all items that contribute to the construction of each company standard dwelling,together with the quantities required.Each dwelling type has a code.	26
AD	ADDENDUM DWELLING TYPES - contains an itemised breakdown of addendum dwellings illustrating the variance from the standard from which it originates.	29
PH	PHASE DETAILS - contains a description of under construction,with details of plots and dwelling types to be constructed. Each phase has an identifier.	31
VA	VALUATION CODES - contains details of the classification used as a basis for valuations .Each valuation class has a heading code, sub-divided to indicate valuation stages.	22

MAIN SPECIFICATION FILE

The main specification file contains detailed specifications covering all work involved in the construcition of company dwellings. These are classified and filed by use of a specification code.

Specification codes are identified by the alphabetic prefix 'S' followed by two paired digits separated by a decimal point, e.g.

S04.01

The following example is typical of an entry from the company's main specification file:

Specification: S04.01

LOAD BEARING WALLS
Cavity Walls: 265mm facings and Hemelite U1 blocks or 250mm of two block skins. Tile hung walls always cavity construction. Plus 50mm Rockwool batts in cavity.

The first pair of digits in the code identify a primary class within the specification file, while the second pair identify a sub-division within the primary class.

In the above example, the primary class is 04 - LOAD BEARING WALLS; the sub-division .01 identifies Cavity Walls. Further sub-divisions within the primary class 04 - LOAD BEARING WALLS are exemplified by :-

04.02 - solid internal walls,
04.03 - lintels,
etc.

Although the coding structure would suggest that the file will accommodate up to 99 primary classes and similarly 99 possible sub-divisions within each, the need to restrict file space demands the maximum number of entries to be reduced from 9800 (99 x 99) to 300.

This restriction requires that the system manager should classify specifications and sub-divisions both in accordance with company requirements and within the physical constraints of the computer file. You should therefore refer to the system manager to ascertain the current file status should further entries be required.

When entering new specifications into the file the operator will enter the code, provide a primary class heading if required, and a sub-division description in detail. This data is limited in format to a maximum number of characters in each case. Details of the required format are listed in the following table. You should adhere to these in order to avoid an invalid entry.

TABLE 2. MAIN SPECIFICATIONS FILE - DATA ENTRY CONSTRAINTS

DATA	FORMAT
Specification code	Alphanumeric code.Refer to page 20
Specification heading	Up to 72 alphanumeric characters
Specification description	4 lines of upto 72 characters each

To locate the main specifications file you should select the command 'MS' - Main Specification from the company data file menu. The screen will then display the following menu :-

MAIN SPECIFICATION

AD . . . Add a New Specification
CH . . . Change an Existing Specification
DE . . . Delete an Existing Specification
RE . . . Refer to a Specification
PC . . . Print the Complete Specification
QU . . . Quit

Enter Command >-

The commands displayed in the menu provide the operator with the facilities to :-

* refer to specifications;
* print the specifications;
* add to, change, or delete specifications (edit the file).

Access to each of the three groups of facilities above may be restricted by virtue of the user's registration number. Control of user access is the responsibility of the system manager.

For detailed description of the procedure for referring, printing, and editing company data files, refer to page 37.

VALUATION CODES FILE

The valuation codes file contain details of the cost centres used as a basis for phase valuation. Each cost centre is classified by use of a valuation cost code.

Valuation cost codes are identified by the alphabetic prefix 'C' followed by two paired digits separated by a decimal point, e.g.

C04.06

The following example is typical of an entry from the company's valuation code file:

Valuation : 04.00 BRICKS:

04.01 fndn
04.02 1st lift
04.03 2nd lift
04.04 3rd lift
04.05 4th lift
04.06 top out
04.07 externals

The first pair of digits in the code identify the valuation cost centre heading and is referred to as the valuation heading code. The second pair of digits identify valuation stages within the cost centre. In the above example, the valuation heading code is 04 - BRICKS; the valuation stage .06 identifies TOP OUT.

Although the coding structure would suggest that the file will accommodate up to 99 valuation cost headings and similarly 99 possible stages within each, the need to restrict file space demands the maximum number of entries to be reduced from 9800 (99 x 99) to 960.

This restriction requires that the system manager should classify valuation headings and specify stages both in accordance with company requirements and within the physical constaints of the computer file. You should therefore refer to the system manager to ascertain the current file status should further entries be required.

When creating new valuation cost centres or subsequently entering additional stages within a cost centre, the operator will enter a valuation heading code, a heading description if required, and provide descriptions for each valuation stage required. This data is limited in format to a maximum number of characters in each case. Details of the required format are listed in the table overleaf . You should adhere to these in order to avoid an invalid entry.

TABLE 3. VALUATION CODES FILE - DATA ENTRY CONSTRAINTS

DATA	FORMAT
Valuation code	Alphanumeric code.Refer to page 22
Valuation heading	Up to 40 alphanumeric characters
Valuation stage description	Up to 26 alphanumeric characters

To locate the valuation codes file you should select the command 'VA' - Valuation Codes from the company data files menu. The screen will then display the following menu:

VALUATION CODES

AH . . . Add a Valuation Heading
CH . . . Change a Valuation Heading
DH . . . Delete a Valuation Heading
AC . . . Add, Change or Delete a Valuation Stage
RC . . . Refer to a Valuation Heading and Stages
PC . . . Print all Valuation Headings and Stages
QU . . . Quit

Enter Command >-

The commands displayed in the menu provide the operator with the facilities to :-

* refer to a valuation cost centre,
* print the file contents,
* add, change, or delete a valuation heading (edit the file).

Access to each of the three groups of facilities above may be restricted by virtue of the user's registration number. Control of user access is the responsibility of the system manager.

For detailed description of the procedure for referring, printing, and editing company data files, refer to page 37.

MATERIALS, PRELIMINARIES AND SUB-CONTRACTOR ITEMS FILE

This file is intended to list a description of all those items which contribute to the construction of company dwellings. They are classified and filed by use of an item code.

Item codes have no alphabetic prefix but take the form of a pair of digits, a decimal point, and three additional digits, e.g.

01.003

The following example is typical of an entry from the items file:

SCHEDULE REF: 01.003 BRICK, BLOCKS ETC.

Item Code	Description	Units
01.003/S04.01/C04.00	FACINGS IN 225 X 225 ISOLATED PIERS	TH

The first pair of digits in the code refers to the 'schedule' into which the item is classified. There are a number of schedules covering all aspects of building undertaken by the company. The three additional figures following the decimal point identify the individual item within the specified schedule.

In the above example the schedule reference is 01 - BRICKS, BLOCKS; the item is .003 - FACINGS IN 225 x 225 ISOLATED PIERS.

Against each item code in the file is stored the relevant specification code for the item and the relevant valuations cost code. In the above example these are S04.01 and C04.00 respectively.

The code structure for items provides for a total of 99 item schedules. In practice this is limited to 79. Individual schedule headings can be specified and changed at the discretion of the company provided that the following general classification is adhered to :-

TABLE 4. SCHEDULE HEADING CLASSIFICATIONS

SCHEDULE REF.	DESCRIPTION
1 - 20	Materials
21 - 43	Sub-contractors
44 - 49	Standard house foundations
50 - 55	Standard garage foundations
56 - 61	Garage superstructure
62 - 67	Abnormals
68 - 73	Drainage
74 - 78	External works
79	Preliminaries
80	Summary of schedules 1 - 79

Although the coding structure would suggest that the file will accommodate 999 items within a single schedule, with a total of 79 schedules, this would require a file capable of holding 78,921 items! For technical reasons associated with the size of the computer processor this limit has been reduced to approximately 6,700.

This restriction requires that the system manager should specify the maximum number of entries required within each schedule both in accordance with company requirements and within the physical constraints of the computer file. You should therefore refer to the system manager to ascertain the total number of items permitted within a schedule should further entries be required.

When creating item schedules or subsequently entering additional items the operator will be required to enter a description and the relevant units and codes against each item. This data is limited in format to a maximum number of characters in each case. Details of the required format are listed in the following table. You should adhere to these in order to avoid an invalid entry.

TABLE 5. ITEMS FILE - DATA ENTRY CONSTRAINTS

DATA	FORMAT
Schedule Reference	Number in range 01 - 80
Schedule heading	Up to 40 alphanumeric characters
Item code	Numeric code. Refer to page 24
Specification code	Alphanumeric code. Refer to page 20
Valuation cost code	Alphanumeric code. Refer to page 22
Item description	Up to 40 alphanumeric characters
Units	Up to 4 alphanumeric characters

* When allocating an item to a relevant valuation cost centre, as identified by the valuation cost code, the operator can specify the valuation cost centre and valuation stage by using the full code, e.g. C04.06. This will ensure that the total cost of the item will be apportioned entirely within the valuation stage in question at the time of phase valuation.
  Alternatively, the valuation heading code only may be specified, e.g. C04.00. This will enable the cost of the item to be apportioned across number of valuation stages within the cost centre. Percentage apportionments for stages are entered when any item is subsequently specified for inclusion in a dwelling item schedule.

To locate the items file you should select the command 'IT' -

Materials, Preliminaries and Sub-contractor Items from the company data file menu. The screen will display the following menu :-

MATERIALS, SUBCONTRACTOR AND PRELIMINARY ITEMS

AS . . . Add a Schedule Heading
DS . . . Delete a Schedule Heading
CS . . . Change a Schedule Heading
AI . . . Add a New Item
CI . . . Change an Item
DI . . . Delete an Item
RI . . . Refer to an Item
RS . . . Refer to a Schedule
PS . . . Print a Schedule
QU . . . Quit

Enter Command >-

The commands displayed in the menu provide the operator with the facilities to :-

* refer to a schedule or an item,
* print a schedule,
* add, change, or delete a schedule heading or an item (edit the file).

Access to each of the three groups of facilities above may be restricted by virtue of the user's registration number. Control of user access is the responsibility of the system manager.
For detailed description of the procedure for referring, printing, and editing company data files, refer to page 37.

STANDARD DWELLING TYPES FILE

The standard dwelling types file contains details of all the items that contribute to the construction of each of the company's standard dwellings. Each dwelling type is identified by a dweling code.

Dwelling codes take the form of a 3 digit number, a single aphabetic character, and a pair of alphabetic characters, e.g.

365/G/GG/

The following example typifies the brief description that is

stored in the file against each standard dweling type:

Dwelling Type: 365/G/GG/

Description: 4 BEDROOM/2 BATHROOM (ONE EN SUITE) WITH INTEGRAL DOUBLE GARAGE AND PORCH

Habitable Area: 98.

The details of items that contribute to the construction of a standard dwelling type are listed in numerical order under their respective schedule headings. Each item is stored with the total quantity required for a single dwelling.

The following example illustrates an extract from schedule 01 - BRICKS, BLOCKS etc. for the dwelling type 365/G/GG/

SCHEDULE REF. 01.000 BRICKS,BLOCKS ETC.

Item Code	Description	Units
01.001/S04.01/C04.00	FACINGS IN HB SKIN	TH
01.002/S04.01/C04.00	FACINGS IN HB GARAGE PROTECTION	TH
01.003/S04.01/C04.00	FACINGS IN 225 X 225 ISOLATED PIERS	TH
01.004/S04.01/C04.00	FACINGS IN 225 X 328 ISOLATED PIERS	TH
01.005/S04.01/C04.00	FACINGS IN 328 X 328 ISOLATED PIERS	TH
01.006/S04.01/C04.00	FACINGS IN ONE BRICK WALL	TH
01.008/S04.01/C04.00	WIDGETS	NR
01.010/S04.01/C04.00	COMMONS OVER LINTOLS IN STACKS ETC	TH
01.011/S04.01/C04.00	75 BLOCKS IN OUTER SKIN	M2
01.012/S04.01/C04.00	100 BLOCKS IN OUTER SKIN	M2

Press RETURN to continue, Q to Quit or R to Restart >

When initially creating item schedules for a dwelling type or when subsequently adding items to an existing dwelling schedule, the operator will enter the total quantity for each item.

If the valuation cost code for the item has a .00 suffix, i.e. no valuation stage is specified, then the operator will be required to enter appropriate percentages against each of the stages within the valuation cost centre. This will apportion the total cost for the item into the valuation stages accordingly at the time of phase valuation.

All data entered when creating or updating dwelling schedules is limited in format to a maximum number of characters in each case. Details of the required format are listed in the following table. You should adhere to these in order to avoid an invalid entry.

TABLE 6. STANDARD DWELLINGS FILE - DATA ENTRY CONSTRAINTS

DATA	FORMAT
Dwelling type code	Alphanumeric code. Refer to page 26
Dwelling description	2 lines of up to 40 characters each
Habitable area	A number in the range 000.1 - 999.9
Discount lump sum	4 characters providing a number in the range -999 to 9999
Wastage	A percentage in the range 01 - 99
Dwelling division factor	2 paired digits separated by oblique e.g. 01/01
Item code	Numeric code. Refer to page 24
Quantity	7 characters providing a number in the range 0.00001 - 9999999
Item apportionment percentages	Percentage figures in the range 001 to 100. Sum of apportionments must not exceed 100.

To locate the standard dwelling types file you should select the command 'DW' - Standard Dwelling Types from the company data file menu. The screen will then display the following menu:

STANDARD DWELLING DETAILS

AD . . . Add New Dwelling Type
DD . . . Delete Dwelling Type
CD . . . Change Dwelling Description
RD . . . Refer to Dwelling Description
AH . . . Add/Change Dwelling Schedule Headings
AS . . . Add/Change Dwelling Schedule Items
RS . . . Refer to Dwelling Schedule
PS . . . Print Dwelling Schedule
PA . . . Print All Schedules for a Dwelling Type
QU . . . Quit

Enter Command >-

DEVELOP - USER DOCUMENTATION

The commands displayed in the menu provide the operator with the facilities to :-

* refer to dwelling descriptions and schedules,
* print dwelling schedules,
* add, change, or delete dwelling types, schedule headings, and schedule items (edit the file).

Access to each of the three groups of facilities above may be restricted by virtue of the user's registration number. Control of user access is the responsibility of the system manager.

For detailed description of the procedure for referring, printing, and editing company data files, refer to page 37.

ADDENDUM DWELLING TYPES FILE

The addendum dwelling types file is similar to the file of standard dwellings in that it contains a list of all items that contribute to the construction of a dwelling. In this case however the dwellings are addendums to a company standard type and are identified as such by using the same dwelling code as the standard type suffixed by an additional digit, e.g.

365/G/GG/3

The addendum dwelling description would normally indicate the nature of the variation from the standard dwelling. The following is a typical example :

Dwelling Type: 365/G/GG/3
Description: 4 BEDROOM/2 BEDROOM (ONE EN SUITE) WITH INTEGRAL DOUBLE GARAGE BUT NO PORCH

Habitable Area: 98.

The details of items that contribute to the construction of an addendum dwelling are listed within schedules in the same manner as that of the standard dwellings file, i.e. in numerical order with appropriate quantities and valuation apportionments.

In most cases there will be little difference in the itemised breakdown of an addendum from that of the standard dwelling. The creation of item schedules for an addendum is therefore facilitated by initially copying the standard dwelling schedules. From this the operator will be able to make the necessary amendments by adding and deleting items and changing quantities as required.

Where item schedules are amended from standard, this is indicated in the display and printed copy of item schedules. The nature of variance from standard is indicated against the individual item codes in question, e.g.

c01.001 - indicates a CHANGE to an item quantity or apportionment.

+01.008 - indicates an additional item to the standard schedule.

No indication is provided where items have been deleted from the standard schedule.

The following example illustrates an extract from schedule 01 - BRICKS, BLOCKS, etc. for the addendum dwelling type 365/G/GG/3. This provides an example of each of the two code endorsements :-

STANDARD AND ADDENDUM ITEMS OF SCHEDULE FOR DWELLING: 365/G/GG/1

SCHEDULE 01.000 BRICKS,BLOCKS ETC.

CODE	DESCRIPTION	QUANTITY	UNITS
*c01.001/S04.01/C04.00	FACINGS IN HB SKIN	11	TH
*+01.008/S04.01/C04.00	WIDGETS	3	NR
* 01.010/S04.01/C04.00	COMMONS OVER LINTOLS IN STACKS ETC	1.16	TH
* 01.017/S04.01/C04.00	100 BLOCKS IN INNER SKIN	156	M2
* 01.021/S05.01/C04.00	100 BLOCKS IN INTERNAL WALLS	22	M2
* 01.023/S04.02/C04.00	200 BLOCKS IN INTERNAL WALLS	3	M2
* 01.027/S04.05/C04.00	NATURAL MORTAR IN HB WALL	19	M2
* 01.029/S04.05/C04.00	NATURAL MORTAR IN 100 BLOCK WALL	178	M2
* 01.033/S04.05/C04.00	COLOURED MORTAR IN HB WALL	198	M2
* 01.036/S04.06/C04.00	WALL TIES (PLASTIC)	560	TH
* 01.038/S07.01/C04.00	FRAME CRAMPS (HOLDFAST)	118	TH
* 01.042/S04.04/C04.02	100 MM HORIZONTAL DPC	5	ROLL
* 01.044/S04.04/C04.02	225 MM HORIZONTAL DPC	1	ROLL

Press RETURN to continue, Q to Quit or R to Restart >

The facility is provided for the operator to refer merely to the addendum items within a dwelling schedule. In this case the computer display will omit all items that are unchanged from the standard dwelling schedule. An example is illustrated below :

ADDENDUM ITEMS OF SCHEDULE FOR DWELLING: 365/G/GG/3

SCHEDULE 01.00 BRICKS, BLOCKS ETC.

CODE	DESCRIPTION	QUANTITY	CODE
c01.001/S04.01/C04.00	FACINGS IN HB SKIN	11	TH
+01.008/S04.01/C04.00	WIDGETS		

To locate the addendum dwelling types file you should select the command 'AD' - Addendum Dwelling Types from the company data file menu. The screen will then display the following menu :-

ADDENDUM DWELLING DETAILS

```
AD . . . Add Addendum Dwelling Type
DD . . . Delete Addendum Dwelling Type
CD . . . Change Addendum Dwelling Description
RD . . . Refer to Addendum Dwelling Description
AH . . . Add/Change Item Schedule Headings
AS . . . Add/Change Items in Addendum Dwelling Schedule
RA . . . Refer to Addendum Items of Dwelling Schedule
RC . . . Refer to Complete Addendum Dwelling Schedule
PA . . . Print Addendum Items for Addendum Dwelling
PC . . . Print all Schedules of Addendum Dwelling Type
QU . . . Quit

Enter Command  >-
```

The commands displayed in the menu provide the operator with the facilities to :-

* refer to dwelling descriptions and schedules,
* print addendum items and complete item schedules,
* add, change, or delete addendum dwelling types and item schedules (edit the file).

Access to each of the three groups of facilities above may be restricted by virtue of the user's registration number. Control of user access is the responsibility of the system manager.

For detailed description of the procedure for referring, printing, and editing company data files, refer to page 37.

PHASE DETAILS FILE

The phase details file contains a description of each phase currently on file with details of building plots and dwelling types to be constructed. Details may also be stored for phases temporarily off loaded from the computer onto tape storage. The maximum number of phases that can be held on file concurrently is 25.

Each phase must be provided with a unique identifier. Phase identifiers can be composed of any alpha-numeric characters including spaces, up to a maximum of 10 characters.

The following examples illustrate the data held in the file in respect to a single phase:

REFERENCE TO PHASE DETAILS

Phase Identifier : LEDBURY 5A

Phase Code: 1000

Number of Dwellings: 10

Final Building Budget Date: 01.06.84

Start Date of Phase: 12.10.83
Completion Date of Phase: 01.10.84

Site Agents Name: A SMITH

Site Delivery Address:
131 DERBY RD. LEDBURY

Site Telephone Number: 012 345 678

Press RETURN to continue >

The phase code has no significance within the computer system but relates to the company's own internal phase referencing system. In addition to the above description of the phase, the details of plots and dwelling types are stored in numerical order by plot number. For example :-

LEDBURY 5A 1000 DOB 01.06.84 Page 1

PLOT NO.	DWELLING TYPE	POSTAL ADDRESS	PURCHASERS NAME	INSPEC DATE
100	365/G/GG/	NO.1 DERBY RD.	M.BIGGINS	13.02.84
101	365/G/GG/1	NO.2 DERBY RD.	A.THORPE	13.02.84
102	374/G/GG/	NO.3 DERBY RD.		11.03.84
103	222/G/GG/	NO.4 DERBY RD		11.03.84
106	365/G/GG/	11 THE AVENUE	T.P.SMITH	. .
107	365/G/GG/	12 THE AVENUE	H.MORRELL	01.05.84
109	365/G/GG/		A WILSON	. .
120	365/G/GG/	10 THE AVENUE		. .
121	365/G/GG/			. .
122	365/G/GG/			. .

When creating a new phase, or subsequently making additions to phase details the operator will be required to enter the above data. This data is limited in format to a maximum number of characters in each case. Details of the required format are listed in the following table. You should adhere to these in order to avoid an invalid entry.

TABLE 7. PHASE DETAILS FILE - DATA ENTRY CONSTRAINTS

DATA	FORMAT
Phase identifier	Alphanumeric code upto 10 characters Cannot be blank
Phase code	Upto 4 characters
Number of dwellings	A number in the range 01 - 99
Budget date Start date Inspection date Completion date	Upto 8 alphanumeric characters of the form 01.01.84
Site agents name	Upto 28 alphanumeric characters
Site delivery address	Upto 70 alphanumeric characters
Site telephone no.	Upto 28 alphanumeric characters
Plot number	A number in the range 001 - 999
Dwelling type	Alphanumeric code. Refer to page 26
Postal address	Upto 30 alphanumeric characters
Purchasers name	Upto 22 alphanumeric characters

Following the entry of details for a new phase, the operator must set-up the phase specific files for the phase estimate and purchasing sub-systems before work can commence. The files for the purchasing sub-system however should only be set-up when the phase estimate is complete in order to reflect any changes made to item details by the estimator.

Setting-up the files in each case is an automatic process initiated by simply selecting the appropriate command from the phase details menu.

To locate the phase details file you should select the command 'PH' - Phase Details from the company data files menu. The screen will then display the two phase details menu :-

PHASE DETAILS

```
AD . . . Add Phase Details
CH . . . Change details of an Existing Phase
DE . . . Delete an Existing Phase
RE . . . Refer to a Phase
PP . . . Print Details of One Phase
PA . . . Print Details of All Phases
SE . . . Setup Phase Specific Files for Estimating
SP . . . Setup Phase Specific Files for Purchasing
QU . . . Quit

Enter Command   >-
```

The commands displayed in the menu provide the operator with the facilities to :-

* refer to a phase,
* print details of a single phase or all phases,
* add, change, or delete details of a phase (edit the file),
* Set-up the phase specific files.

Access to each of the three groups of facilities above may be restricted by virtue of the user's registration number. Control of user access is the responsibility of the system manager.

For detailed description of the procedure for referring, printing, and editing company data files, refer to page 37.

MATERIAL SUPPLIERS AND SUB-CONTRACTORS FILE

The suppliers and sub-contractors file contains details of sources for all material and labour items used by the company for the construction of dwellings. Each supplier or sub-contractor is specified by use of a supplier/sub-contractor code.

The supplier/sub-contractor code is identified by a prefix of two alphabetic characters followed by 5 digits, e.g.

LO01001

The following example illustrates a typical entry in the company's material suppliers and sub-contractors file :-

Supplier/Sub-contractor : LO01001

BRICKLAYER

T. DAVID
5 UNION STREET
ST. ALBANS
HERTS

011 628 5522

The code is used to classify all entries as follows :

The alphabetic prefix is of three types :-

LO - indicates a LABOUR ONLY source such as a sub-contractor

MA - indicates a MATERIAL supplier

LM - indicates a LABOUR and MATERIAL source such as a sub-contractor supplying his own material.

The next two digits of the code together with the alphabetic prefix complete the identity of a supplier/sub-contractor type. In the above example this is LO01 - LABOUR ONLY,BRICKLAYER

Note that there is no necessary correspondence between types with the same number but differing prefixes, e.g. LM01 could well identify an asphalt roofer rather than a bricklayer.

The final three digits of the code identify the specific supplier or sub-contractor. In the above example this is 001 - T.DAVID. This is summarised as follows :-

LO01001

Labour only bricklayer Sub-contractor No.

Although the coding structure would suggest that the file will accommodate 999 entries within each of 300 types, the need to restrict file space demands the maximum number of entries to be restricted to 400.

This restriction requires that the system manager should classify and number suppliers and sub-contractors both in accordance with company requirements and within the physical constraints of the computer file. You should therefore refer to the system manager to ascertain the current file status should further entries be required.

When entering new supplier/sub-contractor details the operator will enter a supplier/sub-contractor code, a type description if required, and the source name, address and telephone number. This data is limited in format to a maximum number of characters in each case. Details of the required format are listed in the

following table. You should adhere to these in order to avoid an invalid entry:

TABLE 8. SUPPLIERS & SUBCONTRACTORS FILE - DATA ENTRY CONSTRAINTS

DATA	FORMAT
Supplier/Subcontractor code	Alphanumeric code.Refer to page 34
Supplier/Subcontractor type	Up to 40 alphanumeric characters
Supplier/Subcontractor name	2 lines of upto 19 characters each
Supplier/Subcontractor address	2 lines of upto 19 characters each
Telephone number	Upto 38 alphanumeric characters

To locate the suppliers/sub-contractors file you should select the command 'SU' - materials suppliers and sub-contractors from the company data files menu. The screen will display the following menu :-

MATERIALS SUPPLIERS AND SUBCONTRACTORS

AD . . . Add a New Supplier/Subcontractor
CH . . . Change details of an Existing Supplier/Subcontractor
DE . . . Delete an Existing Supplier/Subcontractor
RE . . . Refer to a Supplier/Subcontractor
AS . . . Add a Supplier/Subcontractor Type
CS . . . Change a Supplier/Subcontractor Type
DS . . . Delete a Supplier/Subcontractor Type
PS . . . Print Details of One Supplier/Subcontractor
PT . . . Print Details of One Type of Supplier/Subcontractor
PA . . . Print Details of All Suppliers and Subcontractors
QU . . . Quit

Enter Command >-

The commands displayed on the menu provide the operator with facilities to :

* refer to a supplier or subcontractor,
* print a single entry, type, or the complete file,
* add, change, or delete types and entries (edit the file).

Access to each of the three groups of facilities above may be restricted by virtue of the user's registration number. Control of user access is the responsibility of the system manager.
For detailed description of the procedure for referring, printing, and editing company data files, refer to page 37.

PRINTING, EDITING AND REFERRING TO COMPANY DATA FILES

The procedures for printing, editing and referring to files are basically similar throughout the company data sub-system. For this reason examples are provided below in respect of the Phase Details File only, thus avoiding unnecessary duplication.

The user should be aware that access to the files may be restricted at each of the following 3 levels :

* referring
* printing
* editing

This limitation is exercised by the system manager through the user's registration number.

REFERRING TO COMPANY DATA FILES

The user may refer to the contents of a company data file by first locating the appropriate file from the company data files menu; refer to page 18.

Once located, the file may be referred to by selecting a REFER command from the screen menu. In the following example, only the Phase Details File is examined in detail. The procedure for other company data files is similar.

PHASE DETAILS

AD . . . Add Phase Details
CH . . . Change details of an Existing Phase
DE . . . Delete an Existing Phase
RE . . . Refer to a Phase
PP . . . Print Details of One Phase
PA . . . Print Details of All Phases
SE . . . Setup Phase Specific Files for Estimating
SP . . . Setup Phase Specific Files for Purchasing
QU . . . Quit

Enter Command >-

From the menu above select the command 'RE' - Refer to a Phase. The operator will be requested to identify the phase by keying-in the phase identifier :

Input Phase Identifier <

Note the position of the screen cursor to the right of the first screen prompt. The identifier should be keyed-in between the screen prompts which limit the length of the data 'field'.

Press the 'RETURN' key after the last character or when the cursor reaches the second screen prompt, whichever is the soonet.

Provided the identifier is recognised, i.e. already in the file, the phase descriptions will be displayed on the screen :

REFERENCE TO PHASE DETAILS

Phase Identifier : LEDBURY 5A

Phase Code: 1000

Number of Dwellings: 10

Final Building Budget Date: 01.06.84

Start Date of Phase: 12.10.83
Completion Date of Phase: 01.10.84

Site Agents Name: A SMITH

Site Delivery Address:
131 DERBY RD. LEDBURY

Site Telephone Number: 012 345 678

Press RETURN to continue >

To refer to the phase plot numbers and dwelling details, press the 'RETURN' key to continue :

LEDBURY 5A 1000 DOB 01.06.84 Page 1

PLOT NO.	DWELLING TYPE	POSTAL ADDRESS	PURCHASERS NAME	INSPEC DATE
100	365/G/GG/	NO.1 DERBY RD.	M.BIGGINS	13.02.84
101	365/G/GG/1	NO.2 DERBY RD.	A.THORPE	13.02.84
102	374/G/GG/	NO.3 DERBY RD.		11.03.84
103	222/G/GG/	NO.4 DERBY RD		11.03.84
106	365/G/GG/	11 THE AVENUE	T.P.SMITH	. .
107	365/G/GG/	12 THE AVENUE	H.MORRELL	01.05.84
109	365/G/GG/		A WILSON	. .
220	365/G/GG/	10 THE AVENUE		. .
221	365/G/GG/			. .
222	365/G/GG/			. .

Refer to another Phase ? Y/N >

The number of items being referred to, in this case plot numbers and dwellings, may exceed the limit imposed by the screen capacity. In this event the display will conclude with the following request :

press RETURN to continue

You may press the RETURN key at each successive screen display until the relevant section of the file has been referred to in total. In this case the display will conclude with the following request :

Refer to another Phase ? Y/N

Key-in 'Y' for YES to refer to another section of the file, or 'N' for NO to return to the file menu.

PRINTING COMPANY DATA FILES

The user may print the entire contents or a selective extract of a company data file by first locating the appropriate file from the company data files menu; refer to page 18.

Once located, the file may be printed by selecting a PRINT command from the screen menu. In the following example, only the Phase Details File is examined in detail. The procedure for other company data files is similar.

PHASE DETAILS

AD . . . Add Phase Details
CH . . . Change details of an Existing Phase
DE . . . Delete an Existing Phase
RE . . . Refer to a Phase
PP . . . Print Details of One Phase
PA . . . Print Details of All Phases
SE . . . Setup Phase Specific Files for Estimating
SP . . . Setup Phase Specific Files for Purchasing
QU . . . Quit

Enter Command >-

From the menu above select the command 'PA' - Print Details of All Phases. Alternatively the command 'PP' may be selected in order to print the details of one phase only. In this latter case the operator will be requested to identify the phase by keying-in the phase identifier :

Input Phase Identifier > <

Note the position of the screen cursor to the right of the first screen prompt. The identifier should be keyed-in between the screen prompts which limit the length of the data 'field'.
Press the 'RETURN' key after the last character or when the cursor reaches the second screen prompt, whichever is the sooner.

Provided the identifier is recognised, i.e. already in the file, the following guidelines regarding the preparation of the printer will be displayed on the screen :

Adjust printer paper to page correctly :

1) Put printer off-line
2) Press form-feed
3) Set paper perforation just above print head
4) Put printer back on-line
5) Press RETURN

Check that the printer is correctly set up in accordance with the above guidelines and then press the 'RETURN' key to commence the print.
During the print the operator is provided with the following menu of options displayed on the screen :

OPTIONS WHILE PRINT IN PROGRESS

P . . . Pause Print
R . . . Resume Print After Pause
S . . . Re-start Print
Q . . . Quit Print

Press Key if necessary >P

The above options which can be initiated by keying-in the appropriate single character commands allow the operator to control the printing operation. This can be particularly useful where the operation is likely to be lengthy as in the case of printing a complete file.

Upon completion of the print the user will be provided with the Phase Details File menu.

ENTERING COMPANY DATA

The user may enter data into a company data file by first locating the appropriate file from the company data files menu; refer to page 18.

Once located, data may be entered into the file by selecting an ADD command from the screen menu. In the following example, only the Phase Details File is examined in detail. The procedure for other company data files is similar.

PHASE DETAILS

AD . . . Add Phase Details
CH . . . Change details of an Existing Phase
DE . . . Delete an Existing Phase
RE . . . Refer to a Phase
PP . . . Print Details of One Phase
PA . . . Print Details of All Phases
SE . . . Setup Phase Specific Files for Estimating
SP . . . Setup Phase Specific Files for Purchasing
QU . . . Quit

Enter Command >-

From the menu above select the command 'AD' - Add Phase Details. The operator will be requested to enter a new phase identifier :

Input Phase Identifier > <

Note the position of the screen cursor to the right of the first screen prompt. The identifier should be keyed-in between the screen prompts which limit the length of the data 'field'.
Press the 'RETURN' key after the last character or when the cursor reaches the second screen prompt, whichever is the sooner.

Provided the identifier is unrecognised, i.e. NOT already in the file, the screen will display prompts for the entry of the new phase description :

PHASE INPUT

Phase Identifier : MATLOCK 1A

Phase Code ——

Number of Dwellings —

Date of Final Building Budget —.—.—

Start Date of Phase —.—.—

Completion Date of Phase —.—.—

Site Agents Name <

Site Delivery Address

Site Tel No. <

Note the position of the screen cursor. It will be located at the first screen prompt ready for the entry of the phase code.

Screen prompts for data entry are of two types :

* DASHES indicate that the required data must be input in a specific format defined by display characters, i.e. spaces are NOT permitted.
  For example, a date must be entered in the following format :

--.--.--

day month year

e.g. 01.06.84

Keying-in the date as : 1.6.84 represents an invalid entry

CHEVRONS indicate that the data is limited in format by length only. The positions of the chevrons indicate the length of the data 'field', i.e. the maximum number of characters permissable. Spaces can be included and the data can be of -any- number of characters not exceeding this maximum.

The 'RETURN' key must be pressed as you complete the entry of each data field. The action of pressing the 'RETURN' key will automatically file the data and send the cursor to the first screen prompt of the next data field for entry.

The entry of new phase details is concluded by the following system request :

Are Phase Details correct ? Y/N

You should confirm by entering the command 'Y' for YES. Should the details be incorrect, key-in the command 'N' for NO in which case you will automatically enter 'EDIT MODE' so that you can change the data. Refer to page 45 for a detailed description of changing data.

Editing Company Data Files

The Develop system has been designed to be as flexible as possible within the constraints of the data stored. It is possible therefore to amend and update company and phase data to reflect the changing circumstances of its use. The ability to amend, update (and in some cases add and delete), data is referred to here as 'editing'.

Two types of editing are used within the system:

i) 'Edit Mode' - this is used within the Company, Estimating, Purchasing and Cost Forecasting Sub-systems. It is denoted by the use of asterisks in the display and operated by selecting commands as show in table 9. It is this type of editing that is described here.

ii) 'Form Editing' - this is used within the Valuation sub-systems. It is a combined input/editing facility and is operated by using the 'arrow' keys to move the cursor between data fields which can be changed at will. This type of editing is described in the section on Valuation on page 61.

It should be noted that not every item of the data can be edited. Some data constitute the basic parameters for the system and thus are invariable. An example of this 'invariable data' is the phase identifier.

The user may edit the contents of a company data file by first locating the appropriate file from the company data menu ; refer to page 18.

Once located the file may be edited by selecting a CHANGE (AMEND) command from the screen menu. In the following example only the Phase Details File is examined in detail. The procedure for other company data files is similar.

PHASE DETAILS

```
AD . . . Add Phase Details
CH . . . Change details of an Existing Phase
DE . . . Delete an Existing Phase
RE . . . Refer to a Phase
PP . . . Print Details of One Phase
PA . . . Print Details of All Phases
SE . . . Setup Phase Specific Files for Estimating
SP . . . Setup Phase Specific Files for Purchasing
QU . . . Quit

Enter Command  >-
```

From the menu above select the command 'CH' - Change details of an Existing Phase. The operator will be requested to identify the phase by keying-in the phase identifier:

Input Phase Identifier

Note the position of the screen cursor to the right of the first screen prompt. The identifier should be keyed-in between the screen prompts which limit the length of the data 'field'. Press the 'RETURN' key after the last character or when the cursor reaches the second screen prompt, whichever is the sooner.

Provided the identifier is recognised, i.e. already in the file, the following display will occur on the screen :

```
                    PHASE CHANGE

Phase Identifier :  LEDBURY 5A

   Phase Code                          Number of Dwellings
     >1000< *                              >10< *

Date of Final Building Budget
        01.06.84< *

   Start Date of Phase                 Completion Date of Phase
        12.10.83< *                          01.10.84< *

Site Agents Name
A SMITH                    < *
Site Delivery Address
131 DERBY RD. LEDBURY                                  < *
Site Tel No.
012 345 678                < *
```

Note the display with asterisks and the position of the cursor over the first asterisk. The asterisks show that the user is in 'edit mode' and that data entries may be changed. Various

options are available to the user and these are selected by entering the appropriate one letter command and pressing the RETURN key. Table 9 shows the commands available when in 'edit mode'.

TABLE 9. EDIT MODE COMMANDS

Command	Action	Description
RETURN	Forward	Move to next data field
B	Back	Move to previous data field
C	Change	Change current data field
D	Delete	Delete current data field
I	Insert	Insert new entry
P	Page	Move to specified page
L	Locate	Locate specified data entry
F	Finish	Exit edit mode

It should be noted that not all the commands shown in Table 9. are applicable in every edit situation. The commands 'Page' and 'Locate' for example are only relevant where the data fills more than one 'screen' (or page) and overflows to subsequent 'pages'. If an invalid or appropriate command is entered the cursor remains in position and no action is taken until a valid command is issued.

After the required changes have been made and an 'F' to exit the edit mode has been entered the following request will be displayed:

Change House Details ? Y/N

Key-in 'Y' for YES to change the plot/house details or 'N' for NO to receive the following request :

Another Phase change ? Y/N

If the answer is 'Y' the user is prompted for the Phase identifier. A negative response returns the user to the file menu.

DELETING COMPANY DATA

The type and scale of data that can be deleted within the system ranges from the inspection date of a particular dwelling on a particular phase, to the entire stored information for one phase. Great care must be taken therefore when deleting any item of data as DELETION IS FINAL AND IRREVERSABLE.

The user may delete data items from a company file by first locating the appropriate file from the company data files menu; refer to page 18.

Once located, data from the file may be deleted by selecing a DELETE command from the screen menu. In the following example

only the Phase Details File is examined in detail. The procedure for other company data files is similar.

PHASE DETAILS

AD . . . Add Phase Details
CH . . . Change details of an Existing Phase
DE . . . Delete an Existing Phase
RE . . . Refer to a Phase
PP . . . Print Details of One Phase
PA . . . Print Details of All Phases
SE . . . Setup Phase Specific Files for Estimating
SP . . . Setup Phase Specific Files for Purchasing
QU . . . Quit

Enter Command _ >-

From the menu above select the command 'DE' - Delete an Existing Phase. The operator will be requested to identify the phase by keying-in the phase identifier:

Provided the identifier is recognised, ie. already in the file the phase details will be displayed on the screen.

The system request - 'Do you wish to keep the Phase Details in Company Data? Y/N enables the user to :

(i) keep the phase details in the company data whilst deleting the phase specific files;

or

(ii) delete the phase details in the company data as well as the phase specific files.

If the answer to the request is 'N' (i.e. the user wishes to delete both company and phase specific data) the warning -
'This will Delete both Company and Phase - Specific Data'
'Are you sure? Y/N' will be displayed. If the answer is affirmative the user will be prompted for the Phase Identifier and the deletions will occur.

If the answer is negative no deletion will occur.

If the answer to the request is 'Y' (i.e. the user wishes to keep the company data intact and only delete the Phase-specific files), the system request -
'Do you wish to DELETE the Phase specific files? Y/N ' is displayed. If the answer is affirmative the user will be prompted for the Phase Identifier and the deletion will occur.
If the answer is negative no deletion will occur.
Finally the display will conclude with the following request:
'Delete another Phase? Y/N '
Key-in 'Y' for YES to delete another phase or 'N' for No to return to the file menu.

7. ESTIMATING SUB-SYSTEM

The Estimating sub-system comprises numerous computer files. Each individual phase has a set of these files relating to the specific requirements of that phase.

To locate the Estimating sub-system, first load the Develop system and obtain the Main Menu of company sub-system options. This is described in Section 5.

From the Main Menu select the command 'ES' .... 'Estimating Sub-System. This will result in the following display of commands:-

P H A S E D A T A F I L E S

MS . . . Phase Specification
SU . . . Materials Suppliers and Subcontractors
IT . . . Materials, Preliminaries and Subcontractor Items
DW . . . Standard Dwelling Types
AD . . . Addendum Dwelling Types
PH . . . Phase Details
VA . . . Valuation Codes
BS . . . Calculate and Print Phase Budget Summary
QU . . . Quit

Enter Command >-

The commands displayed in the menu permit the operator to refer to any of the eight areas within the estimating sub-system.Table 10. summarises the operations which comprise the Estimating sub-system.

As many of the files and facilities available within the Estimating Sub-system are similar to those found in the Company data sub-system, described in the previous section, only those files facilities which differ significantly will be dealt with in detail here.

Phase Phase Update

After selecting any option from the Estimating Sub-system command menu the user is prompted for the Phase identifier:

Input Phase Identifier

Note the position of the screen cursor to the right of the first screen prompt. The identifier should be keyed-in between the screen prompts which limit the length of the data 'field'. Press the RETURN key after the last character or when the cursor reaches the second screen prompt, whichever is the sooner.

Provided the identifier is recognised, i.e. the phase exists in the company data and it has been 'set-up' for estimating (see

section 6) the following message will be displayed.

PHASE FILES UPDATE

Please wait while data files are updated. After a few seconds the file menu of the option chosen will be displayed together with the Phase identifier in the top right hand corner of the screen.

TABLE 10. SUMMARY OF ESTIMATING DATA FILES

COMMAND	DESCRIPTION
MS	PHASE SPECIFICATION - contains a detailed specification of each item which the company may use to construct a dwelling on a particular phase.
SU	MATERIAL SUPPLIERS and SUBCONTRACTORS - enables the user to reference the supplier and sub-contractor lists held in the company data.
IT	MATERIALS,PRELIMINARY and SUBCONTRACTOR ITEMS - contains the phase specific items which contribute to the construction of phase dwellings.These are coded and grouped into schedules.
DW	STANDARD DWELLING TYPES - contains a list of all items that contribute to the construction of particular standard dwellings on a phase. Each item has an associated quantity and rate.
AD	ADDENDUM DWELLING TYPES - contains groups of items that contribute to the construction of particular addendum dwellings on the phase. Each item has an associated quantity and rate.
PH	PHASE DETAILS - contains the details of the phase under consideration.
VA	VALUATION CODES - contains the phase specific classification of the cost codes.
BS	BUDGET SUMMARY - enables the user to aggregate and print the phase budget summary.

For example if the user entered 'MS' at the Estimating Sub-system menu the resulting display is:

```
                    PHASE SPECIFICATION          LEDBURY 5A


        CP . . . Choose/Change current Phase
        AD . . . Add a New Specification
        CH . . . Change an Existing Specification
        DE . . . Delete an Existing Specification
        RE . . . Refer to a Specification
        PA . . . Print the Specification Addenda
        PC . . . Print the Complete Specification
        QU . . . Quit

        Enter Command >-
```

The options available are exactly the same as described for the Main (Company) Specification file (see section 6) apart from the extra command:

'CP .. Choose/Change current Phase'

This command is common to all Phase Specific areas of the system and it allows the user to move between different development phases whilst remaining in the currently selected option.

The other Estimating system files are basically the same as the company data files already described apart from the following :

(i) Materials Suppliers and sub-contractors - there is no 'phase specific' file of material suppliers and sub-contractors so the user can only refer or print details of supplier and sub-contractors held in the company data.

(ii) Phase Details - as the estimating system is 'phase specific' the user can only refer or print details of the current phase. The details of the phase can only be changed/added or deleted in the Company Data system.

(iii) Standard Dwelling Types - this option contains the same facilities to add/change/delete dwelling schedule items and headings as the company data sub-system and also extra facilities to price dwelling items and thus produce the estimate.

PHASE DWELLING DETAILS LEDBURY 5A

CP . . . Choose/Change current Phase
TD . . . Transfer Dwelling Type from Company Data
AD . . . Add One-Off Dwelling Type
DD . . . Delete Dwelling Type
CD . . . Change Dwelling Description
RD . . . Refer to Dwelling Description
AH . . . Add/Change Dwelling Schedule Headings
AS . . . Add/Change Dwelling Schedule Items
CS . . . Copy Schedules between Dwelling Types
RS . . . Refer to Dwelling Schedule
PS . . . Print Dwelling Schedule
PA . . . Print All Schedules for a Dwelling Type
BP . . . Price Schedules for a Dwelling
RP . . . Refer to Priced Dwelling Schedule
SP . . . Print Single Priced Dwelling Schedule
AP . . . Print All Priced Schedules for a Dwelling
AG . . . Aggregate Schedule-80 for a Dwelling
QU . . . Quit

Enter Command >-

Pricing the dwelling schedules

The first task the estimator/user must undertake is to transfer the dwellings required onto the phase form the company data system. This is achieved by selecting the option :-

'TD ... Transfer Dwelling Type from Company Data'

The user is prompted for the code of the dwelling to be transferred and the dwelling type is then copies across. It is recommended that all dwelling types required on the phase are transferred before any pricing is undertaken.

The method by which items are priced is as follows :-

From the PHASE DWELLING DETAILS Menu select the

'BP ... Price Schedules for a Dwelling' option.

The user is then prompted for the dwelling code.

DWELLING SCHEDULE/S PRICING

Input Dwelling Code ..././../

Once the code is entered the user is prompted for the schedule code :

Enter Schedule Code ... 000

Assuming a valid two digit code is entered the screen will

display the required schedule in the following format.

SCHEDULE No.01 DWELLING TYPE 365/G/GG/ Page 1

Item	Description	Quantity	Units	Rate	Total
01.001	FACINGS IN HB SKIN	10.9	TH	125.00	1362.50
01.002	FACINGS IN HB GARAGE PROTECTION	2.275	TH	120.00	273.00
01.003	FACINGS IN 225 X 225 ISOLATED PIERS	2.24	TH	120.00	268.80
01.004	FACINGS IN 225 X 328 ISOLATED PIERS	1.2	TH	120.00	144.00
01.010	COMMONS OVER LINTOLS IN STACKS ETC	2.4	TH	118.00	283.20
01.017	100 BLOCKS IN INNER SKIN	156	M2	4.50	702.00
01.021	100 BLOCKS IN INTERNAL WALLS	22	M2	5.50	121.00
01.022	150 BLOCKS IN INTERNAL WALLS	23	M2	5.00	115.00
01.023	200 BLOCKS IN INTERNAL WALLS	3	M2	6.50	19.50
01.027	NATURAL MORTAR IN HB WALL	19	M2	1.20	22.80
01.029	NATURAL MORTAR IN 100 BLOCK WALL	178	M2	1.22	217.16
01.033	COLOURED MORTAR IN HB WALL	198	M2	1.75	346.50
01.036	WALL TIES (PLASTIC)	560	TH	.30	168.00
01.038	FRAME CRAMPS (BOLDFAST)	118	TH	.40	47.20
01.042	100 MM HORIZONTAL DPC	10	ROLL	7.50	75.00
01.044	225 MM HORIZONTAL DPC	1	ROLL	15.00	15.00

The user may move around the table by using the edit command described in section 6 . To enter a rate the user types 'C' (for change) and RETURN. This results in the following display for an item :

		Quant	Unit	Rate	Total
*01.001	----------	10.9	Th	--------	xxxxxxxxx

The user types in the required rate and presses RETURN. The total for the item is automatically calculated and the item re-displayed.

01.001	----------	10.9	T4	125	1362.5

A new rate may be entered against an item that has been already priced in the same manner.

It is important for the user to realise that once an item is priced for one dwelling in a phase, that same item will automatically be priced at the given rate for all other dwellings on that phase. Dwellings on different phases will obviously remain unaltered. What this means in practice is that as the estimator enters rates for a phase he will have successively less items to price as he moves from dwelling to dwelling. The priced dwelling schedules may be printed or referred to in the usual manner. Another extra option is :-

'AG ... Aggregate Schedule -80 for a Dwelling'

This facility totals the items in each schedule, applies the appropriate discount, wastage and dwelling division factor and allocates each resulting schedule total to an item in schedule 80. Therefore the totol cost of item 80.001 for a particular dwelling type is the total cost of schedule 1. for the same dwelling type.

SCHEDULE FOR DWELLING: 365/G/GG/

SCHEDULE 80.000 SUMMARY OF SCHEDULES 1-79

Item	Description	Quantity	Units	Rate	Total
80.001	BRICKS AND BLOCKS	1		4753.97	4753.97
80.002	STRESSLIN LINTOLS	1		3162.50	3162.50
80.003	EXTERNAL FRAMES	1		700.44	700.44
80.004	REGULARIZED JOISTS	1		2545.20	2545.20
80.005	MAIN ROOF CONSTRUCTION	1		887.15	887.15

(iv) Addendum Dwelling Types :- the facilities available are similar to those outlined above but refer to addendum rather than standard dwellings.

(v) Calculate and Print Phase Budget Summary. This facility allows the estimator to produce a summary of the priced dwellings on a phase. This summary will normally be produced when the estimate for each dwelling on the phase is complete. It may however be produced at any stage of the estimate to form an interim-budget summary. The production of the budget summary involves 3 steps :-

(i) the user must input percentage constraints for overheads and inflation;
(ii) the budget summary must be aggregated (i.e. the calculation must be done);
(iii) the budget summary must be printed (it cannot be viewed on the screen).

To produce the budget summary the user must first select the

'BS .... Calculate and print phase budget summary'

option from the Phase Data Files menu.

The following menu will then be displayed on the screen :

BUDGET SUMMARY LEDBURY 5A

```
RC . . . Refer/Input/Change Percentage Constants
AG . . . Aggregate Budget Summary
PB . . . Print Budget Summary
QU . . . Quit

Enter Command >-
```

To change or refer to the percentage constants the user selects the

'RC .... Refer/Input / Change Percentage Constants' option

```
        INPUT/EDIT PERCENTAGE CONSTANTS    LEDBURY 5A


    The Current Percentage Constants are :

    Inflation   3.4%      Overheads  Ø6.Ø%


Are these values O.K.?  Y/N
```

Type 'N' to change the constants or 'Y' to return to the file menu. To aggregate for the budget summary the user selects the

'AG ..... Aggregate budget summary' option.

The time taken by the computer to perform the calculations involved is in direct proportion to the number of different house types on the phase.

If an item is found during the aggregation which has :

(i) an invalid quantity;
or (ii) an invalid rate;
or (iii) an invalid cost code.

the message -

```
ERROR - Item xx xxx has been ignored

Press RETURN to continue
```

will be displayed. Any item thus displayed will need correcting and the budget summary re-aggregating if it is to be included in the estimate.

When the aggregation is successfully completed the budget summary may be printed by selecting the :-

'PB ... Print Budget Summary' option.

This will result in the following display:

PRINT BUDGET SUMMARY LEDBURY 5A

Adjust printer paper to page correctly :

1) Put printer off-line
2) Press form-feed
3) Set paper perforation just above print head
4) Put printer back on-line
5) Press RETURN

When the RETURN key is pressed the Budget Summary will be printed.

It should be noted that any alteration made to the estimate once the summary has been produced will not be reflected in the budget summary until it has been re-aggregated.

8. PURCHASING SUB-SYSTEM

The Purchasing sub-system comprises numerous computer files. Each individual phase has a set of these files relating to the specific requirements of that phase.

To locate the Purchasing sub-system, first load the Develop system and obtain the Main Menu of Company sub-system options. This is described in Section 5.

From the Main Menu select the command:

'PU ... Purchasing system' This will result in the following display of commands :-

PURCHASING

MP ... Materials Purchasing
SP ... Sub-contract Purchasing
QU ... Quit

Enter Command ...

The access to the purchasing schedules depends upon the option chosen.

The materials buyer will be able to access schedules 1 - 20 and 41 - 80 whereas the sub-contract buyer will have access to schedules 21 - 80.

After the user has entered the required command the following display will be shown.

P U R C H A S I N G

AG . . . Aggregrate Item Quantities
MS . . . Purchase Specification
SU . . . Materials Suppliers and Subcontractors
IT . . . Materials, Preliminaries and Subcontractor Items
PH . . . Phase Details
SA . . . Selective Aggregation of Item Quantities
PA . . . Print Selective Aggregation
QU . . . Quit

Enter Command >-

The first task that must be done is to aggregate the item quantities from the estimate. To do this the user selects the

'AG ... Aggregate Item Quantities' option.

The user will be prompted for the Phase Identifier and then the following will be displayed

PURCHASING - HOUSES ON PHASE: LEDBURY 5A

HOUSE TYPE NO		HOUSE TYPE NO		HOUSE TYPE NO		HOUSE TYPE NO	
374/G/GG/	1	365/G/GG/	7	222/G/GG/	1	365/G/GG/1	1

Press RETURN to continue.

The system will then ask the user to wait whilst the calculations are performed. This process need only be performed once at the beginning of the Purchasing stage. However, should the estimate be revised later in respect to item quantities the purchasing item quantities will need re-aggregating.

The options :-

'MS ... Purchase Specification'
'SU ... Material Suppliers and Sub-contractor'
'PH ... Phase Details'

are all similar in scope and operation to the corresponding estimating files (see Section 7.) and will not be discussed further.

Materials, preliminary and sub-contractor items.

To form the purchasing record the user selects the

'IT ... Materials Preliminary and Sub-contractor Items'

option from the Purchasing menu.
The purchasing items menu is then displayed :

PURCHASING - MATERIALS, SUBCONTRACTOR AND PRELIMINARY ITEMS - LEDBURY 5A

CP . . . Choose/Change current Phase
AS . . . Add Schedule Heading
DS . . . Delete Schedule Heading
CS . . . Change Schedule Heading
CI . . . Change an Item
DI . . . Delete an Item
CD . . . Cost/Date/Add Supplier Code to Schedule of Items
RI . . . Refer to an Item
RS . . . Refer to a Schedule
PS . . . Print a Schedule
QU . . . Quit

Enter Command >-

The options available are as for the estimating items file with the addition of the

'CD ... Cost/Data/Add Supplier Code to Schedule of Items'

option. If this is selected the user is prompted for the schedule number and the purchasing schedule is then displayed.

PURCHASING - SCHEDULE PRICING Page 1

SCHEDULE 01 BRICKS,BLOCKS ETC.

Item Code 01.021 100 BLOCKS IN INTERNAL WALLS Units: M2

Wastage : 13.6%

Code	Ag.Quan.	Tot.Ord	Rate	Ordered	Date	Disc.	Cum.Tot	Supplier
01.001	128.3	130.0*	115.00*	130.0*	02.03.84*	0.0*	14650.0	MA12355*
01.002	20.5	20.0*	112.00*	20.0*	02.03.84*	0.0*	2240.0	*
01.003	22.1	22.0*	112.00*	22.0*	02.03.84*	0.0*	2464.0	*
01.004	10.8	0.0*	0.00*	0.0*	. . *	0.0*	0.0	*
01.005	3.1	4.0*	115.00*	4.0*	08.05.84*	0.0*	460.0	*
01.010	24.0	25.0*	105.00*	15.0*	05.03.84*	0.0*	1575.0	MA12255*
01.017	1560.0	1600.0*	2.50*	1200.0*	. . *	0.0*	3000.0	*

The user then enters data into the appropriate columns using the edit commands (see Section 6).

The information required is :-

Tot ord - the total quantity of the item to be ordered. The difference between this and the aggregated quantity automatically gives the wastage percentage.

Rate - the current buying rate for the item

Ordered - the amount ordered to date

Date - the date of the last order

Disc. - the supplier discount given if any

Supplier - the supplier code

This table is designed to be updated periodically as information becomes available and can be printed in the usual way.

Selective Aggregation

One further option in the purchasing sub-system is the aggregation of quantities for particular combinations of dwelling types. This allows the buyer to stage his orders according to the building program. Any number of combinations may be used, the results being printed in the normal manner.

9. Cost Forecasting Sub-System

The cost forecasting sub-system allows a comparison to be made, item by item, between the estimated item price (i.e. estimated rate x aggregated item quantity) against the purchasing item cost (i.e. purchase rate x total quantity to order). This forecast/comparison can be made at any stage of the phase but will obviously become more complete (and thus accurate) as the phase progresses and more of the purchasing information is known.

The cost forecasting sub-system is located by first loading the Prowting System and obtaining the company sub-system options. From the menu select the :

'CF ... Cost Forecasting Sub-System' option.

The Forecasting system menu will then be displayed as follows :

F O R E C A S T I N G

AG . . . Aggregate for Phase Forecast
RS . . . Refer to Single Schedule of Phase Forecast
PS . . . Print Single Schedule of Phase Forecast
PA . . . Print all Schedules of Phase Forecast
QU . . . Quit

Enter Command >-

As in the purchasing system the user must aggregate the quantities from the purchasing sub-system and the rates from the estimating sub-system before the forecast can be referred to or printed. To do this the user selects the :

'AG ... Aggregate for Phase Forecast' option

This results in the display :

Cost Forecasting Aggregation Ledbury 5A

Initialising Aggregation File

and a dynamic record counter which shows that the aggregation is in progress.

Unlike previous cases the time taken for the aggregation is not in direct proportion to the size of the phase but will be similar for all phases.

When the aggregation is complete the system returns to the forecasting menu. The user may then refer to or print schedules of the phase forecast in the usual manner. A typical phase forecast schedule is shown below :

COST FORECAST/COMPARISON LEDBURY 5A

Inflation = 3.%

ITEM CODE	CURRENT PURCHASE RATE	CURRENT PURCHASE FORECAST	ESTIMATED RATE	ESTIMATE FORECAST	ESTIMATE FORECAST+ % INFL.	DIFFERENCE EST-FOR	DIFFERENCE EST+INF-FOR
01.001	115.00	14650.1	125.00	17640.1	18240.1	2990.1	3590.
01.002	112.00	2240.1	120.00	2701.1	2793.1	461.1	553.
01.003	112.00	2464.1	120.00	2912.1	3011.1	448.1	547.
01.004	0.00	0.1	120.00	1426.1	1474.1	1426.1	1474.
01.005	115.00	460.1	0.00	0.1	0.1	-460.1	-460.
01.010	105.00	2625.1	118.00	3115.1	3221.1	490.1	596.
01.017	2.50	4000.1	4.50	7722.1	7985.1	3722.1	3985.
01.021	4.50	1125.1	5.50	1331.1	1376.1	206.1	251.
01.022	5.00	1250.1	5.00	1265.1	1308.1	15.1	58.
01.023	0.00	0.1	6.50	214.1	222.1	214.1	222.
01.027	0.00	0.1	1.20	251.1	259.1	251.1	259.
01.029	0.00	0.1	1.22	2389.1	2470.1	2389.1	2470.
01.033	0.00	0.1	1.75	3811.1	3941.1	3811.1	3941.
01.036	0.00	0.1	.30	1848.1	1911.1	1848.1	1911.

Press RETURN to continue, Q to Quit or R to Restart >

10. THE VALUATIONS SUB-SYSTEM

A change in the method of operation of the system was necessitated due to the nature of the valuations data. This change is most apparent to the user in the method of adding and changing data. The 'edit mode' used in the other sub-systems and described in section 6 . is replaced with the 'form editing mode'. This alows the user greater flexibility in editing data and also greater speed. It is described in more detail later in this section.

The valuation sub-system uses data from many parts of the system and it is important that the estimate is FINAL AND COMPLETE before the valuations are started.

To locate the Valuations sub-system, first load the Develop system and obtain the Main menu of company sub-system options. This is described in Section 5.

From the Main Menu select the command :

'VA ... Valuations Sub-System'

This will result in the following display of commands :

V A L U A T I O N S

AG . . . Aggregate Value from Estimate
MV . . . Monthly Valuation
MP . . . Print Monthly Valuation Sheets
VA . . . Variations Orders
VP . . . Print Variations Orders
AS . . . Aggregate for Summary Sheets
SA . . . Summary Sheet A
PA . . . Print Summary Sheet A
SB . . . Summary Sheet B
PB . . . Print Summary Sheet B
QU . . . Quit

Enter Command >-

Before any work can be done on the valuations system the value must be aggregated from the estimate into the valuation stages. To do this the user selects the :

'AG ... Aggregate Value from Estimate' option

The user is prompted for the Phase Identifier and the following display occurs :

Valuation Aggregation for Standard Dwelling 365/H/FF

A dynamic display shows that the aggregation is in progress.

Form Editing. This is a combined input/edit mode. The main distinguishing feature between 'Form Editing' and 'Edit Mode' (as described in Section 5) is the use of a display without asterisks. The cursor is simply positioned over the 'data field' to be added or changed and the user types in the required data. The RETURN key is not used to indicate the end of the data. Instead the user must select a key from the following table:

TABLE 11. FORM EDITING COMMANDS.

Command	Action	Description
↑	Move up	Move to data field above
↓	Move down	Move to data field below
→	Move right	Move to next data field
←	Move left	Move to previous data field
ESC }	Finish/	Exit form editing or table
HOME }	next table	
TAB	Next dwelling	View next dwelling {Summary B only }

If an invalid entry is made the cursor will remain in position until it is replaced with a correct entry. The cursor will also move to the next data field automatically when the allowed length of the data field is reached.

Mothly Valuations.
The monthly valuations figures are entered by first selecting the

'MV ... Monthly Valuation'

option from the Valuations menu. The user is prompted for the dwelling code for which the valuation is to be calculated. If it is the first valuation performed on that dwelling the user is then prompted for the month. It it is a second or subsequent valuation the user is given the option of entering a new month.

The valuation sheet is then displayed as follows :

DEVELOPMENT: VALUATION TYPE: 365/G/GG/
PHASE: LEDBURY 5A MONTH: MAY 84 NO. OF UNITS: 7

04.00 BRICKS:		Plot Nos.								
Cost Code + Detail	Value	100	106	107	109	220	221	VWD	MoS	VMoS
01 fndn	846	100	100	100	100	50	0	4653	0	0
02 1st lift	1553	60	120	110	100	0	0	2951	0	0
03 2nd lift	1376	0	110	0	100	0	0	1514	0	0
04 3rd lift	1574	0	120	130	120	0	0	1102	0	0
05 4th lift	1311	0	0	0	0	0	0	0	0	0
06 top out	358	0	0	0	0	0	0	0	0	0
07 externals	797	0	0	0	0	0				

The cursor is positioned over the first plot and first valuation stage. The percentage complete this month can then be entered, the value of work done being automatically updated. The user may move the cursor around the table, at will, changing and adding data as required. The number of sets of materials on site may also be entered. Other cost code can be accessed by either :-

(i) using the 'down arrow' key (↓) to scroll through the cost codes from 1 to 18

(ii) using the escape (ESC) key - the user will then be prompted for the next cost code.

If there are more than six plot numbers the table will automatically 'page' onto the next six when moving from left to right in the table.

To exit the monthly valuations sheet the user must press the escape (ESC) key. This will result in the request :

Another Cost Code {Y/N}

If the answer is affermative the user is prompted for the next dwelling type. If the answer is negative the user is returned to the Valuations Sub-System menu.

The monthly valuations sheets for each dwelling may be printed by selecting the :

'MP ... Print Monthly Valuations Sheets' option.

Variation Orders

To enter or change variation orders select the :

'VA ... Variations Orders' option from the valuations menu.

The following will then be displayed :

Phase: LEDBURY 5A Contract No: 1000
Valuation of Variations Order at Month Ending: May 84

The user may keep the existing date or change it by over-writing. Press RETURN to access the Variation Orders sheet.

New Variation Orders are entered by adding a 3 digit order reference, the description (up to 24 characters), the total value of the order, the amount claimed this month, and the split of that claim between the 23 cost codes. Orders details may be changed at any time using the 'form edit' commands described in Section 10.

Two totals are shown for the Variation Orders:

(i) Total - the arithmetic total of the orders;

(ii) Nett Total - the total discounted by the inflation percentage.

To return to the Valuations Menu press the ESC (escape) key.

The Variation Orders may be printed by selecting the

'VP ... Print Variation Orders' option.

Aggregate for Summary Sheet

The valuations summary sheets (A and B) abstract information held in both the monthly valuations file and the variation orders file. Therefore before the summary sheets can be viewed they must be aggregated. This also implies that the information in the monthly valuation and variation orders files is complete for that month.

To aggregate the user selects the

'AG ... Aggregate for summary sheets' option.

This results in the following heading :

'Valuation aggregation for standing dwelling xxx/x/xx'

and a dynamic display to show that the aggregation is proceeding. If a dwelling is found for which schedule 80 has not been aggregated (in the estimating sub-system) the following message will be displayed.

'Aggregation for this dwelling not yet perfored'
'Press RETURN to continue'

The details for that dwelling will then be omitted from the summaries.

When the aggregation has finished the Valuation System Menu will be displayed once more.

Summary Sheet A

To view Summary A. select the

'SA ... Summary Sheet A' option.

The information is the displayed on 3 'pages' :

(i) the first 'page' summarises the value of work done, materials on site and variation orders, for that particular month.

(ii) the second 'page' allows the user to claim the preliminaries (codes 19-23) for that month. The allowances made in the estimate are shown and the user may claim up to that amount but not exceed it.

(iii) the third 'page' shows the 'Check Forecast Final Account' which hold the totals for the work done, preliminaries, inflation etc. and the construction program.

The first page of Summary sheet A is shown below :

```
DEVELOPMENT                    VALUATION                    SUMMARY A
PHASE:        LEDBURY 5A       MONTH:     MAY 84
-----------------------------------
|   Type     + Work Done +  V.M.o.S. |
|------------+-----------+-----------|          ALL SUMS EXCLUDE O H P
| 365/G/GG/  |      1887 |      1678 |
| 374/G/GG/  |      1649 |         0 |
| 222/G/GG/  |         0 |         0 |
| 365/G/GG/1 |         0 |         0 |
|            |           |           |
|            |           |           |
|            |           |           |
|            |           |           |
------------+-----------+-----------|
            |      3536 |      1678 |
             -----------------------

                                VO excl those for inflation  |     270
                                Materials on site            |    1678
                                Total of estimated work      |    3536
                                                             |=========
                                                       TOTAL |    5484
          Press RETURN to continue or R to restart
```

The arrow keys are used throughout to move around and between the pages and the escape (ESC) key returns the user to the Variations Menu.

Summary sheet A. may also be printed by selecting the

'PA ... Print Summary A.' option.

Summary Sheet B.

To view Summary B. select the

'SB ... Summary Sheet B.' option from the Valuations Menu.

This results in the following display :

ELOPMENT phase LEDBURY 5A VALUATION MONTH MAY 84

	365GGG	374GGG	VMoS	VOrd	Total	Su Ac	SubAc	B Cost	T Cost	Diff
1	1241	1261	01	901	3401				01	340
2	01	01	01	701	701				01	70
3	01	01	01	01	01				01	0
4	17631	15231	16781	01	49641				01	4964
5	01	01	01	1101	1101				01	110
6	01	01	01	01	01				01	0
7	01	01	01	01	01				01	0
8	01	01	01	01	01				01	0
9	751	751	01	01	3001				01	300
10	01	01	01	01	01				01	0
11	01	01	01	01	01				01	0
12	01	01	01	01	01				01	0
13	01	01	01	01	01				01	0
14	01	01	01	01	01				01	0
15	01	01	01	01	01				01	0
16	01	01	01	01	01				01	0
17	01	01	01	01	01				01	0
18	01	01	01	01	01					

The value of work done in each cost code is shown for each house type together with the value of mnaterials on site and variations orders. The values for the supplier and subcontractor accurals and the Building Cost may be entered against the appropriate cost code to give a 'difference', either positive or negative.

Codes 19 to 23 and the totals may be accessed by using the 'down arrow' key (↓) to scroll off the bottom of the table.

Other dwelling types are viewed by using the TAB key.

To return to the valuation menu the user must press the escape (ESC) key.

Summary Sheet B. may also be printed by selecting the

'PB ... Print Summary Sheet B' option.

APPENDIX 2

Examples of standard company forms

A2-1 Quantities schedule for one dwelling

A2-2 Extract from company specification

A2-3 Building budget summary

A2-4 Monthly valuation sheet

A2-5 Application for stage payment

Project: _____ for dwelling type _____

QUANTITIES FOR ONE DWELLING SHEET 1 of 2

Schedule No.: 15

Item	Nett Quantity	Size/Description	Notes	PRICE Gross qty	Rate	£ P
A.	Sink	Single bowl single drainer or				
		Single bowl double drainer or				
		Double bowl single drainer*				
		State LH or Rh bowl				
B		* Basket waste & strainer to one bowl				
C.		1½" waste & plug & chain				
D.		High necked pillar tapes pair				
E.		Sink deck mixer				
	Baths	Colour for single/family				
		Colour for en-suite				
F.		1700 x 700 acrylic bath				
G.		1½" waste,overflow unit, plug & chain				
H.		½" taps with acrylic heads pair				
J.		Deck mixer with acrylic heads with shower kit No.1				
K.		Side bath panel : hard board/moulded				
L.		End bath panel : hard board/moulded				
M.	Coloured basins	560 x 406 colour to match baths				
N		Pedestal to match last				
P.		1½" waste, plug & chain				
Q.		½" taps with acrylic neads pair				
R.	White Basins	500 x 300 white basins and basin waste bracket.				
S.		Wall brackets pair				
T.		1½ waste, plug & Chain				
U.		½" taps with arcrylic heads pair				

CARRIED FORWARD 16 £

8 INTERNAL PARTITIONS

8.1 Non load bearing partitions - 58mm Stramit partitions erected as manufacturer's directions.

8.2 Sound insulation - Where required by NHBC allow for additional thicknesses of plasterboard bonded to Strammit.

9 CLADDINGS

9.1 Battens and felt - 19 x 38mm pre-treated battens will be fixed with galvanised nails to felt/visqueen backing.

9.2 Tiles - Plain tile hanging with/without corner angles.

9.3 Shiplap - Pre-treated shiplap boarding secret nailed.

9.4 Vinyl - 'Westbrick 300' fixed as manufacturer's instructions.

9.5 Rendering - 12mm rendering finished with two coats Thi-buildfinish in white with bellmouth.

10 FRAMES, LININGS AND SCREENS

10.1 Windows - Standard Boulton & Paul frames with softwood cills and hardwood thresholds; standard Boulton & Paul ironmongery to windows. Front door frames to be set up to allow door to swing over mat on carpet on screed.
Allow for cramps.

10.2 Side Cheeks - Ex 75 x 38 wrot treated softwood cheeks to be site fixed in tile hanging rendered or boarded elevations.

10.3 Garages - Standard Boulton & Paul frames to garages with asbestos roofs; Prowting standard frame with glazed fanlight to other garages.

10.4 Linings - Internal linings to allow for 19mm gap under doors for carpets; where possible allow full architrave all round; wardrobe linings to be door height with plywood fanlights.

10.5 Screens - Softwood screens with double stops as Prowting standard detail.

SITE	PLOT NOS.						PRICING DATE		
DESIGN REF.									
1. Materials as Schedule 16									
2. Subcontracts as Schedule 17									
3. Std dwelling foundation									
4. Std.Garage foundation									
5. Garage Superstructure									
6. SUB TOTAL									
7. Abnormal foundations									
8. Drainage									
9. External Works									
10. Preliminaries									
11. SUB TOTAL									
12. Inflation during work %									
13. SUB TOTAL									
14. OHP									
15. TOTAL									
Number of units									
Habitable area M²/SF									
Cost per SF item 6									
" " " item 15									
Plot numbers									

Building programme: commence:
complete:
No.months:

*Figures for Final Dev.Budget

Distribution: DBP: GSH: Surveyor

A. E. A. PROWTING LTD

PROWTING ESTATES VALUATION

AT _____ 19

_____ REGION

A.E.A.P. JOB NO.	SITE	CURRENT VALUE	PREVIOUS VALUE	MONTH VALUE	COST JOB	COST HEAD	POST NOMINAL

DISTRIBUTION
Accounts (2)
Reg. Manager
File

AUTHORISED BY.....

APPLICATION FOR STAGE PAYMENT

PROWTING GROUP

FROM..... SITE.....

TRADE..... WEEK ENDING.....

PLOT	STAGE	£	p
	Value Total Stages		
	B/F from 'Extras' sheet		
	Total cert. & paid this wk.		

The first payment must include a note of the Subcontractor's Tax Certificate Number with the expiry date and the VAT number

APPENDIX 3

Example of data held in company data sub-system

A3-1 Extract from main specification file

A3-2 Standard item schedule

A3-3 Standard dwelling schedule

A3-4 Priced dwelling schedule

A3-5 Phase details

WORK BELOW D.P.C. LEVEL

01.01 Vegetable Matter: Excavate 150mm deep: stockpile for gardens.

01.02 Foundation Trenches: Excavate to depths required by Local Authorities allowing minimum 1200mm depth.

01.03 Cart Away: Cart away only excavated material that cannot be spread and levelled or mounded: Note NHBC requirements regarding minimum depth of topsoil returned to gardens.

01.04 Foundation Concrete: Trenchfill (1:8-28mm): minimum depth 1200: 500 wide under 265/225 walls: 400 under 100 walls.

01.05 Foundation Brickwork: LBC Flettons/concrete blockwork: cement mortar 1:3 cavity fill concrete 1:8 19mm.
Lay facings minimum 3 courses below finished ground level and as necessary to follow sloping ground.

01.06 Hardcore: Make up levels with broken brick/stone(to pass 100mm gauge): lay 100mm bed well consolidated: 50mm sand blinding for 1000 gauge polythene membrane lapped and jointed to DPC.

01.07 Reinforced Slabs: Where hardcore filling exceeds 600mm construct suspended floor as specialist's details.

01.08 Oversite: 100mm concrete (1:8 19mm) tamped: garage trowelled smooth sloping 75mm back to front with lip to drive behind piers.

01.09 Formwork: To exposed edges in wrot material only.

01.10 Lintols Over Drains: Concrete lintols over drain and duct entries.

01.11 Horizontal Damp Courses: Durathene 2000E.

01.12 Ducts: Provide through foundations for gas, water, electricity and telephone services in positions marked on drawings, allowing sufficient ducting to clear drives and footpaths adjoining dwellings.

DRAINAGE

02.01 Foul & Storm Drain Runs: Marscar or Osma plastic pipes and fittings with pea shingle beds.

02.02 Manholes: Plastic bowls with precast concrete manholes at major direction changes.

02.03 Covers: Medium weight in drives: lightweight elsewhere set out square to buildings and fitting in paths where possible.

02.04 Soakaways: Hardcore filling with polythene and top soil over.

02.05 Gullies: Back inlet to kitchens/cloakrooms: garage gully:

A3-1

SCHEDULE 01.000 BRICKS,BLOCKS ETC.

Item Code	Description	Units
01.001/S04.01/C04.00	FACINGS IN HB SKIN	TH
01.002/S04.01/C04.00	FACINGS IN HB GARAGE PROTECTION	TH
01.003/S04.01/C04.00	FACINGS IN 225 X 225 ISOLATED PIERS	TH
01.004/S04.01/C04.00	FACINGS IN 225 X 328 ISOLATED PIERS	TH
01.005/S04.01/C04.00	FACINGS IN 328 X 328 ISOLATED PIERS	TH
01.006/S04.01/C04.00	FACINGS IN ONE BRICK WALL	TH
01.008/S04.01/C04.01	CIOB DEMO ITEM	M2
01.010/S04.01/C04.00	COMMONS OVER LINTOLS IN STACKS ETC	TH
01.011/S04.01/C04.00	75 BLOCKS IN OUTER SKIN	M2
01.012/S04.01/C04.00	100 BLOCKS IN OUTER SKIN	M2
01.013/S04.01/C04.00	150 BLOCKS IN OUTER SKIN	M2
01.014/S04.01/C04.00	75 BLOCKS IN INNER SKIN	M2
01.015/S04.01/C04.00	50 BLOCKS IN INNER SKIN	M2
01.017/S04.01/C04.00	100 BLOCKS IN INNER SKIN	M2
01.018/S04.01/C04.00	150 BLOCKS IN INNER SKIN	M2
01.020/S05.01/C04.00	75 BLOCKS IN INTERNAL WALLS	M2
01.021/S05.01/C04.00	100 BLOCKS IN INTERNAL WALLS	M2
01.022/S04.02/C01.00	150 BLOCKS IN INTERNAL WALLS	M2
01.023/S04.02/C04.00	200 BLOCKS IN INTERNAL WALLS	M2
01.027/S04.05/C04.00	NATURAL MORTAR IN HB WALL	M2
01.028/S04.05/C04.00	NATURAL MORTAR IN 75 BLOCK WALL	M2
01.029/S04.05/C04.00	NATURAL MORTAR IN 100 BLOCK WALL	M2
01.030/S04.05/C04.00	NATURAL MORTAR IN 150 BLOCK WALL	M2
01.031/S04.05/C04.00	NATURAL MORTAR IN 200 BLOCK WALL	M2
01.033/S04.05/C04.00	COLOURED MORTAR IN HB WALL	M2
01.034/S04.05/C04.00	COLOURED MORTAR IN ONE BRICK WALL	M2
01.036/S04.06/C04.00	WALL TIES (PLASTIC)	TH
01.038/S07.01/C04.00	FRAME CRAMPS (HOLDFAST)	TH
01.042/S04.04/C04.02	100 MM HORIZONTAL DPC	ROLL
01.043/S04.04/C04.02	150 MM HORIZONTAL DPC	ROLL
01.044/S04.04/C04.02	225 MM HORIZONTAL DPC	ROLL
01.045/S04.04/C04.02	328 MM HORIZONTAL DPC	ROLL
01.046/S04.04/C04.00	360 MM CAVITY TRAY DPC	ROLL
01.047/S04.04/C04.00	150 MM VERTICAL DPC	ROLL
01.049/S19.01/C04.02	POLYTHENE BACKING TO METER BOX	M2
01.050/S19.01/C04.02	FIBREGLASS BACKING TO METER BOX	M2
01.052/S18.01/C04.02	COLT 99 COMBUSTION AIR GRILLE	NO
01.053/S04.01/C04.02	225 X 225 CAVITY LINER	NO
01.054/S04.01/C04.02	225 X 225 AIR GRILLE	NO
01.055/S04.01/C04.00	225 X 225 AIR BRICK	NO
01.056/S04.01/C04.00	225 X 225 LINER	NO
01.057/S04.01/C04.02	75 X 225 AIR BRICK	NO
01.060/S04.07/C04.00	184 X 184 FIRECLAY FLUE LINING	MR
01.061/S04.07/C04.06	POT TO CHIMNEY STACK	NO
01.062/S04.07/C04.02	CONCRETE LINTOL TO THROATING	NO
01.064/S04.06/C04.00	150 X 250 CREASING TILE	NO
01.066/S04.07/C04.00	FXY GAS FLUE TYPE X BLOCKS (RECESS PANEL	NO
01.067/S04.07/C04.02	IY BLOCK (LINTOL UNIT)	NO
01.068/S04.07/C04.00	3YB BLOCK (FLUE BLOCKS)	NO
01.069/S04.07/C04.00	5Y BLOCK (REVERSE REBATED UNIT)	NO

DWELLING CODE: 365/G/GG/

4 BEDROOM/2 BATHROOM (ONE EN SUITE) WITH
INTEGRAL DOUBLE GARAGE AND PORCH

Habitable Area: 98.

SCHEDULE 01.000 BRICKS,BLOCKS ETC.

Discount Lump Sum: 100 Waste: 10% Dwelling Division Factor: 01/01

CODE	DESCRIPTION	QUANTITY	UNITS
01.001/S04.01/C04.00	FACINGS IN HB SKIN	10.9	TH
01.002/S04.01/C04.00	FACINGS IN HB GARAGE PROTECTION	2.3	TH
01.003/S04.01/C04.00	FACINGS IN 225 X 225 ISOLATED PIERS	2.1	TH
01.004/S04.01/C04.00	FACINGS IN 225 X 328 ISOLATED PIERS	1.2	TH
01.006/S04.01/C04.00	FACINGS IN ONE BRICK WALL	.4	TH
01.008/S04.01/C04.01	CIOB DEMO ITEM	25	M2
01.010/S04.01/C04.00	COMMONS OVER LINTOLS IN STACKS ETC	1.2	TH
01.017/S04.01/C04.00	100 BLOCKS IN INNER SKIN	156	M2
01.021/S05.01/C04.00	100 BLOCKS IN INTERNAL WALLS	22	M2
01.023/S04.02/C04.00	200 BLOCKS IN INTERNAL WALLS	3	M2
01.027/S04.05/C04.00	NATURAL MORTAR IN HB WALL	19	M2
01.029/S04.05/C04.00	NATURAL MORTAR IN 100 BLOCK WALL	178	M2
01.033/S04.05/C04.00	COLOURED MORTAR IN HB WALL	198	M2
01.036/S04.06/C04.00	WALL TIES (PLASTIC)	560	TH
01.038/S07.01/C04.00	FRAME CRAMPS (HOLDFAST)	118	TH
01.042/S04.04/C04.02	100 MM HORIZONTAL DPC	5	ROLL
01.044/S04.04/C04.02	225 MM HORIZONTAL DPC	1	ROLL
01.045/S04.04/C04.02	328 MM HORIZONTAL DPC	0/5	ROLL
01.046/S04.04/C04.00	360 MM CAVITY TRAY DPC	31	ROLL
01.047/S04.04/C04.00	150 MM VERTICAL DPC	33	ROLL
01.049/S19.01/C04.02	POLYTHENE BACKING TO METER BOX	2	M2
01.050/S19.01/C04.02	FIBREGLASS BACKING TO METER BOX	2	M2
01.052/S18.01/C04.02	COLT 99 COMBUSTION AIR GRILLE	1	NO
01.053/S04.01/C04.02	225 X 225 CAVITY LINER	1	NO
01.054/S04.01/C04.02	225 X 225 AIR GRILLE	1	NO
01.055/S04.01/C04.00	225 X 225 AIR BRICK	1	NO
01.056/S04.01/C04.00	225 X 225 LINER	1	NO
01.057/S04.01/C04.02	75 X 225 AIR BRICK	1	NO
01.060/S04.07/C04.00	184 X 184 FIRECLAY FLUE LINING	7	MR
01.061/S04.07/C04.06	POT TO CHIMNEY STACK	1	NO
01.062/S04.07/C04.02	CONCRETE LINTOL TO THROATING	1	NO
01.064/S04.06/C04.00	150 X 250 CREASING TILE	12	NO
01.091/S04.06/C04.03	75 X 100 X 120 ANGLE IRON	1	NO
01.092/S04.06/C04.03	75 X 100 X 1500 ANGLE IRON	1	NO

DWELLING CODE: 365/G/GG/ LEDBURY 6A

4 BEDROOM/2 BATHROOM (ONE EN SUITE) WITH
INTEGRAL DOUBLE GARAGE AND PORCH

Habitable Area: 102.5

SCHEDULE 01.000 BRICKS,BLOCKS ETC.

Discount Lump Sum: 0000 Waste: 10% Dwelling Division Factor: 01/01

Item Code	Description	Quantity	Units	Rate	Total
01.001/S04.01/C04.00	FACINGS IN HB SKIN	10.9	TH	35.00	381.50
01.002/S04.01/C04.00	FACINGS IN HB GARAGE PROTECTION	2.3	TH	36.50	83.95
01.003/S04.01/C04.00	FACINGS IN 225 X 225 ISOLATED PIERS	2.1	TH	32.20	67.62
01.004/S04.01/C04.00	FACINGS IN 225 X 328 ISOLATED PIERS	1.2	TH	30.00	36.00
01.006/S04.01/C04.00	FACINGS IN ONE BRICK WALL	0.2	TH	60.00	12.00
01.010/S04.01/C04.00	COMMONS OVER LINTOLS IN STACKS ETC	1.16	TH	29.00	33.64
01.017/S04.01/C04.00	100 BLOCKS IN INNER SKIN	156	M2	2.60	405.60
01.021/S05.01/C04.00	100 BLOCKS IN INTERNAL WALLS	22	M2	6.00	132.00
01.023/S04.02/C04.00	200 BLOCKS IN INTERNAL WALLS	3	M2	3.50	10.50
01.027/S04.05/C04.00	NATURAL MORTAR IN HB WALL	19	M2	.22	4.18
01.029/S04.05/C04.00	NATURAL MORTAR IN 100 BLOCK WALL	178	M2	.10	17.80
01.033/S04.05/C04.00	COLOURED MORTAR IN HB WALL	198	M2	.55	108.90
01.036/S04.06/C04.00	WALL TIES (PLASTIC)	560	TH	.01	5.60
01.038/S07.01/C04.00	FRAME CRAMPS (HOLDFAST)	118	TH	.03	3.54
01.042/S04.04/C04.02	100 MM HORIZONTAL DPC	5	ROLL	1.20	6.00
01.044/S04.04/C04.02	225 MM HORIZONTAL DPC	1	ROLL	1.40	1.40
01.045/S04.04/C04.02	328 MM HORIZONTAL DPC	0/5	ROLL	0.00	0.00
01.046/S04.04/C04.00	360 MM CAVITY TRAY DPC	31	ROLL	20.60	638.60
01.047/S04.04/C04.00	150 MM VERTICAL DPC	33	ROLL	2.30	75.90
01.049/S19.01/C04.02	POLYTHENE BACKING TO METER BOX	2	M2	0.00	0.00
01.050/S19.01/C04.02	FIBREGLASS BACKING TO METER BOX	2	M2	0.00	0.00
01.052/S18.01/C04.02	COLT 99 COMBUSTION AIR GRILLE	1	NO	0.00	0.00
01.053/S04.01/C04.02	225 X 225 CAVITY LINER	1	NO	0.00	0.00
01.054/S04.01/C04.02	225 X 225 AIR GRILLE	1	NO	0.00	0.00
01.055/S04.01/C04.00	225 X 225 AIR BRICK	1	NO	0.00	0.00
01.056/S04.01/C04.00	225 X 225 LINER	1	NO	0.00	0.00
01.057/S04.01/C04.02	75 X 225 AIR BRICK	1	NO	0.00	0.00
01.060/S04.07/C04.00	184 X 184 FIRECLAY FLUE LINING	7	MR	0.00	0.00
01.061/S04.07/C04.06	POT TO CHIMNEY STACK	1	NO	0.00	0.00
01.062/S04.07/C04.02	CONCRETE LINTOL TO THROATING	1	NO	0.00	0.00
01.064/S04.06/C04.00	150 X 250 CREASING TILE	12	NO	0.00	0.00
01.091/S04.06/C04.03	75 X 100 X 120 ANGLE IRON	1	NO	0.00	0.00
01.092/S04.06/C04.03	75 X 100 X 1500 ANGLE IRON	1	NO	0.00	0.00

GROSS SCHEDULE TOTAL: 2024.73

NETT SCHEDULE TOTAL: 2227.20

Phase Identifier : LEDBURY 6A

Phase Code: 1010

Number of Dwellings: 12

Final Building Budget Date: 01.08.84

Start Date of Phase: 01.11.84

Completion Date of Phase: 30.09.85

Duration of Phase:

Site Agents Name: K.RAWLINGS

Site Delivery Address:

BEESTON,NOTTINGHAM

Site Telephone Number: 0602.78659

PLOT NO.	DWELLING CODE	POSTAL ADDRESS	PURCHASERS NAME	INSPECTION DATE
078	365/B/BB/	44,FOREST GATE	BOLTON	01.10.85
079	365/B/BB/1	45,FOREST GATE		
080	374/B/BB/	46,FOREST GATE	ROBINSON	01.10.85
081	222/B/BB/	47,FOREST GATE	BARNEY	01.10.85
082	365/B/BB/	48,FOREST GATE	BUTANE	01.11.85

APPENDIX 4

An example of a phase budget summary

BUDGET SUMMARY

PLOT NUMBERS	009 059	010	011	012 015 056 060	013 014	057 058	
HOUSE TYPES	401/H/FF/	416/H/FF/	295/B/FF/	297/B/FF/	264/B/FF/	364/H/FF/	CUM.TOTAL
A. TOT MATS (Schd 1-20 Ex.Fits)	8955.4	7235.6	6404.8	4711.8	4872.7	7384.6	74913.2
B. TOT S/C (Schd 21-43 Ex.Fits)	10052.4	8292.7	7962.9	6921.7	6847.2	9320.3	96382.1
C. STD HSE FNDN (Schd 44-49)	2372.4	1510.7	2439.6	1681.5	1567.8	1998.7	22553.7
D. STD GAR FNDN (Schd 50-55)	0.0	484.2	0.0	484.6	389.8	450.8	4103.9
E. GAR SUPERSTR (Schd 56-61)	0.0	0.0	0.0	1771.2	917.3	1983.7	12886.7
F. PLASTERED SHELL	21380.1	17523.2	16807.3	15570.8	14594.7	21138.0	210839.6
G. "FITTINGS" - (see footnote)	2491.8	2193.1	1942.8	1796.6	1736.3	2589.6	24957.8
H. DRAINAGE (Schd 68-73)	1105.3	1105.3	1105.3	1105.3	1105.3	1105.3	13263.6
J. EXTERNAL WKS (Schd 74-78)	1709.7	1729.3	1729.3	1729.3	1729.3	1729.3	20712.1
K. PRELIMS .0% (Schd 79)	4996.0	4996.0	3330.7	3330.7	3330.7	4996.0	48295.0
L. BASIC COST	31682.9	27546.9	24915.3	23532.7	22496.3	31558.2	318068.0
M. ABNORMALS (Schd 62-67)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. INFLTN 3.4%	1077.2	936.6	847.1	800.1	764.9	1073.0	10814.3
P. TOTAL FOR F.D.BUDGET	32760.2	28483.5	25762.5	24332.8	23261.2	32631.2	328882.3
Q. MARGIN 6.0%	1965.6	1709.0	1545.7	1460.0	1395.7	1957.9	19732.9
R. TOTAL FOR WORKS ORDER	34725.8	30192.6	27308.2	25792.8	24656.8	34589.1	348615.3
NUMBER OF UNITS	2	1	1	4	2	2	12
HABITABLE AREA M2 (FT2)	118.3/1273.	91.0/ 979.	101.9/1096.	78.9/ 849.	77.1/ 830.	122.7/1320.	
COST/M2 (FT2) PLASTERED SHELL	180.7/ 16.8	192.6/ 17.9	164.9/ 15.3	197.3/ 18.3	189.3/ 17.6	172.3/ 16.0	
COST/M2 (FT2) BASIC COST	267.8/ 24.9	302.7/ 28.1	244.5/ 22.7	298.3/ 27.7	291.8/ 27.1	257.2/ 23.9	
COST/M2 (FT2) F.D.BUDGET	276.9/ 25.7	313.0/ 29.1	252.8/ 23.5	300.4/ 28.7	301.7/ 28.0	265.9/ 24.7	
COST/M2 (FT2) WORKS ORDER	293.5/ 27.3	331.8/ 30.8	268.0/ 24.9	326.9/ 30.4	319.8/ 29.7	281.9/ 26.2	
BUILDING PROGRAMME	START: . .		END: . .		DURATION: 0 WEEKS		
DATE OF ESTIMATE							

N.B. Elevation Alternatives, steps and staggers etc. are included in items A & B.

"FITTINGS"
MATERIALS : Kitchen units, Appliances Sanitaryware, Mirrors etc.
SUBCONTRS : Floor & Wall tiling fix only, Sanitaryware & Kitchen Units, Electrical & Plumbing to appliances.

APPENDIX 5

An example of a phase purchasing schedule

SCHEDULE 01.000 BRICKS,BLOCKS ETC.

Item Code	Description	Units	Ag.Qnt	Tot.Ord	Rate	Ordered	Ord.Dat	Di c	Cum.Tot	Supplier
01.001/S04.01/C04.00	FACINGS IN HB SKIN	TH	54.1	56.0	29.00	56.0	09.10.84	0.0	1624.0	LO12345
01.002/S04.01/C04.00	FACINGS IN HB GARAGE PROTECTION	TH	11.7	12.0	32.50	6.0	09.10.84	0.0	195.0	LM44552
01.003/S04.01/C04.00	FACINGS IN 225 X 225 ISOLATED PIERS	TH	11.4	12.0	30.00	8.0	. .	0.0	240.0	MA12434
01.004/S04.01/C04.00	FACINGS IN 225 X 328 ISOLATED PIERS	TH	4.8	5.0	33.25	5.0	08.11.84	0.0	166.2	MA78632
01.006/S04.01/C04.00	FACINGS IN ONE BRICK WALL	TH	.8	1.0	35.00	.5	08.11.84	0.0	17.5	
01.010/S04.01/C04.00	COMMONS OVER LINTOLS IN STACKS ETC	TH	5.2	5.5	29.30	5.5	12.11.84	0.0	161.1	MA44563
01.011/S04.01/C04.00	75 BLOCKS IN OUTER SKIN	M2	52.0	55.0	8.00	10.0	. .	0.0	80.0	
01.017/S04.01/C04.00	100 BLOCKS IN INNER SKIN	M2	624.0	650.0	4.00	200.0	20.12.84	0.0	800.0	MA12345
01.020/S05.01/C04.00	75 BLOCKS IN INTERNAL WALLS	M2	50.0	60.0	6.20	30.0	12.03.85	0.0	186.0	MA12355
01.021/S05.01/C04.00	100 BLOCKS IN INTERNAL WALLS	M2	88.0	0.0	0.00	0.0	. .	0.0	0.0	
01.023/S04.02/C04.00	200 BLOCKS IN INTERNAL WALLS	M2	12.0	0.0	0.00	0.0	. .	0.0	0.0	
01.027/S04.05/C04.00	NATURAL MORTAR IN HB WALL	M2	76.0	0.0	0.00	0.0	. .	0.0	0.0	
01.029/S04.05/C04.00	NATURAL MORTAR IN 100 BLOCK WALL	M2	712.0	0.0	0.00	0.0	. .	0.0	0.0	
01.033/S04.05/C04.00	COLOURED MORTAR IN HB WALL	M2	792.0	0.0	0.00	0.0	. .	0.0	0.0	
01.036/S04.06/C04.00	WALL TIES (PLASTIC)	TH	2240.0	0.0	0.00	0.0	. .	0.0	0.0	
01.038/S07.01/C04.00	FRAME CRAMPS (HOLDFAST)	TH	472.0	0.0	0.00	0.0	. .	0.0	0.0	
01.042/S04.04/C04.02	100 MM HORIZONTAL DPC	ROLL	117.0	0.0	0.00	0.0	. .	0.0	0.0	
01.044/S04.04/C04.02	225 MM HORIZONTAL DPC	ROLL	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.046/S04.04/C04.00	360 MM CAVITY TRAY DPC	ROLL	124.0	0.0	0.00	0.0	. .	0.0	0.0	
01.047/S04.04/C04.00	150 MM VERTICAL DPC	ROLL	132.0	0.0	0.00	0.0	. .	0.0	0.0	
01.049/S19.01/C04.02	POLYTHENE BACKING TO METER BOX	M2	8.0	0.0	0.00	0.0	. .	0.0	0.0	
01.050/S19.01/C04.02	FIBREGLASS BACKING TO METER BOX	M2	8.0	0.0	0.00	0.0	. .	0.0	0.0	
01.052/S18.01/C04.02	COLT 99 COMBUSTION AIR GRILLE	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.053/S04.01/C04.02	225 X 225 CAVITY LINER	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.054/S04.01/C04.02	225 X 225 AIR GRILLE	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.055/S04.01/C04.00	225 X 225 AIR BRICK	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.056/S04.01/C04.00	225 X 225 LINER	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.057/S04.01/C04.02	75 X 225 AIR BRICK	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.060/S04.07/C04.00	184 X 184 FIRECLAY FLUE LINING	MR	28.0	0.0	0.00	0.0	. .	0.0	0.0	
01.061/S04.07/C04.06	POT TO CHIMNEY STACK	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.062/S04.07/C04.02	CONCRETE LINTOL TO THROATING	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.064/S04.06/C04.00	150 X 250 CREASING TILE	NO	48.0	0.0	0.00	0.0	. .	0.0	0.0	
01.091/S04.06/C04.03	75 X 100 X 120 ANGLE IRON	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
01.092/S04.06/C04.03	75 X 100 X 1500 ANGLE IRON	NO	4.0	0.0	0.00	0.0	. .	0.0	0.0	
							TOTAL		3469.9	

APPENDIX 6

An example of a monthly valuation sheet

MONTHLY VALUATION

DEVELOPMENT PHASE: LEDBURY 6A

VALUATION MONTH: DEC 84

TYPE: 365/G GG/
NO. OF UNITS: 3

Cost Code + Detail	Value	Plot Nos. 078	079	082	VWD	MoS	VMoS
01.00 BMC							
01 foundations	0	0	15	15	0	0	0
02 oversite	0	0	0	0	0	0	0
03 externals	0	0	0	0	0	0	0
TOTALS	0				0		0
03.00 DRAINS							
01 foul	0	0	20	15	0	0	0
02 storm	0	0	0	0	0	0	0
03 precast	0	0	0	0	0	0	0
TOTALS	0				0		0
04.00 BRICKS							
01 fndn	26	0	100	100	53	0	0
02 1st lift	108	20	20	50	97	0	0
03 2nd lift	101	10	10	30	50	1	101
04 3rd lift	252	10	50	100	404	0	0
05 4th lift	0	100	20	20	0	0	0
06 top out	0	0	0	10	0	0	0
07 externals	72	0	0	0	0	3	21.
TOTALS	559				604		312

APPENDIX 7

An example of summary sheet A

DEVELOPMENT PHASE: LEDBURY 6A

VALUATION MONTH: NOV 84

SUMMARY A

Type	+ Work Done +	V.M.o.S.
374/0/00/	0	0
365/0/00/	82	317
222/0/00/	0	0
	82	317

ALL SUMS EXCLUDE O H P

VO excl those for inflation	1400
Materials on site	317
Total of estimated work	82
TOTAL	1799

DEVELOPMENT PHASE: LEDBURY 6A

VALUATION MONTH: NOV 84

SUMMARY A

Code 19	Site setting-up value [max	$	0]		1
Code 20	Site bills total	$	0	this valn	0
Code 21	Wages total	$	0	this valn	0
Code 9.02	AEA Plant total	$	0		0
					1800
Code 22	Capital cost contribution [max	$	0]		0
Code 23	Maintenance provision [max	$	0]		0
					1800
INFLATION	Total in original estimate	$	320	for this	0
	add V O excluding OHP	$	0	valuation	0

TOTAL VALUATION EXCLUDING OHP	$	1800
TOTAL VALUATION INCLUDING OHP	$	1908

CHECK FORECAST FINAL ACCOUNT		
Orig value codes 1-18	$	399
" " " 19-23	$	1
" inflation	$	0
Orig estimate excl OHP	$	400
All VOs excl OHP	$	1400
Total excl OHP	$	1800
Total incl OHP	$	1908

CHECK PROGRAMME		
Orig start date	01.11.84	
Orig compl date	30.09.85	
" period	47	weeks
Extn granted	0	weeks
Revised period	0	weeks
Period remaining	0	weeks

APPENDIX 8

An example of summary sheet B

VALUATION

DEVELOPMENT PHASE: LEDBURY 6A VALUATION MONTH: NOV 84 SUMMARY B

CODE	TYPES 374/B/BB/	365/B/BB/	222/B/BB/		VMoS	V ORD	TOTAL	SUPPLY ACCRUE	SUB CON ACCRUE	BUILD. COST	TOTAL COST	DIFFERENCE
1	0	0	0		0	20	220	50	20	10	80	140
2	0	0	0		0	140	140	0	0	0	0	140
3	0	0	0		0	50	50	0	0	0	0	50
4	0	82	0		317	300	699	0	0	0	0	699
5	0	0	0		0	270	270	0	0	0	0	270
6	0	0	0		0	420	420	0	0	0	0	420
7	0	0	0		0	0	0	0	0	0	0	0
8	0	0	0		0	0	0	0	0	0	0	0
9	0	0	0		0	0	0	0	0	0	0	0
10	0	0	0		0	0	0	0	0	0	0	0
11	0	0	0		0	0	0	0	0	0	0	0
12	0	0	0		0	0	0	0	0	0	0	0
13	0	0	0		0	0	0	0	0	0	0	0
14	0	0	0		0	0	0	0	0	0	0	0
15	0	0	0		0	0	0	0	0	0	0	0
16	0	0	0		0	0	0	0	0	0	0	0
17	0	0	0		0	0	0	0	0	0	0	0
18	0	0	0		0	0	0	0	0	0	0	0
				Totals:	317	1400	1799	50	20	10	80	1719
19	0	0	0		0	0	1	0	0	0	0	1
20	0	0	0		0	0	0	0	0	0	0	0
21	0	0	0		0	0	0	0	0	0	0	0
22	0	0	0		0	0	0	0	0	0	0	0
23	0	0	0		0	0	0	0	0	0	0	0
				Inflation	0	0	320	0	0	0	0	320
				Total excluding O.H.P.	317	1400	2120	50	20	10	80	2040
				O.H.P.	0	0	569	0	0	0	0	569
				Financial Position	317	1400	2689	50	20	10	80	2609

APPENDIX 9

An example of a cost forecast/comparison

PHASE I FEBRURY 6A — COST FORECAST COMPARISON

SCHEDULE 01.000 — Inflation: 5.%

ITEM NUMBER	CURRENT PURCHASE RATE	CURRENT PURCHASE FORECAST	ESTIMATED RATE	ESTIMATE FORECAST	ESTIMATE FORECAST +% INFLATION	DIFFERENCE (ESTIMATE-FORECAST)	DIFFERENCE (EST+INFL FORECAST)
01.001	29.00	1624.	35.00	2083.	2156.	59.	532.
01.002	32.50	390.	36.50	469.	485.	79.	95.
01.003	30.00	360.	32.20	403.	418.	43.	58.
01.004	33.25	166.	30.00	158.	164.	8.	2.
01.006	35.00	35.	60.00	53.	55.	18.	.0.
01.008	0.00	0.	5.00	0.	0.	0.	0.
01.010	29.30	161.	29.00	166.	172.	5.	11.
01.011	8.00	440.	0.00	0.	0.	440.	440.
01.017	0.00	0.	2.60	1785.	1847.	1785.	184 .
01.021	0.00	0.	6.00	581.	601.	581.	601.
01.023	0.00	0.	3.50	46.	48.	46.	48.
01.027	0.00	0.	.22	18.	19.	18.	19.
01.029	0.00	0.	.10	78.	81.	78.	81.
01.033	0.00	0.	.55	479.	496.	479.	496.
01.036	0.00	0.	.01	25.	26.	25.	26.
01.038	0.00	0.	.03	16.	16.	16.	16.
01.042	0.00	0.	1.20	154.	160.	154.	160.
01.044	0.00	0.	1.40	6.	6.	6.	6.
01.046	0.00	0.	20.60	2810.	2908.	2810.	2908.
01.047	0.00	0.	2.30	334.	346.	334.	346.
TOTAL		3176.		9664.	10002.	6488.	6826.
TOTAL (-DISC.)		3176.		9254.	9592.	6078.	6416.