

**INFORMATION AND PROCESS
MODELLING FOR IT
IMPLEMENTATION AT THE
BRIEFING STAGE**

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Ph.D. Thesis

1997

INFORMATION AND PROCESS MODELLING FOR IT IMPLEMENTATION AT THE BRIEFING STAGE

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Submitted in Partial Fulfilment for
the Degree of Doctor of Philosophy,
February 1997

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LIST OF ABBREVIATIONS

Abbreviations	Meaning
AIA	American Institute of Architects
BCO	British Council of Offices
BIW	Building Information Warehouse
BRE	Building Research Establishment
BSI	British Standards Institution
CFE	Client Future Enterprise
CIG	Construction Information Gateway
CIRIA	Construction Industry Research and Information Association
CPI	Coordinated Project Information
DDL	Dynamic Document Linking
DFD	Data Flow Diagrams
DOE	Department of Environment
eLR	<i>electronic</i> Law Reports
ERD	Entity Relationship Diagram
ICE	Integrated Construction Environments
ILO	International Labour Organisation
ISO	International Organisation for Standardisation
IT	Information Technology
NBS	National Building Specifications
NEDO	National Economic Development Office
OFD	Object Flow Diagram

ORD	Object Relationship Diagram
OSH	Occupational Safety and Health
PPO	Project Participant Organisation
RGO	Related Group Organisation
RIBA	Royal Institute of British Architects
SADT	Structured Analysis and Design Technique
STEP	STandard for the Exchange of Product model data
VE	Virtual Environment
VR	Virtual Reality

ACKNOWLEDGEMENTS

Firstly, I would like to express my gratitude to Prof. Dr. Mustafa Alshawi for his invaluable advice and guidance in all aspects of the work.

I would also like to express my thanks to all the staff at the Department of Surveying and the members of the AIC Research Group for their direct or indirect contribution to the successful completion of the work.

Finally, I would like to express my appreciation for the support provided by my husband, Mustaffa Samad and the rest of my family.

Faridah Yusuf

February 1997

University of Salford

ABSTRACT

During the early stages of a construction project, clients often have difficulties in identifying and communicating their actual requirements to designers or other project participants. This is mainly due to their difficulty in comprehending the vast amount of information involved. In order to effectively address this information during the briefing process, this study has modelled such information into structured data models using EXPRESS-G technique. These data models represent a framework for the presentation of the client's brief, with the aim of establishing a computerised tool to assist both clients and designers to carry out this process effectively.

The process of developing the brief is then modelled using IDEF0 technique. A two step process modelling has been undertaken. Firstly, in the form of an abstract representation of the briefing operations deduced from literature review, and secondly, within the context of the forthcoming prototype development. The latter considers two viewpoints; system architecture of the prototype and the information to be elicited from the user.

The developed models establish the foundation for the development of a prototype which utilises an object oriented environment. The use of structured analysis techniques for the modelling process entails the relevant constructs of the developed models to be transformed into their equivalents in the object oriented environment. The implemented object oriented data models, then form the framework for the textual presentation of the client's brief. The resulting prototype is called AUTOBRIEF (AUTOMated BRIEF

development). AUTOBRIEF is a prototype for the generation of the client's brief, which provides access to project information prior to the brief generation.

The implementation of the prototype has been tested to reflect how effective it is in support of the briefing process, using IT as a tool. At the end of the study, conclusions are drawn and recommendations are made for future research.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Over the last three decades, despite a number of research projects being carried out and efforts to improve the briefing process, there is little evidence to demonstrate that briefing practice has significantly changed. As early as 1964, the Banwell report concluded that insufficient resources were dedicated towards defining project requirements (Ministry of Public Buildings and Works, 1964). More recently, the report by Sir Michael Latham (Latham, 1994), arrived at similar conclusions, i.e. on the need to improve the briefing process. Indeed, one of the recommendations made by Latham (1994) was for the preparation of a client's guide on briefing.

Meanwhile, several professional organisations and academics have also addressed the subject of briefing and the briefing process. In the main, issues of communication between clients and other project participants are highlighted (Higgin and Jessop, 1965; Graham, 1983; Rougvie, 1987; Hudson et al, 1991; Pilling, 1993; Gray et al, 1994) in order to emphasise their crucial roles in determining the eventual design, or even the success of a construction project. Checklists or guidelines for the formulation or

presentation of the client's brief have also been published (CIRIA, 1985; O'Reilly, 1987; BSI, 1995). Other publications which cover various aspects of the brief or the briefing process include those by Atkin, 1990; Salisbury, 1990; Duerk, 1993; Murray et al, 1993; Spekkink and Smits, 1993; Barrett and Stanley, 1996; Barrett et al, 1996; Hansen et al, 1996; Atkin et al, 1996, and many others.

The development of a client's brief results in the transformation of the client's perceived needs and requirements into a verbal and written expression of functional problems related to the client's business activity (Pilling, 1993). This brief will then form the basis for the production of alternative design solutions. A design solution may, to a large extent, be considered a personal and subjective interpretation of the client's requirements into a three dimensional built form. The design solution is usually one of a range of possible alternative solutions constrained by the designer's perceptions of the system boundaries which are defined by the client (Rougvie, 1987). It is imperative therefore to eliminate sources of error and confusion or uncertainty that could arise if the boundaries were to be stated in a subjective and imprecise manner. Uncertainties or deferred decisions can affect the quality, costs and programme targets for a particular project. In view of this, the communication between the parties involved plays a crucial role in determining the eventual design or even the success of a construction project.

The "Johari Window" concept has been applied by Bejder (1991) and Barrett (1993) to the briefing process to demonstrate the importance of communication and the various forms of situations that reflect the process of communication during the briefing process. Four main situations were portrayed. Firstly, where the client communicates his

requirements without difficulty to his advisers or the project participants via the “public” window. Secondly, the needs which the project participants manage to identify from the client after a two-way discussion, via the “blind” window. Thirdly, the “private” window which relates to the information which the project participants are not prepared to disclose, and finally, the “unknown” window which reflects the information not known to the client or the project participants (Figure 1.1). The Johari Window illustrates the fact that many decisions are made on an inadequate basis during the briefing process, sometimes through the “unknown” window, which might result in future changes.

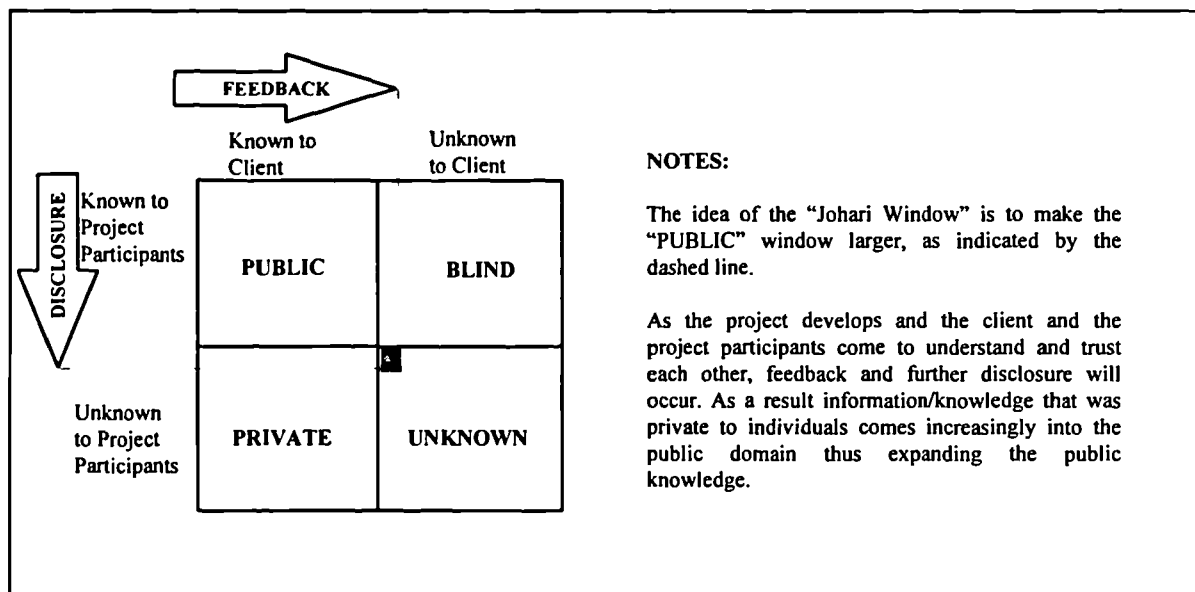


Figure 1.1: The “Johari Window”

Thus, communication can come in the form of the quality of advice provided by the project participants to the client, either during the brief development or the design stage. For communication to be effective, there should exist a level of trust and mutual respect between construction professionals and clients during the briefing process. Furthermore, the briefing process can be considered as a dialogue (Turner, 1986 and Hudson et al,

1991) or verbal communication between clients and the construction professionals, in particular, the designer. It symbolises a two-way educational process (Green, 1986) which takes place between the parties involved in a construction project. Therefore, effective communication would permit the processes of extended discussion, investigation and analysis of requirements to be achieved. This gives rise to an agreed baseline or premise suitable for secure design development. The agreed baseline then represents the essential framework for the design process, i.e. in the form of a brief.

1.2 Background

Previous studies carried out by Graham (1983), Hudson et al (1991), Barrett and Stanley, 1996, Barrett et al, 1996, and others suggests that the client's brief is often inadequate, poor or not sufficiently explicit. Besides, it may not truly represent the client's requirements. This may be due to a lack of experience on the part of the client, with respect to construction projects, or his inability to identify and convey his actual needs accurately to the design team. Another contributory factor could be the lack of mutual understanding or lack of trust and common objectives between the parties involved. Most significant, however, is the vast amount of project information that needs to be acknowledged and dealt with by one or more parties during the briefing process.

The situation can be improved by encouraging clients to participate fully during the briefing process. This can be done by increasing the client's level of awareness through effective presentation and manipulation of the project information and the associated processes. In doing so, the client's knowledge of the entire briefing process may be

enhanced considerably. Clients and other project participants will work together, both to identify a clear range of opportunities available for the development and to highlight those problems which require a solution (Gray et al, 1994). Through such discussions, a closer rapport between the parties involved, and an understanding of and sympathy for each other's objectives, will be established. On this basis, it is presumed that the communication channel between the client and other project participants, in particular the designer, will be improved significantly.

1.3 Aims of the Study

The principal aim of the research is to improve the communication channel between clients and designers, and/or other project participants. The ultimate goal is to bridge the gap between clients and the key players of a construction project.

The aim of the research can be expressed as follows:

1. to improve the client's understanding of the processes involved during the early design stage of a building project, especially during the briefing process.
2. to encourage the client to participate fully during the briefing process. This opportunity would assist him in identifying and understanding his actual needs and requirements.
3. to highlight to the client and to raise his level of awareness on issues related to the development of a construction project from as early as the briefing process.

4. to assist clients in arriving at a client's brief which reflects their requirements. This could lead to a more appropriate design solution which satisfies the client's requirements.
5. to provide an avenue for continuous professional training to clients/designers and to provide a basis for training to trainee designers/architects.

1.4 The Objectives of the Research

The objectives of the research are summarised as follows:

1. To examine the briefing process that takes place during the early design stage of a building project.
2. To examine and review available publications and guidelines to the contents of the brief for building projects
3. To identify and accumulate the required information which can produce an comprehensive client's brief for a building project
4. To examine, analyse, classify and organise the above information using information modelling techniques. This aims to :

- identify the specific items of information which are required at every stage of the brief development process
 - identify the relationships between specific items of information
5. To develop a set of information models which will portray the information required for inclusion in the client's brief. The most suitable information modelling technique will be identified through a thorough comparison of the various techniques available.
 6. To model the processes that transpire during the development of a brief. The most suitable process modelling technique will be identified through a thorough comparison of the various techniques available.
 7. To link the information and process models in order to establish a conceptual model for an object oriented computer environment. The conceptual model would serve as an architecture for an information system prototype for the development of the client's brief. The aims and objectives of the prototype development will be described in section 1.4.1.
 8. To map the information and process models into an object oriented environment development tool to achieve the above objective.
 9. To incorporate an integrated concept into the development of the above prototype system to accommodate future concurrent engineering and to allow for integration with other research being conducted within the university.

10. To draw conclusions and to give recommendations for further research.

1.4.1 Aims and Objectives of the Prototype

The principal aim of the prototype is to generate a documented brief for the client and to provide easy access to project and relevant construction industry related information.

The prototype will also aim to demonstrate the viability of the developed information and process models for the client's brief.

In order to achieve this, the main objectives for the prototype are to:

1. Assist designers in the design process in order to:

- obtain and interpret the client's requirements
- resolve conflicts between the client's requirements, i.e. ensure that the client's requirements do not contradict each other and that they are compatible, for example, in terms of compliance with regulations
- advise the client on technical issues, e.g. regulatory issues, design and performance requirements, as well as other related construction industry know-how, such as technical product data for specific materials
- enable designers to link the prototype to existing or future Integrated Construction Environments (ICE), where facilities will be available which allow them to visualise and document the design implications on costs and time, and to examine the implications of a particular set of client requirements on construction.

2. Present relevant information to the client in the most appropriate format and medium, and in a timely and efficient manner using the support of multimedia technology.

Such information could include:

- instructions or explanations in the form of recorded audio and text
- regulatory issues, e.g. Building Regulations, Laws and British Standards and Codes
- on-line product information in the form of manufacturer's or supplier's technical product data, product specifications, photographic images or graphical portrayal of design details for specific materials and/or construction technology

3. Generate the client's brief. The generated brief should:

- reflect the client's actual requirements
- be clear, consistent, organised and coherent enough to be easily understood in order to facilitate the process of design interpretation by designers and/or other project participants.
- be presented in a format that is appropriate for the construction industry

1.5 Research Outline

The difficulty in comprehending the vast amount of information involved in a construction project, often leads clients to experience difficulties in identifying and communicating their actual requirements to designers or other project participants. In

order to enable this amount of information to be effectively addressed and imparted to clients during the briefing process, this study has modelled such information into structured information models using the EXPRESS-G technique. These information models represent a framework for the presentation of the client's brief.

The process of developing the brief is examined. This entails the modelling of the processes involved using the IDEF0 technique. A two step modelling process has been undertaken. Firstly, the processes have been modelled in the form of an abstract representation of the briefing practice deduced from the literature review, and secondly, in the context of the forthcoming development of the information system prototype. The latter considers two viewpoints: the system architecture of the prototype and the information to be elicited from the user.

The developed information and process models establish the foundation for the development of an information system prototype using an object oriented environment. Since structured analysis methods have been adopted for the modelling process, the implementation into the object oriented environment entails the transformation of the relevant constructs, or components, of the developed models into their equivalent in the object oriented environment.

The selected information and process modelling techniques have proved to be very effective in this translation process. The mapping into the object oriented environment was conducted with relative ease. These object oriented data models form the framework for the textual presentation of the client's brief, along with the presentation

of project or construction industry related information. This has led to the development of an information system prototype for the generation of the client's brief and for the presentation of project information prior to the brief generation.

1.6 Scope of the Research

This research will focus on the vast amount of project information required for the development of the client's brief during the early design stage of a construction project. The main sources of information include currently available publications and guidelines relevant to the briefing process and to the development of the client's brief.

The way in which clients select the route for the overall management of a project is referred to as the procurement system. Such systems include traditional, management contracting, design and build, and project management. The procurement system selected by clients to implement their building projects can influence the success of the design and construction process (Masterman, 1992). However, the scope of this research does not include this aspect. This research takes the view that the modelling of information required for brief formulation would be applicable to all types of building procurement systems.

In addition, the scope of the prototype development has been limited to office buildings only. Further, the development of the prototype will focus on certain aspects of the design and performance requirements only. These aspects cover the client's requirements with respect to the overall appearance and function of the building as a whole, the space requirements within the building and the associated activities to be

performed within them. A limited number of wall cladding systems which form part of the external envelope of the building are also considered. The prototype will also include the identification of the project and parts of the aims, resources and context of the project. However, the scope of the research and the prototype does not extend beyond the development of the brief. In other words, it does not encompass the development of a design solution based on the generated brief.

Because the system is only a prototype, the databases and presentation of information are limited. A small number of options will be presented to the system's users in terms of identifying and selecting the client's requirements. The incorporation of images and multimedia techniques will also be limited, and the users of the system will be provided with access to a limited number of external information resources. Nevertheless, the development of the prototype will take into account the applicability of the system in terms of achieving its main aims and objectives.

The implementation of the prototype will be subjected to a limited testing procedure, chiefly to demonstrate its effectiveness in supporting the briefing process using IT as a tool. At the end of the study, conclusions will be drawn and recommendations will be made for future work.

1.7 Guide to Thesis Contents

This section presents the structure of the thesis and the contents of each chapter. The thesis has been divided into twelve chapters as follows:

Chapter 1

This chapter introduces the reader to the background of the research, the aims and objectives of the research, the research outline, its scope, and the contents of the thesis.

Chapter 2

The concepts of the brief and the briefing process based on current practices conducted within the construction industry are presented in this chapter. The problems encountered during the briefing process are highlighted, and ways to improve/facilitate the briefing process are proposed.

Chapter 3

This chapter examines current publications and guidelines relevant to the formulation of the client's brief. Six main sources of information have been identified. These are examined, compared and contrasted. A structured framework for the presentation of the brief is proposed, which will aid the information modelling process.

Chapter 4

In this chapter, a number of research findings which relate to the briefing process are examined, together with a number of electronic databases on CD-ROMs, visual information databases and the use of the internet as a means of transmitting and accessing information. These serve to demonstrate the role of information technology in support of the briefing process.

Chapter 5

This chapter investigates the various techniques available for organising project information. A number of information and process modelling techniques are examined and the most suitable is identified for modelling the information required for the brief development. The most appropriate process modelling technique is also identified for modelling the processes that take place during the development of the brief.

Chapter 6

A full analysis of the information required for the presentation of the client's brief is presented in this chapter. The modelling of the information and the decomposition of the information at various levels of detail are portrayed. The items of information, their relationships and properties or attributes are highlighted. These constructs form the information models for the presentation of the brief.

Chapter 7

This chapter presents the process analysis of the development of the brief. Firstly, the processes involved during the development of the brief are modelled within the context of an abstract portrayal of briefing practices within the construction industry. The process is then re-modelled within the context of the proposed prototype system, with two viewpoints: the first is based on the system architecture of the forthcoming prototype, while the second is based on the process of obtaining the information required for inclusion in the brief.

Chapter 8

This chapter discusses the implementation of the information and process-models into the object oriented environment. It begins by emphasising the need to link the information and process models prior to the implementation process. The object oriented environment to be used for the prototype development is then presented, followed by the translation of the relevant constructs in the information models into objects in the object structure representation. It then describes the inclusion of attributes attached to the relevant objects. The reasoning and behaviour capability of the object oriented environment is presented, followed by the translation of the process models into object methods in the object oriented environment.

Chapter 9

This chapter highlights the system architecture of the “AUTOBRIEF” prototype. It describes the functions to be performed by each component of the system architecture, the development of the user interface, and how the external resources are linked to the object oriented environment. Finally, it describes the real time integration of the prototype with external resources.

Chapter 10

The running prototype is demonstrated here, with the aid of screen dumps. The main screens are described. The system’s main operations are presented with reference to the system’s two modes; “consultation” mode, which refers to the process of identifying and obtaining suitable client’s requirements, and the “generate brief” mode, which

generates the brief, and displays the generated brief in the object oriented environment or a selected word processing application.

Chapter 11

This chapter describes the limited testing procedure to which the developed prototype was subjected. The testing procedure was aimed towards evaluating the overall conceptual approach of the prototype implementation and its flexibility for future development, as well as to ascertain the usability and applicability of the prototype.

Chapter 12

In this chapter, the research work conducted for this study is summarised. The main conclusions derived from the study are drawn, followed by recommendations for future development.

CHAPTER 2

THE BRIEFING PROCESS

2.1 Introduction

The planning, design and management of our physical environment normally affects the behaviour, performance and satisfaction of individuals, groups and whole organisations, who end up as users of the built environment. Careful planning or the lack of it ultimately leads to creditable benefits or avoidable costs, or possibly both, to clients and users, of the built environment. To avoid failure to meet financial and programme targets, not only in terms of the completed built environment, but also throughout the life cycle of the project, it is useful to conduct a 'design research' prior to the design process.

During this period, a disciplined process is carried out which includes data elicitation, collection, analysis and organisation of information enabling all the factors influencing the proposed environment to be explored. The requirements of the users and the entire organisation are examined in terms of their functions as well as any other associated characteristics, such as economics, symbols, etc. The 'design research' also focuses on the important design issues which ultimately makes the project participants more

resourceful. The 'research' provides "a set of explanations for suggestions" (Duerk, 1993). It should investigate why certain requirements are selected and which of these selected requirements are priorities. This 'design research' can be referred to as the briefing process. In fact, this has been put forward by Zeisel (1981), who refers to the briefing process as a research activity in that the objectives are those of enquiry. The product of this design research is the 'brief'. In fact, it has been increasingly recognised that the brief plays a crucial role in achieving high quality and value for money of the completed building.

This chapter presents the briefing process, its problems and its output, the brief. It explains the problems of current briefing practices and suggests ways to improve or facilitate the briefing process. It begins by outlining the briefing process as part of the overall life cycle of a construction project, followed by an overview of the project participants usually involved during the briefing process.

2.2 Briefing as a Phase in the Life Cycle of a Construction Project

The life cycle of a construction project has been categorised into stages from inception to completion, and beyond. Harvey and Ashworth (1993) separates the development cycle of a construction project into five stages. They are Inception, Design, Construction Project Planning, In-use and Demolition. Atkin (1990) divides it into five phases, comprising: Project Initiation, Design Development and Documentation, Construction, Commissioning and Operations and Maintenance. The conventional Plan of Work contained in RIBA (1967), on the other hand, classifies the cycle of work into 12 stages, from A to M. The stages are:

- A. Inception and B. Feasibility (termed as Briefing)
- C. Outline Proposals and D. Scheme Design (termed as Sketch Plans)
- E. Detail Design, F. Production Information, G. Bills of Quantities and H. Tender Action (termed as Working Drawings)
- J. Project Planning, K. Operations on Site and L. Completion (termed as Site Operations)
- M. Feedback

Gray et al (1994) has redefined the above stages to suit “design management plan of work”. Stage A is termed the “Brief”, Stages B, C and D have been designated as “Concept design, Feasibility studies, Scheme Design”, Stages E, F and G have been referred to as “Engineering”, Stages H and J have been called as “Procurement”, while Stage K is termed “Construction” and Stage L is referred to as “Commissioning and handover”.

The above has listed just a few from an extensive list of methods of categorising the life cycle of a construction project. It can be seen that the stages may vary or overlap each other. What is common though is the point in time at which briefing comes into the overall process. The “Brief” phase is considered as part of the “Inception” stage of Harvey and Ashworth’s (1993) and a main activity of Gray et al’s (1994). Atkin (1990) uses the term “Project Initiation” to include briefing while RIBA (1967) identifies Stages A and B as “Briefing”. This observation indicates that the briefing process is best practised prior to the initiation of the design stage. This is supported by the American

Institute of Architects (AIA) Design Process (Duerk, 1993) which places “Programming” (the term used for “Briefing” in U.S.) as part of the “Pre-Design” stage.

2.3 The Project Participants

The following briefly describes the project participants who may be involved during the briefing process.

2.3.1 Clients

Clients range from private individuals, partnerships, special organisations, central government to consortia of local authorities, special public corporations, companies or groups of companies, housing associations or trusts and many more (Greenstreet, 1989).

It is the clients who initiate, commission and finance any particular construction project.

Clients are thus the core of the construction industry.

Various classifications have been put forward to distinguish clients. Amongst these are:

- Experienced versus inexperienced (or sophisticated versus naive (Higgin and Jessop, 1965)) - depending on the client’s previous experience of the building process
- Continuing versus one-off (Hillebrandt, 1984) - Continuing clients are those actively involved in repetitive developments as opposed to one-off clients who may be involved with only one project. One-off clients are synonymous with inexperienced clients.
- Primary versus secondary (Nahapeit and Nahapeit, 1985) - Primary clients are those whose main income is derived from constructing buildings, e.g. property developers.

Secondary clients are those who build in order to perform some other business activity, such as retailing.

- Public sector versus private sector (Hillebrandt, 1984; Forster, 1986) or individual clients, public clients versus corporation (Rougvie, 1987) - Individual clients can be referred to as private individuals. Public clients or public sector clients refer to governing bodies, such as the central government and local authorities. Private sector clients refer to private individuals, organisations or corporations. Organisation clients tend to view architectural production from a purely rational and instrumental perspective (Gutman, 1988), i.e. they regard buildings as capital assets, which should be managed like any other potential source of productivity, income and profit, e.g. in terms of maintenance costs and resale value.
- unitary versus multifaceted (pluralistic) (Cherns and Bryant, 1984; Green, 1996) - depending on the social complexity of a client organisation. Multi-faceted clients refer to client organisations which comprise various interest groups, such as different departments or even a consortium of different organisations or public bodies, each with differing objectives and its own social or cultural complexity. Unitary clients are therefore those with only one main interest group with a set of specific objectives.

The client may represent himself or provide his own management team, or an appointed or designated representative to manage the project on his behalf or to work directly with others appointed (RIBA, 1991). To ensure smooth collaboration which is necessary for the design team to progress effectively, the representatives should be vested with adequate power to make appropriate decisions. During the briefing process, the client or

his/her representatives are expected to play the key role in identifying and communicating the client's needs and requirements to the design team.

2.3.2 Designers

A designer is the one responsible for some aspect of the design of the works which may include the architect, engineer, specialist consultant or contractor (Davis Langdon Consultancy, 1996). Harvey and Ashworth (1993) classifies designers into four categories depending on the type of the project or the procurement route:

- Building projects - generally the architect is normally the first point of contact with the client
- Engineering projects - civil engineering consultants
- Smaller works and schemes of refurbishment - building surveyor is usually the client's main advisor on design aspects
- Design and build or management contracting - Clients either appoint the consultant firm direct, choose an alternative consultant as a main partner in the venture/project, or appoint a project manager to be in charge of the overall scheme.

During the briefing process, the designer is chiefly expected to capture the client's true requirements to ensure that the design solution meets the actual needs of the client.

2.3.3 The Quantity Surveyor

The quantity surveyor may act as the client's advisor, or as part of the design team. In either case, the quantity surveyor is responsible for cost control. His/her role is to advise the client of the cost aspects during the briefing and design stages and to check

expenditure throughout the construction stage. The quantity surveyor ensures that none of the project participants overlooks the financial implications of their ideas or actions.

2.3.4 Other Consultants

Other consultants include:

Structural Engineer: responsible for the design of the building structure

Services Engineer: responsible for the design of the building services

Specialist consultants: e.g. for interior designing, lighting, acoustics, landscaping, planning, etc.

2.3.5 The Design Team

The design team normally comprises four professions: architect, quantity surveyor, structural engineer and services engineer. Others may also contribute to the design process depending on the nature of the project. These may include specialist consultants. During the briefing process, the whole or particular members of the design team collaborate with the client and/or his/her representatives to arrive at a definitive statement which expresses the client's true needs in the form of a brief.

2.4 The Briefing Process

2.4.1 Briefing

The term *briefing* is used rather loosely and in different ways by different stakeholders of the construction industry. The following differentiates between two of its uses:

1. **Briefing** as a stage or stages in the design or construction process, or as part of the overall life cycle of the project as described in section 2.2. For example, the Royal Institute of British Architects (RIBA, 1967; RIBA, 1991) classifies Stages A (Inception) and B (Feasibility) of the RIBA Plan of Work (1967) as Briefing. Blyth et al (1996), on the other hand, suggests that the briefing process lasts throughout the project, which is divided into three main stages: pre-project, project and post-project. During the pre-project and project stages, the needs are identified and the approaches are explored, while in the post-project stage, the result is analysed against the original identified need.

2. **Briefing** as a systematic method of enquiry or process by which client's requirements are made explicit. It is the process of eliciting or "brief-taking" (Barrett and Stanley, 1996) the information or requirements from clients. Briefing can be best expressed by the definition used by the British Standards Institution (BSI, 1995), which defines *briefing* as a process of identifying and analysing the needs, aims and constraints (the resources and the context) of the client and the relevant parties, and formulating any problems that the designer is required to solve. Briefing can therefore be considered as the problem definition (Duerk, 1993), or the "*problem seeking*" phase, as opposed to design, which is referred to as the "*problem solving*" phase (Pena, 1987). In the US, the term *programming* (e.g. Pena, 1987; Duerk, 1993; Palmer, 1981) is widely used instead of the UK's briefing terminology. In fact, "Programming" is considered as part of the "Pre-design" stage of the American Institute of Architects (AIA) Design Process. The terms architectural programming (Duerk, 1993) or facility programming (Palmer, 1981) are used instead of briefing. By virtue of the above definitions, briefing, or programming, therefore, involves the gathering, organising, analysing, identifying,

interpreting, compiling, and documenting or presenting all the information required for a construction project. For the purpose of this research, this second usage of *briefing* has been adopted, and the *brief* is considered as the output of the briefing process.

2.4.2 The Brief

The brief documents the client's aspirations in terms of his/her real need and feasibility within overall budgetary constraints. The *brief*, sometimes termed the *client's brief*, is a definitive written statement or working document prepared during the briefing process, which sets out the client's requirements for a construction project (a new building, renovations/refurbishment, changes to layout, etc.). It specifies at any point in time the relevant needs and aims, the resources of the client and user, the context of the project, and any appropriate design requirements within which all subsequent briefing and designing can take place (BSI, 1995). A good brief is one which creates a functional basis for design, i.e. one which produces a pragmatic foundation to design information. There is a clear understanding of all the constraints for the project, together with the quality of the desired solution (Duerk, 1993). Getting the brief right is therefore crucial for the effective delivery of a construction project (Latham, 1994).

Latham (1994) identifies two categories within the brief: *the outline brief* and the *design brief*. The *outline brief* or *strategic brief* (Davis Langdon Consultancy, 1996; Blyth, 1996) specifies the basic objectives of the client. It represents a clear and accepted statement of the client's strategic objectives (Green, 1996) which can include the scope and purpose of project, with key parameters including overall budget and programme (Davis Langdon Consultancy, 1996). The *design brief*, however, defines the client's

specific requirements. It contains everything a designer and/or engineer needs to know about a client's proposed project (Hansen et al, 1996). The definition used by Murray et al (1993) and supported by Hansen et al (1996) defines the design brief as "a communication process between a client organisation and construction professional to produce a statement from which a facility which satisfies the client's requirements can be produced".

On some large projects there may be more than one brief, each representing a particular aspect of the brief in detail. They include functional brief, financial brief, facility management brief and implementation brief (Atkin, 1990; Atkin et al, 1996). These are defined as follows:

Functional brief: a statement of spatial needs, services, quality of finishes, etc.

Financial brief: the financial parameters within which the project must perform

Facility management brief: directed towards the subsequent operation and maintenance of the building

Implementation brief: setting out the policy of design, procurement, construction contracts, master development programme and the information management requirements.

Spekkink and Smits (1993), on the other hand, divides the development of a "project-oriented client's brief" into phases. Indicated below are the phases and the corresponding outputs:

<u>Phase</u>	<u>Terminology</u>	<u>Output of each phase</u>
Phase 1	Initiative	Global brief
Phase 2	Feasibility study	Feasibility
Phase 3	Project definition	Basic brief
Phase 4	Structural plan phase	Brief for the provisional plan
Phase 5	Provisional plan phase	Brief for the definitive plan
Phase 6	Definitive plan phase	Definitive brief
Phase 7	Specification phase	Final specifications

According to Spekkink and Smits (1993), the client's brief is developed in phases from "rough to fine" together with the plan. In such a case, the brief contains, prior to each planning phase, the minimum amount of information which is necessary to be able to direct the plan in that phase. This introduces a strong connection between the development of the brief and the plan. While this approach is quite useful for the design and build procurement method, it is, however, indirectly promoting the stage controlled approach.

Best practice suggests that the brief should be prepared once the procurement route has been decided upon in principle and roughly how much risk and direct involvement should be accepted. This research, nonetheless, takes the view of the brief as the integration of both the outline and the design brief, which also encompasses Atkin's four briefs, excluding the procurement and construction contract. These two factors have been excluded to support the view that a good and adequate brief can be developed irrespective of the method of procurement, and that the same briefing problems occur

irrespective of procurement route. The outcome is thus a brief which is comprehensive and coherent, and encompasses all the client's strategic objectives (Duerk, 1993; Latham, 1994; Green, 1996) and organisation metaphors (Green, 1996), as well as the client's and users' requirements. The brief, therefore, not only serves as the repository of all the relevant factual materials with regard to the construction project, but also documents decisions about the scope and direction of the project (Duerk, 1993).

2.5 Problems of the Briefing Process

During the briefing process, the project participants often misunderstand each other about how the proposed building is to be used and designed. The client specifically misunderstands the intention of the designer and more crucially, the designer, misunderstands the needs, requirements and values of the client and the building's users. Contractual disputes arise all too often as a result of these misunderstandings, or due to incorrect or insufficient information being made available to both parties. Therefore, the development of the brief serves as a tool for communicating both the intentions of the client and the design team. However, previous studies suggests that the client's brief is often inadequate, poor or not sufficiently explicit (Newman et al, 1981; Graham, 1983; Atkin, 1990; Hudson et al, 1991). On numerous occasions, the brief does not truly represent the client's requirements. This indicates a breakdown in communication at one point or another. This gap in the communication channel may be due to a lack of experience on the part of the client with respect to construction projects, or his inability to identify and convey his actual needs accurately to the designer. Another contributory factor could be the lack of mutual understanding or lack of trust and common objectives between the parties involved. Client's organisations are often multi-faceted in nature,

comprising several different interest groups whose objectives differ and may well be in conflict (Cherns and Bryant, 1984; Green, 1996).

Another factor that contributes to problems during the briefing process is the tendency of designers to rely on their previous experience. This represents the level of knowledge or preference of the designers and other project participants in developing the brief. Construction professionals tend to act in accordance with a pre-determined set of assumptions or rules, and a fixed course of action which has been acquired from previous experience (Gammon, 1992; Green, 1996; Barrett and Stanley, 1996). This factor varies between individuals or design teams, depending on their own set of conduct which form the basis of their preference. This ultimately leads to varying ways of conducting the briefing process as well as a non-standardised way of formulating and presenting the brief. Green (1996) went further to illustrate that this “concept of ‘default’ paradigm” to such an extent explains why practitioners who are used to working with “unitary” (individual) clients often find it difficult to adjust to “pluralistic” clients (multi-faceted client organisations).

Most significant, however, is the vast amount of project information that needs to be acknowledged and dealt with by one or more parties of a construction project during the briefing process. Difficulty in identifying and accessing this information often leads to poor interpretation of the client’s needs which consequently results in ill-defined briefs. Furthermore, the information required for the development of the brief not only covers the brief domain specifically, but also encompasses all the information related to the construction industry in general. This information which can be referred to as

“construction industry know-how” or “supporting information” covers aspects like technical product data, new or innovative construction technology, availability of specific materials and many others. The lack of such information or refusal to acknowledge this as part of the information gathering or analysis stage by the designer can lead to an inadequate brief.

2.6 Improving/Facilitating the Briefing Process

Research has been carried out on the briefing process and the consequences of inadequate briefs. The most frequently cited causes stem from the lack of communication between clients and designers, which leads to poor scope definition and inaccurate identification of client’s requirements.

Several proposals have been made to improve or facilitate the briefing process, or to create best practice amongst project participants. These can be summarised as follows:

1. Encourage clients’ participation

The lack of communication between clients and other project participants can be improved by encouraging clients to participate fully or to a greater extent during the briefing process. Clients should be encouraged to recognise the positive and sustained contribution they have to make if buildings of excellence are to be the norm rather than the exception (Blackmore, 1990). Hence, the wide gap of understanding and confidence between clients and users, and the construction industry need to be bridged. Professionals involved in a construction project should work *with* clients, and not, simply *for* clients (Green, 1996). Therefore, by extensive collaboration

between clients and the project participants (Goodacre et al, 1982; Bennett, 1985; Gameson, 1991), in particular the designers, the needs and objectives of the clients can be explored in depth. The adequate articulation and analysis of a client's requirements together with rigorous evaluation of available options (Atkin et al, 1996) is the key to successful briefing. Successful briefing in turn, paves the way for successful design development.

2. Educate or inform inexperienced clients

Inexperienced clients (involved in one-off projects) often come to the designer or a chosen consultant with a broad outline of their aspirations, a budget which is often insufficient and a time scale for occupation which is often impossible (Harvey and Ashworth, 1993). It has also been widely observed that such clients are often unable to articulate their requirements until they have been exposed to a range of initial design concepts (Goodacre et al, 1982; Murray et al, 1993, Green, 1996). This can be done by increasing the client's level of awareness through effective presentation and manipulation of project specific and supporting information, along with the relationships between items of information and the associated processes. In doing so, the client's knowledge of the entire briefing process may be enhanced considerably.

3. Understand the client organisation

Designers should understand the individual clients or client organisations for which they work. In the case of client organisations, it is often necessary to accept that there will never be a single interpretation of requirements (Green, 1996) due to differing objectives between all the interested groups. This calls for the designers to

understand the characteristics of the client organisation, as well as the ways in which the client makes sense of his organisation. There is a need therefore to create a balance between all the conflicting priorities and arrive at some form of compromise and understanding. With such an understanding, designers and clients (or client organisations) will be able to work together, both to identify a clear range of opportunities available for the development and to highlight those problems which require a solution (Gray et al, 1994). Through such discussions, a closer rapport between the parties involved, and an understanding of and sympathy for each other's objectives, will be established.

4. Briefing as an iterative process

Briefing should be an iterative process. Often there are loops in the briefing process where for several reasons it may be necessary to return to, and adjust an earlier brief (Atkin, 1990). This allows a new, revised or unplanned condition or requirement to be accommodated at a later stage in the briefing process. For this reason, adequate time must be allowed for the evolution of the brief (Pena et al, 1987). Designers should not assume that clients already know what their requirements are.

5. Formulation of the brief and its contents

Various guidelines to the formulation and contents of the brief exist within the construction industry. In any form, the concepts within the brief should be kept generic and abstract so that the alternatives for a concrete solution are not limited during the design process. The performance requirements can be developed as measurable statements of functions, this way they will serve as the yardsticks for

evaluating the design in both its early and final forms (Duerk, 1993).

6. The case of the standard brief

The approach adopted by clients who are repetitive developers or those involved in frequent capital development have been highlighted by Bennett (1985), Harvey and Ashworth (1993), Gray et al (1994) and Green (1996). Such clients are able to develop standard briefs which can be presented to designers at the time of their appointment. These standard briefs reflect a very clear statement of their needs for specific building uses, the completed built and work environment, use of space and quality standards. They can include experience, guidance and lessons learned from previous projects. In such cases, “the underlying philosophy was one of continuous improvement by means of ‘responsible innovation’” (Green, 1996). This practice of developing standard briefs coupled with a commitment to a continuous development programme, to a large extent, has also been adopted by supermarket and chainstore developers (NEDO, 1988). If this is extended further to cover other clients, substantial benefits could be gained in terms of the impact of the standard brief on construction costs, construction time as well as investment value (if relevant).

Although the above could be desirable for developer clients, the opposite may be true for owner-occupier clients. These clients are not primarily motivated by a building’s exchange value (Green, 1996). For them, value for money in terms of how the design or building accommodates the activities of the client organisation (or use value) is of more importance. The success of a project is not only measured in terms of time and

cost. Issues of building performance during use (or post occupation period) has emerged as one of the main criteria for project evaluation.

7. Dealing with concurrent brief development

Depending on the size and complexity of the building and the method of procurement adopted for the project, there may be some overlap between the development of the brief and design. If such is the case then the matters affected should be agreed upon and settled by all parties concerned at the earliest possible time. Communication and collaboration between the project participants plays a crucial role in ensuring the success of the project.

8. Use of IT in the briefing process

Information technology (IT) may be utilised throughout or during certain stages of the briefing process. During the elicitation process of the client's needs and requirements, IT may be used to present supporting information to clients as a way of educating and informing them, with the aim of assisting them to identify and recognise their requirements accurately. During the brief formulation stage IT may be used as the tool for analysing, classifying and compiling the contents of the brief. Essentially, the use of IT during the briefing process serves as a tool for data capture, analysis, manipulation, synthesis, communication and presentation of specific information (Atkin et al, 1996). Due to the iterative nature of the briefing and design processes the development of the brief and design may overlap. In such cases, various IT tools can be utilised not only for the brief development process but also for effective presentations of alternative design solutions.

9. Improved presentation and manipulation of information

During the briefing process, improved presentation and manipulation of information with respect to a specific project and the construction industry as a whole can be achieved by structuring the relevant information in such a way as to enable existing technologies to manipulate the information quickly and effectively. This research proposes the following strategies to accomplish the above:

- model the information required for brief development (discussed in Chapter 6)
- model the processes involved during brief development (discussed in Chapter 7)
- develop a prototype to demonstrate the effectiveness of an IT environment for brief development and information presentation (discussed in Chapters 9 and 10)

On the basis of the above proposals, it is envisaged that the communication channel between clients and other project participants, in particular, the designer will be improved significantly. This would lead to improved productivity and quality of both the service provided by the design team to the client, and the end-product.

2.6.1 Proposed Steps for Developing the Brief

Three approaches can be applied to the process of developing the brief, i.e. using pragmatism, empiricism and structuralism.

The first approach includes the following steps:

1. Identify and define the problem
2. Formulate alternative actions
3. Select an action
4. Evaluate the consequences of the action
5. Identify general findings

The second approach involves the following steps:

1. Collect and classify information into relevant categories.
2. Formulate potential feasible solutions to the problem based upon information gathered.
3. Judge by the use of criteria which of the feasible solutions most clearly satisfies the client's requirements.

The third approach, which uses structuralism, implies a process based upon pattern analysis. The steps are:

1. Observe the field
2. Form categories
3. Arrange typologies, hierarchies, and matrices and develop taxonomies.

The first approach is generic and is applicable to every single activity carried out by an individual. It creates discipline in the individual. In the context of the brief development process, the approach encourages the person or organisation responsible for developing the brief to be systematic in their approach. The second approach can be applied to the

briefing process during the elicitation of the client requirements. In this instance, the requirements of the client require identification and interpretation. This information once collected and classified needs to be formulated to establish the client's true requirements. Formulation involves clarification, resolving conflicts between requirements and identifying feasible solutions to the problem, such as making suitable recommendations, based on information gathered. Using appropriate criteria, the feasible solutions can be judged to arrive at one which truly reflect the client's requirements within the constraints imposed by the internal or external factors. These two approaches are combined together in the form of a process model which describes the process of developing the brief. The developed process models are presented in Chapter 7.

The third approach encourages the organisation of information into some form of taxonomy. In other words, the modelling of the gathered information. Within the brief context, this implies that the information required for the development of the brief, or the brief domain, should be modelled to give a portrayal of not only, the categorisation or classification of information, the hierarchical concept between information items but also the links or relationships between these items of information. The resulting modelling process using the selected modelling technique and the developed information models are presented in Chapter 6.

By integrating all the three approaches to represent or portray the brief development process, along with the information required for the brief, a more comprehensive brief

document is accomplished, which not only, has been systematically prepared but also reflects the client's requirements.

2.7 Summary and Conclusions

This chapter has discussed the briefing process as part of the life cycle of a construction project. It has highlighted the project participants involved, the terminologies used and the problem encountered during the briefing process. Proposals have been made to improve/facilitate the briefing process together with the steps to be undertaken while developing the brief.

Developing a brief prior to or during the early design stage, saves time and effort in the design process. Some of the benefits that can be gained from the client's active participation in the brief development process include:

- Clients appreciate the need for briefing and the extent of work that the project participants have to put into in order to establish the clients' aspirations.
- Clients become knowledgeable in terms of the information required for the briefing process and the processes involved.
- Clients become more resourceful, sensitive and knowledgeable due to an increased understanding of themselves and what they really need from their environments. Clients learn to identify and express their needs in a structured way. They become aware of their responsibilities in the decision making process, and the implications of changing their minds once their expectations have been agreed.
- The client and the designer work together to develop a set of jointly-agreed expectations about what the new environments should accomplish. During the

process, the client gain insights about his true needs and expectations, which enables him to be a much wiser user of the new built environment.

- Once the project is completed and the building is occupied, the contents of the brief can form a basis for an evaluation of how well the new built environment performs.

This evaluation permits:

- improvement of the new environment to suit any changing needs of the user and to maintain a good fit for purpose, i.e. between the environment and the users' needs. If this evaluation is conducted on a regular basis, e.g. annually, it could assist design to become a continuous learning process.
- based on the user and occupation analysis of buildings of specific type and nature, comparisons can be made, and compiled for use in lessons learned analysis, for future brief development process.

The preparation of an 'ideal' brief, encompassing all the essential project information is the ultimate aim of the briefing process. However, such a comprehensive brief will not be able to rule out the possibility of subsequent future changes in user requirements: even the most researched brief contains the possibility for errors and omissions. Clearly though, it provides for consideration and analysis of the anticipated project from the earliest possible time. It encourages discipline amongst the participants who collaborate together in full knowledge of the boundaries within which they are operating. If necessary, it allows changes to be introduced in a controlled and decisive manner, permitting their implications to be assessed against stated client objectives (NEDO, 1975). It removes a large amount of uncertainty from a project since all the parameters

of a project are addressed at a very early stage and it results in an improved client/designer relationship due to the increased degree of client involvement during the briefing process.

CHAPTER 3

CURRENT GUIDELINES TO BRIEF FORMULATION

3.1 Introduction

There have been great efforts to improve the briefing process and the formulation of the brief. This research takes the view that the various publications or sources of information which are currently available within the construction industry contain valuable information or knowledge. If this information is examined thoroughly, analysed and considered in a systematic manner, it would provide a vital source of information for formulating a good brief. It is with this notion in mind that the approach of reviewing sources of information relevant to the construction industry in general, and specifically to the brief domain, has been adopted.

This chapter examines selected documents which define or support the briefing process and the development of the brief and reviews selected materials within these documents. Such documents include Gray et al (1994), O'Reilly (1987), BCO (1994), BSI (1995), Duerk (1993) and CIRIA (1985). The review of each of the above is

followed by a comparison and analysis. The chapter ends with the summary and conclusions.

3.2 “The Successful Management of Design”

The “Successful Management of Design” (Gray et al, 1994) is a practical handbook which examines the design process. The main objective of the handbook is to help improve the efficiency of the design process and its integration with construction procedures. The handbook is divided into two parts, the first of which relates to “understanding the design process” and the second, “managing the design process”. The process of design and construction is divided into four stages to accommodate four “key sign-off points” needed from the client. These are:

- the approval of the functional brief
- the approval of the scheme design
- the completion of engineering design and the placing of contracts
- the final acceptance and handover of the completed project

To suit the above disciplined regime of signing-off which reflects the stages of management, Gray et al (1994) present a design management plan of work, outlined in Chapter 2. This plan of work considers the “Brief” stage as the first work stage, i.e. for the “approval of functional brief”. This work stage is equivalent to the Inception stage of the RIBA Plan of Work (RIBA, 1967; RIBA, 1991).

To examine further the briefing process, the chapter on “defining the tasks” within each stage of the design work, in particular, is reviewed. The briefing process comprises

three stages, namely: preparing the 'statement of need', confirming the need, and preparing the 'functional brief'. The 'statement of need' establishes the extent of and relationship between all the various activities and functions that need to be accommodated in the building. Confirming the need calls for a thorough examination of the 'statement of need' to ensure viability of the project. Once a formal 'statement of need' has been approved it is translated into a "well-researched comprehensive 'functional brief' which truly represents the client's needs" (Gray et al, 1994). Indeed, these are the characteristics of the brief which are being promoted and advocated by this study.

The handbook also provides checklists of information to be included in the 'statement of need' and the 'functional brief'. The former is found to be particularly useful in establishing the factors related to the intended occupancy of the building in relation to the activities and functions to be accommodated within the building. The checklist enables the relationships between these activities and their related properties to be identified and used during the information modelling process (Chapter 6). The checklist of information to be included in the statement of need is reproduced in Table 3.1.

While these checklists may be useful and contain relevant information for certain aspects of the development of the brief, they remain mere guidelines in that they provide headings or lists of items to be included in the brief. Some of these items are rather vague or general and could be interpreted differently by different people. However, if such items were further decomposed into their constituents, with each item being precisely defined, the checklist would indeed form a basis for the production of the

1 Activities and functions For each activity give the following information <ul style="list-style-type: none"> • a thorough description of the function or use • the number of rooms and/or open areas required • additional access, area for maintenance of equipment • the numbers of people involved • the space required for each activity • the required minimum floor to ceiling height of each space • frequency of use - continuous, permanent, or intermittent in hours or days • special equipment, function, type, size, weight 	3 Environmental Control <ul style="list-style-type: none"> • temperature, air changes, pressure zones, dust particle control, fume extraction, bacteria control 	11 Facilities provided by others <ul style="list-style-type: none"> • services • waste treatment • storage • component/material supplies • computing, data • people movement • access, egress, size, shape, flow rates
2 Services required by each activity <ul style="list-style-type: none"> • telecommunications • air conditioning • ventilation, extract • lighting • power - low voltage, high voltage, vacuum • piped gases • effluent treatment • wastes • water - potable, treated, H&C • heating/system • IT • fibre optic links 	4 Cleanliness standards	12 Environmental factors <ul style="list-style-type: none"> • impact on landscape • security • visual appearance • access • delivery vehicles - size, shape, frequency, time • parking - permanent, visitors • protection against pollution of the environment with scale and type of pollutants • planning restrictions - constraints, public enquiry, conservation areas, listed buildings, preservation orders, rights of light • requirements of statutory authorities and services companies • site surveys of available sites
	5 Security <ul style="list-style-type: none"> • privacy • soundproofing • safety - theft, access, egress, fire 	
	7 Hazardous activities <ul style="list-style-type: none"> • radiation • pollution • chemicals • bacteria • vibrations 	
	8 Wall, floor, ceiling finishes <ul style="list-style-type: none"> • specify standards and specific type of finishes required 	
	9 Relationships <ul style="list-style-type: none"> • relationships with which room/activity/function • define if room/activity/function is associated 	
	10 Interrelationship between function and local environment	

Table 3.1: Checklist for Information to be Included in the Statement of Need
 (Source: Gray et al, 1994)

brief. In fact, some of the items included in the checklist of information for the statement of need can form the basis for the sub-sections of the brief presentation framework proposed in section 3.9. In addition, the checklist for the functional brief, although worded differently, contains the same emphasis as that proposed by O'Reilly (1987) and BCO (1994), which will be presented in the later sections. Table 3.2 shows the checklist for the functional brief.

1 Descriptions of <ul style="list-style-type: none"> • the client • the functions or uses to be accommodated • any requirement for future flexibility or expansion • services required • functional quality standards • standard brief, modified to the specific requirements • statutory and corporate safety requirements • prioritisation of objectives • value analysis, buildability and hazardous operations studies 	3 A budget or cost estimate which should include separate items for <ul style="list-style-type: none"> • construction cost and time • commissioning • design fees • site management and organisation • furniture and equipment • contingency
2 Outline plans of the proposed building which show the arrangement of spaces and their use	4 Client's direct and indirect costs of <ul style="list-style-type: none"> • moving, and where appropriate, temporary accommodation • hardware • operation and running costs • maintenance • cleaning and servicing • marketing

Table 3.2: Checklist for Information to be Included in the Functional Brief

(Source: Gray et al, 1994)

3.3 “Better Briefing Means Better Buildings”

“Better Briefing Means Better Buildings” (O'Reilly, 1987) is a booklet which provides a framework in the form of a checklist, to aid briefing. Although it was published in 1987, its contents are still valid and applicable to the briefing process. The booklet suggests ways in which the early stages of building projects may be set up and carried out to ensure that the outcome of the project will be satisfactory to the client. The checklist was originally developed as part of a BRE (Building Research Establishment) research project. The checklist is structured in three parts; Part A: ‘Project identification’, Part B: ‘Aims, resources and context’, and Part C: ‘Design requirements’. ‘Project identification’ provides a brief outline of the project and the participants involved while ‘Aims, resources and context’ outlines the context of the project, its aims, and the resources available for it. ‘Design requirements’ establishes the

requirements of the design, taking into account the building and site as a whole. Design decisions made here will take into account information collected in the parts A and B.

The booklet provides relatively detailed guidelines for the content of the brief, with each part being subdivided into sections and with the contents of each section being further itemised. The main headings of each section are listed in Table 3.3 below. However, some of the items within the checklist are rather non-specific or general and may be interpreted differently or even inaccurately by different people. Certain items are rather inadequate in that no further explanation is provided with respect to the actual information which is required to be included in the brief.

A Project identification A1 The project A2 The participants B Aims, resources and context B1 The project's organisation and methods B2 Organisation and methods of related groups B3 Laws, regulations, standards, codes B4 Finance	B5 Time B6 Background to the project B7 Current state of the project B8 Surroundings of the site B9 The site B10 Intended future client enterprise - general description B11 Intended future occupancy of site and buildings - detailed description B12 Aims of the project	C Design requirements C1 Surroundings of the site C2 The site C3 Whole building C4 Groups of spaces C5 Unit spaces C6 Building fabric C7 Equipment and furniture
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Table 3.3: Main Headings of Checklist for Briefing

(Source: O'Reilly, 1987)

3.4 “Performance Standards in Building - Checklist for Briefing - Contents of Brief for Building Design”

“Performance Standards in Building - Checklist for Briefing - Contents of Brief for Building Design” (BSI, 1995) is an international standard which describes the content of a brief for building design. It contains a checklist, the purpose of which is to provide a

standard framework for the presentation of a written brief that can be adapted for use with all sizes of building projects. The content of the brief is divided into three sections, namely; Annex A: 'Project identification', Annex B: 'Context, aims and resources' and Annex C: 'Design and performance'. The first and second sections are similar to those of O'Reilly (1987), while the third is an improvement on that of O'Reilly in that the emphasis is more on the performance aspects. An analysis of the contents indicates that O'Reilly (1987) was used as a reference, with certain information being maintained or excluded and new, improved aspects being included in the international standard. The addition of explanatory notes to selected items is a vital contribution in that it provides some form of clarification as to the extent of information which needs to be included in the brief. Even so, certain items are still rather obscure, leaving the readers to make their own interpretations or definitions.

The main headings of the checklist recommended by the international standards are tabulated in Table 3.4.

Annex A: Project identification A.1 Identity of the project A.2 Purpose of the project A.3 Scope of the project A.4 Identity of participants A.5 Identity of other related groups	Annex B: Context, aims and resources B.1 Project Management B.2 Laws, standards and codes B.3 Financial and time constraints B.4 Background and historical influences B.5 Influences of site and surroundings B.6 Client's future enterprise B.7 Intended occupancy in detail B.8 Intended effects of the project	Annex C: Design and performance requirements C.1 Sites and surroundings C.2 The building as a whole C.3 Building fabric performance C.4 Groups of spaces C.5 Spaces in detail C.6 Plant, equipment and furnishings
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Table 3.4: Main Headings of Checklist for Briefing - Contents of Brief for Building Design
(Source: BSI, 1995)

3.5 Duerk's Model

Duerk's Model (Duerk, 1993) is a format for organising the data required for design. It sorts information into issue-based categories to form what is called an issue-based programming (the US's term for briefing). Table 3.5 illustrates the model, in the form of a matrix. The 'Issue' list provides column headings while 'Facts', 'Values', 'Goals', 'Performance Requirements' and 'Concepts' label the rows.

Issues →	Privacy	Security	Territori- ality	Image	Mainte- nance	Physical Comfort	Audibility	Visibili- ty	Etc
Facts									
Values									
Goals									
Performance Requirements									
Concepts									

Table 3.5 Duerk's Model

(Source: Duerk, 1993)

Duerk (1993) uses 'Issues' to mean any matter, concern, question, topic, proposition, or situation that demands a design response. 'Issues' include circulation, convenience, durability, economy, energy efficiency, environmental effect, etc. 'Facts' refer to information about the existing state or context in which the design must perform. 'Facts' include Site, Person/user and Context. The first comprises climate, codes, site conditions and traffic levels, and the second includes activity analysis, age group, number of people/groupings, etc. The last of the three, Context, includes cultural, demographic, economic, historical political and social aspects. In other words, 'Facts' is synonymous with the term 'context' used by O'Reilly (1987) and BSI (1995).

Also from Table 3.5, 'Values' refers to the relative importance of specific issues to different people; clients, users or designers, which gives rise to different design

responses. ‘Goals’ define the general quality of the design outcome for each issue. In other words, both ‘Goals’ points towards the ‘aims’ aspects of O’Reilly’s (1987) “Aims, context and resources” and BSI’s (1995) “Context, aims and resources”. ‘Performance requirements’ state the level of function required. It is sometimes referred to as a performance specification, performance standard, or criterion and can be labelled as an objective. This relate to a combination of O’Reilly’s (1987) ‘Design requirements’ and BSI’s (1995) ‘Design and performance requirements’, as well as ‘aims’. ‘Concepts’ show the physical relationship between the design elements needed to meet the performance requirements. Examples of ‘Concepts’ include form (e.g. dimension), material, texture, colour and adjacency. ‘Concepts’ refer to diagrammatic solutions or proposals that implement the requirements of the brief. In other words, this refers to a thin line between the brief development and the conceptual design stage.

Each specific issue along the top row of Table 3.5 is weighted against those items in the first column. These items should be decided upon, up or down, whichever way in order to establish accurate design decisions. This model assists in organising design information by issue and allows the clients and designers to set priorities and make careful distinction between design information that is fact, issue or potential solution. Although the concept of ‘issue’ may be well recognised by most designers, it could be a major problem for clients (especially inexperienced ones) to understand the extent of each issue and its implications. For this model to be successful, extensive two-way communication between clients and designers is necessary.

Once the necessary data have been acquired and organised, the “program document”, i.e. the brief, is structured. The format of the contents proposed by Duerk (1993) is

summarised in Table 3.6. The established ‘Goals’, ‘Performance Requirements’ and ‘Concepts’ are incorporated in the third section of the brief content .

Introduction Existing State - Context <ul style="list-style-type: none"> • Background: Cultural, Social, Political, Historical • Physical Conditions: Geography (regional, district, etc.), Site, Climate, Archaeology • Client Profile: Demography, Organisational Analysis, Preferences • Constraints: Codes, Master Plans 	Future State - Goals, Performance Requirements, Concepts <ol style="list-style-type: none"> 1. Goal Statement 1 <ol style="list-style-type: none"> 1.1 Performance Requirement Statement 1 <ol style="list-style-type: none"> 1.1.1 Concept Diagram 1 1.1.2 Concept Diagram 2 1.1.3 Concept Diagram 3 2. Goal Statement 2 <ol style="list-style-type: none"> 2.1 Performance Requirement Statement 1 <ol style="list-style-type: none"> 2.1.1 Concept Diagram 1 2.1.2 Concept Diagram 2 2.1.3 Concept Diagram 3 <p>..... and so on as necessary</p>	Summaries and Conclusions <ul style="list-style-type: none"> • Summaries: Budget, Space Summaries • Conclusions: Organising concepts, Themes, Phasing Plans Appendix <ul style="list-style-type: none"> • Research Studies, Proformas, Client Scenarios
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Table 3.6: Duerk’s Brief Contents Format
(Source: Duerk, 1993)

3.6 “Specification for Urban Offices”

“Specification for Urban Offices” (BCO, 1994) is not a guideline for brief production but a form of performance specification which is primarily concerned with high quality urban office buildings. It recommends changes to existing standards to match more accurately the needs of the occupier and to provide flexibility and adaptability for future use. Recommended standards are expressed in terms of performance rather than in descriptive terms. Where this is not possible, recommendations of good practice are incorporated into the document. It also takes into account the growing awareness of environmental issues within the building industry, in particular, energy consumption. Therefore, it forms a useful point of reference, particularly in facilitating the analysis of the performance related information required for inclusion in the brief. For example, the

best practice criteria recommended for indoor climate control is used in the information modelling process (see Chapter 6) to establish the relationships between the internal environment of a building and the factors that influence its performance.

3.7 “A Client’s Guide to Design-and-Build”

“A Client’s Guide to Design-and-Build” (CIRIA, 1985) provides a short and concise checklist for the client’s requirements to suit the stated procurement. The checklist is very brief but it provides a useful guideline on how to classify the vast amount of information required for the brief of any form of building procurement.

3.8 Analysis and Comparisons

The knowledge and information obtained from each publication was analysed and compared. From the main four sources of briefing checklist/format, i.e. O’Reilly (1987), BSI (1995), Gray et al (1994) and Duerk (1993), it can be seen that the emphasis is almost the same. The major components of each are also almost identical. All four also stress on the importance of the brief being comprehensive or complete as a key to avoiding inadequacies. As seen from Tables 3.3 and 3.4, the main headings and contents of the checklist proposed by O’Reilly (1987) and BSI (1995) are very similar. Both are divided into three main sections. Although the main headings of each section slightly differ, the essence of the contents do not vary that much.

When these two are compared to the checklist for the functional brief proposed by Gray et al (1994), portrayed on Table 3.2, there are similarities on the emphasis, even though the checklist is structured differently. However, the framework provided by Gray et al

(1994) is not as organised as those of O'Reilly (1987) and BSI (1995). Item 1 ("Descriptions of...."), for example contain items which have been structured under more than one main section in O'Reilly (1987) and BSI (1995). Item 3 ("A budget...."), and part of item 4 ("Client's direct...."), however, point very much towards the financial aspects presented by O'Reilly (1987) and BSI (1995). In essence, the checklists proposed by O'Reilly (1987) and BSI (1995), provide more explanations in terms of the details of the brief contents. Even so, it must be recognised that there are two steps to the brief formulation proposed by Gray et al (1994). Indeed, the contents of the checklist for the statement of need depicted in Table 3.1 can be used as the inner content of the headings provided by the checklist for the functional brief (Table 3.2).

The format proposed by Duerk (1993), to some extent is similar in nature to that of O'Reilly (1987) and BSI (1995). The 'Introduction' section of Duerk's format can be associated with O'Reilly's and BSI's 'Project Identification'; 'Existing State' with 'Context'; 'Future State' with O'Reilly's 'Design requirements' and BSI's 'Design and Performance Requirements'; and, Duerk's 'Summaries and Conclusions' with O'Reilly's and BSI's 'Aims and Resources'.

Generally, all the above guidelines propose that textual information be part of the brief contents. Gray et al (1994) and Duerk (1993), however, have some aspect of the conceptual design being incorporated in the brief. Item 2 in the functional brief proposed by Gray et al (1994) reads "Outline plans of the proposed building which show the arrangement of spaces and their use" certainly indicates the inclusion of some form of plans. The "Future State" item in Duerk's Brief Format clearly indicates and

encourages the inclusion of conceptual design. While these conceptual designs may be useful in extracting or assisting clients to identify or understand their requirements during the “brief taking” process they should be done in such a way that they do not prohibit or limit the design interpretations.

3.9 Proposals

From the analysis, the majority of the selected publications were found to contain valuable and vital information for the formulation of the brief. However, none of the sources was found to be resourceful and flexible enough to allow information to be articulated precisely enough to facilitate the process of information modelling. This being the case, more than one source of information or publication is necessary. The following recommendations are made:

1. Structured framework

Useful and relevant information are extracted from the selected publications with the aim of reproducing a set of information which not only represents that essential for inclusion in a brief, but is also flexible enough to be modelled. A structured framework for the presentation of the brief is established, which will also aid the process of modelling the information. The framework should contain robust information that is common to most of the reviewed guidelines which demonstrate the client’s genuine requirements.

The proposed structured framework is divided into five main sections: ‘Project Identification’, ‘Project Aims’, ‘Project Resources’, ‘Project Context’ and ‘Design and Performance Requirements’. The title of these main sections have been adapted from

BSI's (1994) and O'Reilly's (1987) main headings. 'Project Identification' and 'Design and Performance Requirements' have been adopted directly from O'Reilly (1987) and BSI (1995). Nonetheless, the O'Reilly's (1987) "Aims, context and resources" and BSI's (1994) "Context, aims and resources" have been separated to obtain three individual main sections: 'Project Aims', 'Project Resources' and 'Project Context'. In doing so, the individuality of each section will allow a more versatile and manageable approach to the process of modelling the information. Further more, the identity of each section will be better defined in terms of assisting clients to distinguish and identify the needs and requirements of a project.

These main sections will then be further divided into sub-sections with headings and sub-headings if necessary. The structured framework for the brief presentation is tabulated in Table 3.7.

Project identification <ul style="list-style-type: none"> • Project identity • Project Purpose • Project scope • Identity of project participant organisations • Identity of related group organisations Project Aims <ul style="list-style-type: none"> • Intended effects of the project 	Project Resources <ul style="list-style-type: none"> • Financial • Time • Project management Project Context <ul style="list-style-type: none"> • Intended occupancy in detail • Regulatory issues • Background and historical influences • Site and surrounding influences • Client's future enterprise 	Design and performance requirements <ul style="list-style-type: none"> • Site and surroundings • The building as a whole • Building fabric • Spaces in detail • Grouping of spaces • Plant, equipment and furnishings
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Table 3.7: Structured Framework for the Brief Presentation

Table 3.7 shows that the main sections and headings follow similar lines to the checklist by BSI (1995), although being divided into five instead of three parts. This framework has been adopted because it represents a clear and precise definition of information for

clients or other project participants alike, in establishing the client's needs. The contents of each sub-section, however, cannot be determined at this stage of the research. The actual contents will only be identified once the links and relationships within the information is established. The contents of each sub-section, therefore, will be formulated after the information necessary for inclusion in the brief has been modelled.

2. Modelling the information

The fact that the above reviewed publications provide only guidelines or checklists means that the brief presentation exists in textual format. With textual information, one cannot visualise the information flow, nor the links or relationships within the information. Even though the relationships between the items of information do exist in these guidelines, they are not highlighted as such. The research therefore aims to model the information identified within the structured framework shown in Table 3.7. These information models will represent a framework for the presentation of the client's brief, with the aim of establishing a computerised tool to assist both clients and designers to carry out this process effectively.

A set of models is thus developed to illustrate the contents of the brief. These models will form the basis for the presentation of brief information. The information necessary for decomposing the above five main sections will be derived mainly from a combination of selected constituents from the reviewed publications. Where additional information is essential, other sources of information will be sought. These include publications on construction technology (e.g. Barry, 1986), technical data (e.g. Barbour

Index, 1994; Powell-Smith and Billington, 1995; Stephenson, 1993; Haverstock, 1993) and other relevant publications available within the construction industry.

3.10 Summary and Conclusions

This chapter has examined and analysed a set of briefing guidelines or checklists together with a limited number of related documents. The review confirms the availability and accessibility of useful and vital information for inclusion in the client's brief. The analysis indicates that although the format and structure of the briefs differ, they share a common emphasis, i.e. to ensure that the developed brief is comprehensive and reflects the true needs of the client. The five essential items of information to be included in the brief (although the wording and format differ between publications) can be summarised as follows:

- Project Identification
- Project Aims
- Project Resources
- Project Context
- Design and Performance Requirements

The chapter then proposes the use of the above classification of information as the structured framework for the presentation of the brief. This structured framework, along with the detailed information available from within the published guidelines will form the basis for the information modelling process to be presented in Chapter 6.

CHAPTER 4

IT AND THE BRIEFING PROCESS

4.1 Introduction

The briefing process involves the identification, collection, storage, retrieval, analysis and presentation of information about a building project. During the briefing and design stages, as the project evolves, the information base is not static and changes continually over time owing to the dynamic nature of the design process (Campion, 1976). The role of IT in information and data handling offers an alternative method of working with the potential of greater accuracy, time and cost savings and greater job satisfaction. IT enables data to be accessed and manipulated to achieve the system's objectives. Moreover, through the enormous increase in computing power and connectivity, IT has enabled vast amounts of data to be made available to millions of IT users world-wide via the internet.

This chapter examines the various ways of utilising IT to support the briefing process. It begins by highlighting IT related research with regard to the briefing process. It continues by outlining a number of currently available electronic databases on CD-ROM or on-line, followed by databases of visual information and visualisation tools.

Finally, this chapter presents the various information available on the internet that is useful to the briefing process.

4.2 IT Related Research

In the UK, the post-Latham years have significantly increased the research activities to improve and support the briefing process. Work has been carried out in the areas investigating current practices, understanding the process, identifying and recommending best practice as well as the role of IT in the briefing process. A selected number of related research initiatives are highlighted below:

4.2.1 “Managing the Brief as a Process of Innovation”

This project has been undertaken by a joint industry/academic team based at the University of Salford (Barrett et al, 1996; Barrett and Stanley, 1996). It has been undertaken as part of the DoE/EPSRC sponsored LINK IDAC programme. The project focuses, though not exclusively, on alteration and refurbishment projects. The three main objectives of this project are to:

1. model the briefing process to understand better its strengths and weaknesses as currently practised and to identify best practice.
2. stimulate innovations leading to better best practice (which can be indirectly related to IT).
3. locate the objectives 1 and 2 firmly in the context of experience in other disciplines and other industries.

The first stage of the project involves literature review. The second stage is designed to establish best practice in the construction industry and the third stage moves from description to controlled innovation through a programme of action research.

The initial findings of the research suggest that briefing may not in itself be improved by merely implementing good practice recommendations. The overall project environment plays a crucial role in this aspect. In fact, “accepted good practice may not work where it restricts the project team and a good team may be able to make bad practice work” (Barrett et al, 1996).

4.2.2 Construct IT Centre of Excellence

The Construct IT Centre of Excellence “has been set up as an industry-led network to co-ordinate and promote research, development and technology transfer in information technology for construction to improve the competitive performance of the UK construction industry” (Construct IT, 1996). One of its work plans is to undertake and report on benchmarking studies. For this purpose reports are published, one of which is “Benchmarking Best Practice Report” on “Briefing and Design” (Atkin et al, 1996).

This report has been prepared based on a study on benchmarking of IT in briefing and design, in which both processes have been taken in totality, to signify the continuity and iterative nature of the process. Nine stages have been identified as representing both processes. These are strategic analysis, client analysis, facilities analysis, statement of need, confirmation of need, functional brief, concept design, scheme design and detail design.

The results of the study indicate a wide variation in performance in the use of IT across the briefing and design process. Performance during the earlier stages, is far weaker than later in the process. In design, there has been a long established use of IT compared to the briefing process. The translation of a client's business needs into a workable solution has been identified as the area of greatest need for both a better understanding of the underlying processes and the opportunities for the use of IT. The reports suggests that IT tools should serve to support the interaction or communication between project participants to converge on the best solution in the shortest time. That is "the essence of a *world class, best practice* organisation".

The issue of integration has also been examined. The study identified two components of the integration in briefing and design: horizontal and vertical integration. The results suggest that the IT support for the vertical integration of stages is better than the horizontal integration of complementary activities within those stages.

The report concludes that IT is under-utilised by the construction industry in briefing, and to a certain extent, in the formative stages of design. Recommendations which have been made for successful implementation of IT in support of the briefing and design processes include:

- IT that enables more efficient gathering of data and its subsequent analysis, manipulation, synthesis, communication and presentation.
- The automation of routine technical tasks.

- Horizontal integration (sharing of data between project participants within a stage) should be encouraged, to the same degree as vertical integration between consecutive stages in the process.
- A strategy to increase the importance of IT in supporting the briefing process to bring it to a level comparable to that of IT use in routine design and detailing.

4.2.3 “A Model for Guiding Clients and the Design Team during Briefing for Construction Projects”

The above refers to a research project carried out at the University of Reading (Hudson et al, 1991). One of the objectives of the project was to investigate new means of improving the effectiveness of communication in briefing. A prototype computer system was developed. The aim was to incorporate the findings of the research, based on a case study approach, into a system that would assist the inexperienced client to participate fully in the briefing process. It is designed to be used as a pre-briefing tool, a primer, to advise and raise the awareness of the inexperienced client on a number of issues.

Although an expert system shell, “Leonardo” was used for developing the system, the result is not an expert system. It was merely intended to organise a loosely-structured body of knowledge to allow for easy manipulation by an inexperienced user. The system is structured to contain two main sections. The first section establishes a project profile, e.g. building type, anticipated size, etc. The second section, which can only commence once the profile has been established, contains more detailed topics for detailed investigation. These include cost, timescale, function, environment and organisation. Another option called sensitivity analysis allows information in the project

profile to be altered systematically. At the end of the section a report screen is displayed which gives advice and information based on the responses given by the user.

4.2.4 BriefMaker

BriefMaker is a pc-based computer application developed as a result of a research conducted at the University of Strathclyde (Hansen et al, 1996). The project involves using the world wide web (WWW) to develop an interface to a system that assists in the creation of design briefs. The application runs on the WWW and involves the design and implementation of pages of information written in HTML (Hyper Text Mark-up Language). The information that the briefing tool needs to capture includes that from past projects, checklists, communication with clients, statutory regulations, building codes, costs and existing databases. The forms of information include verbal, written, computer graphics, computer databases and video. Users can create new briefs through a user specified format using Word 6.0, the BRE checklist form, or the brief from a similar project.

While the type and form of information has been indicated, together with the mode of interface for the system (Hansen et al, 1996), there was no mention of how the actual system development was carried out to allow for any in-depth analysis to be carried out.

4.3 Electronic Databases on CD-ROM or On-line

Efforts have been made by various research groups and organisations to gather, compile and electronically store specific information related to the construction industry. Proprietary databases have been created for various types of technical and product

information which include building regulations, specific legislation, building products, along with their suppliers and manufacturers, etc. Such information is then made available on a mass storage and distribution medium. Amongst the benefits that can be gained from these information services are:

- large amounts of highly focused and up-to-date information or datasets can be made available and accessible from a single CD-ROM
- manual searching, which is tedious and time consuming, is avoided or minimised
- the time and cost for finding and using information is reduced

A number of the CD-ROM packages which are available to assist the briefing process are explained below:

4.3.1 Barbour Index Construction Expert

Barbour Index Construction Expert is an interactive technical and product information desktop database available on two CD-ROMs (Barbour Index, 1996). It is continuously updated to provide users with up-to-date information. It enables users “to answer design questions from inception to completion of a project”. It provides interactive technical and product information, an alternative product search, a specification building facility and a project file audit trail capability. The technical information is presented in the form of building regulations while the product information combines a comprehensive directory (of manufacturers and their products) with essential product data for performance specification, initial product selection and finding alternative products.

Access to such information during the briefing process will provide supporting and supplementary information to both clients and designers which will facilitate the decision making process.

4.3.2 EuroOSH

EuroOSH is the Occupational Safety and Health (OSH) database of European Union and Member State legislation with International Labour Organisation (ILO) Conventions and Recommendations. The database, which contain legislation, guidelines and recommendations from European and pan-European legislative bodies, is held on CD-ROM. It claims to represent the most comprehensive and accessible single database of European OSH legislation available anywhere. EuroOSH provide access to four major sources of occupational safety and health information (Neal and Wright, 1996):

- a) the occupational safety and health legislative instruments of the European Union in English full text from 1957 to the present day.
- b) the full text, plus summaries and source references of ILO International Labour Conventions and Recommendations.
- c) summaries and source references of the legislation of all Member States of the European Union.
- d) the first release contains the full text, plus summaries and source references of legislation of the British Isles (United Kingdom and Eire) including Codes of Practice.

EuroOSH is a continuously updated and developing database. Future releases are expected to contain the full text of legislation of other member states and regions, together with further useful data sources on health and safety law.

Accessibility to this package during the briefing process would allow users to identify the relevant legislation related to occupational safety and health. With particular significance to clients in the United Kingdom, is the item (d) above. This information would enable clients to make appropriate decisions in terms of the choices of building structure, materials, layout and others to suit the stated client objectives or user requirements.

4.3.3 The CONTEXT JUSTIS CD-ROM/ On-line Range

The CONTEXT JUSTIS CD-ROM /On-line range aims to inform and support the legal, corporate, consultancy and government sectors. European and UK parliamentary, legal and official information is published on CD-ROM or through on-line services .

a) JUSTIS European Range on CD-ROM

The JUSTIS European range on CD-ROM include CELEX, Official Journal C Series, European References, European Commentaries and Statutory Instruments (IN Context, 1996). Each CD-ROM enables users to monitor information on legislation in the European Union. The five titles can be interlinked via Dynamic Document Linking (DDL). DDL is a function of JUSTIS software and will link from a reference in any JUSTIS CD-ROM title to a document in any JUSTIS full text CD-ROM title.

Accessibility to these titles would serve as an added bonus to interested users to trace the complete progress of European Communities legislation, from proposal and debate through to the eventual enactment in the UK. It could be particularly useful for international projects within the European Community.

b) *electronic* Law Reports (eLR)

The eLR CD-ROMS are the product of a joint venture of Context with the Incorporated Council of Law Reporting for England and Wales. The first eLR CD-ROMs were issued to subscribers in June 1996 (IN Context, 1996). All the 753 volumes are on one CD-ROM, with the index on a second disc. Users are offered the facilities that fully exploit the familiar structure and typographical layout of a law report while incorporating DDL for enhanced case referencing.

4.4 Visual Information Databases/ Visualisation Tools

Apart from technical information, work has also been carried out to create extensive databases for visual information. This comes in the form of pictures, images and graphics. To ensure effective presentation of such information, visualisation tools have been developed to suit a particular set of objectives.

4.4.1 “Dynamic Building Archive”

“Dynamic Building Archive” is a research project undertaken by the University of Reading in conjunction with Imperial College (Finch et al, 1996). The aim of the project is to develop a visualisation tool based on photographic images. These images can be used to familiarise students and professionals with specific construction environments

and facilities. These images serve as visual information to enhance the teaching process through experiential learning. The project also aims to exploit multimedia technology for this purpose. The 'surrogate travel' technology achieved by connecting a large collection of still frame images is used to allow the user to 'walkthrough' an environment, e.g. a site visit.

If this tool is made available during the development of the brief, it will assist clients and other project participants to 'visit' 'actual' construction sites and thereby gain experiential knowledge regarding aspects of the construction process.

4.4.2 The Adoption of Interactive Video in Construction

Interactive video is an effective form of computer based training (Finch, 1991). It represents a fundamental advance in education and training methods. The development of the laser disc allows almost instantaneous retrieval of high quality video (both still and moving), sound and graphics. The potential of interactive video as an educational tool in the construction industry is enormous. It allows the user to tour a site without actually going there and it allows fine surface detail to be shown at high picture quality. It also enables the use of survey images obtained from thermal cameras and the time-lapse sequencing of real time events (Finch, 1991). Another advantage of interactive video is that it offers the potential to bring the experiential learning process into the classroom, or the office if used for continuous professional development, or to the computer screen if used in conjunction with an inbuilt system or software. To ensure effective learning is achieved, these interactive video packages should not only

emphasise the content but also the concept of learning psychology and learning strategies of different target users.

A great number of interactive video packages are available within the construction industry, e.g. “Escape from burning buildings”, “What a site”, “On the right lines”, “Energy Design”, etc. (Finch, 1991). If videos related to construction works are made available during the development of the brief, it will assist clients to ‘visit’ ‘actual’ construction sites and thereby gain experiential knowledge regarding aspects of the construction process. In contrast, videos relating to design aspects of the building would highlight design and performance related issues, as well as any lessons learned. Both would serve to assist in the decision making process.

4.4.3 “Construction Design Visualisation through Virtual Reality (VR)/Virtual Environment (VE)”

This research project aims to develop a working prototype Virtual Construction Design Engineering (VCDE) design tool that can be used by clients and designers to visualise different design options. The prototype will be tested, evaluated and refined in collaboration with firms operating in the construction engineering field. The project also aims to provide guidance for future developers. This project is undertaken by the Construction Virtual Environment Centre, University of Salford (Powell, 1996).

Access to this tool during the briefing process could assist the client to visualise alternative design options which suit his requirements.

4.5 Using the Internet as a Means of Transmitting and Accessing Information

The internet provides a means of providing information which can be linked to other information sources. It is an essential medium for accessing, delivering and exchanging information in various forms. Such information may be in the form of text, graphics, images, simulations, sound, etc., encompassing the entire multimedia presentation. The internet has an added advantage over laser discs and CD-ROMs, in that it is virtually “free” and limitless, and not restricted to the amount of information that can be squeezed onto one CD.

A selected number of information sources on the internet which serve the construction industry in general and can be beneficial during the briefing process are described below.

4.5.1 Construction Information Gateway (CIG) Demonstrator

The Department of Environment (DOE) has worked with BT to develop a “Construct IT” strategy, for using IT to integrate the construction processes (CIG, 1996). One of the recommendations made for the future use of IT involves the development of the Construction Information Gateway Demonstrator project which will create a single entry point to the internet’s construction related knowledge base.

This project is undertaken by the Building Research Establishment in collaboration with Engineering Technology and Newcastle University. The CIG provides access to a list of information services. Currently, the list includes the Building Research Establishment,

the Building Information Warehouse, Building On-line and the Royal Institute of British Architects, amongst others.

4.5.2 The Building Research Establishment (BRE)

The BRE is the principal organisation in the UK carrying out research into building and construction and the prevention and control of fire (BRE, 1996). The BRE on the internet provides information on technical aspects of buildings and forms of construction, all aspects of fire and other issues related to buildings. The availability of such information during the briefing process would highlight the technical aspects of buildings and other related issues, especially with regard to the performance requirements of the various components of the building. This knowledge would allow alternative choices to be considered prior to the identification of the precise requirements of the client.

4.5.3 The Building Information Warehouse (BIW)

A key aspect of the DOE sponsored Construct IT initiative is to encourage construction professionals to use email on projects and on-line services to ensure the most current and appropriate knowledge is applied. This entails the development of methods for application software to integrate seamlessly with information sources on the internet. To encourage the industry to publish information on the internet in a form which is accessible to most users, a free access service using a high specification WEB server has been established with the internet service provider Pipex. This WEB server is known as the Building Information Warehouse (BIW, 1996). It contains directories of construction professionals, contractors, product suppliers, service suppliers, educational

institutions, research and publications which register their presence on the web. This service is intended to complement and not compete with established information providers.

Access to the above information during the briefing process would enable clients to obtain further information on construction professionals prior to selecting them for their project team. The product suppliers information would enable both clients and designers to examine the products of particular suppliers or the suppliers for specific products. This will assist clients in identifying their requirements in relation to a particular product or to ensure the availability of such products within the market.

4.5.4 Building Online

Building Online is a leading web site creation and marketing agency for the building products industries. It provides the latest news on the building industry and an up-to date search engine for the building industry (Wickstrom, 1997). This includes top retailers, top builders, lumber news, builder shows, hot news, etc. The benefit to be gained from this information is similar to that gained from BIW in terms of building products.

4.5.5 RIBA Information Services

The RIBA, in collaboration with RIBA Companies and Newcastle University, are currently developing a fully operational internet service (RIBA, 1996a). The services provided include: RIBA Product Selector, NBS Model Specifications, RIBA Office Library Service, RIBACAD and RIBA Mail (RIBA, 1996b). The first and fourth

services, can be particularly useful to the briefing process. The product selector can create product awareness within an acknowledged product reference or category, while the RIBACAD, provides a graphics library of pre-drawn product details. Together, these services could assist clients and other project participants in the decision making process.

4.6 Summary and Conclusions

This chapter has reviewed a number of research initiatives and studies related to the role of IT in support of the briefing process. It has outlined a number of ways that relevant information can be stored and delivered to users. This includes the use of CD-ROMs, databases, visualisation tools as well as the internet.

A number of conclusions and recommendations can be drawn from this chapter. These are:

1. There are a small number of IT systems that are available or being proposed within the construction industry which specifically support the briefing process, e.g. BriefMaker. The approach adopted by these systems differs but the aim is mainly to achieve better performance during the briefing process.
2. The research by the Construct IT Centre of Excellence (Atkin et al, 1996) suggests that routine and technical tasks should be automated. IT exists to support a range of activities associated with design but to a lesser extent, with the briefing process. The greatest need of IT within the briefing process could be during the translation of the client's business needs into a workable solution.

3. IT has enabled information to be gathered and compiled in a more efficient manner.

It allows information to be analysed, manipulated, communicated and presented.

Several sources of information are available electronically that can support the briefing process. Such information can be made available through databases, CD-ROMs, visualisation tools and the internet. The types of information available include building regulations, legislation, technical and product information, directories of construction professionals, suppliers and manufacturers, photographic images, simulations, publications and many more.

4. The information that can support the briefing process is presented in several forms of media, such as text, graphics, pictures, images, computerised/electronic documents and audio.

5. Much of the information is fragmented and not interlinked to each other (except for that on the internet). If access to such information is made available to clients and project participants, it can be presented to users in a systematic and organised manner. One way to achieve this is to develop a prototype which provides direct access to all this information within one sitting. The availability of such valuable information in an effective manner would significantly enhance the level of awareness and knowledge on the part of those involved during the briefing process. This is crucial for effective decision making.

CHAPTER 5

TECHNIQUES FOR MANAGING PROJECT INFORMATION

5.1 Introduction

Managing project information can be considered as the identification, gathering, classifying, categorising and structuring of information related to a project. Effective management of information can ensure that information about a project is communicated to the right person, in the right format, at the right time in order to achieve the project's specific objectives. For successful briefing, information management is essential.

The previous chapters have highlighted the vast amount of information available within the construction industry in general and the briefing process in particular. Such information exists in various forms and media. However, much of the information is fragmented. The briefing process, in particular, lags behind in the search for standardised and organised information that can be followed through the entire project life cycle. Although a large number of guidelines and checklists are available for the brief development process, they do not highlight the relationships within the

information, the cardinality constraints between such information, its properties and behaviour. In addition, such information is not normally linked to the processes involved in producing it. Hence, in order to effectively analyse and structure the information required for the brief development and the activities involved during this process, a set of information and process modelling techniques have to be identified.

This chapter initially examines two approaches to managing information. Selected techniques for modelling information and processes are then discussed followed by the analysis of the modelling techniques. The most suitable technique for each is then identified.

5.2 Approaches to Managing Project Information

There are various approaches available that can be used to identify, examine and structure project information and processes or functions. The following highlights two such approaches that can be applied to the briefing process.

5.2.1 Static Modelling

An approach to managing the huge amount of information required for inclusion in the brief is through modelling. The *static* model (Cribbs et al, 1992) captures information regarding the static structure or characteristics of a domain or system. This involves the information or knowledge gained for a particular domain being graphically portrayed in some form of simple and recognisable pattern or representation to aid the understanding of the domain problem. It enables the domain to be described independently of the development environment that might support it during the implementation stage. Items

of information are described as entities or objects and are classified into specific hierarchies based on type or constituents. Relationships between the items are established and their cardinalities are identified.

Static models are often referred to as *information* or *data* models. Techniques available for information/data modelling include object diagrams, entity relationship diagrams, EXPRESS-G, etc.

5.2.2 Dynamic Modelling

Dynamic modelling is an approach used to capture the system's non-static characteristics. It is divided into two categories:

- a) temporal
- b) transformational

The *temporal* model captures a system's time dependent characteristics including object life cycles, event processing, state transitions and timing constraints or considerations (Cribbs et al, 1992). Ways to represent this information include state transition diagrams, event diagrams, object timing diagrams, etc.

The *transformational* model, also referred to as *process* modelling or *activity* modelling, captures the functional or algorithmic information that describes the logical (not physical) implementation of the system's behaviour (Cribbs et al, 1992). This approach involves the modelling of the processes or functions performed by a particular system to facilitate the understanding of the system activities. It entails a top-down decomposition

of the activities for each process. The information that flows or the data constraints that exist between the activities are portrayed. Ways to represent this kind of information include data flow diagrams, IDEF0, object flow diagrams, etc.

5.3 Information/Data Modelling Techniques

In order to identify the modelling technique that best suits the modelling of the information required for the brief development process, a number of information/data modelling techniques are examined. Three such techniques have been selected and a brief overview of each is presented below.

5.3.1 Entity Relationship Diagrams

Entity relationship diagrams (ERDs) are widely used for conceptual modelling. ERDs are used to develop a high level model of a system that describes its major system objects, their relationships and their properties, using a graphical representation (Chen, 1976; Martin, 1982; Ross, 1988; Yourdon, 1989; Shelly et al, 1991; Kendall and Kendall, 1992; Pressman, 1992; Andleigh and Gretzinger, 1992). The major system objects are referred to as *entities*. An entity may be a person, a place, a thing or an event. A *relationship* is the logical association between entities (Shelly et al, 1991). The relationship represents a set of connections between entities. Each instance of the relationship represents an association between zero or more occurrences of the other entity. The *cardinality ratio* thus defines the expected number of related occurrences of the second entity. It can be expressed one-to-one, zero-to-one, one-to-many, many-to-one or many-to-many. *Attributes* are the properties of each entity or relationship.

The standard format for drawing an ERD uses two types of symbol: a rectangle to represent each entity and a diamond to represent a relationship. The attributes that belong to each entity or relationship are placed alongside or below the relevant rectangle or diamond. Figure 5.1 depicts the notation for ERD.

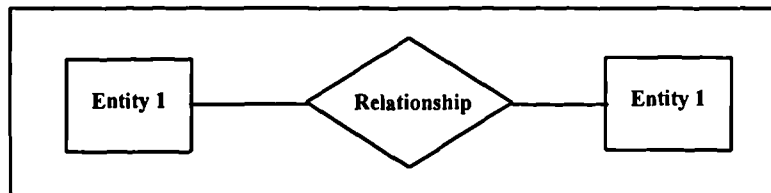


Figure 5.1: ERD Notations

5.3.2 Object Oriented Techniques

In an object oriented data modelling technique, real world items of interest are referred to as *objects*. Objects have properties called *attributes*. Relationships exist between objects. *Cardinality constraints* are used to describe the restrictions of how many of one item can be associated with another. The cardinality symbols express a minimum and maximum constraint, for example, one-to-one, zero-to-one, zero-to-more than one, zero-to-more than one or more than one-to-more than one. Object oriented techniques support supertype-subtype (“kind of”) and composed-of (“part of”) relationships.

A number of object oriented methodologies are available. Examples include Shlaer & Mellor (1988), Coad and Yourdon (1991), Rumbaugh’s Object Modelling Technique (Rumbaugh et al, 1991), Martin and Odell’s approach (Martin and Odell, 1992; Martin, 1993), and Booch (1994). Consequently, various notations exist for different methodologies. For the purpose of this study, only the notation for the Object-Relationship Diagram (Martin, 1993) is examined. Objects are represented by square

cornered boxes. Lines between boxes denote relationships between such boxes. These lines can be read in either direction. Different symbols are used to express cardinality constraints. Subtyping is represented by a little rectangle and composed-of relationships are represented by an arrow drawn like a “C”. Figure 5.2 shows the notations used for the ORD.

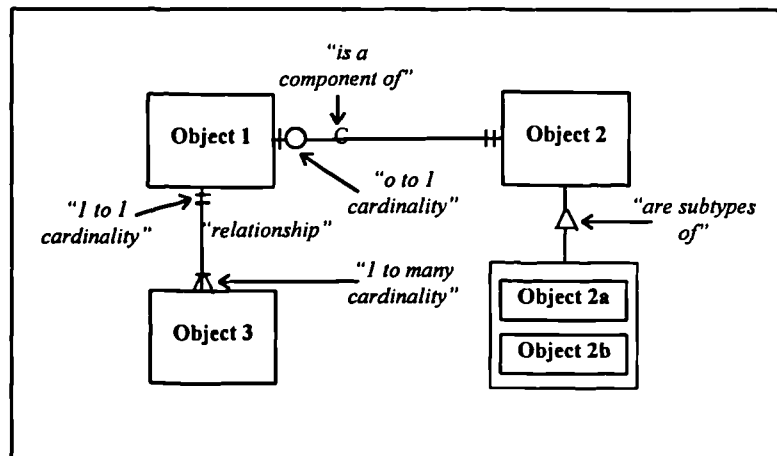


Figure 5.2: ORD Notations

5.3.3 EXPRESS-G

EXPRESS-G is an entity modelling technique. It provides numerous graphical notations that enable the static model of a domain (system/application) to be developed. EXPRESS-G is the graphical representation of EXPRESS, which is a formal data specification language that provides the mechanism for the normative description of product data for both integrated resources and application protocols (Mason, 1992). Its use is mandatory in the STEP (STandard for the Exchange of Product model data) product modelling standardisation effort (Björk, 1992). EXPRESS-G has been included as one of the documentation forms for the requirements (application reference model) of the application protocol of STEP (Bloor and Owen, 1995).

EXPRESS-G refers to real world items of interest as *entities*. These entities are represented by rectangular boxes. An entity may have *attributes*, which are the specific properties of interest. Attributes are represented by relationships. A *relationship* can be defined as an association between two constructs in a model. Relationship lines are used to connect an entity with its attributes. The lines are labelled with the name of the attribute, followed by a cardinality specification if necessary. *Cardinality* refers to the specification of the number of instances of one construct that can be associated with one instance of a related construct. The attribute end of the relationship is denoted by the circled end of the line. There exists an implicit relationship between an entity and its attributes. In addition, *supertype/subtype* inheritance hierarchies are also supported by EXPRESS-G. Solid (bold) lines connect entities forming a supertype/subtype tree. The circled end of the relationship denotes the subtype end of the relationships (Schenk and Wilson, 1994). Figure 5.3 illustrates the basic notation for EXPRESS-G.

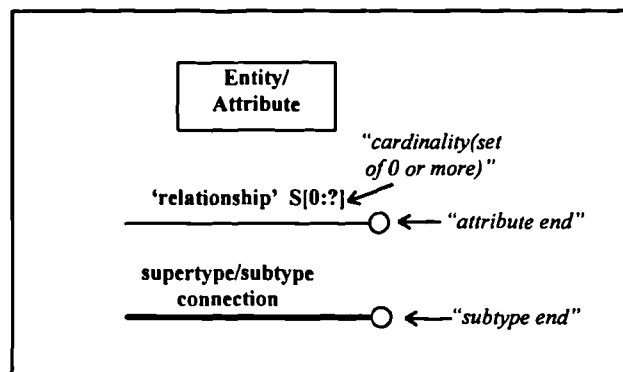


Figure 5.3: EXPRESS-G Basic Notations

5.4 Process Modelling

Similar to information modelling, a set of process modelling techniques are examined in order to identify the most suitable technique for modelling the briefing process. Again, three techniques have been selected and a brief overview of each is presented below.

5.4.1 Data Flow Diagrams (DFDs)

Data flow diagrams are graphical representations of information systems showing their active components and the data interfaces between them. DFDs show how data moves and changes through an information system in a graphical top-down fashion. The DFDs are often used to produce a logical model of an information system in a simple, direct way. It is widely used as a functional decomposition tool. It decomposes a system according to the functions and emphasises the data transformation without considering the sequence and control aspects (De Marco, 1979; Yourdon, 1989; Coad and Yourdon, 1991; Lee and Carver, 1991; Shelly et al, 1991; Kendall and Kendall, 1992; Pressman, 1992; Andleigh and Gretzinger, 1992).

Four basic symbols are used in DFDs (Figure 5.4):

- a) A *process* is an element which represents data transformation. It modifies or changes data from one form to another. A process is represented by a circle (or bubble) with its name placed inside the circle.
- b) A *data flow* is an element which represents the flow of data and its direction. A given data flow in a DFD represents a specific piece of data or a set of data. The symbol for a data flow is a line with an arrowhead which indicates the direction of data flow. The name of the data flow is positioned alongside the line.

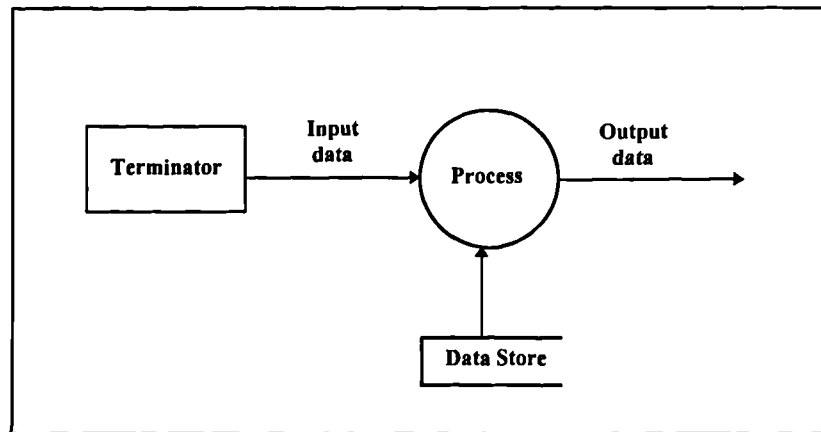


Figure 5.4: DFD Notations

c) A *data store* is a data repository. It is a place where data is stored permanently for future retrieval. Data may be stored on a disk, a calendar, a card index, etc. A data store is represented by two parallel lines with a vertical line at the left. The data store name is written inside the symbol.

d) A *terminator* is a place where data required by the system come from (a source) and where data produced by the system goes to (a sink). Terminators are sometimes referred to as *external entities* because it is considered to be external to the study. Although it interacts with the system it is considered as external to the boundaries of the system. A terminator is represented by a rectangle with its name placed inside the rectangle.

The functional decomposition is carried out in a top-down manner beginning with the highest level, called the context diagram. A context diagram is a data flow diagram that signifies the boundaries of the information system. It is usually depicted by a process symbol representing the entire information system, drawn in the centre of the page, with the terminators placed around the process and data flows to link these terminators

properly to the central process. Further decomposition leads to levels 1, 2, etc., each representing a more detailed view of the processes involved in the system.

5.4.2 Object Oriented Techniques

Amongst the many object oriented techniques available, this thesis studies Martin and Odell's Object Flow Diagram (OFD). OFD is an object oriented technique suitable for use for strategic level planning where only a high level of understanding is necessary (Martin, 1993). It is similar to DFDs in that it depicts activities interfacing with other activities. The difference is that the OFD indicates which objects are produced and the activities that produce and exchange them. The OFDs are useful as overview diagrams.

The notations used by OFDs are as follows (Figure 5.5):

- a) An activity is represented as a round cornered box.
 - b) A three dimensional box is used to represent objects that flow between activities.
- Products are used to represent objects. OFDs describe objects by the way in which they are produced and consumed. The product is the end result that fulfils the purpose of the activity.

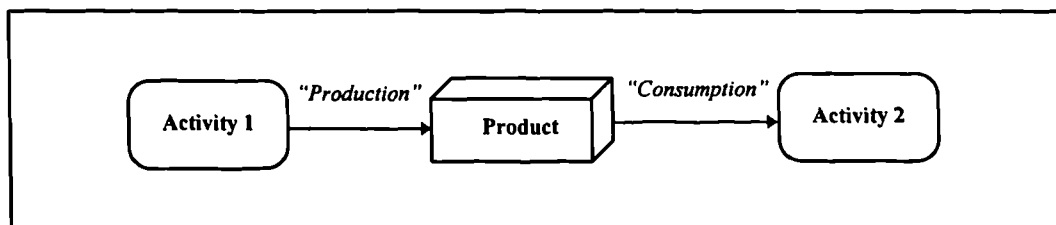


Figure 5.5: OFD Notations

5.4.3 IDEF0

IDEF0 is a modelling technique specifically developed for use in the modelling of functions of complex and interrelated systems. It has been derived from a well established graphical language known as the Structural Analysis and Design Technique (SADT) (Ross, 1977; Ross and Schoman, 1977; Connor, 1980; Pressman, 1992). The IDEF0 was designed to allow a graphical expansion of the description of a system's functions through the processes of functional decomposition and categorisation of the relationships between functions (i.e. in terms of the input, output, control and mechanism classification).

The use of IDEF0 results in a model which has a specific viewpoint and comprises diagrams, text and a glossary which are cross-referenced (Bloor and Owen, 1995). The major components are the diagrams, which provide top-down decomposition with successive introduction of detail. An IDEF0 model is therefore, a hierarchically organised set of diagrams with a single master diagram at the root (context diagram) and a number of subdiagrams forming a series of levels. In fact, IDEF0 is one of the graphical presentations used within ISO 10303 in which it is described as an activity modelling notation used for application activity models within application protocols (Mason, 1992). In relation to that, IDEF0 is the application activity model recommended in the scope of the application protocols for STEP (Bloor and Owen, 1995).

The notations used by IDEF0 are depicted in Figure 5.6 below:

- a) activities are represented by rectangles which are connected by arrows

b) each activity may have inputs, outputs, controls and mechanisms which are represented by the arrows shown in Figure 5.6.

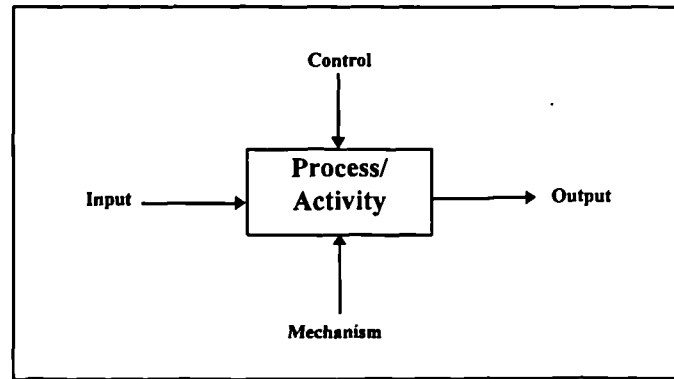


Figure 5.6: IDEF0 Notations

5.5 Analysis of Modelling Techniques

The main obstacle encountered while analysing the modelling techniques is the lack of a common frame of reference. Each modelling technique approaches the problem from a slightly different viewpoint, with a slightly different vocabulary and with emphasis on slightly different aspects of modelling.

Basically, a modelling language of sufficient semantic power is needed for defining the information and processes involved during the brief development process. In the case of information, the language should support the basic abstraction mechanisms of generalisation-specialisation and association between objects or entities. For processes, activities and data constraints between activities at different levels of abstraction should be supported. Some more powerful mechanisms provided by object-oriented programming languages, such as messages are not required at the modelling stage because it is a design issue.

An additional consideration is the conformance of the modelling technique to STEP (STandard for the Exchange of Product model data) which was approved as an international standard in 1994 and is included in the ISO 10303. STEP provides a representation of product information along with the necessary mechanisms and definitions to enable product data to be exchanged among different computer systems and environments. In order to support such uses, product information needs to be represented in a common computer-interpretable form that is required to remain complete and consistent when exchanged among different computer systems (Mason, 1992; Froese, 1995; Bloor and Owen, 1995).

Based on the above considerations, EXPRESS-G has been selected as the most appropriate technique for modelling the brief information. IDEF0, on the other hand, has been selected for modelling the activities involved during the development of the brief.

5.6 Summary and Conclusions

This chapter has discussed a number of approaches to managing project information within the context of information and processes. A set of techniques for modelling information and processes have been examined. The techniques were then analysed based on a number of considerations.

EXPRESS-G was found to be the most suitable information modelling technique. IDEF0 was selected as the process modelling technique for the brief development. The

information modelling process utilising EXPRESS-G is presented in Chapter 6 while Chapter 7 discusses the IDEF0 modelling process.

CHAPTER 6

INFORMATION MODELLING (EXPRESS-G MODELS)

6.1 Introduction

The information structure of a project can be decided upon at the initial briefing of a project, i.e. in the form of a client's brief. This information needs to be well structured and classified and then presented in the form of models to the parties involved so that it can be identified and understood, and possibly agreed upon in the very early stages of a construction project.

In order to model the relevant information required for the development of the brief, the EXPRESS-G modelling technique has been adopted. The developed models will represent a framework for the presentation of the client's brief, with the aim of establishing a computerised tool to assist both clients and designers to carry out this process effectively.

This chapter discusses the process of modelling the information required for inclusion in the brief by using the EXPRESS-G modelling technique. It begins by presenting the

technique and its notations, followed by the phases involved in developing the EXPRESS-G models. Following this, the developed models are depicted and discussed, firstly in the form of the context diagram, followed by the level 1, 2 and 3 diagrams.

6.2 EXPRESS-G Models and Notations

EXPRESS-G is a graphical notation for the display of information models. EXPRESS-G was created in 1990 as a means of graphically displaying models written in the EXPRESS lexical language (Schenck and Wilson, 1994). The EXPRESS language, which was developed during the technical development of the emerging ISO Standard for the Exchange of Product model data (STEP), presents information models in textual format. EXPRESS-G, however, uses graphical symbols, which when assembled together, form a diagram. Although EXPRESS-G has been specifically developed for the graphical interpretation of information models defined in the EXPRESS language, it can be used as a modelling technique in its own right.

6.2.1 Graphical Symbols

EXPRESS-G has three kinds of basic symbols: definition, relation, and composition. The first two symbols are used to define the contents of the structure of an information model while the last one enables the diagrams to be spread across many physical pages. The *definition* symbol denotes the things (i.e. concept, ideas, etc.) which form the basis of the information model. These are represented by rectangular boxes. These rectangular boxes are used to represent *entities*, a modelling construct that represents some form of item of interest in the real world. An entity may have *attributes*, which are the specific properties of interest, i.e. properties that identify an interesting trait and how

it is represented. These properties may either be of *simple types* (e.g., numbers, strings or Boolean) or *complex types* (e.g., another entity). Lines are used to connect an entity with its attributes. The lines are labelled with the name of the attribute, together with any cardinality constraints. *Cardinality* refers to the specification of the number of instances of one construct that can be associated with one instance of a related construct, while *constraint* is defined as a particular kind of property that specifies a restriction on other properties of an entity, or the entity taken as a whole, or on relationships (Schenk and Wilson, 1994).

A *relationship* can be defined as an association between two constructs in a model. A relationship may be implicit or explicitly identified, for example, there is an implicit relationship between an entity and its attributes. The relationship symbol is represented by a line which connects the definition and composition symbols denoting relationships between the defined items. The *composition* symbol on the other hand, enables a model diagram to be displayed on more than one page. Boxes with rounded corners are used to represent this.

The symbols used are outlined below:

a) Definition Symbols

There are four types of definition symbols in EXPRESS-G; entity, schema, simple type and data type. Each is represented by a rectangle enclosing the name of the item being defined. The type of definition is signified by the style of the rectangle. Figure 6.1 (a) depicts the symbol for an entity, which is a solid rectangle enclosing the name of the

entity. The symbol for a schema, which is a collection of items forming part of, or the whole model is shown in Figure 6.1 (b). The use of schemas allow partitioning of data onto discrete topics of interest. A schema is represented by a solid rectangle divided in half by a horizontal line. The name of the schema is written in the upper half of the rectangle, with the lower half being empty.

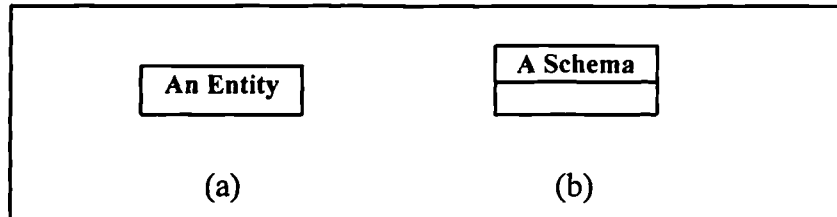


Figure 6.1: Symbols for an Entity and a Schema

EXPRESS-G supports a number of predefined simple types. They include Binary, Boolean, Integer, Logical, Number, Real and String. The symbol for the simple type is a solid rectangle with a double vertical line at its right end. The name of the simple type is enclosed within the box, as shown in Figure 6.2 (a). Also, there are three types of symbols used to select, enumerate and define data types. These are represented as dashed boxes as shown in Figure 6.2 (b).

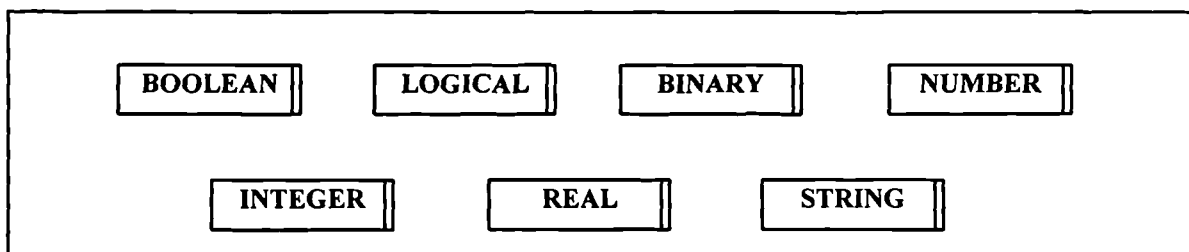


Figure 6.2 (a): Simple Type Symbols

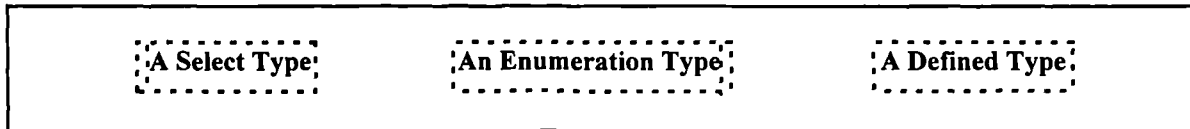


Figure 6.2 (b): Type Definition Symbols

b) Relationship Symbols

The relationship symbol is represented by a line which connects the definition and composition symbols denoting relationships between the defined items. There are three types of different line styles: dashed, thick or normal, as shown in Figure 6.3 (a). A dashed line represents a relationship for an optional valued attribute. A thick solid line represents a supertype-subtype relationship. A supertype is a generalisation of its subtypes and, conversely, a subtype is a kind of specialisation of its supertype(s). This indicates that EXPRESS-G supports supertype/subtype inheritance hierarchies. Finally, a normal solid line represents all other relationships. Relationships are bi-directional, with one direction being emphasised. For example if an entity E has an explicit attribute whose type is A, then the emphasis will be in the direction E to A. In EXPRESS-G, the *to* end of the relationship is marked with an open circle. An example is shown in Figure 6.3 (b).

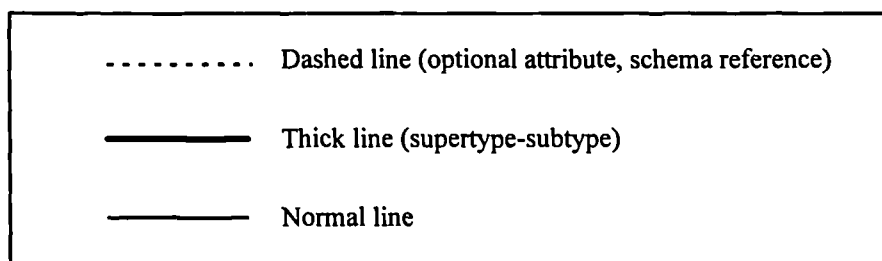


Figure 6.3 (a): Relationship Line Styles

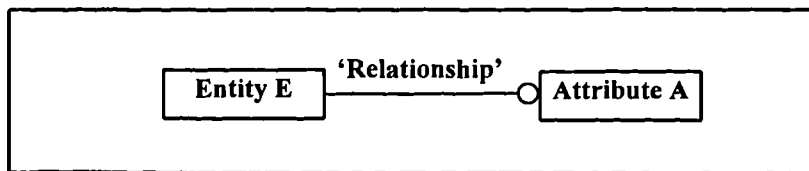


Figure 6.3 (b): Open Circle showing the *to* end relationship

c) Composition Symbols

The composition symbol enables a model diagram to be spread out over a number of pages. Boxes with rounded corners are used to represent the composition symbol, as shown in Figure 6.4. For “reference onto another page”, “name” refers to the named entity or attribute which is referred on page “page #”, with reference number “ref #”. For “reference onto this page”, “page #” represents the page on which the entity/attribute is currently shown with reference number “ref #”, while “#, #,” represent the page(s) from which the entity/attribute is referenced.

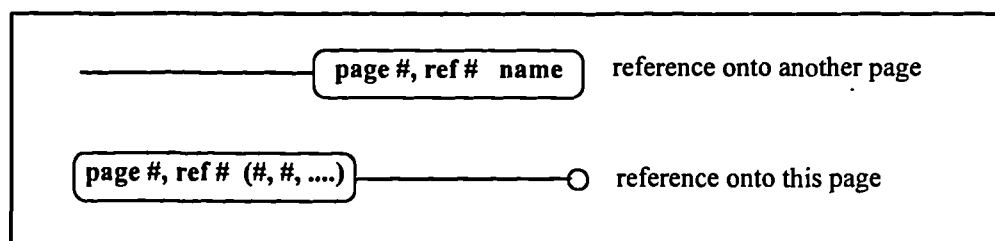


Figure 6.4: Composition Symbols

6.3 Forms of Model

An EXPRESS-G model can be produced in one of several forms depending on whether a single schema or multiple schemas are being represented, and on the amount of detail being displayed. Therefore, an EXPRESS-G model comes in one of two forms:

1. **A single schema model**, which displays only the definitions and relationships that comprise an information model within the schema (**an entity-level model**)

2. **Multiple schemas model**, which displays the schemas, and the relationships between the schemas that comprise an information model (**a schema-level model**). The contents of the schema (i.e. the entities, types, etc.) are not displayed.

For the purpose of examining, analysing and classifying the information required for the development of the client's brief, the entity-level model has been used.

6.4 Developing the EXPRESS-G Models

Prior to the development of the data models, the scope has to be specified. The scope of the model comprises all information related to the development and presentation of the client's brief. This information incorporates all information relevant to individual projects as well as that available from within the construction industry, which may have some influence or bearing on the outcome of the final design solution. This information is referred to as the "Construction Industry Know-how". The scope of the model, however, does not include the generation of the design solution, and is limited to the information or data which leads to the presentation of the contents of the client's brief. The level of detail of the modelling process for a specific item of information was decided upon by considering its dependency on other related information or vice versa.

Once the scope for the development of the models has been identified, all the information pertaining to the development of the brief is gathered, organised and classified to allow for the systematic creation of the models. The modelling process utilises the structured framework for the brief presentation which was derived in Chapter 3, together with additional information from the main sources of literature

discussed in Chapter 3. Where appropriate or necessary, other relevant sources of information have also been referred to in order to fill any gaps in the information.

The starting point for the information modelling was conducted by using the top-down approach, whereby the information was first analysed and modelled at a high level, followed by the lower levels of abstraction. In certain parts of the models, however, the different levels of abstraction need to be cross-referenced. The result is, a mixture of top-down, bottom-up and middle-out strategies.

The development of the models follows the four phase approach recommended by Schenck and Wilson, (1994). These phases are:

- Basic objects
- Relationships and attributes
- Completion of constraints
- Model Integration

6.4.1 Phase 1: Basic Objects

The main objective of this phase is to develop the major aspects of the items/objects in, and the general structure of, the model. In other words, this phase involves finding and identifying the real world entities, according to the problem domain or scope, which in this case refers to the entities relevant to the development of the brief. This entails recognising the major pieces of information that need to be represented in the model, and selecting appropriate names for these items. This involves, firstly, the creation of entities that will form the data model at the highest possible level, i.e. the Context

Diagram. This is followed by the identification of entities at lower levels of detail, labelled as Level 1, Level 2, and so on. For example, the entities identified for the context diagram are “Project” and “Brief”, along with “Project Identification”, “Project Aims”, “Project Resources”, “Project Context” and “Design and Performance Requirements”, which have been obtained from the structured framework derived in Chapter 3.

Once the entities have been identified, the next stage involves finding and identifying their attributes. By describing the major aspects or properties of the entities, simple type attributes are identified. During the process, more complex ones also emerge, which may require further objects for their representation. This results in the identification of a new object, which is then added to the model. For example, “Design Criteria” was initially identified as an attribute of “Design and Performance Requirements”. With further analysis, it was discovered that this attribute is in itself a large source of information which can be further sub-divided. This leads to the formation of the “Design Criteria” entity.

The next step is to find out whether the entities can be categorised and whether there are any specialisation relationships between the entities. This involves recognising that some entities may be a special type of another entity, which will result in a supertype/subtype relationship. This normally leads to the identification of the more general entity, i.e. a more general name for the supertype, which can then be added to the model. For instance, the subtypes added to the “Design and Performance Requirements” entity were “Site and Surroundings”, “The Building as a Whole”,

“Building Fabric”, “Spaces in Detail”, “Grouping of Spaces” and “Plant, Equipment and Furnishings” (Figure 6.10).

Another factor considered during the development of the models was whether any local consistency constraints apply to any of the entities. If there are readily identifiable constraints that apply to every instance of an entity, these are recorded. For example, if a number represents the age of an entity, then that number should be constrained to be positive.

To facilitate with the process of understanding the model, the entities and attributes are documented by describing the intended meaning of all the constructs in the model. This is followed by the examination of the simple types to make sure that they are appropriately used. At the end of the phase, the model is reviewed to ensure that the developed entities and attribute represent all the information required for the development of the client’s brief.

6.4.2 Phase 2: Relationships and Attributes

This phase is concerned with refining the model developed in phase 1. It entails the identification of the relationships between the entities in the model. The manner in which the entities are associated with each other is determined, and the constraints on these relationships, if any, are identified.

The process of categorising the entities is repeated in this phase. The entities are categorised to identify any inheritance, subset or specialisation relationships between

them. Further categorisation takes place, especially at the lower levels of detail. Throughout the phase, the categorisation structures in the model are reviewed and refined.

This phase also calls for a re-examination of simple types to check whether they are appropriate. Entities and attributes are also examined to find out whether additional attributes are required to characterise an entity. The method for deriving the attribute values is identified to see if these values are dependent on or derived from other attribute values. If so, these are recorded and the necessary relationship added to the model.

Further analysis includes checking whether the existence of one entity is dependent on its usage by another entity. Indirectly, this will lead to a form of relationship being identified between the two entities. Combinations of attribute values are also examined to see if any combinations uniquely identify an entity instance. To complete the relationship identification, local consistency constraints are identified to see if they are applicable to the entities. An example of a local constraint is where the value of an attribute is constrained within a certain range, such as the number of months in a year is between 1 and 12.

During this phase, entities, relationships, attributes, and types are added to the entity-level models. The phase is iterated at various levels of abstractions until the model reaches the desired level of detail. The model is then reviewed to ensure that all the

relevant information has been embodied. Finally, the resulting entities, attributes and relationships are documented.

6.4.3 Phase 3: Completion of Constraints

Once the developed model is sufficiently mature and stable, the global constraints are defined. Global consistency rules refer to constraints that either apply between entities in a model, or apply to some instances of a particular entity. When the global rules are identified, they are documented. During this phase, further analysis is carried out to ensure that all the existence dependencies, the uniqueness constraints and other cardinality constraints are captured. Existence dependency refers to the situation where the existence of an instance of a class is dependent on an instance of another related class. A uniqueness constraint, on the other hand, occurs when the value of some attributes, or a combination of attribute values, are unique across all instances of a class, which indicates that they can be used to identify objects. The model is also checked to see if there are any local consistency rules.

Another consideration is whether the model developed is well partitioned. The partitioning of the models was carried out based on the levels of detail of the information required for the development of the brief. Entities which required further examination were partitioned to ensure a rigorous portrayal of the contents of the client's brief at various levels of detail, as well as, for understandability and explanatory purposes. This gave rise to the models being developed at different levels of diagram; level 0 (context diagram), level 1, level 2, and so on. At the end of this phase all the constraints are documented.

6.4.4 Phase 4: Model Integration

Phase 4 is usually carried out for a large information model, where the work is broken down into parts with different modelling groups being responsible for certain parts of the model only. When all parts of the model have been completed they are integrated to form one whole model. For this study, since the model has been divided into partitions at different levels of detail, it is essential to make sure that all the components that make up the partitions at various levels, are consistent, compatible and non-contradictory. Due to the large nature of the model, the overall integration of the model requires more than one physical page. For this reason, the final presentation of the model maintains the partitioning at different levels of detail. Links or relationships between a component of one diagram (partition) and a component in another diagram, are made by using the composition symbols. Once the overall integration has been carried out, the links between the relevant components are reviewed to ensure consistency in the data model.

For this study, this phase represents the final stage of the model development process. The resulting data model portrays the full representation of the information required for the development and presentation of the client's brief.

The succeeding sections in this chapter present the developed data models for brief development. A full set of the developed models are also presented in Appendix B. The models will be presented sequentially based on the levels of detail within them. It begins with the highest level, the context diagram, followed by the level 1, level 2, and level 3 diagrams. For each diagram, the main components of each model will be described.

Where necessary, the source from which the component of the model has been derived is also highlighted.

To assist with the presentation and discussion of the data models in the following sections, each data model is depicted by a figure, for example Figure 6.1. Each figure is also labelled as “Page x of y”, where “x” refers to the page corresponding to the data model; and “y” refers to the total number of pages for all the data models, which is 22. The page references denoted by the composition symbols on the data models refer to the above mentioned data model pages, and not the pages of this document.

6.5 The Context Diagram - The Framework of the Brief Presentation

Figure 6.5 depicts the complete entity-level model for the framework of the brief presentation. This is the highest level of information, which constitutes the contents of the client’s brief. It illustrates that the brief, represented by the “Brief” entity, is a statement which describes a construction project. This is depicted by the “describes” relationship between the “Brief” entity and the construction project, denoted by the “Project” entity. Conversely, a project may or may not be described by a brief, indicated by the default cardinality of [0:?], which is not shown in the figure. The [0:?] cardinality is also meant to cover cases where a project may be described by more than one brief. This occurs whenever the brief is prepared iteratively as more client’s requirements are identified and included in the brief. In such cases, the brief becomes more comprehensive as more information or requirements are incorporated within it.

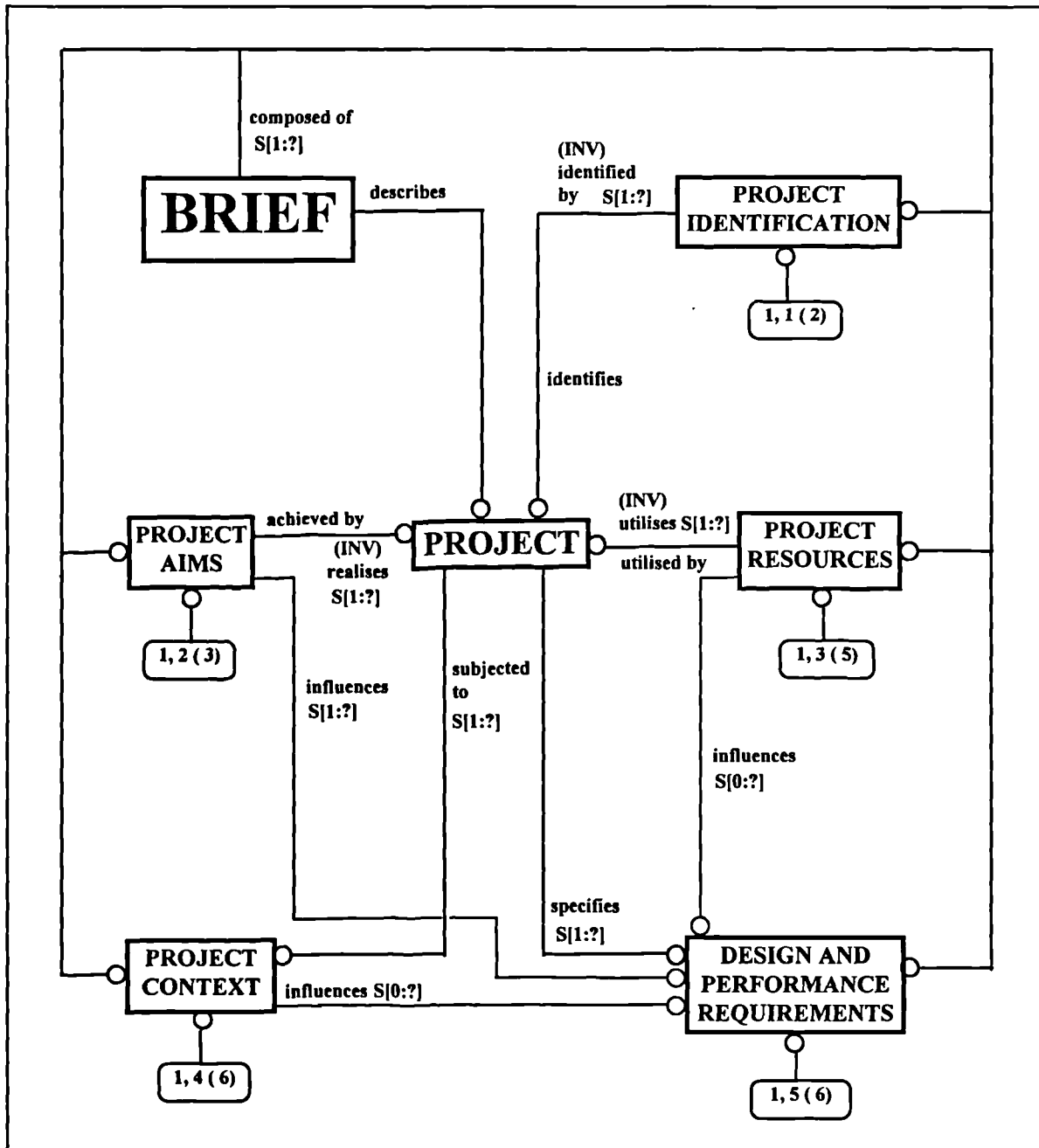


Figure 6.5: Context Diagram - The Framework of the Brief Presentation
(Page 1 of 22)

The project itself has explicit relationships with specific related entities such as “Project Identification”, “Project Resources”, “Project Aims”, “Project Context” and, “Design and Performance Requirements”. These entities, referred to as the main entities, were obtained from the main sections of the structured framework for the brief presentation derived in Chapter 3. “Project Identification” summarises the project identity, its scope

and purpose. “Project Aims” emphasises the objectives of the project in terms of the “intended effects” to be achieved from the project. “Project Resources” identifies the resources that can be utilised by the project. “Project Context” states the internal and external constraints imposed on the project. Finally, “Design and Performance Requirements” refers to the design and performance aspects which influence the physical characteristics of the project.

Figure 6.5 illustrates that the “Project” entity is linked by the “identifies” relationship from the “Project Identification” entity, and inversely, by the “identified by” relationship. This implies that an instance of a “Project Identification” entity can identify an instance of a “Project” entity, whereas an instance of a “Project” entity is identified by one or more instance(s) of “Project Identification”. In addition, the “Project Aims” and the “Project Resources” entities are each connected to the “Project” entity by the “achieved by” and “utilised by” relationships respectively. In the opposite direction, the “Project” entity realises one or more “Project Aims”, and utilises one or more “Project Resources”. The “Project” entity is also “subjected to” one or more instances of the “Project Context” entity. This means that the “Project Aims” entity can only be realised by utilising the available “Project Resources” within the constraints imposed on the project as stipulated by the “Project Context” entity.

Furthermore, the “Project” entity “specifies” the “Design and Performance Requirements” entity which represents the physical aspects of the project. To complete the picture, the “influences” relationships exist between the “Project Aims”, “Project Resources” and “Project Context” entities and the “Design and Performance

Requirements” entity, with their respective cardinalities as shown in the figure. This suggests that some form of influence exist between these three entities and their subtypes or attributes before the “Design and Performance Requirements” entity can be specified for the project.

The five main entities described above, represent the information which is essential for inclusion in the brief. This is signified by the “composed of” relationship between the “Brief” entity and the five main entities. The cardinality [1:?] indicates that a brief can contain one or more instance(s) of each of the five entities. Inversely, however, an instance of any of these entities may or may not be contained or documented in any form of a brief, i.e. reflected by the default [0:?] inverse cardinality. This is meant to cover situations where the brief does not exist at all for some projects, as well as those where one or more briefs are prepared for one project.

From each of these five entities, a composition symbol is attached which indicate reference onto this page, from other pages. For example, the composition symbol for the “Project Identification” entity shows the numbers “1,1 (2)”. The first number “1” refers to the data model page, Page 1 (Figure 6.5), which is where the context diagram is. The second number “1” is the reference number attached to the “Project Identification” entity, while the number in the bracket refers to the page number(s) of the model from which further information on “Project Identification” can be obtained, i.e. Page 2 (Figure 6.6). The five entities are then further sub classified according to their subtypes and/or relationships with other entities, which gives rise to the Level 1 diagrams.

6.6 The Level 1 Diagrams

At this level of abstraction, the main entities which forms part of the “Brief” entity depicted in Figure 6.5, are examined and decomposed further. Each main entity will be presented individually or otherwise, along with their attributes and subtypes, where applicable.

1. The “Project Identification” Entity

Figure 6.6 illustrates the complete entity-level model for “Project Identification”. The “Project Identification” entity has a subtype “Project Identity” which identifies the particular project uniquely, i.e. by “describing” in terms of its title, reference, building type and location. The first three are attributes of “Project Identity”, while the fourth one is an entity in itself, which has the attributes lot number or reference, road name, town, postcode and county, as shown on Figure 6.6.

The “Project Identification” entity has the relationship “outlines” with the “Project Purpose” and the “Project Scope”. The “Project Purpose” entity “identifies” the “Project Main Reasons”, “Project Main Aims” and the “Purpose of the Brief”. The “Project Main Reasons” are obtained from the “Reasons for Current Action” entity on Page 11. The “Project Main Aims” summarises the “Project Aims” entity found on Page 3 and considers the “Life Expectancy” of the building. The purpose of the brief may be included in the brief document. This can be either for the purposes of instruction, discussion, recording or as a basis for evaluation. The “Purpose of the Brief” can be considered as an attribute of the “Project Purpose” entity.

The “Project Scope”, on the other hand is linked to six entities by the “determines” relationship. The first entity, “Project Size” “can be expressed as” “Gross Floor Area”, “Lettable Floor Space” and/or “Total Occupancy” which is sometimes referred to as occupant capacity or simply as number of users. These three entities are attributes of the “Project Size” entity. The other entities linked to “Project Scope” are also linked to their respective related entities by the composition symbols. This indicates that the necessary information for these items is obtained from other parts of the model, and transferred to this part for summing up or identification purposes. The “determines” relationship between “Project Scope” and its related entities differ in terms of cardinality. This is shown at the attribute end of the relationship. The cardinality for “Project Size” and “Quality Standards” is [1:?] each, while that for “Future Changes” is [0:?], indicating that “Project Scope” may identify none or more “Future Changes”. Where no cardinality is displayed on the relationship line, it indicates a [1:1] cardinality, which identifies the entity as an attribute.

Apart from the above, the “Project Identification” entity also “provides” the “Identity of Project Participant Organisations” (such as the client, the designer and the engineers) as well as those who are indirectly involved with the project, referred to as the “Related Group Organisations”. These include the central and local government, the building authorities, the town planning authorities, etc. Further information regarding these two entities is compiled in the “Identity” entity on Page 7 of the model as indicated by the composition symbol.

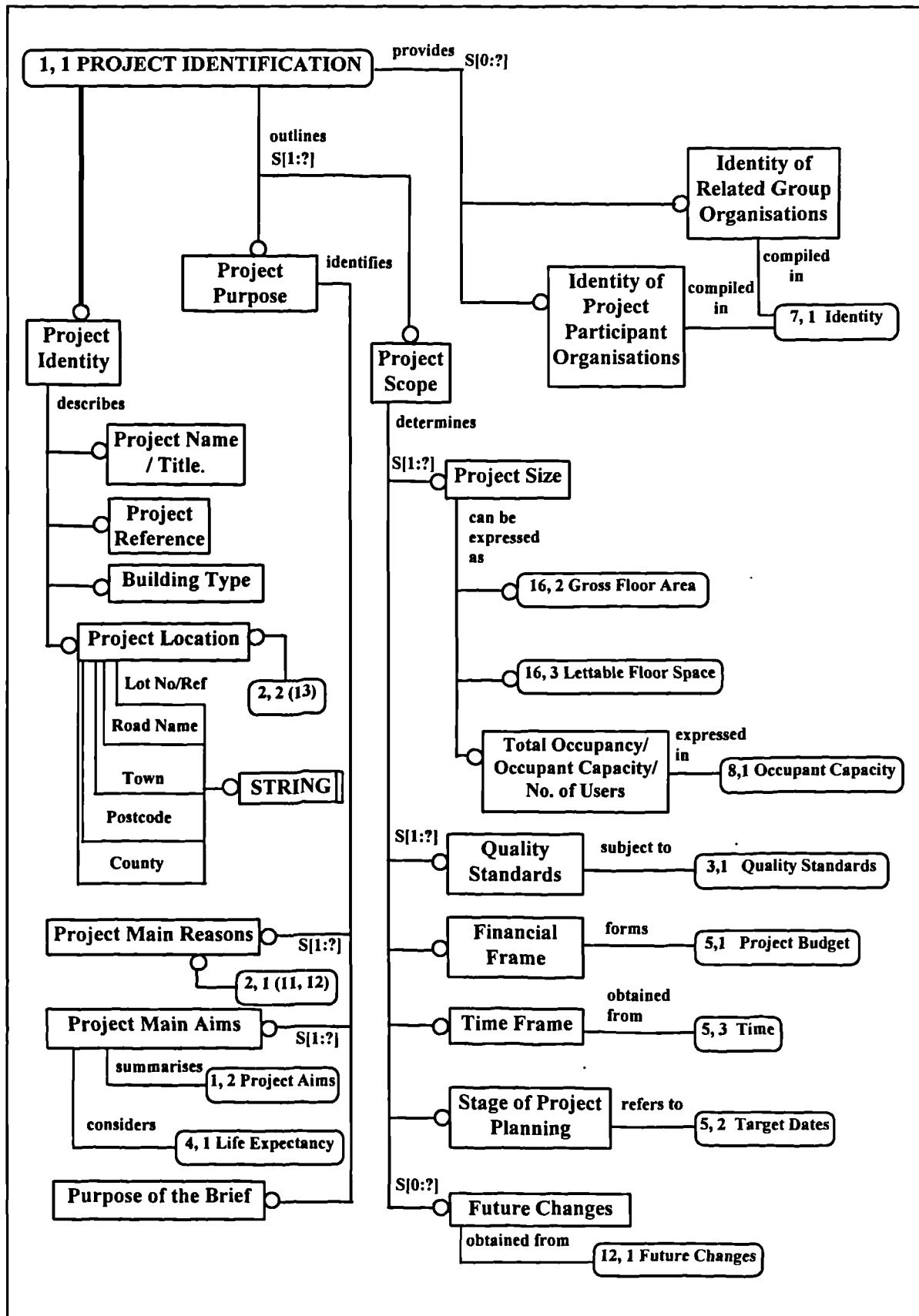


Figure 6.6: Level 1 Diagram - Project Identification (Page 2 of 22)

2. The “Project Aims” Entity

The “Project Aims” entity contains information associated with the realisation of the project as shown in Figure 6.5. Figure 6.7 illustrates the level 1 diagram for Project Aims. The “Project Aims” entity is “expressed as” “Intended Effects of the Project”. The “Intended Effects of the Project” is meant to contain brief outlines of the client’s requirements in terms of the desired effects to be achieved by and the benefits gained from the project. The “Intended Effects of the Project” entity has four subtypes; “Effects on Client Enterprise”, “Effects on Users/ the Public”, “Effects on the Environment” and “Control of Undesirable Effects/External Environment”.

The “Intended Effects of the Project” entity is linked to the “Priorities” entity by the “establishes” relationship. This encourages the weighting of the priorities of a project from the early stages of design. For example, aspects such as the time available for the project, the allocation of costs, the quality standards, and above all, the value for money, can be clearly set out before the client actually embarks on the project. These priorities make up the subtypes of the “Priorities” entity. One way of prioritising these is by introducing a ranking for each of the subtypes, which is denoted by the “Ranking” attribute. The inclusion of ranking as a form of expressing the priorities is meant to serve as an example. Other methods used for this purpose are outside the scope of this model. For the “Quality Standards” subtype, the models suggests two ways of expressing the quality standards, firstly in the form of materials, workmanship and finishes, and secondly, in relation to functional, technical and aesthetic aspects, whichever is appropriate.

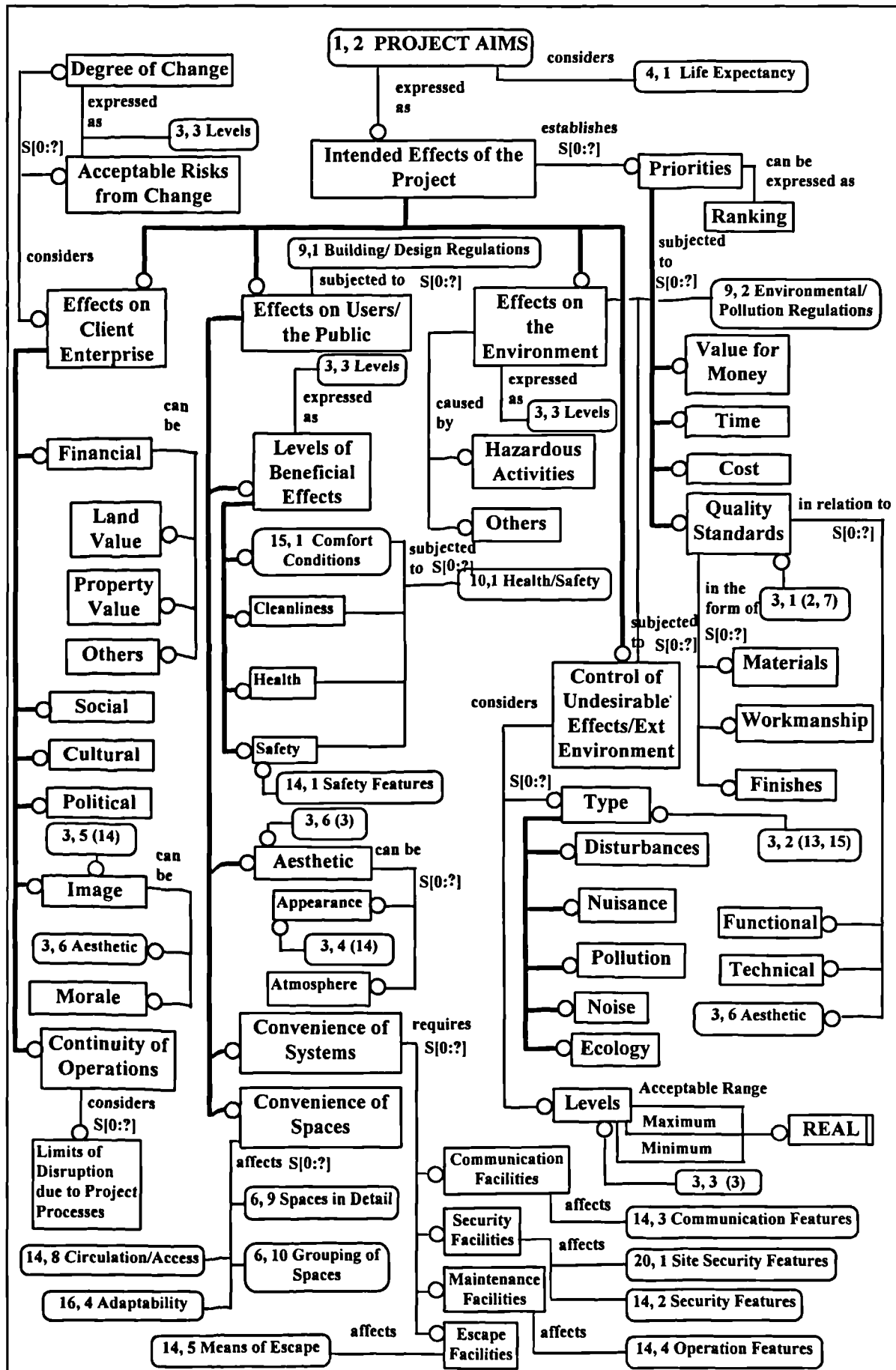


Figure 6.7: Level 1 Diagram - Part Entity-Level Model of Project Aims
(Page 3 of 22)

The first subtype of “Intended Effects of the Project”, which is the “Effects on Client Enterprise” entity, considers two entities, “Degree of Change” and “Acceptable Risks from Change”. Both these entities are linked to the “Levels” entity by the composition symbol, “3,3 Levels”. The “Levels” entity is a general entity with attributes “Acceptable Range”, “Maximum” and “Minimum”. It is applicable to most of the information. The appropriate levels and the method of measurement would depend on the actual item being investigated. Also depicted in Figure 6.7, are the subtypes of “Effects on Client Enterprise”. These are “Financial”, “Social”, “Cultural”, “Political”, “Image” and “Continuity of Operations”. These subtypes have been modelled to the entity level only. The “Financial” entity has the “can be” relationship with “Land Value”, “Property Value” and “Others”. This indicates that the effects on the client’s enterprise can be measured financially in terms of the value of the land, property or in other forms. For each of these, the levels of the degree of change and the acceptable risks from changed can be measured as appropriate. Similarly, the “Image” entity, which is associated with the prestige level of the client enterprise “can be” in the form of “Aesthetic” or “Morale”. The last subtype, “Continuity of Operations”, however, is linked to the “Limits of Disruption due to Project Processes” defined type. This indicates that the continuity of operation can be measured by some defined type which suits the particular client’s enterprise. For example, it can be defined as the number of hours per day or access to certain floor space within a specified duration, etc. The “Continuity of Operations” is only applicable if the new project affects the client’s current premises.

“Effects on Users/ The Public” represents the second subtype of “Intended Effects of the Project”. It has four subtypes, which are “Levels of Beneficial Effects”, “Aesthetic”,

“Convenience of Systems” and “Convenience of Spaces”. The “Levels of Beneficial Effects” entity, in turn, has four subtypes. They are “Comfort Conditions”, “Cleanliness”, “Health” and “Safety”. This information is required in the brief so that the precise levels of beneficial effects can be determined earlier on before the design solution is obtained. For this reason, the “Levels of Beneficial Effects” entity is linked to the “Levels” entity, indicating that its subtypes can be measured in some form or another. The “Comfort Conditions” entity is further linked to its counterpart on Page 15 (Figure 6.19), which depicts its attributes and relationships. All four subtypes of “Levels of Beneficial Effects” are subjected to none, one or more regulations found in the “Health/Safety” entity. The “Safety” entity is also linked to the “Safety Features” entity on Page 13 (Figure 6.17).

The next entity, “Aesthetic”, which represents the second subtype of the “Effects on Users/ The Public” entity, has the relation “can be” with the entities, “Atmosphere”, and “Appearance”, which is referenced from Page 14 (Figure 6.18). “Atmosphere” can be considered as a user defined type with values, such as “formal”, “friendly”, etc. which may affect the design solution. The “requires” relationship links the third subtype, “Convenience of Systems”, to “Communication Facilities”, “Security Facilities”, “Maintenance Facilities” and “Escape Facilities” which relate to the desired systems or features to be incorporated within the building. Each of these entities is linked to their respective features as shown by the composition symbols. Similarly, the “Convenience of Spaces” entity has a bearing on the “Spaces in Detail”, “Grouping of Spaces”, “Circulation/Access” and “Adaptability” entities, portrayed on different pages as shown by the composition symbols.

The third subtype of “Intended Effects of the Project”, which is “Effects on the Environment”, refers to the effects that the new project will have on the environment. It is linked to the “Hazardous Activities” and the “Others” entities by the “caused by” relationship. Hazardous activities can be in the form of radiation, pollution, chemicals, ecology, bacteria, vibrations, etc. which come about with the realisation of the project. Each of these effects can be measured in some way, which give rise to the link from the “Effects on the Environment” to the “Levels” entity.

Finally, the fourth subtype of the “Intended Effects of the Project” entity, is “Control of Undesirable Effects/External Environment”. This refers to the control of existing types of undesirable effects to the completed building. Therefore, this entity “considers” the “Type” and “Levels” entities, where “Type” represents the types of undesirable effects that need to be controlled, and “Levels” indicate the acceptable range and values. The “Type” entity is also referenced from Page 13 and 15 (Figures 6.17 and 6.19 respectively).

Figure 6.8 depicts the continuation of the entity-level model for Project Aims. Figure 6.7 shows that the “Project Aims” entity is related to the “Life Expectancy” entity by the “considers” relationship. The “Life Expectancy” entity is expanded further in Figure 6.8. Firstly, it has two subtypes; “Structural”, which refers to the life expectancy of the structural components of the building, and “Finishes”, that is the life expectancy of the finishes to the building. Secondly, the “Life Expectancy” entity has “Start Date” and “End Date”, both of which are linked to the “Date” entity. The attribute “duration” has an “*” in front of it indicating that there is some constraint involved, i.e. it is dependent

on other attribute values (the difference between the end date and the start date). The “Date” entity has three attributes; namely “Day”, “Month” and “Year”, which are all of simple types, integer.

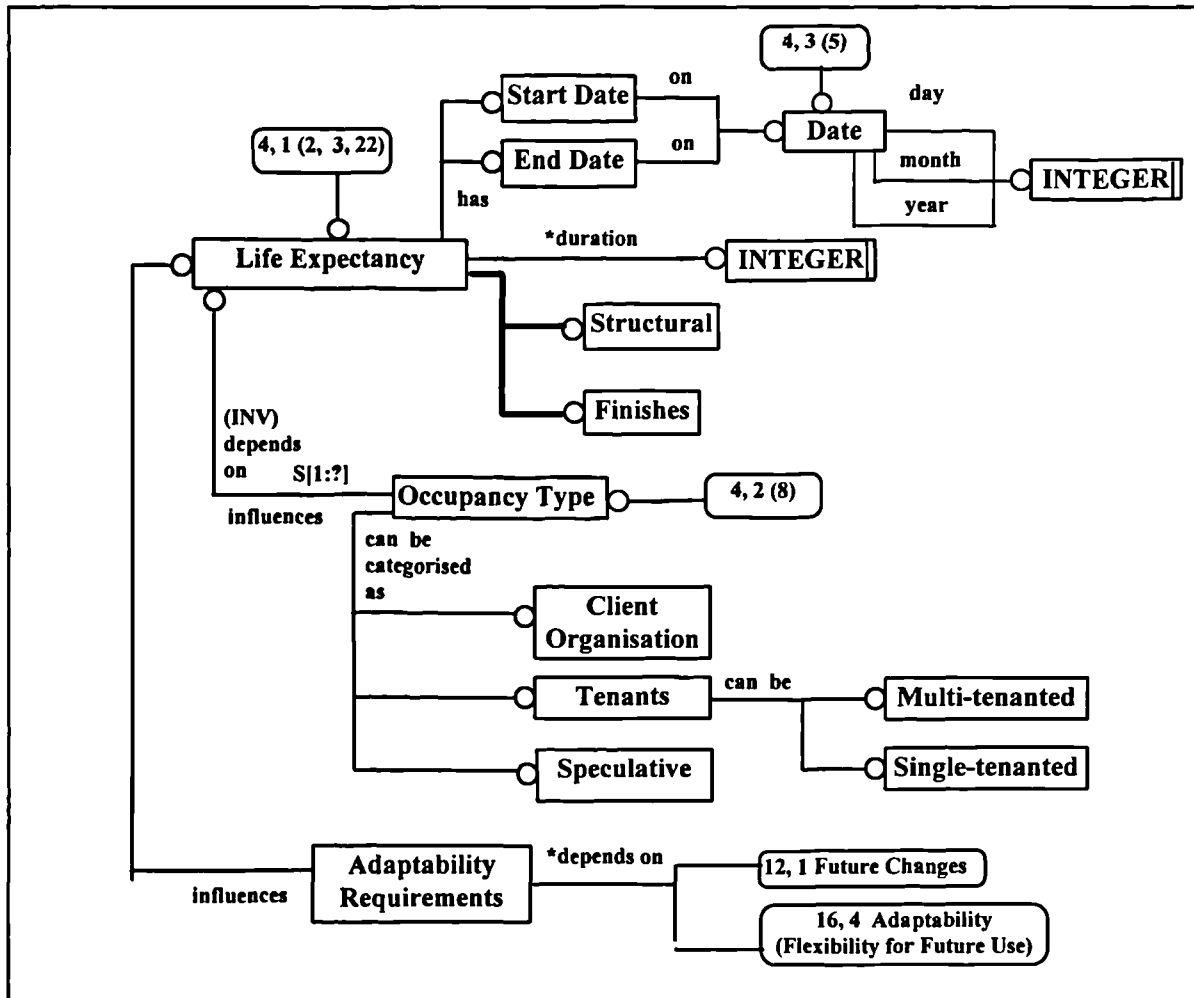


Figure 6.8: Level 1 Diagram - Part Entity-Level Model of Project Aims -Life Expectancy (Page 4 of 22)

Figure 6.8 also shows that the “Occupancy Type” entity “influences” the “Life Expectancy” entity, which is inversely dependent on one or more instances of the “Occupancy Type” entity. The “Occupancy Type” entity, in turn, can be categorised as “Client Organisation”, “Tenants” or “Speculative”. The “Tenants” entity “can be” either “Multi-tenanted” or “Single-tenanted”. The “Adaptability Requirements” entity also has

the “influences” relationship with the “Life Expectancy” entity. The constraint in this case denotes that the occupancy type and the adaptability requirements would have some influence on the life expectancy of the building in question. The “Adaptability Requirements” entity has the “*depends on” relation to the “Future Changes” entity, found on Page 12 (Figure 6.16) and the “Adaptability (Flexibility for Future Use)” entity shown on Page 16 (Figure 6.20). The constraint here indicates that there is an existence dependency of the “Adaptability Requirements” entity on these two entities. If there are no instances of the “Future Changes” entity and the “Adaptability (Flexibility for Future Use)” entity, then, the “Adaptability Requirements” entity does not exist.

3. The “Project Resources” Entity

The third main entity linked to the “Project” and “Brief” entities shown in Figure 6.5 is the “Project Resources” entity. This is further divided into three subtypes; “Financial Resources”, “Time” and “Project Management” as illustrated in Figure 6.9. “Project Resources” deals with financial and time resources including the risks involved. It can also be considered as a plan for managing the resources available to accomplish the project; from the experts (“Project Management”), to the budget for the project (“Financial Resources”) within the planned programme (“Time”).

All the three subtypes have been adapted from O’Reilly (1987) and British Standard Institution (1995). “Financial Resources” is associated with the sources of financing or funding for the project, and is linked to the “Project Funding” entity by the “comes from” relationship. The cardinality [1:?] indicates that there can be one or more

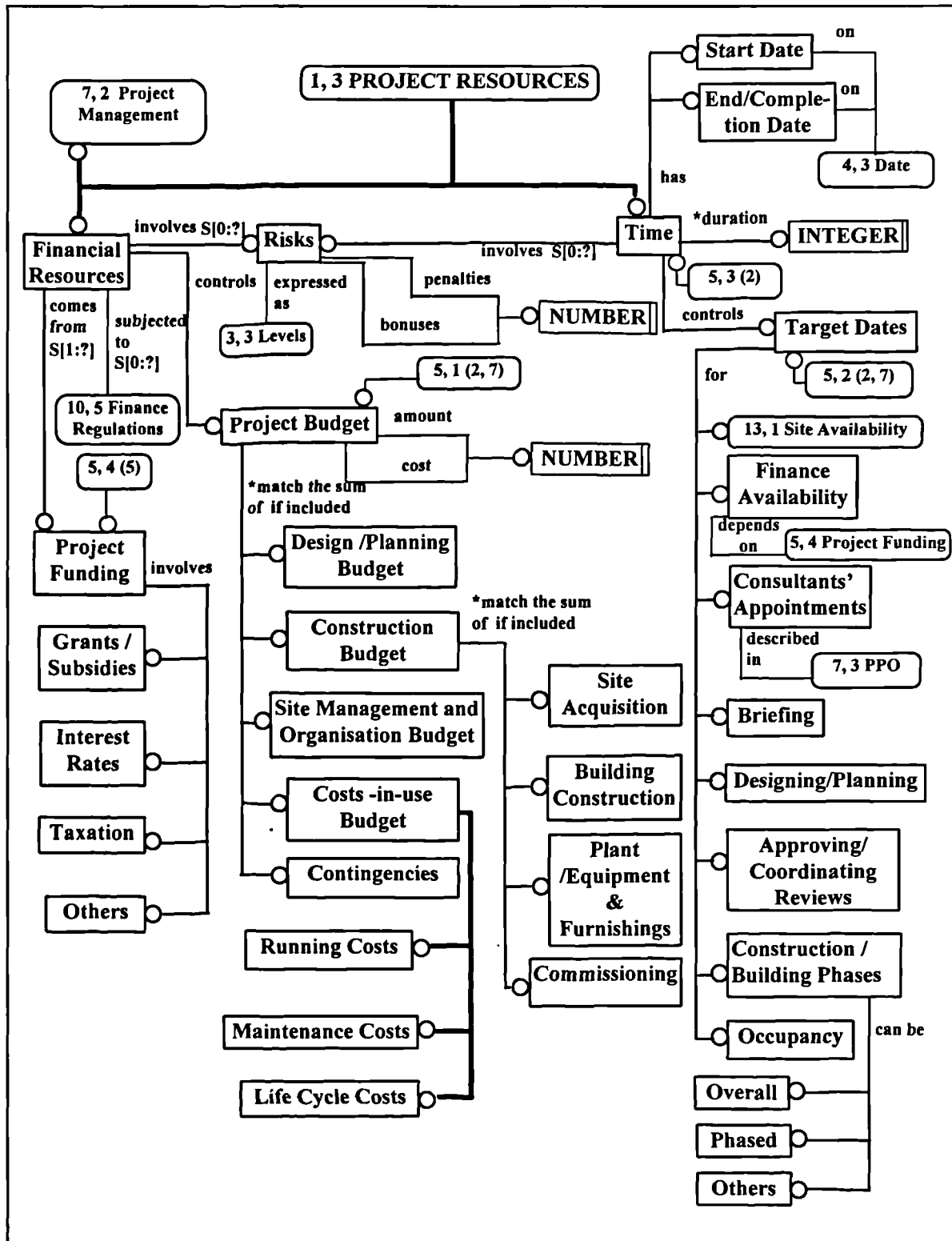


Figure 6.9: Level 1 Diagram - Project Resources (Page 5 of 22)

source(s) of funding. The “Financial Resources” entity “controls” the budget available for the project, represented by the “Project Budget”, and possibly how this budget will

be utilised effectively in terms of the budget size and the actual costs of design, construction, site management, life cycle costs and any other related costs. For this reason, there are two attributes attached to the “Project Budget” entity. These are “amount”, which refers to the budget size, and “cost”, which refers to the actual costs incurred when the project is off the ground. These two attributes can be used for comparison purposes.

The “Project Budget” entity has the “*match the sum of if included” relationship with five entities. These are “Design/planning Budget”, “Construction Budget”, “Site Management and Organisation Budget”, “Costs-in-use Budget” and “Contingencies”. The constraint attached to the “*match the sum of if included” relationship denotes that the total project budget should agree with the sum of the budgets for all the entities put together, if they are included in the project’s budget. As an example, if only the first three entities out of the five are included in the project’s budget, then the sum of these three should match the “Project Budget”. This is incorporated into the model to allow for varying practices carried out by clients and other project participants within the construction industry, as well as to highlight aspects which should be included in the project budget, but which may otherwise be excluded by certain parties in the construction industry.

For similar reasons, the “Construction Budget”, has the “*match the sum of if included” relationship with four entities. These are “Site Acquisition”, “Building Construction”, “Plant/Equipment & Furnishings” and “Commissioning”. Again, due to differing circumstances, not all the entities may be included in the estimate for the “Construction

Budget”. For instance, if the client owns the site where the project is going to be erected, then “Site Acquisition” may not be included in the budget. In any other situation, it is likely to be included in the construction budget. The “Costs-in-use Budget” entity, on the other hand, has three subtypes which include “Running Costs”, “Maintenance Costs” and “Life Cycle Costs”, which refer to the costs that the building will incur after occupation. Information related to these costs may be obtained from historical data of previously completed projects of a similar nature.

Also portrayed in Figure 6.9, is the second subtype of the “Project Resources” entity, “Time”, which refers to the time resource for the project. It is referenced to the “Time Frame” entity on Page 2 (Figure 6.6) which identifies the overall time frame available for the project. The “Time” entity has “Start Date” and “End/Completion Date” which are both linked to the “Date” entity on Page 4 (Figure 6.8). It also has the attribute “duration”, whose constraints refer to its value being dependent on the start date and the end/completion date. Based on the client’s project planning, the “Time” entity “controls” or schedules the target dates for important events and the attainment of certain milestones during the project life. For this purpose, the “Target Dates” entity has the “for” relationship with eight entities as shown in Figure 6.9. These entities are “Site Availability”, “Finance Availability”, “Consultants’ Appointments”, “Briefing”, “Designing/Planning”, “Approving/Coordinating Reviews”, “Construction/Building Phases” and “Occupancy”. These entities, to a certain extent represent the items to be included in the project planning. The start date, complete date and the duration attributes of each entity would be depended upon the “Time” entity. By virtue of the “Target Dates” entity being controlled by the “Time” entity, it follows that “Target Dates” and

the eight entities linked to it by the “for” relationship, also have these three attributes attached to them.

Figure 6.9 also shows that the “Site Availability” entity is referenced to Page 20 (Figure 6.24) for further analysis, while the “Finance Availability” entity is linked to the “Project Funding” entity by the “depends on” relation. This implies that the availability of finance over the period of the project depends on the terms and conditions agreed upon with the source of project funding. The “Consultants’ Appointment” entity, in contrast, is linked to the “Project Participant Organisation (PPO)” entity depicted on Page 7 (Figure 6.11). The “Construction/Building Phase” entity is meant to accommodate the different ways of staging the construction process for any particular project, either overall, which covers the whole construction process, or in terms of phases, as in phase 1, 2, etc., or in some other way. In view of this, three entities have been linked to the “Construction/Building Phase” entity; “Overall”, “Phased” and “Others”, the last one to assume any other method of dividing the construction process into stages. The last entity linked to the “Target Dates” entity is “Occupation”, which refer to the date targeted for the completed building to be occupied.

The last entity associated with the Level 1 Diagram of the “Project Resources” entity is the “Risks” entity. It is connected to both the “Financial Resources” and the “Time” entities by the “involves” relationship. It denotes that there is some form of risk involved in terms of the time and financial resources of a project. “Risks” can be expressed as “Levels” as depicted on Page 3 (Figure 6.7). Two attributes are also attached to the “Risks” entity. These are “bonuses” and “penalties” which have the

simple type, number. For example, early completion of a project would give rise to some kind of bonus arrangement to be gained, whilst late completion would lead to penalties being imposed.

The “Project Management” entity which forms the third subtype of the “Project Resources” entity, will be described further in the level 2 diagrams (Figure 6.11). This has been identified as a subtype of the “Project Resources” entity by virtue of the “utilises” relationship that exists between the “Project” entity and the “Project Resources” entity depicted in Figure 6.5.

4. The “Project Context” Entity

Fig. 6.5 shows that the “Project” entity is “subjected to” the “Project Context” entity. This means that the project has to conform to the constraints imposed on the project as stipulated by the “Project Context” entity. “Project Context” explores and describes the existing state of affairs or the context within which design is to be carried out. For this purpose, the “Project Context” entity is sub-classified into five entities as shown in Figure 6.10. They are “Intended Occupancy in Detail”, “Regulatory Issues”, “Background and Historical Influences”, “Site and Surrounding Influences”, and “Client’s Future Enterprise”. The subtypes have been adopted from British Standard Institution (1995) with the exception of “Regulatory Issues” which has been adapted from O’Reilly’s (1987) “Laws, regulations, standard, codes” and “Laws, standards and codes” from BSI (1995). Each subtype is decomposed further in their respective level 2 diagrams.

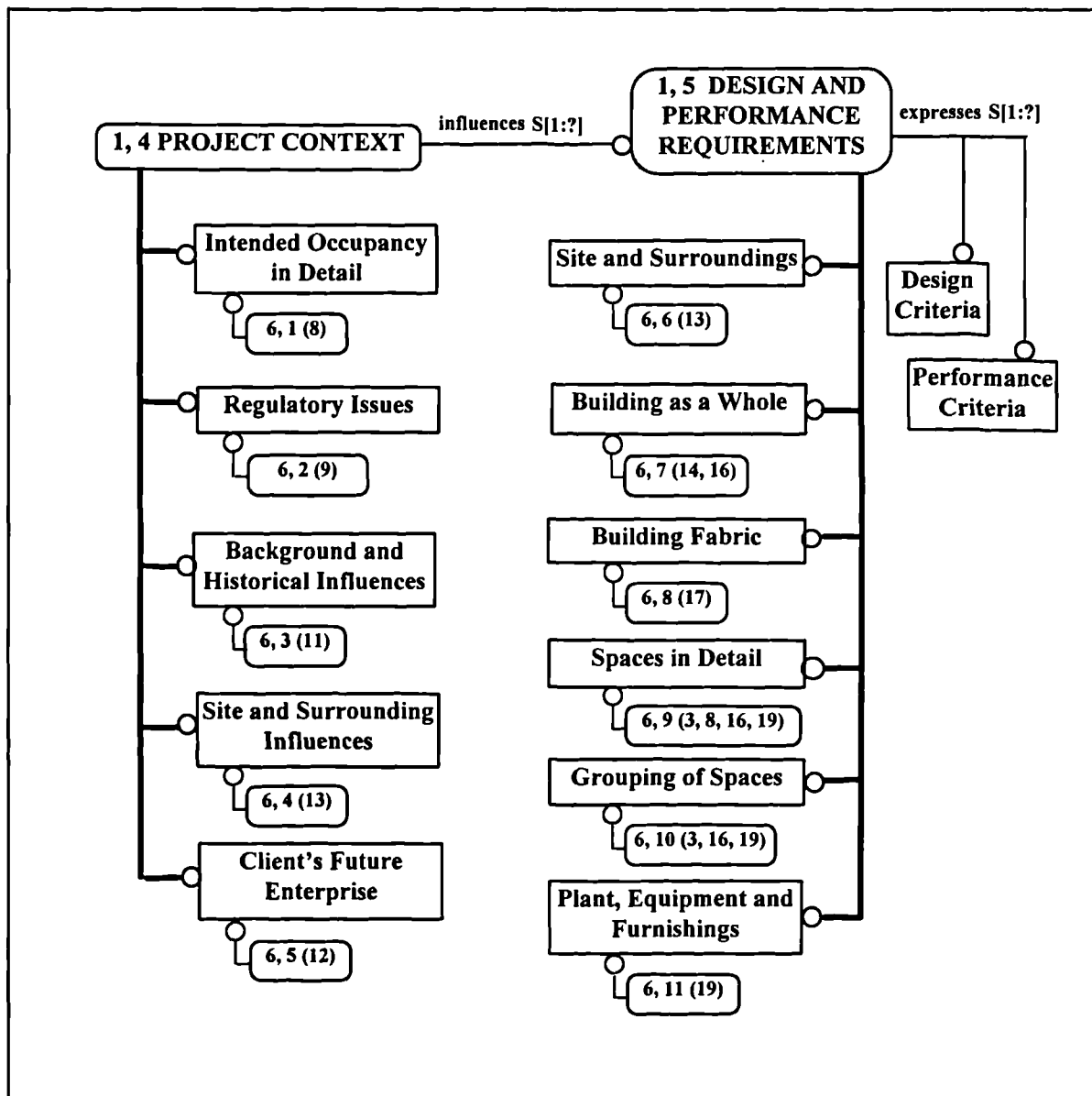


Figure 6.10: Level 1 Diagram - Project Context and Design and Performance Requirements (Page 6 of 22)

The “Intended Occupancy in Detail” spells out the intended occupancy in terms of the activities to be carried out in a building. As such, it examines the “Spatial Activity” entity, as shown in Figure 6.12. This entity identifies the activities or functions to be performed and accommodated within a specific space, represented by the “Spaces in Detail” entity (shown in Figures 6.12), along with other associated factors related to each spatial activity.

The “Regulatory Issues” entity, on the other hand, refers to the existing laws, standards and codes such as planning regulations, building regulations and occupancy laws which the project should comply. The “Background and Historical Influence” entity comprises factors that contribute to the client’s decision to proceed with the project, whilst the “Client’s Future Enterprise” considers decisions concerning the future activities and plans for the client’s organisation. This determines whether the adaptability factor should be incorporated within the design, i.e. whether the “Adaptability Requirements” entity exists or not in Figure 6.8. The “Site and Surrounding Influences” entity identifies all the factors associated with the site and its surroundings such as site availability, ground characteristics, environmental data, and existing infrastructure available for the site and its surroundings.

5. The “Design and Performance Requirements” Entity

The “Design and Performance Requirements” entity refers to the aspects of design and performance that the project aims to achieve, i.e. by specifying what should be accomplished by the project. “Design and Performance Requirements” expresses what the design solution must do, or how it must perform during use, but not what it must specifically be (Duerk, 1993). The “Design and Performance Requirements” entity is therefore, linked to the “Project” entity by the “specifies” relationship as shown in Figure 6.5.

Figure 6.10 depicts the “Design and Performance Requirements” entity and its six subtypes, which are “Site and Surroundings”, “The Building as a Whole”, “Building

Fabric”, “Spaces in Detail”, “Grouping of Spaces” and “Plant, Equipment and Furnishings”, all adopted from BSI (1995). These subtypes represent the intended physical features (product) of the project, based on the specified design and performance requirements.

Figure 6.5 also shows that the “Project Aims”, “Project Resources” and “Project Context” entities, each “influences” the “Design and Performance Requirements” entity. The “influence” relationships imply that certain aspects of the “Project Aims”, “Project Resources” and “Project Context” entities, such as their subtypes and/or attributes, would have some kind of influence on those of the “Design and Performance Requirements” entity. This means that the outcome of the project cannot be achieved successfully without considering the project aims, project resources and project context. The relevant relationship links will be presented in the level 2 diagrams of the data model. As an example, the “creates” relationship between “Intended Occupancy in Detail”, which is a subtype of “Project Context”, and “Spaces in Detail”, which is a subtype of the “Design and Performance Requirements” is shown in Figure 6.12, to illustrate the dependency of the latter on the former.

The “Site and Surroundings” subtype represents information related to the intended design and performance requirements of the site and its surroundings. “The Building as a Whole” records the client’s requirements on how the whole building should look and perform when it is completed. It should perform and blend well with the choice of fabric for the whole building, represented by the “Building Fabric” entity. The “Building Fabric” entity covers information related to the structure, components, finishes, etc.

including the services to be incorporated into the building. The “Spaces in Detail” entity identifies the requirements for individual spaces to be accommodated within the building, the relationships between individual spaces and how these spaces can be grouped together based on the client’s requirements. This aspect is covered by the “Grouping of Spaces” entity. Finally, the “Plant, Equipment and Furnishings” entity deals with aspects of plant, equipment and types of furnishings that the client wishes to install into the building.

Figure 6.10 also shows the relationship “expresses” which exists between the “Design and Performance Requirements” entity and the “Design Criteria” and “Performance Criteria” entities, with the cardinality of [1:?]. This means that each design requirement can express one or more design criteria. Each of the “Design Criteria” and “Performance Criteria” entities has attributes or characteristics which may be similar or unique to a particular subtype of the “Design and Performance Requirements” entity and its constituents. For example, if the “Building Fabric” subtype is decomposed into its constituents such as building systems, building sub-systems or elements, it will be found that some of the attributes can be inherited as we go down the hierarchy whilst others cannot. This is an important criterion to be taken into consideration during the development of the computerised environment stage.

6.7 The Level 2 Diagrams

The previous sections have discussed the main entities associated with the contents of the brief, represented by the “Brief” entity. The level 1 diagrams have been portrayed for each main entity. For the “Project Identification”, “Project Aims” and “Project

Resources” entities, certain parts of the data model contain information at the level 2 diagrams. This has been done to aid the understanding and portrayal of the components of the data model. The level 2 diagrams that follow will cover further decomposition of the last three main entities; the “Project Resources”, “Project Context” and “Design and Performance Requirements”.

1. The “Project Management” Entity

The “Project Management” entity is a subtype of the “Project Resources” entity (Figure 6.9). It keeps a record of all the project participant organisations and related group organisations, as well as describing the responsibility, authority, extent of involvement and roles to be played by each organisation, highlighting any relationships that should exist between any parties concerned. By considering these factors during the development of the brief, it is envisaged that important decisions and any necessary compromises can be made in terms of design evaluation procedures and quality control. These decisions can then be incorporated to form part of the brief.

Figure 6.11 depicts the links between the “Project Management” entity and other related entities and their respective relationships. The information for these entities is portrayed up to the entity level only. The aim here is to demonstrate only the relationships between the relevant entities with the emphasis that better organisation and relationships between the various parties will lead to better communication, and consequently to better management of the project.

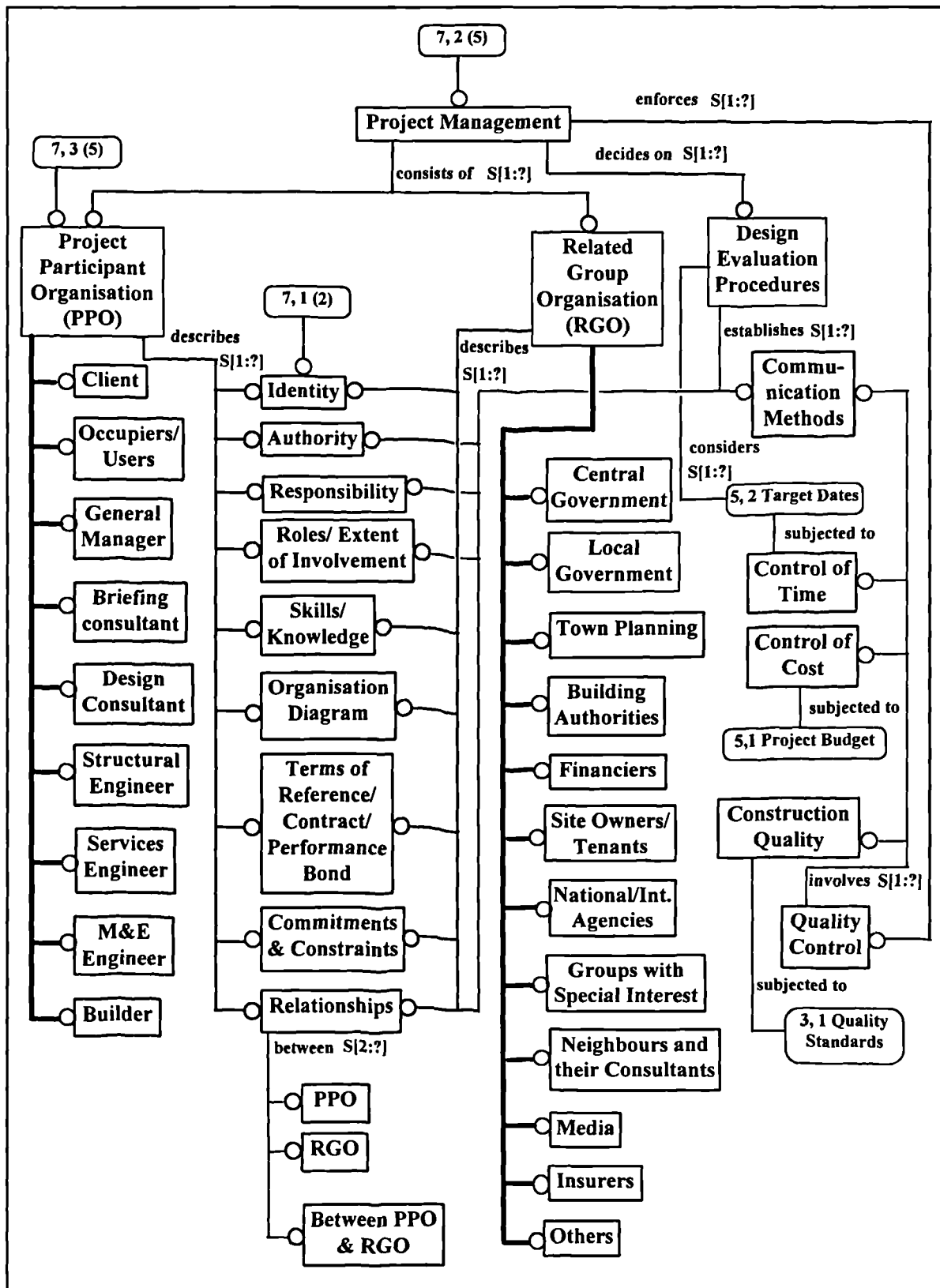


Figure 6.11: Level 2 Diagram - Project Management (Page 7 of 22)

The “Project Management” entity carries the “consists of” relationship with the “Project Participant Organisation (PPO)” and the “Related Group Organisation (RGO)”

entities. The cardinality [1:?] indicates that the management of the project is made up of any one or more organisations (or individuals) from both groups. The subtypes of the “PPO” entity includes the “Client”, “Occupiers/Users”, “General Manager”, “Briefing Consultant”, “Design Consultant”, “Structural Engineer”, “Services Engineer”, “M&E Engineer” and the “Builder”. Although the actual list involved in a project may or may not cover all the subtypes listed, it refers only to parties who are actively responsible for the actual realisation of the project, for example in terms of designing and construction of the building. In contrast, the “RGO” entity is concerned with organisations or individuals whose involvement is necessary for the success of the project, but who are not directly involved in the actual running of the project. For example, the “Town Planning” subtype is necessary in order to get planning approval prior to the inception of the project. Figure 6.11 shows the subtypes of the “RGO” entity, of which “Town Planning” is one. The list is meant to be exhaustive depending on the particular nature and requirements of individual projects.

The “PPO” and “RGO” entities are each linked by the “describes” relationship to a set of entities, which include “Identity”, “ Authority”, “Responsibilities”, “Roles/ Extent of Involvement”, “Skills/Knowledge”, “Organisation Diagram”, “Terms of Reference/ Contract/ Performance Bond”, “Commitments and Constraints” and “Relationships” as shown in Figure 6.11. Each of these entities lays down the relevant requirements in terms of the roles, duties and commitments, etc., required from each organisation. The “Relationships” entity describes the relationships between “PPO”, “RGO” and between “PPO” and “RGO”.

In addition, the “Project Management” entity relates to the “Design Evaluation Procedures” entity by the “decides on” relationship. The “Design Evaluation Procedures” entity “considers” “Target Dates” shown on Page 5 (Figure 6.9) and “establishes” “Communication Methods”, “Authority”, “Responsibility”, “Roles/Extent of Involvement” and “Relationships” entities of the relevant organisations involved for the design evaluation purposes. Further, the “Project Management” entity “enforces” the “Quality Control” entity for the project. This involves the “Communication Methods” entity mentioned earlier, together with “Control of Time”, which is subjected to the “Target Dates”, “Control of Cost”, which is subjected to the “Project Budget”, and “Construction Quality”, which is subjected to “Quality Standards”. When all aspects of these entities are considered and documented in the brief, the quality of the impending project can be controlled. Lastly, the strengths of the relationships between the relevant entities are portrayed by the cardinalities shown, and the composition symbols depicted in the figure illustrates the cross referencing of the items concerned.

2. The “Intended Occupancy in Detail” Entity

The “Intended Occupancy in Detail” entity is a subtype of the “Project Context” entity as shown in Figure 6.10. It contains information related to aspects of occupancy in a building, which is essential for inclusion in the brief. It addresses issues on how the activities of the client organisation are to be performed in relation to habits, preferences and special needs of the activities. Figure 6.12 portrays the “Intended Occupancy in Detail” entity together with its relationships to other entities.

The “Intended Occupancy in Detail” entity “creates” the “Spaces in Detail” entity, which is a subtype of the “Design and Performance Requirements” entity, and “examines” the “Spatial Activity” entity. The main purpose of the “Intended Occupancy in Detail” entity, however, is to “examine” the “Spatial Activity” entity. The “Spatial Activity” identifies the activity (use or function) to be carried out within a specific space, i.e. an instance of the “Spaces in Detail” entity.

The links between the “Intended Occupancy in Detail” entity to either the “Spaces in Detail” entity and the “Spatial Activity” entity arise from the explicit relationships between these two individual entities. During initial analysis, the “Spaces in Detail” entity was found to have the “accommodates” relationship with a cardinality of S[1:?] with the “Spatial Activity” entity. Inversely, the “Spatial Activity” entity was found to have the “occupies” relationship with the “Spaces in Detail” entity, also with a cardinality of S[1:?]. In such a case, a joint entity has to be created between the two entities. For this purpose, the “Intended Occupancy in Detail” entity was identified as the most suitable link between the two participating entities. The result is as shown in Figure 6.12. The “Intended Occupancy in Detail” entity is joined to the “Spaces in Detail” entity by the “creates” relationship, and inversely by the “accommodates” relationship, with a cardinality of S[1:?]. The other link is represented by the “examines” relationship from the “Intended Occupancy in Detail” entity to the “Spaces in Detail” entity, and by the inverse relationship, “occupies” with a cardinality of S[1:?].

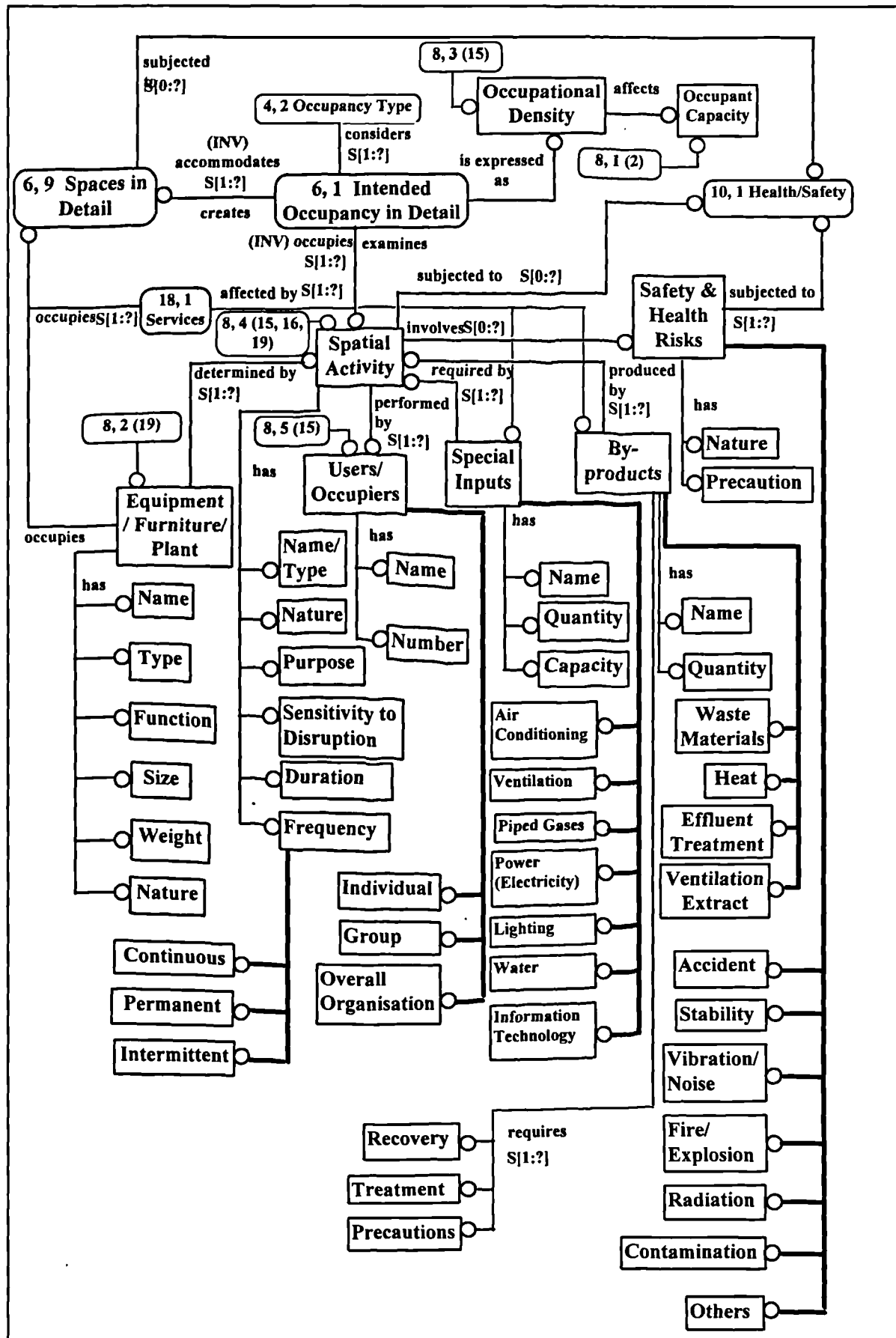


Figure 6.12: Level 2 Diagram - Intended Occupancy in Detail (Page 8 of 22)

By virtue of the relationships that now exist between the “Intended Occupancy in Detail” entity, and the “Spaces in Detail” and the “Spatial Activity” entities, there exists an implied relationship between the “Spatial Activity” entity and the “Spaces in Detail” entity. To illustrate this point further, if an instance of “Spatial Activity”, for example, ‘meeting’, is specified by the client, then it follows that one or more instances of the “Space in Detail” entity can to be created in order to accommodate this activity, in which case, one or more meeting rooms need to be created. Alternatively, if an instance of the “Space in Detail” entity is created, prior to establishing its function (spatial activity), then this space can be occupied by one or more spatial activities.

The “Spaces in Detail” entity is also linked to two other entities. These are “Services” and “Equipment/Furniture/Plant”. The “occupies” relationship exists between these two entities to the “Spaces in Detail” entity, with their respective cardinalities as shown in Figure 6.12. “Services” refers to the types of services that occupy an individual space. The “Services” entity is “affected by” one or more instances of the “Special Inputs” and “By-products” entities. The “Services” entity is referenced to Page 18 (Figure 6.22) and will be presented at a later stage. The “Equipment/Furniture/Plant” entity lists down the various types of equipment, plant and furniture “determined by” the “Spatial Activity” entity. The “has” relationship between the “Equipment/Furniture/Plant” entity and the “Name”, “Type”, “Function”, “Size”, “Weight” and “Nature” entities indicate that these entities are actually attributes of the “Equipment/Furniture/Plant” entity. Therefore, the “determined by” relationship between “Equipment/Furniture/Plant” and “Spatial Activity” indicates that the type of spatial activity, e.g. ‘meeting’, will influence the

choice of equipment and furniture to be accommodated in the space created, i.e., the meeting room.

The “Spatial Activity” entity is linked to six entities by the “has” relationship. These are “Name/Type”, “Nature”, “Purpose”, “Sensitivity to Disruption”, “Duration” and “Frequency”. Alternatively, these entities can be displayed as attributes to the “Spatial Activity” entity, the first four of which can be user defined types, with string as the simple type. “Duration”, however, will be represented as the number simple type, while “Frequency” can be represented as a defined type, in the form of a string simple type, with the three subtypes shown, as the recommended attribute values. They are “Continuous”, “Permanent” and “Intermittent”.

Further to the above, Figure 6.12 also illustrates that the “Spatial Activity” entity is related to the “Users/Occupiers” entity by the “performed by” relationship. This identifies the performer of the activity within the specified space. The three subtypes of the “Users/Occupiers” entity are “Individual”, “Group” and “Overall Organisations”. The “Users/Occupiers” entity is linked to the “Name” and “Number” entities by the “has” relationship, which indicates that these are actually attributes of the “Users/Occupiers” entity. The “Name” attribute can be any user defined names in string form, while “Number” refers to the number of persons involved for each subtype of the “Users/Occupiers” entity.

The “Spatial Activity” is related to the “Special Inputs” entity by the “required by” relationship. “Special inputs” represents the inputs required for a particular activity to be

performed in an acceptable manner. “Special Inputs” has subtypes which include “Air Conditioning”, “Ventilation”, “Piped Gases”, “Power (Electricity)”, “Lighting”, “Water” and “Information Technology”. The “required by” relationship from the “Special Input” entity suggests that an instance of any of the subtypes of the “Special Inputs” entity is required by one or more types of spatial activities. Inversely, by default, it suggests that a type of special activity may or may not require any special inputs. The attributes of the “Special Inputs” entity are linked to it by the “has” relationship. They are “Name” and “Quantity”, which represent the amount required, and “Capacity”, which refers to the amount that can be contained or produced.

The entity, “By-products”, which is connected to the “Spatial Activity” entity by the “produced by” relationship, represents the by-products that may be produced as a result of a particular activity being carried out in a particular space. The subtypes of the “By-products” entity are “Waste Materials”, “Heat”, “Effluent Treatment” and “Ventilation Extract”. The attributes of the “By-products” entity are “Name” and “Quantity”. The “requires” relationship joins the “By-products” entity to three entities: “Recovery”, “Treatment” and “Precautions”. These three entities represent the necessary action to be carried out on the by-products of the spatial activity.

The “Spatial Activity” entity is also linked to the “Safety & Health Risks” entity as shown in Figure 6.12. The “involves” relationship with S[0:?] cardinality indicates that certain activities may or may not involve some kind of risk. The types of risk are represented by the subtypes of the “Safety & Health Risks” entity. They include “Accident”, “Stability”, “Vibration/Noise”, “Fire/Explosion”, “Radiation”,

“Contamination” and “Others”. The attributes of the “Safety & Health Risks” entity are “Nature” and “Precaution”, which may contain some user defined descriptions of the nature of the risks involved and the precautions to be taken or rules to be followed during the performance of specific activities in a particular space. The “Safety & Health Risks” entity is linked to the “Health/Safety” entity by the “subjected to” relationship. The “Health/Safety” entity represents the specific regulations or rules laid down in the Occupancy Law. To complete the picture, Figure 6.12 also shows that the “Spaces in Detail” entity and the “Spatial Activity” entity are both “subjected to” the relevant regulations, represented by the “Health/Safety” regulations.

The “Intended Occupancy in Detail” is linked to the “Occupancy Type” entity with the “considers” relationship and to the “Occupational Density” entity with the “is expressed as” relationship. “Occupational Density”, in turn has the “affects” relationship with the “Occupant Capacity” entity. Even though these three items of information have been portrayed as entities in their own right, mainly to accommodate for cross referencing with other Pages, they can be regarded as attributes of the “Intended Occupancy in Detail” entity. In such a case, the simple type of “Occupational Density” and “Occupant Capacity” is number, and the “Occupancy Type” entity can be obtained from Page 4 (Figure 6.8). The “Occupational Density” refers to the floor space factor, or sometimes called the occupational load factor. It specifies an area of floor space to be allowed per person for a specific spatial activity. “Occupant Capacity” refers to the total number of users that can occupy a specific space (the total occupancy).

3. The “Regulatory Issues” Entity

The “Regulatory Issues” entity, which is a subtype of the “Project Context” entity is expanded further in Figures 6.13 and 6.14. The “Regulatory Issues” entity contains information pertaining to existing regulations, laws and standards, with which every aspect of a project must comply. The inclusion of the relevant regulatory issues in the brief would enable the project participants to acknowledge the specific issues and the reasons why certain decisions are made with respect to any particular client requirements.

Figures 6.13 and 6.14 show the subtypes of the “Regulatory Issues” entity. The four subtypes depicted in Figure 6.13 are “Building/Design Regulations”, “Environmental/Pollution Regulations”, “Political/Administration Regulations” and “Social/Cultural Regulations”, while those shown in Figure 6.14 are “Planning Regulations”, “Legal Restrictions on Site”, “Occupancy Laws” and “Finance Regulations”. These two figures are self explanatory, and are meant to portray the existing regulatory issues, their types and contents, as well as the relationships that may exist between the entities concerned. The cardinalities for the relationships are not depicted on these two figures. The various links to other pages are illustrated by the composition symbols.

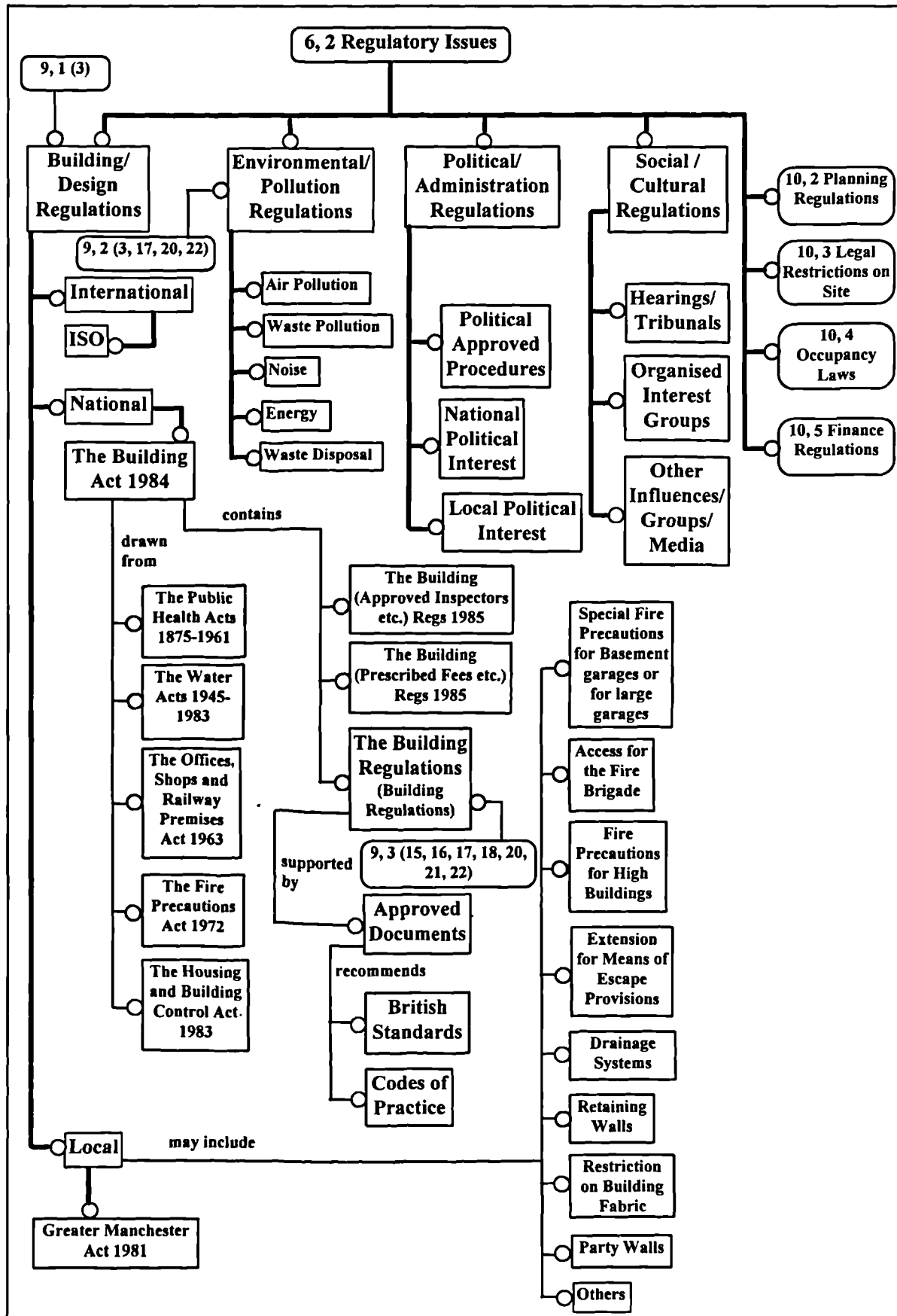


Figure 6.13: Level 2 Diagram - Part Entity-Level Model of Regulatory Issues
(Page 9 of 22)

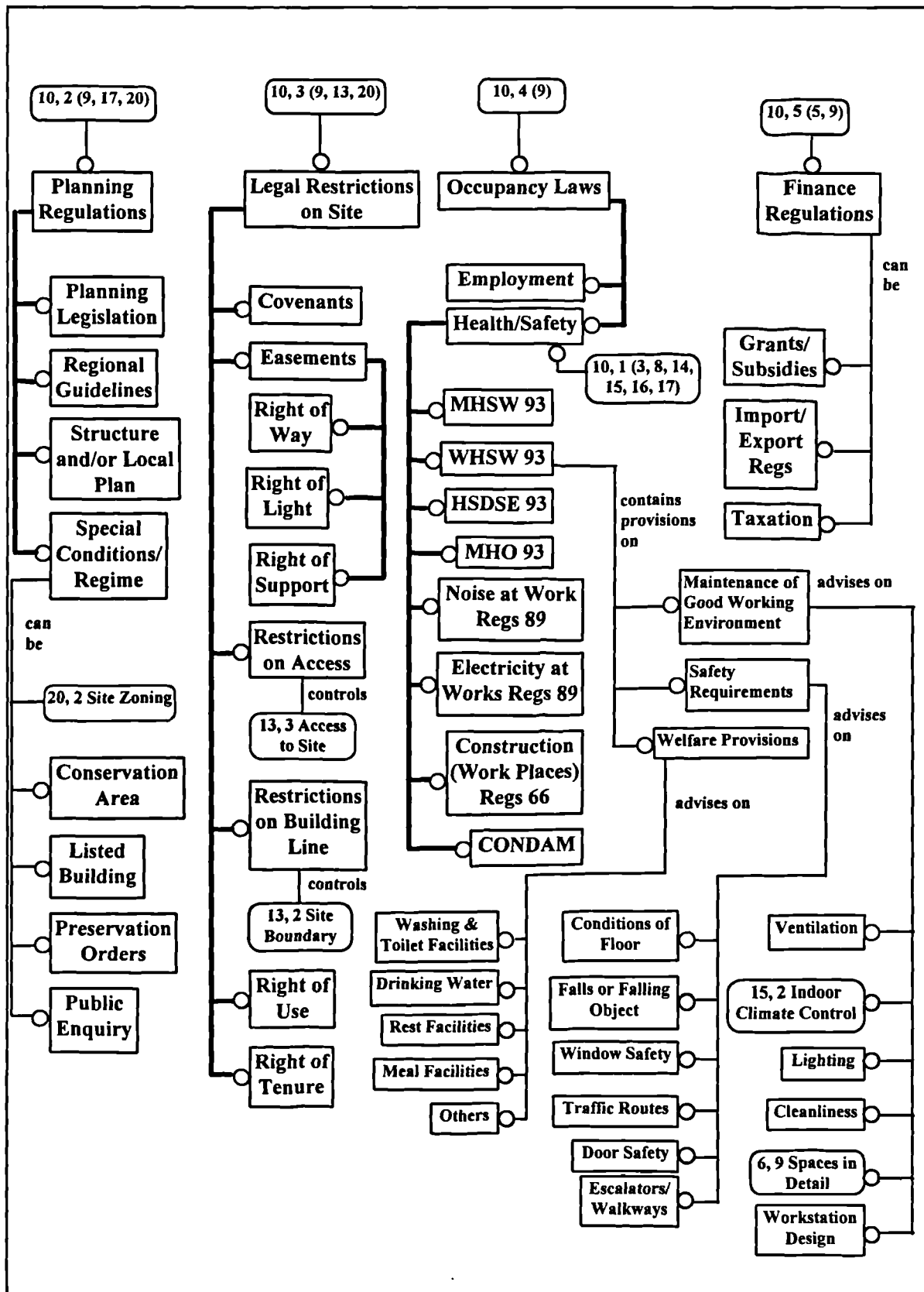


Figure 6.14: Level 2 Diagram - Part Entity-Level Model of Regulatory Issues
(Page 10 of 22)

4. The “Background and Historical Influences” Entity

The “Background and Historical Influences” entity represents one of the subtypes of the “Project Context” entity shown in Figure 6.10. It contains information related to the history of the project, current situations and reasons for current actions, together with any commitments of the client’s organisation, that may have some influence on the outcome of the project. It includes matters which may influence the “Project Main Reasons” identified on Page 2 (Figure 6.6). “Background and Historical Influences” contains information which is represented by the four entities which are linked to it by the “contains” relationship. They are “Project History”, “Current Situations”, “Reasons for Current Action” and “Commitments”, as shown in Figure 6.15. The entities linked to these four entities have been obtained from BSI (1994) and O’Reilly (1987).

The “Project History” entity may contain information with regards to the history of the client’s organisation, represented by the “History of Client’s Enterprise” entity, along with issues on local events, political attitudes, any research studies or reports, and decisions made. These are represented respectively by the “Local Events”, “Political Attitudes”, “Research Studies/Reports” and “Decisions” entities. The “Current Situation” entity may contain information on current activities performed by the client or the users of the existing building. These include the functions and reasons for existence, the structure and methods of operation. It also includes matters relating to the existing sites/facilities/building which is occupied by the users or client, as well as any on-going investigation that may have some bearing on the project. The investigations should include current studies, and any problems encountered. The “Existing Sites/Facilities/Buildings” entity is linked to the “Site Availability” entity by the

“influence” relationship. The [0:?] cardinality implies that it may or may not influence the “Site Availability” entity.

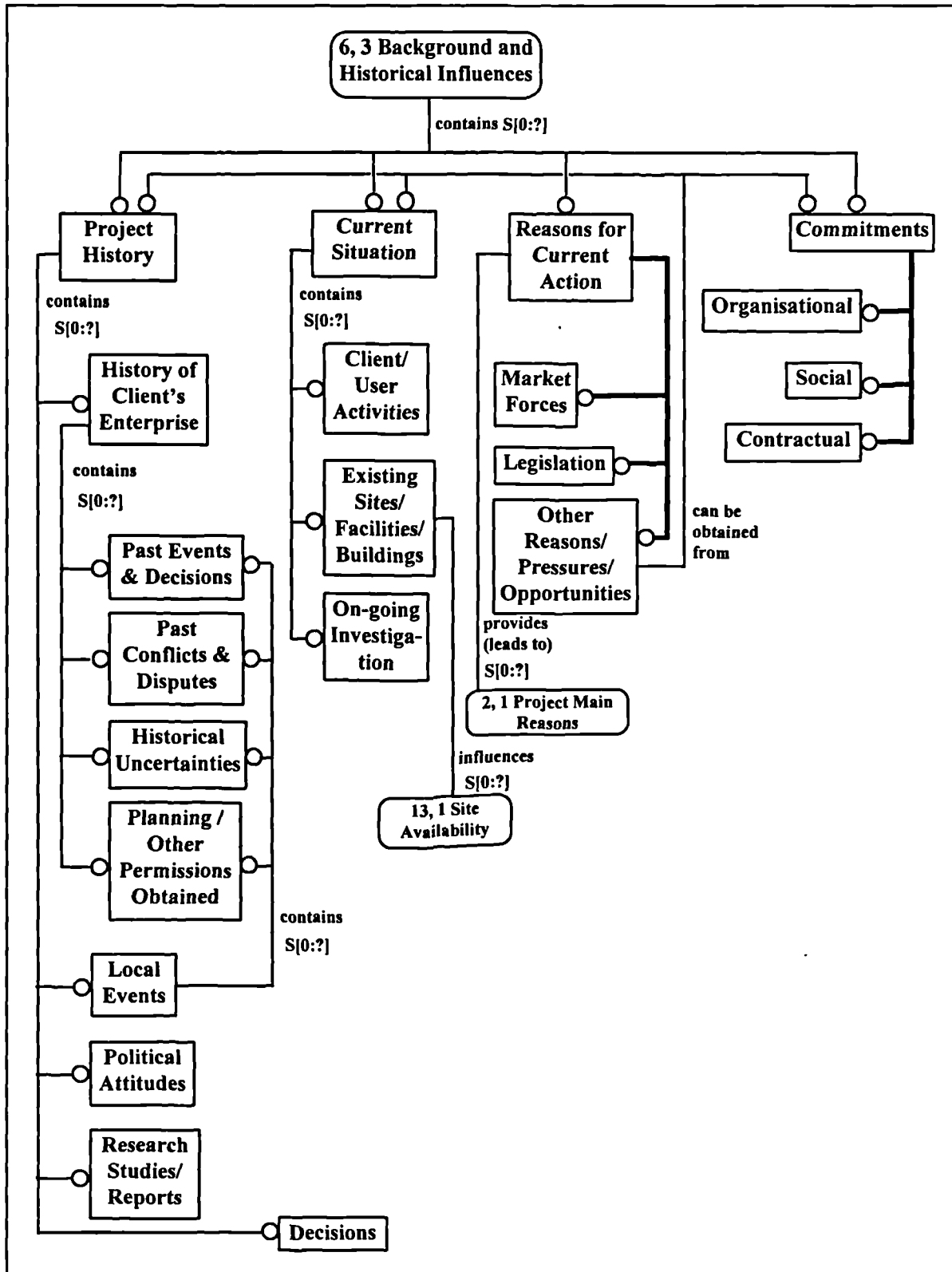


Figure 6.15: Level 2 Diagram - Background and Historical Influences
(Page 11 of 22)

The “Reasons for Current Action” entity has three subtypes: “Market Forces”, “Legislation” and “Other Reasons/Pressures/Opportunities”. The third entity can obtain its information from “Project History”, “Current Situation” and “Commitments”, as well as any other relevant reasons, pressures or opportunities. The reasons established in the “Reasons for Current Action” entity may provide instances for the “Project Main Reasons” entity. Finally, the “Commitments” entity also carries three subtypes. They are “Organisational”, “Social” and “Contractual”, which relate to any organisational, social or contractual arrangements, which may have some influence on the project.

5. The “Client’s Future Enterprise” Entity

The “Client’s Future Enterprise” entity contains information and decisions concerning the future activities of the client’s organisation. The activities of the client’s organisation are those to be pursued overall by the organisation, for example a private quantity surveying firm or an architect’s firm, etc. This is in contrast to the intended occupancy in detail which addresses how these activities are to be performed. By including these aspects in the brief, the relevant decisions made will be documented for future reference. Figure 6.16 depicts the “Client’s Future Enterprise” entity and its related entities.

Figure 6.16 depicts the four entities that are being considered by the “Client’s Future Enterprise” entity. They are “Purpose of CFE”, “Size of CFE”, “Context” and “Future Changes”. The attribute ends of the relationship depend on the cardinality of the respective relationships as shown in Figure 6.16. The “Purpose of CFE” considers the company profiles, strategic aims of the enterprise, any priorities, an image of the future

enterprise, along with any new areas of activity. This is also related to the project main aims. The “Size of CFE” entity has attributes such as the number of employees for the future enterprise, the size of the enterprise in relation to others, and the market share or turnover for the future enterprise.

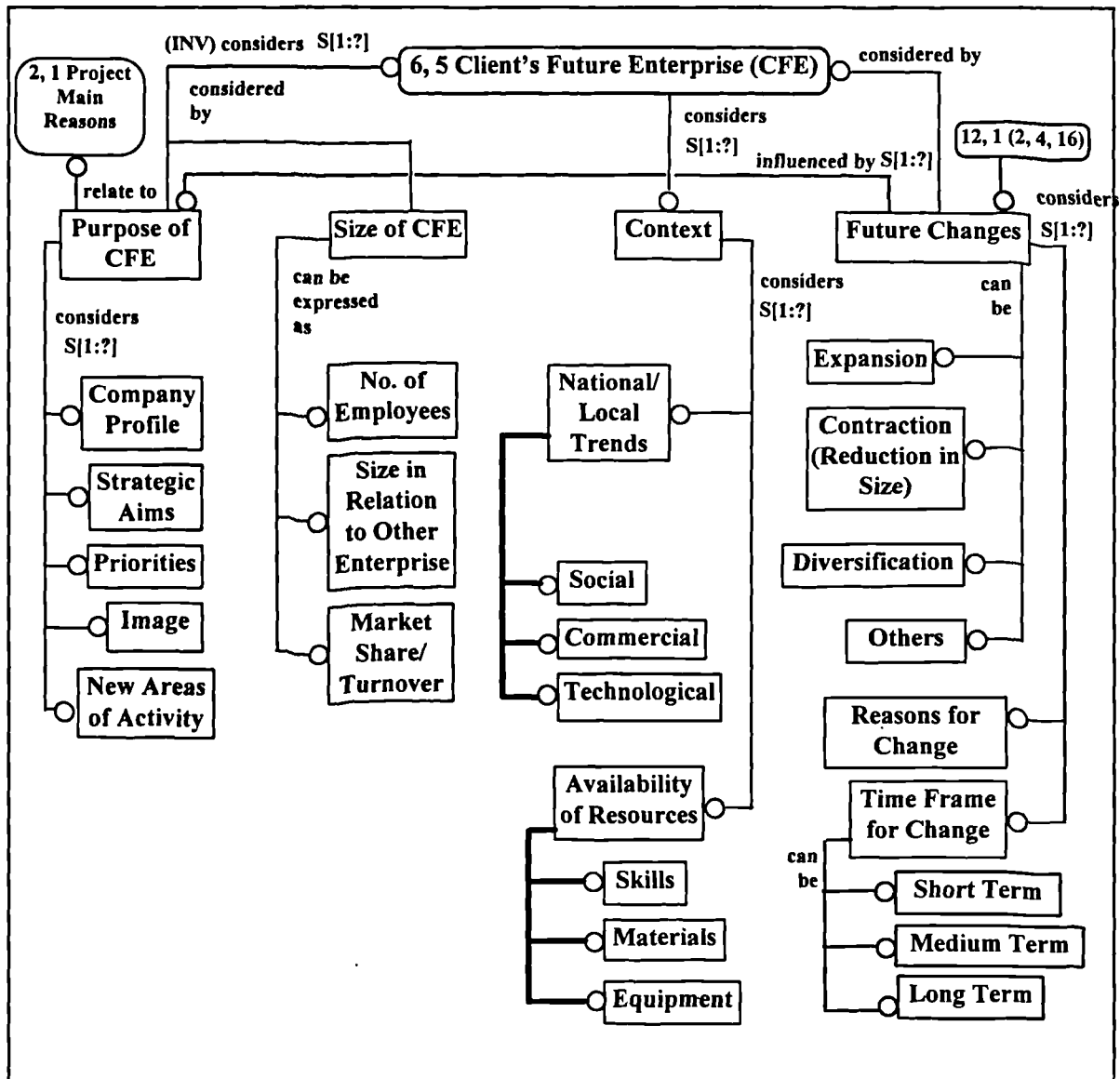


Figure 6.16: Level 2 Diagram - The Client's Future Enterprise (Page 12 of 22)

The “Context” entity refers to circumstances relevant to the client’s future enterprise. This can include any one or more national or local trends, in terms of social, commercial or technological, which are represented by the three subtypes of the “National/ Local Trends” entity. The availability of resources, in the form of skills, materials and

equipment, may also be considered in the “Context” entity. The last entity linked to the “Client’s Future Enterprise” entity, is the “Future Changes” entity. The cardinality shows that an instance of the “Future Changes” entity is considered by an instance of the “Client’s Future Enterprise” entity. Inversely, an instance of the “Client’s Future Enterprise” entity may or may not consider any instances of the “Future Changes” entity. The types of future changes suggested by the data model include expansion or contraction in the size of the client’s current enterprise, diversification in terms of the activities to be carried out, and etc. The instances of the “Future Changes” entity may affect the “Adaptability Requirements” entity depicted on Page 4 (Figure 6.8) and the “Adaptability (Flexibility for Future Use)” entity on Page 16 (Figure 6.20). Finally, “Future Changes” is influenced by “Purpose of CFE” and considers the reasons and the time frame for change.

6. The “Site and Surrounding Influences” Entity

Figure 6.17 depicts the level 2 diagram of the “Site and Surrounding Influences” entity. The “Site and Surrounding Influences” entity represents information with regards to the aspects of the proposed site and its surroundings that may influence the outcome of the project. The “Site and Surrounding Influences” entity examines the “Site” and the “Surroundings” entities. The “Site and Surrounding Influences” entity is divided into seven subtypes, each of which have been decomposed further where necessary. The “Site and Surrounding Influences” entity and its subtypes have been shaded in Figure 6.17 to highlight their presence.

The seven subtypes are “Site Availability”, “Existing Building”, “Commercial & Social Influences”, “Environmental Data”, “Geophysical Data”, “Ground Characteristics” and “Infrastructure”. The “Site Availability” entity has two attributes, “Site Ownership” and “Rental/Purchase/Lease”. The first refers to the ownership of the site, and the second, to the cost to purchase the land, its rental or lease, whichever is applicable. The figure also shows that the site’s previous use(s), any legal conditions and the availability of the site surveys all have an influence on the “Site Availability”. In addition, the “Site Boundaries” and “Access to Site”, each influences the “Site Availability”. Inversely though, one or more instances of each entity need to be considered by the “Site Availability” entity.

The second subtype which belongs to the “Site and Surrounding Influences” is “Existing Building”. This entity represents any existing buildings on the site. The “Existing Building” entity has attributes which include its use, area, form of construction, state of repair, availability of any structural survey and the protected status, if relevant. The “Existing Building” entity, may influence the decision on whether to build a new building or to refurbish the existing building.

The “Commercial & Social Influences” subtype refers to the existing behaviour patterns of the people who use the site and the neighbourhood. It considers the influences that may arise from its subtypes. These include the presence of catchment areas, hinterland, the type of neighbourhood, the population, the users, as well as the amenities provided by society. These may comprise recreational facilities and public services, such as the police force, fire brigade and ambulance service.

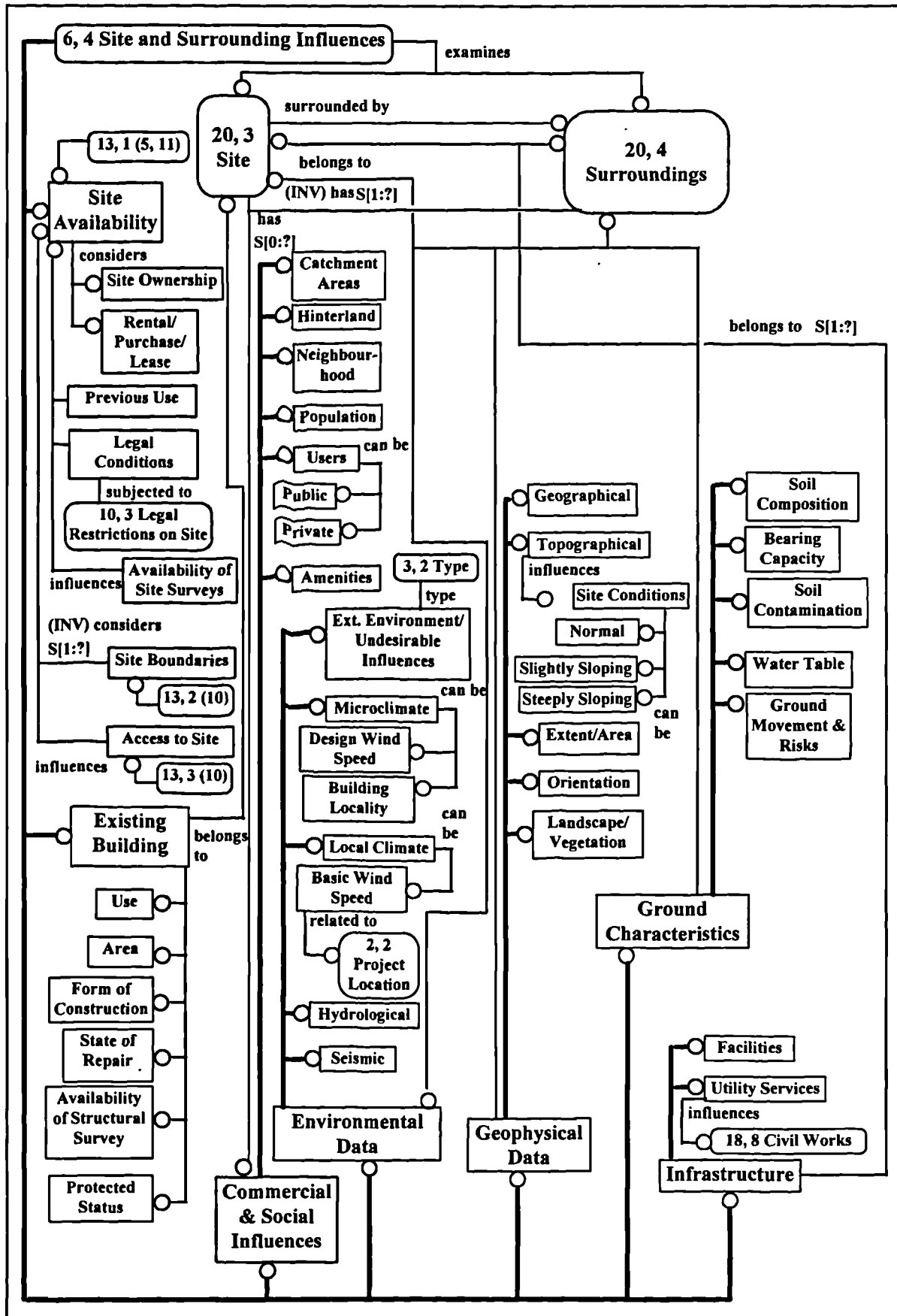


Figure 6.17: Level 2 Diagram - Site and Surrounding Influences (Page 13 of 22)

The “Environmental Data” subtype has been further decomposed into five subtypes: “External Environment/Undesirable Influences”, “Microclimate”, “Local Climate”, “Hydrological” and “Seismic”. “Microclimate” can be in the form of design wind speed and building locality, which considers the actual locality of the site or building, for example, in the city centre or outskirts. The “Local Climate” entity considers factors related to the local climate, such as the basic wind speed. The next subtype of the “Site and Surrounding Influences” entity, “Geophysical Data”, has the subtypes “Geographical”, “Topographical”, “Extent/Area”, “Orientation” and “Landscape/Vegetation”. The “Ground Characteristics” subtype, on the other hand, covers aspects such as soil composition, bearing capacity of the soil, soil contamination, if any, the water table, together with any ground movements and the risks involved. This information is represented by the “Ground Characteristics” subtypes.

The “Infrastructure” entity represents the last subtype of the “Site and Surrounding Influences” entity. It is divided into two subtypes; “Facilities” and “Utility Services”. “Facilities” are concerned with the availability of existing public facilities, such as road works, transport system, etc., while “Utility Services” represents public utility services such as the supply of water, electricity and gas.

Apart from the above, each subtype of the “Site and Surrounding Influences” entity is also linked to the “Site” and the “Surroundings” entities to portray the relationships and the difference in cardinalities that exist between them.

7. The “Building as a Whole” Entity

The “Building as a Whole” entity is a subtype of the “Design and Performance Requirements” entity as shown in Figure 6.10. It represents information about the building taken as a whole. It covers aspects of the design and performance criteria for the building. Figure 6.18 depicts the “Building as a Whole” entity (shaded) and its corresponding relationships to other entities. The “Design Criteria” entity depicted in Figure 6.10 is represented by all the entities linked to the “Building as a Whole” entity by the “belongs to” relationship. In the inverse direction, the “Building as a Whole” entity is linked to these entities by the “has” relationship, with a cardinality of S[1:?]. In other words, an instance of the “Building as a Whole” entity can have one or more instances of these entities. The entities include “Building Appearance”, “Circulation/Access”, “Works of Art” and “Physical Characteristics”. This last entity is expanded further on Page 16 (Figure 6.20).

The “Performance Criteria” entity, on the other hand, is portrayed by those entities connected by the “requires” relationship to the “Building as a Whole” entity. These entities comprise “Indoor Climate Control”, which will be presented on Page 15 (Figure 6.19), “Safety Features”, “Security Features”, “Communication Features” and “Operation Features”.

Figure 6.18 illustrates the three subtypes of “Building Appearance”: “Building Forms”, “Building Symbolic Function” and “Ext. Appearance/Facade”. “Building Forms” can be expressed as the planned shape of the building, e.g. square, rectangle, circular, etc.

“Building Symbolic Function” is related to the image that the proposed building would carry, while “External Appearance/Facade” refers to any specific external features, materials or colours that are preferred by the client. The “Circulation/Access” entity is required by people and goods. The methods of circulation and access can be mechanised, such as the use of lifts and escalators, or non-mechanised, such as pedestrian corridors or staircases. The “plane” relationship represents the attribute for the plane of circulation: horizontal, vertical or sloping. The “Works of Art” entity refers to any requirement for any special art works that need to be incorporated into the building.

On the performance criteria side, the “Safety Feature” entity provides requirements on aspects of structural, construction, safety in use and fire protection, which are represented by their respective entities in Figure 6.18. The “Fire Protection” entity, is divided into two subtypes; “Active Precautions” and “Passive Precautions”, which represent the active and passive form of fire protection in the building. The “Active Precautions” is cross referenced to its counterpart under the “Services” entity data model shown in Figure 6.22. The “Passive Precautions” are concerned mainly with the means of escape from a building, the fire resistance, the spread of flame, as well as the facilities for fire fighters. This entity also considers information on the general floor layout of the building, for example open plan or compartmentalised, the evacuation procedure, the escape routes, the protected stairways, the number of exits, and the place of safety for the occupants in the event of a fire break out, such as the car park.

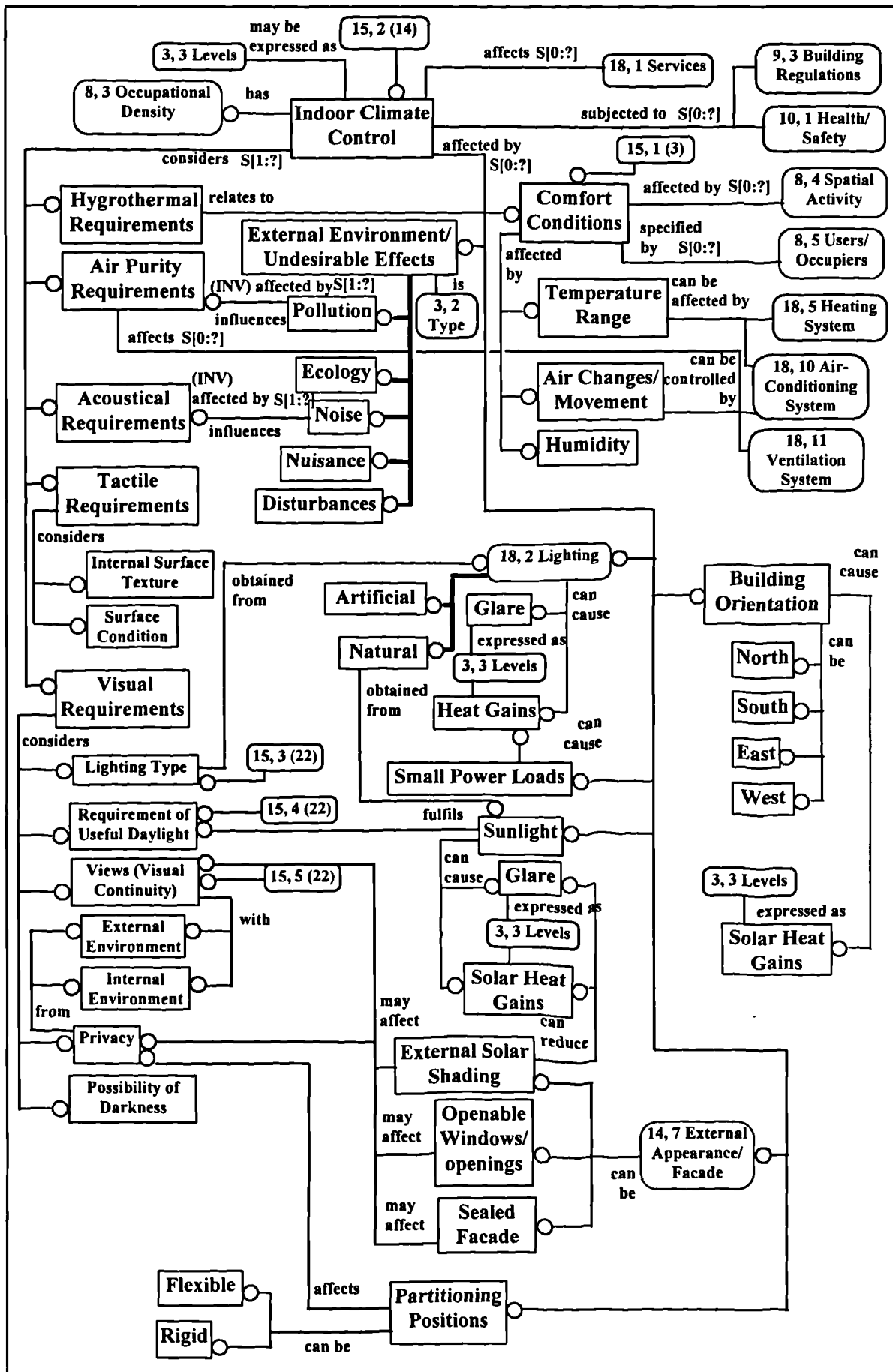
The “Security Features” entity deals with information on the types of exclusion device for unauthorised entry into the building, personal security for the users/occupants and checking facilities required for the building security. This information is represented by the attributes of the “Security Features” entity. They are “Exclusion Device”, “Personal Security” and “Checking Facilities”, the subtypes of each representing the possible types of attribute values as shown in Figure 6.18.

The “Communication Features” entity is concerned with the performance requirements on aspects of communication such as telecommunication, information retrieval and clock facilities; represented by the attributes of the “Communication Features” entity. The “Operation Features” entity on the other hand, refers to the possible features that can fulfil the operational requirements of the occupied building. These include features for cleaning, repair and maintenance as depicted in Figure 6.18.

8. The “Indoor Climate Control” Entity

Indoor climate control refers to the control of the environmental conditions within the whole building, or within specific space. This is represented by the “Indoor Climate Control” entity (shaded) depicted in Figure 6.19.

This entity is linked to particular regulatory issues as shown by the “subjected to” relationship. An instance of the “Indoor Climate Control” entity considers one or more instances of the following entities: “Hygrothermal Requirements”, “Air Purity Requirements”, “Acoustic Requirements”, “Visual Requirements” and “Tactile Requirements”. “Hygrothermal Requirements” is concerned with the control of air



temperature, thermal radiation, air velocity and relative humidity of a space (ISO, 1984). “Air Purity Requirements” considers ventilation and the control of odours, while “Acoustic Requirements”, refers to the control of external and internal noise, intelligibility of sound and reverberation time. “Visual Requirements” deals with natural and artificial lighting, sunlight insolation, the possibility of darkness, aspects of spaces and surfaces, as well as visual contact, internally and with the external world.

Figure 6.19 shows the “relates to” relationship between “Hygrothermal Requirements” and “Comfort Conditions”. “Comfort Conditions”, in turn, is affected by its attributes: “Temperature Range”, “Air Changes/Movement” and “Humidity”, all of which may be affected by “Spatial Activity”, and/or specified by the users or occupiers. The “Air Purity Requirements” entity is influenced by the “Pollution” entity. It may also influence the choice of ventilation system. “Tactile Requirements” considers its attributes “Internal Surface Texture” as well as “Surface Condition”. “Visual Requirements” considers a long list of attributes which include the lighting type, obtained from the “Lighting” entity”, the requirements of useful daylight, which refer to direct sunlight, views and privacy, both internally and with the external environment, along with any requirements for darkness.

The other important link from the “Indoor Climate Control” entity is represented by the “affected by” relationship to the following entities. They are “External Environment/Undesirable Effects”, “Lighting”, “Small Power Loads”, “Sunlight”, “External Appearance/ Facade” and “Partitioning Positions”. The first of these, have subtypes as shown in Figure 6.19. The links from “Pollution” and “Noise” to the

respective “Air Purity Requirements” and “Acoustical Requirements” are also shown in the figure.

“Lighting” is divided into two subtypes; “Natural” and “Artificial”, and has the attributes “Glare” and “Heat Gains”. “Small Power Loads”, which refers to power levels required by equipment, may also cause heat gain, which is represented by its attribute, “Heat Gains”. Similarly, “Sunlight” is linked to its attributes, “Glare” and “Solar Heat Gains”. The “External Appearance/ Facade” entity, which can be in the form of external solar shading, openable windows or sealed facade, may affect the values of the “Views” and “Privacy” attributes. The “Partitioning Positions” entity, which can be either flexible or rigid, may affect the “Privacy” attribute.

Lastly, the “Building Orientation” entity has the attributes north, south, east and west. This entity can have an effect on the indoor climate control, by affecting the solar heat gains in the building. The orientation of the building with windows facing in a particular direction has specific solar flux values for certain types of glazing, which may affect the solar gains, which in turn can affect the standard assessment procedure for energy rating of a particular building type or use. This has not been portrayed on the data model since it is outside the scope of this research.

9. The “Physical Characteristics” Entity

The “Physical Characteristics” entity is concerned with the actual visible effect of the whole building or spaces and space groupings within the building. The “Physical Characteristics” entity is one form of the “Design Criteria” entity depicted in Figure

6.10. This information needs to be included in the brief to enable designers to arrive at a more accurate design solution. Figure 6.20 illustrates the links between the “Physical Characteristics” entity (shaded) and three of the subtypes of the “Design and Performance Requirements” entity depicted in Figure 6.10. These subtypes, which have been shaded, are “Building as a Whole”, “Spaces in Detail” and “Grouping of Spaces”. The “belongs to” relationship links the “Physical Characteristics” entity to these three entities. Each of them, in turn, has the inverse “has” relationship with the “Physical Characteristics” entity, with a cardinality of S[1:?].

The “Physical Characteristics” entity is influenced by the “Adaptability (Flexibility for Future Use)” entity, which is dependent on the “Future Changes” entity. It can be expressed in various ways, such as the size and number of storeys, whichever is relevant to the situation. These are represented by the “Size” and “Storeys” entities. The “Size” entity can be in the form of areas, volumes and/or dimensions. These are represented by the “Area”, “Volume” and “Dimensions” attributes. The subtypes of the “Area” and “Dimensions” attributes present the various ways these attributes can be expressed, all as shown in Figure 6.20. The attributes of the “Storeys” entity on the other hand, are represented by “No. of Storeys” and “Storey Height”, which can be a form of expressing the “Height” dimension.

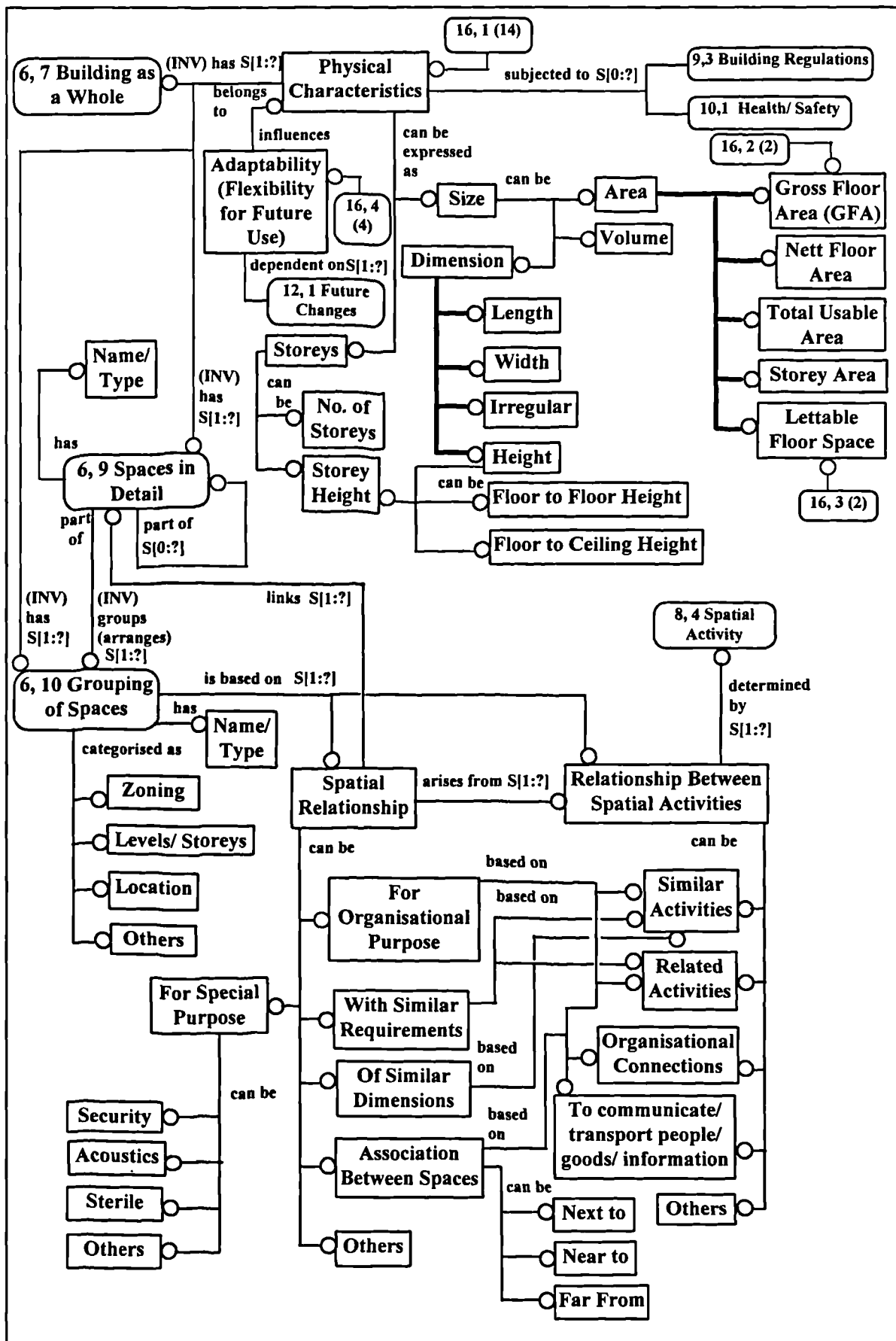


Figure 6.20: Level 2 Diagram - "Physical Characteristics" in relation to "Building as a Whole", "Spaces in Detail" and "Grouping of Spaces" (Page 16 of 22)

For “Spaces in Detail” and “Grouping of Spaces”, the “Performance Criteria” entity shown in Figure 6.10, is represented by the “Spatial Relationship” entity. It is a performance requirement in terms of the relationships that exist between spaces or a group of spaces. The “links” relationship between the “Spatial Relationship” entity and “Spaces in Detail” portrays this fact. This is further supported by the “part of” and the inverse “groups (arranges)” relationships between “Spaces in Detail” and “Grouping of Spaces”. Apart from this, an instance of the “Spaces in Detail” entity may or may not be “part of” of another instance of the “Spaces in Detail” entity. For example, a meeting area may be a room by itself, or may be part of another space, such as, the general office area. The “Spaces in Detail” and “Grouping of Spaces” entities each have the “Name/Type” attribute. The “Grouping of Spaces” entity can be categorised in terms of zoning, levels/storeys/ floors, location, or in some other way desired by the client. These can be considered attributes of the “Grouping of Spaces” entity.

Also present in Figure 6.20 is the “Relationship Between Spatial Activities” entity, which is determined by the “Spatial Activity” entity. The types of relationships between spatial activities can be any one of the followings: “Similar Activities” indicates similarities between the activities concerned, for example between meeting and conference. “Related Activities” implies a specific relationship between activities, such as catering (food provision) and hygiene (toilet facilities). “Organisational Connections” refer to requirements for the activities to establish links with other offices within the organisation. “To communicate/transport people/goods/information” is concerned with relationships that link people, goods or information between one place and another. The figure also shows that the “Relationship Between Spatial Activities” entity is used as the

basis for the grouping of spaces. The “Spatial Relationship” entity, in turn, may arise from one or more instances of the “Relationship Between Spatial Activities” entity. The types of relationship between spaces can be in the form of “For Organisational Purpose”, “With Similar Requirements”, “Of Similar Dimensions”, “Association Between Spaces”, “For Special Purpose” or some other way. Their individual links to the respective relationships between spatial activities are depicted in Figure 6.20.

10. The “Building Fabric” Entity

The “Building Fabric” entity contains information on the physical parts of the building fabric that makes up the building, excluding furniture and furnishings. Figure 6.21 depicts the “Building Fabric” entity.

There are many ways of expressing the fabric of a building, for example, in terms of building system, building elements, building components, according to the trades involved or by stages in the construction process. The building system has been chosen for this data model. The building system approach has been adopted from ISO (1984). The approach is based on the consideration of function only, being independent of any particular method, material or order of constructing the building. The “Building Fabric” entity is therefore, linked to the “Building Systems” entity by the “can be expressed as” relationship. The “Building Systems” entity is composed of one or more sub-systems. These are represented by the “Structure”, “External Envelope”, “Spatial Dividers Outside the Envelope”, “Spatial Dividers Within the Envelope” and “Services” entities.

Each sub-system is composed of one or more components and assemblies as shown in Figure 6.21. However, each sub-system may be formed of components and assemblies distributed throughout the building, such as heating or ventilation services. In contrast, a component or assembly may be part of one or more sub-systems, for example, a wall unit may be part of the load bearing structure of the external envelope, and of the heating and ventilation services, etc. Therefore, a component or assembly does not necessarily correspond exactly to a “functional” sub-system of the building. It may perform all, or only some of the functions of the sub-system. It may also contribute to two or more sub-systems simultaneously. This inverse relationship between the components and assemblies are not portrayed in the data model, since it is outside the scope of this research. The data model only depicts the components and assemblies that make up each sub-system.

Figure 6.21 also depicts the “Design Criteria” and “Performance Criteria” entities, linked to the “Building Systems” entity by the “has” relationship. For a comprehensive brief preparation, the design and performance requirements of each individual sub-system need to be explored in order to identify the client’s actual requirements. For a more detailed brief, this is also required to be carried out on the components and assemblies of each sub-system. For the purpose of this study this has been performed on the “Wall” entity (shaded), a sub-component of the “External Envelope” sub-system. This will be presented in the Level 3 Diagrams.

For office buildings, it is possible to create three additional relationships to the “Building Fabric” entity, which is not depicted in Figure 6.21. These are:

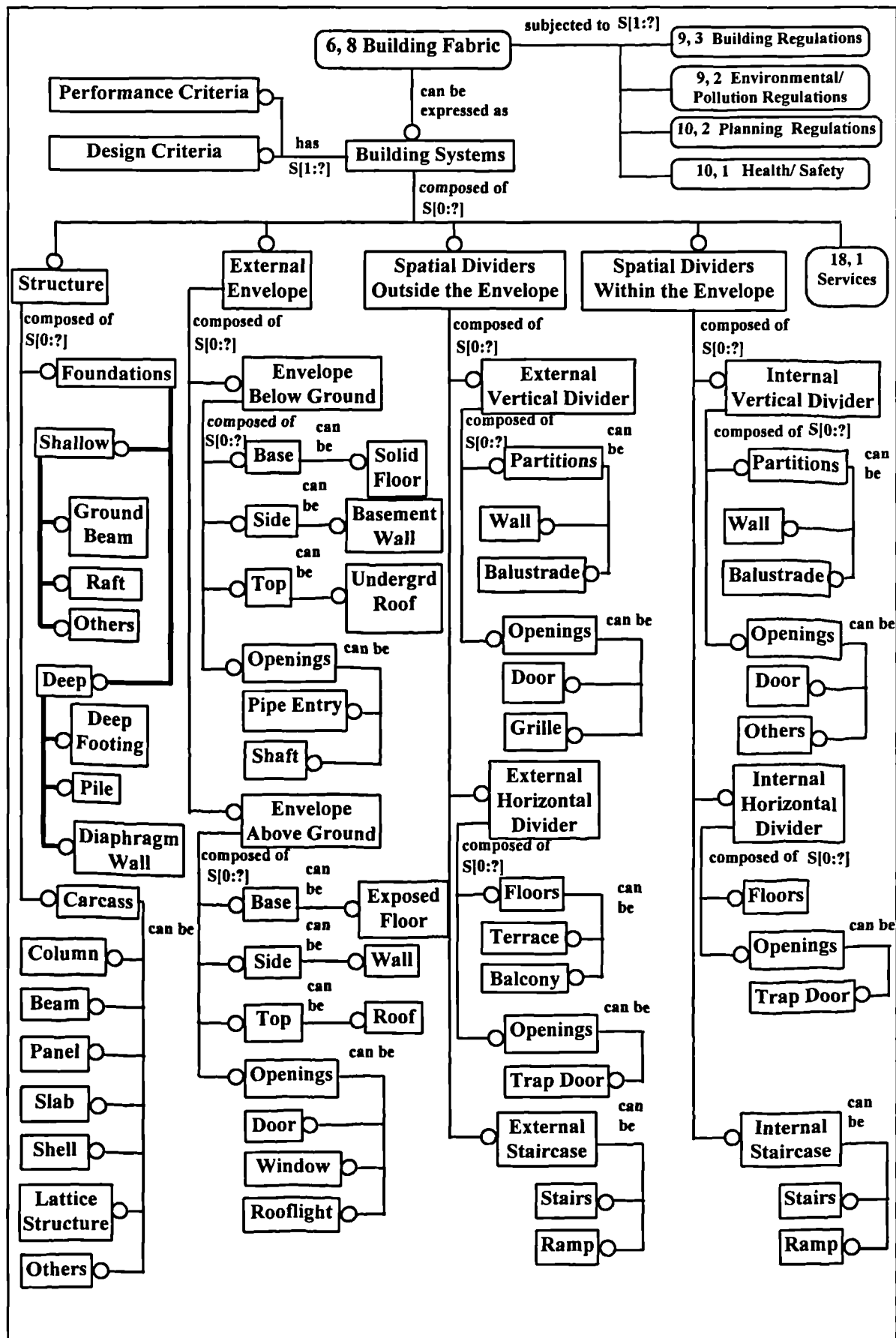


Figure 6.21: Level 2 Diagram - Building Fabric (Page 17 of 22)

1. “purpose-built for” - linked to the “Occupancy Type” entity, shown in Figure 6.8.
This will then relate the “Life Expectancy” entity to the “Building Fabric” entity, especially, in terms of structural and finishes requirements.
2. “suitable for” - linked to three possible standards of image and location; “High quality urban office buildings”, “Suburban” and “Business park buildings”.
3. “specified as” - linked to three possible specification packages suitable for office buildings. These are “Shell and Core”, “Workletter” and “Fully-fitted” (BCO, 1994).

11. The “Services” Entity

The “Services” entity represents one of the sub-systems which makes up the “Building Fabric” entity. Although the other sub-systems have been decomposed into their components and assemblies, the “Services” entity has been divided into its subtypes: “Electrical Works”, “Building Works”, “Mechanical Works”, Fibre Optics Link”, “Safety”, Telecommunications” and “Civil Works”. These subtypes may also be considered as components of the “Services” entity. Each of the subtypes has been further divided into the corresponding subtypes, where necessary, all as shown in Figure 6.22. The links to other data model pages are also represented by the composition symbols.

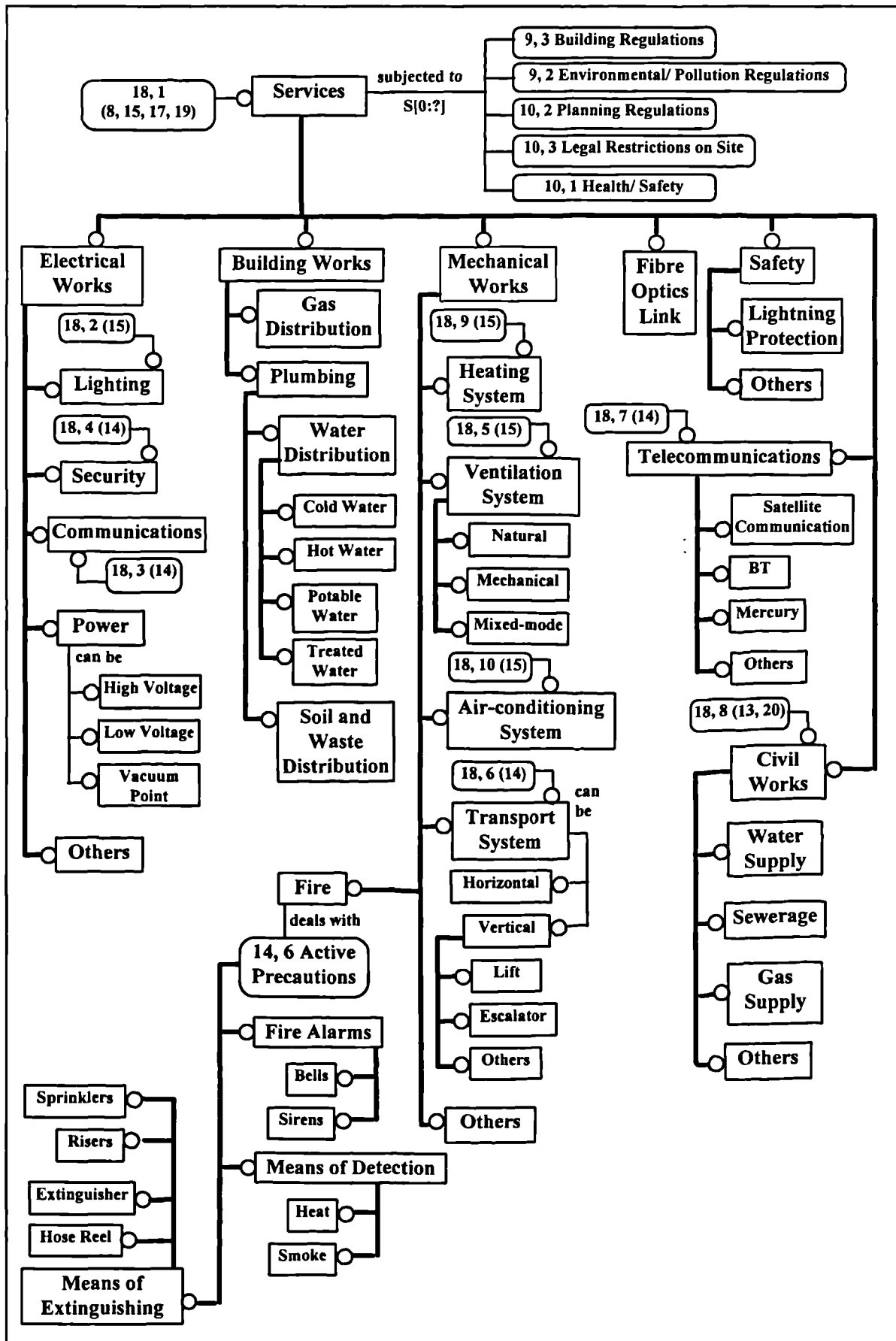


Figure 6.22: Level 2 Diagram - Services (Page 18 of 22)

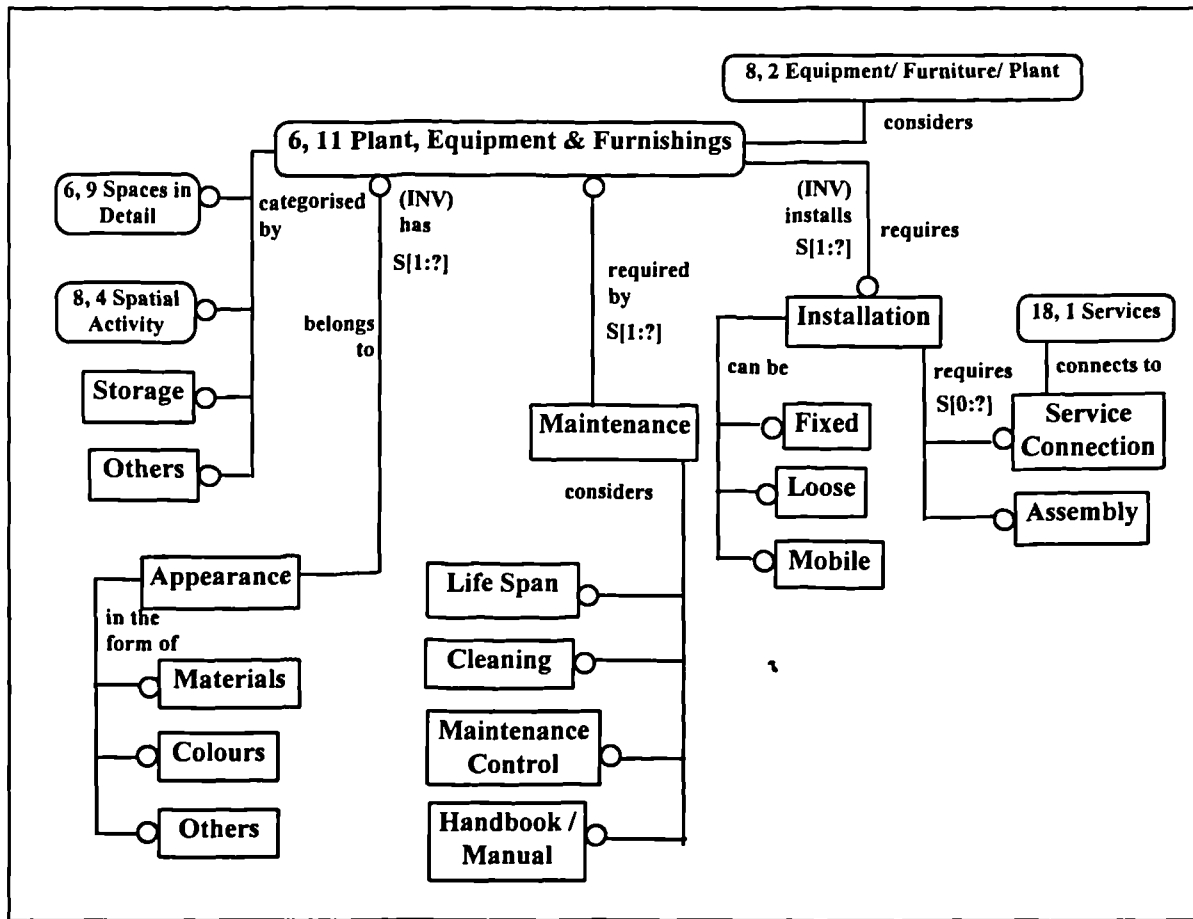


Figure 6.23: Level 2 Diagram - Plant, Equipment & Furnishings (Page 19 of 22)

12. The “Plant, Equipment & Furnishings” Entity

The “Plant, Equipment & Furnishings” entity, depicted in Figure 6.23, contains information about plant, equipment and furnishings that are required to be installed in a building. If this information is available at the brief stage, it serves as a reference point during the design process. The design criteria for the “Plant, Equipment & Furnishings” entity is represented by the “Appearance” entity, which can be in the form of materials, colours, or others. These can represent the entities for “Appearance”.

The performance criteria for the “Plant, Equipment & Furnishings” entity is represented by two entities; “Installation” and “Maintenance”. “Installation” can be in the form of fixed, loose or mobile, and may require service connection or assembly. “Maintenance”

considers the life span of the plant, equipment or furnishings, the cleaning requirements, any maintenance control and the handbook or manual if necessary.

Apart from the above, the “Plant, Equipment & Furnishings” entity considers information obtained from the “Equipment/Furniture/Plant” entity shown on Page 8 (Figure 6.12). It can also be categorised in terms of a particular space in detail, spatial activity, storage, or other form of categorisation.

13. The “Site and Surroundings” Entity

Figure 6.24 depicts the “Site and Surroundings” entity. The “Site and Surroundings” entity contains the “Site” and “Surroundings” entities. The “Site and Surroundings” entity is concerned with the physical aspects of the completed site and its surroundings. Other buildings, sites and other features may form part of the “Surroundings” entity. More importantly though, are the features associated with the outcome of the “Site” entity.

The design criteria for the “Site and Surroundings” entity is represented by the “Site Zoning” and “Site Environmental Control” entities. The former refers to implications of restrictions on design aspects, as set out in the Planning Regulations, such as height limits or facade appearance, the latter, on the control of the physical and visual appearance of the exterior of the building. This can be in the form of landscape, recountouring, external works of art, signposting, site furniture, plants, etc., all of which

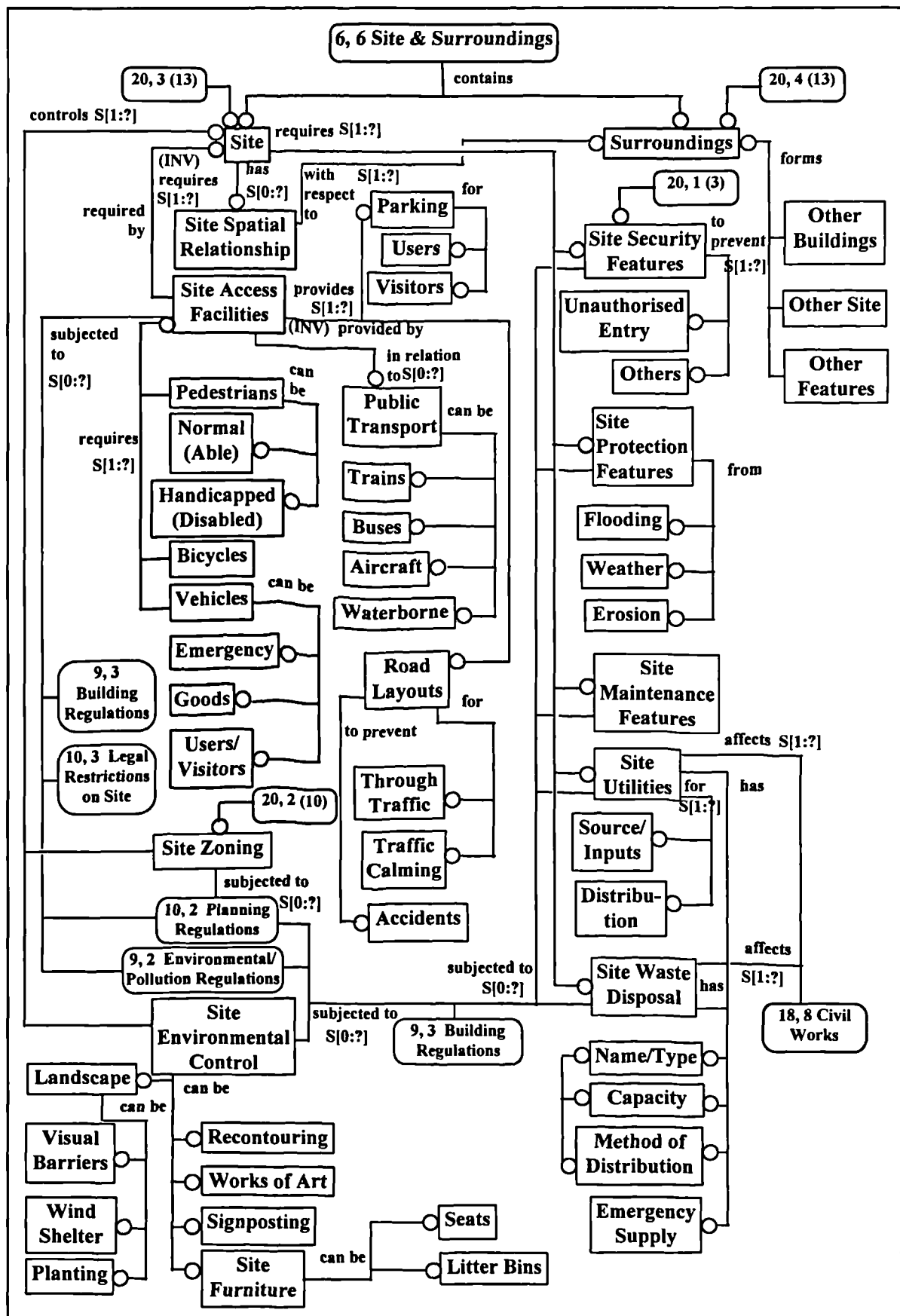


Figure 6.24: Level 2 Diagram - Site and Surroundings (Page 20 of 22)

are subject to the Environmental/Pollution Regulations, Planning Regulations and the Building Regulations.

The performance criteria for the “Site and Surroundings” entity is represented by the “Site Spatial Relationship”, “Site Access facilities”, “Site Security Features”, “Site Protection Features”, “Site Maintenance Features”, “Site Utilities” and “Site Waste Disposal” entities. The “Site” has “Site Spatial Relationship” with respect to an instance of the “Surroundings” entity. “Site Access Facilities” is required by the “Site” entity, which, in turn, is necessary for pedestrians, bicycles and vehicles, all represented by their respective entities in Figure 6.24. The “Site Access Facilities” also provides “Parking” and “Road Layouts”, and may be provided in relation to public transport. “Site Security Features” deals with prevention of unauthorised entry. “Site Protection Features” protects the site from flooding, weather or erosion. “Site Utilities” and “Site Waste Disposal” handle the distribution of incoming inputs into the building and the disposal of waste products from the building. Both of these entities are linked to the “Civil Works” entity.

6.8 The Level 3 Diagrams

The level 1 and 2 diagrams have been presented in the preceding sections. This section will only present the level 3 diagrams for the “Wall” entity (shaded), which forms part of the “External Envelope” sub-system, as shown on Page 17 (Figure 6.21). The “Wall” entity has been extended in order to demonstrate the information required for the “Wall Cladding” entity.

Although current practices for the brief development do not usually address detailed descriptions of the wall cladding system within the brief, this has been included in the scope of this study. The principal reason is to explore the possibility of incorporating detailed issues of the client's requirements into the brief. Part of the decision lies in the context of the development of the prototype for the briefing process. If the brief were to be used as an integral part of an integrated system in which the detailed design is concurrently being generated, then, the generation of a detailed brief would be of vital importance.

The "Wall Cladding" Entity

The "Wall Cladding" entity is depicted in Figures 6.25 and 6.26. Figure 6.25 portrays the "Wall Cladding" entity, as a subtype of the "Non-loadbearing" entity, which is a subtype of the "Wall" entity. The "Wall Cladding" entity, in turn, has three subtypes; "Curtain Walling Systems", "Light Panels" and "Precast Concrete Panels". These subtypes represent the types of wall cladding included in the scope of this study.

The design criteria of the "Wall Cladding" entity is represented by the entities, linked to it by the "has" relationship. They are "Cladding Panel", "Background/Support", and "Glazing Units". The "Cladding Panel" has attributes which include weight category, type, visual size, visual appearance and material. Each of these attributes are linked to their possible values as shown in the figure. The "Background/Support" entity has two subtypes: "Structural Frame" or backing, and "Framed Members" or framed structure. The "Framed Members" entity is expanded to include its attributes, which comprise material, span, frame view and finish to the framed members. The "Glazing Unit" entity,

on the other hand has two attributes which include glass sheet type and thermal properties requirements. In a particular situation either type may be used on its own or combined with the other.

Figure 6.26 illustrates the performance criteria of the “Wall Cladding” entity. These criteria are represented by the entities which are linked to the “Wall Cladding” entity by the “requires” relationship. They include “Fire Safety”, “Tightness Requirements”, “Hygrothermal Requirements”, “Acoustical Requirements”, “Structural Stability”, “Tactile Requirements”, “Visual Requirements”, “Durability Requirements” and “Economics Requirements”. Each of these entities have attributes and recommended values, all as shown in Figure 6.26. Each of these entities are linked to the relevant regulatory issues, where applicable. For the “Building Regulations” entity, certain abbreviations have been used in the composition symbols; “Reg” refers to “Regulation”, “Sch” refers to “Schedule”, “AD” refers to “Approved Document” and “BS” stands for “British Standards”.

The decomposition of the information for inclusion in the client’s brief ends here. The rest of the items are outside the scope of this study. If however, the scope is widened to include the modelling of all the brief information for the development of a detailed design, it is possible to decompose every aspect of the Level 2 Diagrams to obtain a more in-depth portrayal of the actual information that needs to be investigated. During the early design stage, the amount of information presented by the developed models is sufficient to produce a coherent and concise brief.

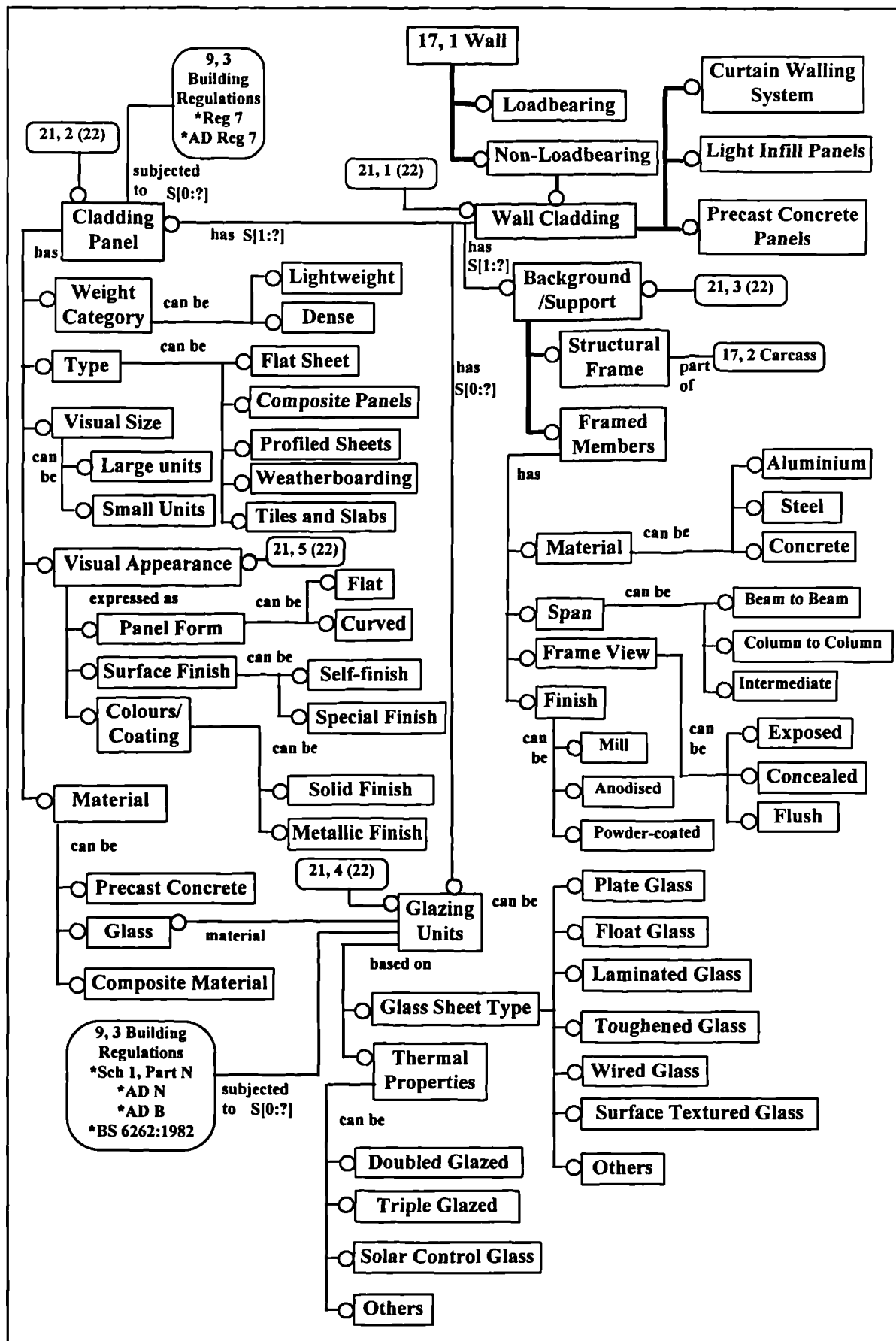


Figure 6.25: Level 3 Diagram - The "Wall Cladding" Entity in Relation to the "Wall" Entity (Page 21 of 22)

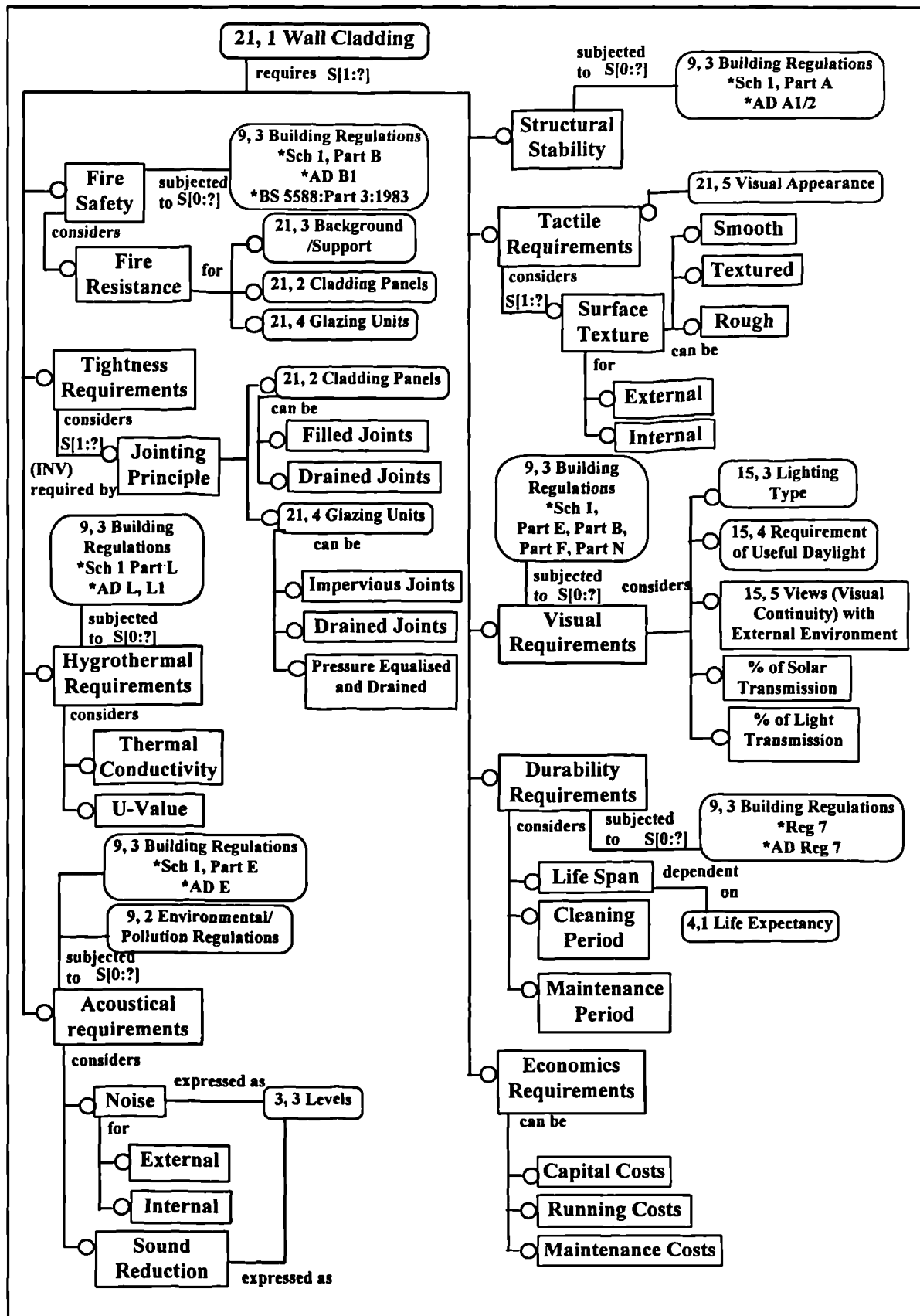


Figure 6.26: Level 3 Diagram - The "Wall Cladding" Entity (Page 22 of 22)

6.9 Summary and Conclusions

A full analysis on the information required for the development of the client's brief has been carried out. The analysis has resulted in the development of data models for the information which are essential for the brief. The data models have been decomposed at varying levels of abstractions, beginning with the context diagram which portrays the framework for the presentation of the brief. The level 1 diagrams illustrate the main entities which form part of the brief contents. The level 2 diagrams depict more detailed issues with respect to the main entities. Finally, the level 3 diagrams present even more detailed information on wall claddings.

As a whole, the developed data models display the entities which correspond to specific information in the client's brief. The relationships between entities are also portrayed along with their subtypes and attributes. The cardinality of the relationships between entities are displayed to impart the strengths of the relationships between one entity and another. Constraints are identified where necessary.

From the point of view of developing the prototype for the development of the client's brief, the data models would provide the basis for the implementation process. The constructs that belong to the developed models provide a set of constituents, ready to be transformed into objects, attributes, etc., which will be incorporated in an object oriented environment. The implementation into the object oriented environment will be discussed in Chapter 8.

Meanwhile, the developed data models can be viewed from the standpoint of the construction project. With the above developed data models in hand, it is conceivable that the parties involved in the initial stages of a construction project would gain substantial benefits. The overall visual impression of the information required for the proposed project is now at their disposal. The relationships between the entities would enable them to understand the project in its entirety. The team would be able to identify, examine and discuss the possible outcomes and solutions for the project. In this way, the development of the brief would produce strong and reliable information which will stand firm throughout the construction project.

CHAPTER 7

PROCESS MODELLING (IDEF0 MODELS)

7.1 Introduction

The previous chapter has discussed the modelling of information required for the development of the brief. This chapter presents the process analysis that has been carried out on the briefing process. The IDEF0 modelling technique has been adopted for this purpose. Initially, the relevant sources of information and the activities carried out by the design team or construction professionals during the process of developing the brief, are identified. This was followed by the development of a set of hierarchical models which represent an abstract portrayal of these activities, along with their inputs, outputs, controls and mechanisms.

By examining the above developed models, a full analysis process has been carried out with the aim of modifying and adapting the models to best fit a computerised prototype system. With careful consideration of the aims and objectives of the prototype, it was found to be necessary to develop the process models for the proposed prototype within two viewpoints. The first viewpoint relates to the system's architecture of the prototype,

i.e. in terms of how the system functions and arrives at certain decisions or operations. The second refers to the information viewpoint, i.e. in terms of what information is to be obtained from the system's user at any particular point, prior to the generation of the brief. The developed process models for both viewpoints are presented in this chapter. Prior to that, the IDEF0 models and the notations used are explained.

7.2 IDEF0 Model and Notations

IDEF0 is a structured analysis technique which expresses the happenings of a subject in the form of an activity or a process decomposition. The underlying concept behind IDEF0 is to understand an existing system by creating a model that graphically shows information and activities performed by either men or machine (SofTech, 1979). There is a need to distinguish between what functions the system has to perform as oppose to how the system is built to accomplish those functions.

The structure of the model is presented in the form of a hierarchy. IDEF0 starts by representing the whole system as a single box, with the key function at the top. This box is normally decomposed into three to six functions, each of which may be further decomposed into sub-processes. Each successive level of decomposition of a function increases the amount of detail, thus gradually exposing details within the boundary of the parent function. Internal consistency of the model is an absolute requirement. For this reason, each lower level diagram connects exactly to the higher level segments of the model, thus maintaining and preserving the logical relationship of each component to the overall system (Ross, 1977; Ross and Schoman, 1977). Decomposition of a particular function is discontinued when the level of detail is sufficient for the

application of the model. Once completed, a developed model should be reviewed with all the decisions documented.

7.2.1 The IDEF0 Notations

The IDEF0 notations provide a set of graphical constructs which describe the functional aspect of a system. Figure 7.1 depicts the IDEF0 notation. It consists of boxes and arrows. The boxes represent the *activities* while the arrows represent *data constraints*. The arrows do not represent flow or sequence. They represent constraints that must be satisfied or the invariant properties that must be true, rather than a sequence of steps that will yield the result. “It is always more powerful to constraint than to sequence” (SofTech, 1979).

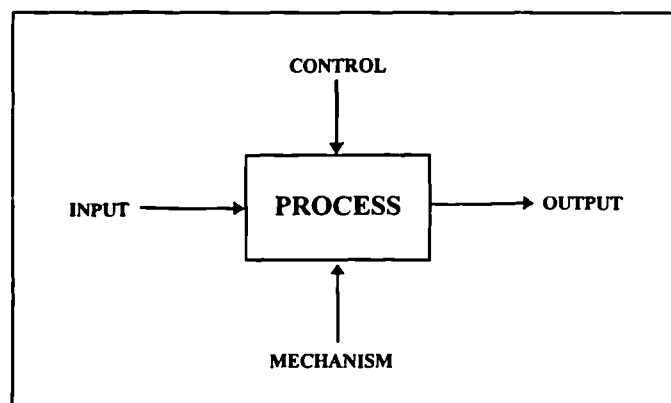


Figure 7.1: IDEF0 Notations

The IDEF0 notations comprise the process, input, output, control and mechanism. Each is briefly described below:

Process: An activity, action, operation, process, or transformation which is described by a verb and an object. The process is represented by a box with the description inside the box.

Input: An entity which undergoes a process and is transformed. An input enters the left hand side of the box. The label allocated to the input describes its name. An input can be an information or a material resource.

Output: An entity which results from the process. An output leaves the box from the right hand side. The label allocated to the output describes its name.

Control: A control describes the conditions or circumstances that governs the transformation. It influences or determines the process of transforming inputs into outputs. It interacts and constraints the transformation to ensure that it is applicable under appropriate circumstances. A control enters the box from the top. The label describes the constraints imposed by the control. If an input also serves as a control then it is displayed as a control.

Mechanism: A mechanism provides means to carry out the process. It can be a person or a machine. A mechanism enters the box from the bottom. The label describes the means of accomplishing the process.

In summary, the input and output denote *what* is done by the activity, the control shows *why* it is done, and the mechanism indicates *how* it is done (SofTech, 1979).

7.2.2 Numbering the IDEF0 Diagrams

The IDEF0 model represents a hierarchy of diagrams. The highest level in the model is labelled A-0, referred to as the node for the diagram. The next level of decomposition presents the major functions of the system, and is called A0. The decomposition of each major function is labelled from A1 to A6. Further decomposition leads to additional digits being placed at the end. For example, if A1 is decomposed into three sub-processes, the decomposition of each of these sub-process are labelled A11, A12 and A13. Beyond this level of decomposition, it will lead to A111, and so on. This numbering system allows the reader to trace the steps of decomposition through the parent function of each diagram.

7.2.3 Reading the IDEF0 Diagrams

The hierarchy of diagrams that constitutes the IDEF0 diagrams is read top-down, based on the numbering of the diagrams (nodes) as described in the above section. Two basic strategies may be used (SofTech, 1979) in reading a model:

- (a) explore the upper levels of the model to gain an understanding of the system,
- or
- (b) study a specific detail

In both cases, reading usually proceeds in a top-down manner, using a well-understood concept as a starting point. The node index may be used to gain a feeling of the structure of the model, and to find all the diagrams which detail the subject of interest.

SofTech, (1979) recommends the following reading sequence:

- (1) Scan the boxes of the current diagram to get a general impression of what is being described.
- (2) Refer back to the parent diagram and note the arrow connections to the diagram. Try to identify a “most important” input, control and output.
- (3) Observe the current diagram. Try to determine if there is a main path linking the “most important” input or control, and the “most important” output.
- (4) Mentally walk through the diagram from upper left to lower right, using the main path as a guide. Study and examine the overall content of the diagram.
- (5) Read the supportive text to gain further understanding of the model intent.

7.2.4 The Orientation of the IDEF0 Models

Prior to the development of the IDEF0 models, the orientation of the models to be produced need to be established (SofTech, 1979). This can be achieved by establishing three aspects of its orientation:

1) the context

The context identifies the subject matter of the model by describing its boundaries.

In other words, it identifies the scope of the model. It relates to viewpoints and component purpose which together describe a given whole subject.

2) the viewpoint

The viewpoint makes clear what aspects are considered to be relevant when describing the subject matter. It considers aspects relevant to achieving some components of the overall purpose. It governs the emphasis given to various features.

3) the purpose

The purpose provides the reason for which the model is being created and which will determine the scope, depth and structure of the model.

Once the orientation of the model has been established, it functions as a guide to the activities involved in creating the model. It provides a systematic approach in the form of a “top-down” hierarchy of leading questions. These questions are properly sequenced, completely decomposed, and successively answered.

7.3 The Development of the IDEF0 Models

The following sections describe the developed process models. The first set of models portray an abstract representation of the “current operations” that take place in the development of the client’s brief. This abstract representation has been deduced from the literature review. The second set, however, have been developed to accommodate a computerised prototype system for developing the client’s brief. These models are meant to establish the processes/activities involved in the development of the proposed prototype.

7.3.1 Process Models for Current Operations in the Brief Development

This section examines the “current operations” that transpire during the development of the client’s brief, based on deductions made from the literature review of the briefing process. It begins with the creation of a functional model, which is a representation of “WHAT the problem is” in terms of “current operations”. This was carried out to

ensure that the problem is fully and clearly understood before the details of a solution are decided upon for the proposed information system prototype.

7.3.1.1 The Orientation of the Functional Model

The orientation of the functional model has been established as follows:

(a) The Context

The subject matter, or domain, for the functional model encompasses the process of developing the client's brief. Current practices normally involve the development of the brief during the "Briefing" phase of the RIBA outline plan of works (RIBA, 1967; RIBA, 1991). The "Briefing" phase is made up of two stages; Stage A: Inception, and Stage B: Feasibility. The purpose of Stage A is to prepare a general outline of the requirements of the project and to plan for future action. In relation to the brief development process, this entails the client to provide information for the brief, e.g. in the form of an outline brief, to the project participants (or consultants). Stage B aims to provide the client with an appraisal and recommendation in order to determine the form in which the project can proceed, while ensuring that it is feasible functionally, technically and financially. With reference to the brief development process, this stage requires the brief to be developed, while the project participants elicit the required information for, and guide the direction of the brief. At the end of this "Briefing" phase, the brief should have been determined in sufficient detail.

Beyond the "Briefing" stage however, for a number of projects, the brief may require further development. This takes place during Stage C: Outline Proposals, and Stage D:

Scheme Design. During Stage C, the brief may require additional requirements or amendments, whilst Stage D ensures the completion of the final brief. The final documentation produced at the end of either Stage B or D, whichever is relevant for a particular project, is therefore the client's brief. However, for the purpose of creating the functional model, the scope has been confined to the process of developing the client's brief, notwithstanding the particular stage in which the brief was finally concluded.

(b) The Viewpoint

The model was developed from the viewpoint of the members of the design team who are responsible for preparing the brief. It is an abstract representation of the domain, taken from current operations conducted by members of the design team. It portrays the sequence of activities that take place during the development of the brief in an abstract form.

(c) The Purpose

The purpose of the model is to portray the activities carried out by the design team during the process of developing the brief.

7.3.1.2 The Diagram Tree

The diagram tree for the process models within the context of current operations in brief development is shown in Figure 7.2. It represents the hierarchy of diagrams for the developed process models. The number at the top of the process box represents the node number with the name of the activity inside the corresponding box.

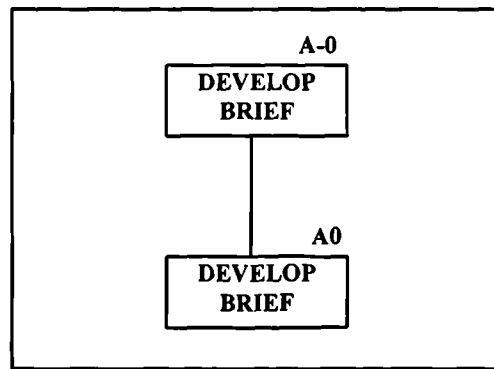


Figure 7. 2: The Diagram Tree (Process Models for the Current Operations in Brief Development)

7.3.1.3 The Context Diagram

Figure 7.3 depicts the highest level of the “Develop Brief” process, represented by the A-0 Node. The “Develop Brief” process was set within the context of the person who develops the brief.

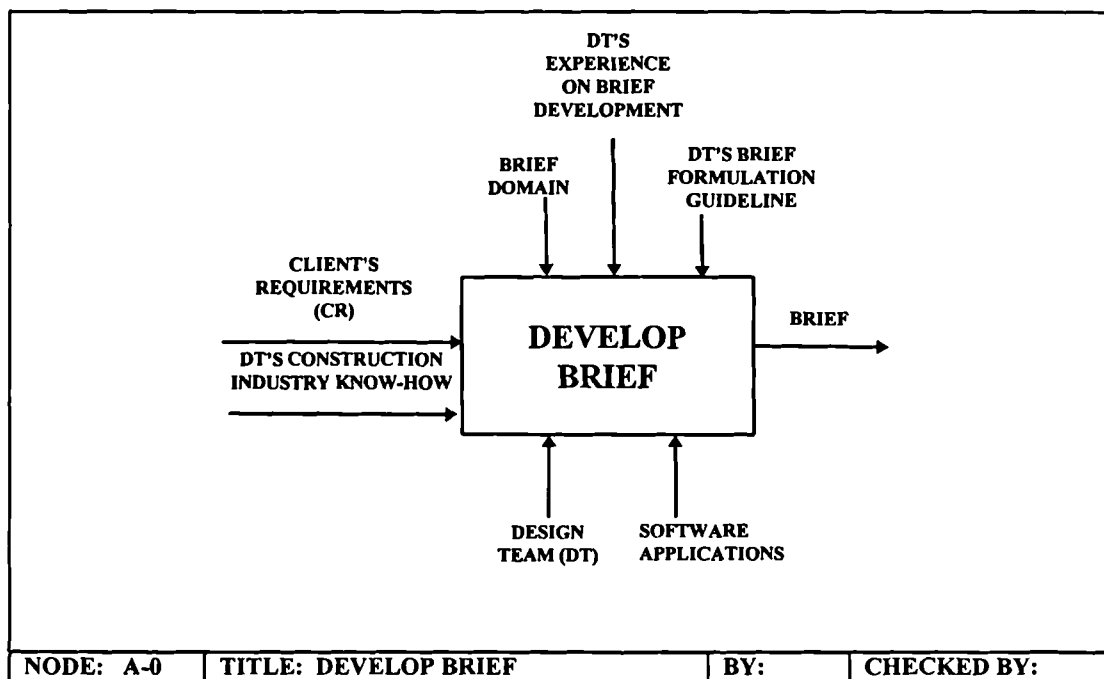


Figure 7.3 : Develop Brief (Context Diagram for Current Operations)

The “Develop Brief” process includes all the activities that are required to support the execution of this process. It comprises a single rectangle, occupied by the “Develop

Brief' process, along with the inputs, outputs and mechanisms as shown in Figure 7.3.

The individual elements are described as follows:

“Develop Brief” process: This refers to the process of eliciting or “brief-taking” (Barrett and Stanley, 1996) the information or requirements from clients. The requirements are collected, collated and classified into some form of organisation. The organised information is then recorded, compiled and documented in the form of the “Brief”, which represents the output of the process.

“Design Team” mechanism: This refers to any member of the design team (abbreviated to “DT”) or project participants, as described in Chapter 6, who are responsible for developing the brief. This could be the architect, engineer, or any member of the design team. For simplicity, the mechanism does not identify any particular member of the design team, i.e. it portrays the design team as a whole.

“Software Applications” mechanism: This mechanism refers to any form of software applications that may be utilised in order to assist with the “Develop Brief” process. This can be in the form of word processors, spreadsheets or some other tools used.

“Client’s Requirements” input: This represents the needs and requirements of the client which determine the final product.

“DT’s Construction Industry Know-how” input: The input represents the amount of knowledge that the design team has with regards to project related information available

within the construction industry. This can include aspects such as the availability of specific materials, technical product data, or even the advent of new technology which may give rise to new or alternative forms of construction or design solution. With this knowledge in hand, the design team would be able to conduct a thorough examination of the client's requirements. The lack of this useful knowledge, however, may lead to a brief which does not meet the client's actual requirements.

“Brief Domain” Control: This control encompasses the subject matter or knowledge with regards to all aspects of the brief.

“DT’s Experience on Brief Development” Control: This represents the level of knowledge and/or preference of the design team in developing the brief. Past experience seems to be the major driving force behind “brief-taking” as far as construction professionals are concerned (Barrett and Stanley, 1996). This factor varies between individuals, depending on their own set of internalised briefing “rules” which they prefer to hang on to. The consequence of which is varying ways of conducting the “Develop Brief” process, as well as a non-standardised way of presenting the “Brief” output.

“DT’s Brief Formulation Guideline” Control: This control refers to any form of checklist or guidelines to the formulation of the brief, which is used by the design team as a point of reference. Again, even though such reference materials exist, certain individuals, or the design team as a whole, may prefer to rely on their own experience when formulating the brief.

“Brief” Output: This represents the final output of the “Develop Brief” process. The brief refers to a documented textual presentation of the needs and requirements of the clients. It can be described as a definitive written statement of client requirements. The “Brief” output can be in any format, in varying lengths and contents, and can be called by different names depending on the specific inputs, controls and mechanisms used for a particular “Develop Brief” process. The names used can be any one of the following; client’s brief, project brief, outline brief, design brief, functional brief and facility management brief, to name a few.

7.3.1.4 The Level 1 Diagrams

The level 1 diagram represents the abstract portrayal of the actual process carried out by the design team during the brief development process. It does not portray the actual steps carried out by the design team. Abstraction has been used because it is an important mechanism for managing complexity. It allows irrelevant details to be hidden when considering information and processes/activities within a particular context (Cooper and Brandon, 1995).

The level 1 model is represented by the A0 diagram shown in Figure 7.4. It represents the decomposition of the “Develop Brief” process, and is therefore restricted to contain only those elements that lie within the scope of its parent module, the A-0 diagram (Figure 7.3). The parent activity is decomposed into the following six sub-activities:

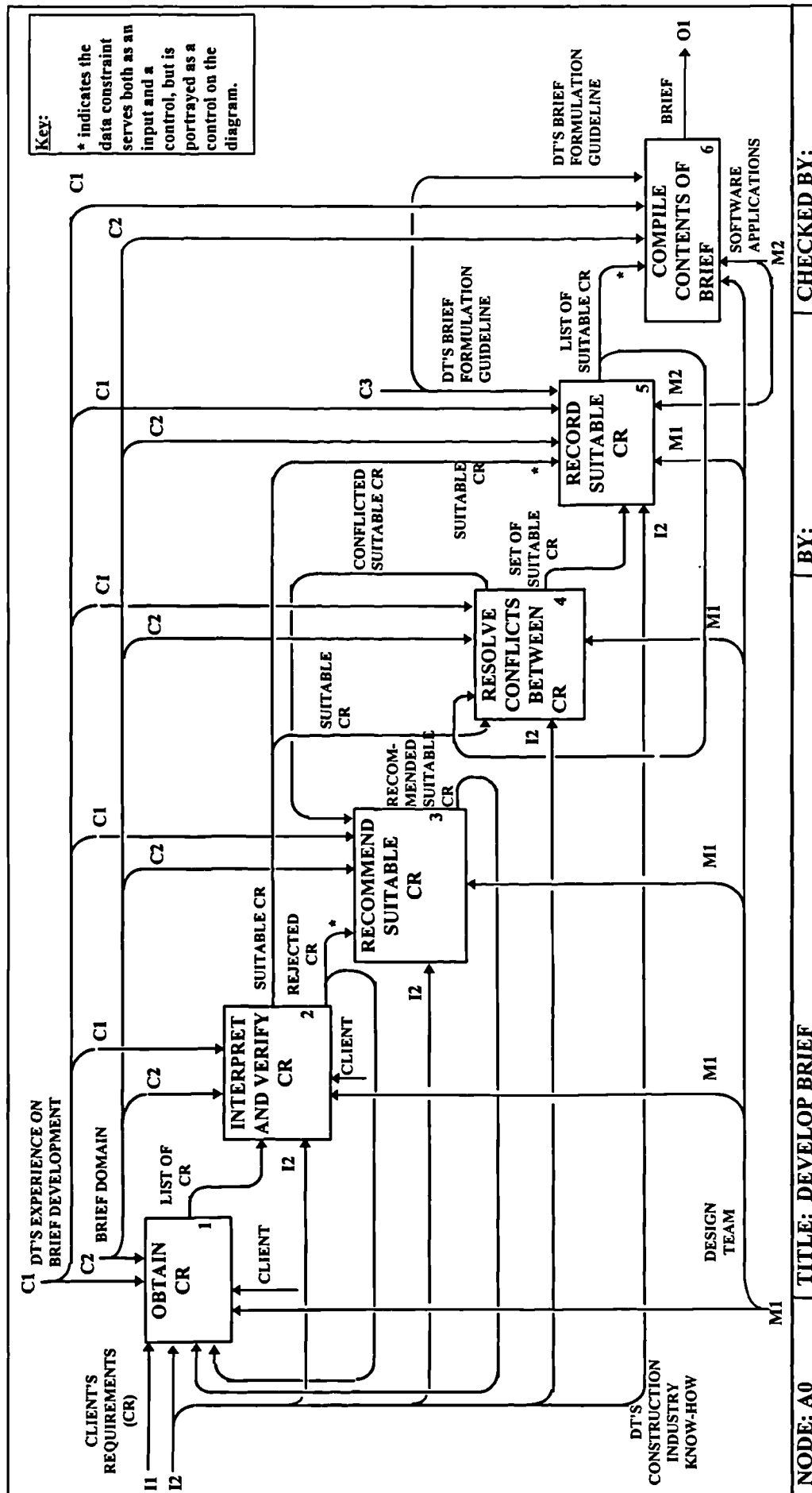


Figure 7.4: Develop Brief (Level 1 Diagram for Current Operations)

“Obtain CR”: This represents the process of eliciting the client’s requirements, i.e. information from the client that leads to the realisation of a building form performed by the design team. The “Client” and the “Design Team” therefore form the mechanisms for the process. The inputs for the process include “Client’s Requirements”, which is obtained from the client, and “DT’s Construction Industry Know-how”, which the design team may require in order to elicit the requirements from the client. The controls for the process “Brief Domain” and “DT’s Experience on Brief Development”, the latter of which may influence the way in which the “Obtain CR” process is carried out by the design team. The output of the process is a list of all the client’s requirements obtained from the client, represented by the “List of CR” output, which then becomes the input into the next process.

“Interpret and Verify CR”: This process interprets the client’s requirements obtained from the client, the “List of CR” input, rephrase any particular items if necessary, e.g. to use a more acceptable term suitable for brief presentation, and verify it by getting agreement from the client. The aim is for the design team to conduct a thorough examination of the requirements in order to identify the client’s actual requirements. The “DT’s Construction Industry Know-how” input is useful for this process. The two controls for the above process are maintained together with the two mechanisms. One of the outputs for the process is “Suitable CR”, which represents the information or client’s requirements agreed by the client, and suitable for presentation in the brief. If, however, any of the requirements are found to be unsuitable, they are rejected by the process as “Rejected CR”, which either goes back as an input of the “Obtain CR” process, or as a control for the next process.

“Recommend Suitable CR”: If any of the client’s requirements proposed by the client do not survive the above preceding process, and are being rejected as the “Rejected CR” output, then this process makes recommendations for a suitable client requirement, based on the rejected client’s requirements, which enters the process as a control. “Rejected CR” serves as both input and control into the process. In such a situation it is portrayed as a control. Another control for this process is “Conflicted CR”, an output of the “Resolve Conflicts Between CR” process. The two controls for the above two processes are maintained together with the “DT’s Construction Industry Know-how” input. This input plays a role in the type or form of recommendations to be made by the design team, the only mechanism for this process. The recommendation(s) is/are represented by the “Recommended Suitable CR” output, which returns back to the “Obtain CR” process.

“Resolve Conflicts Between CR”: This process aims to ensure compatibility between the various accepted client’s requirements. Every time a requirement of the client is accepted as a “Suitable CR”, it becomes the input into this process, whereby it is checked against the “List of Suitable CR”, the output of the “Record Suitable CR”. This output transforms into a control for this particular process, the purpose of which is to prevent and to resolve any conflicting requirements of the client which have been accepted. The result is the “Set of Suitable CR” output. Any conflicted requirements, however, are sent back as a control to the “Recommend Suitable CR” process.

“Record Suitable CR”: The process records all the suitable client’s requirements obtained from the “Interpret And Verify CR” process. The “Suitable CR” output serves both as an input and a control into the process. In such a case, it is portrayed as a control in order to emphasise the suitability of the client’s requirements prior to initiating the process. “Set of Suitable CR” enters the process as an input. By repeating the four processes above whenever necessary, the “Suitable CR” control and the “Set of Suitable CR” input are being refined and improved to ensure a true reflection of the client’s requirements. The “DT’s Experience on Brief Development” and “Brief Domain” controls are maintained. An additional control is depicted for this process, “DT’s Formulation Guideline”, which influences the way in which the client’s requirements are recorded, the output of which is represented by “List of Suitable CR”. The mechanism of this process is the design team, with the use, in some cases, of “Software Applications”. This can be in the form of word processors, spreadsheets or some other tool, used for recording the output.

“Compile Contents of the Brief”: This is the final sub-activity of the “Develop Brief” process. “List of Suitable CR” fulfils both functions as an input and as a control. In this situation, the control emphasises the importance of the suitability or acceptability of the client’s requirements before the “Compile Contents of the Brief” process can commence. During this process, the “List of Suitable CR” is compiled in an organised way depending on the “Brief Domain”, the “DT’s Experience on Brief Development” and “DT’s Brief Formulation Guideline”. The requirements are formulated to generate the final output, which is the “Brief”. The mechanisms for the process are the design

team, together with any software applications, used for the purpose of formatting or presenting the final output.

As a whole, the A0 diagram of the “Develop Brief” process (Figure 7.4) illustrates the iterative nature of the brief development process. This supports Turner’s (1986) suggestion that briefing has an inherent framework within which flexibility and reiteration occurs. Further, Davis Langdon Consultancy (1996) suggests that briefing is likely to be evolutionary, as design concepts are proposed and developed in response to progressive clarification and detailing of the client’s requirements. This occurrence of the iterative nature and the evolutionary concept of the brief is represented by the arrows which carry the output of a process back into a previous process. As an example, the movement of “Suitable CR” or “List of Suitable CR” between the processes demonstrates how the client’s requirements are updated and revised to ensure compatibility. If each individual client’s requirement is investigated thoroughly, the whole process is carried out painstakingly, and a reasonable amount of time is allocated to ensure that this is possible, then the developed brief could be an ideal one.

However, in reality this may not be possible. Due to the subjective nature of the “DT’s Experience on Brief Development” and “DT’s Brief Formulation Guideline” controls, or the absence of either control, the result is a client’s brief which varies in content, format, style and emphasis. The briefs developed by different individuals or design teams lack the consistency factor. More significantly though, if the brief is being developed by an inexperienced team, the resulting brief may not reflect the true requirements of the client. An incomplete or an inadequate brief could lead to cost and time overruns. It is

with this notion in mind that a process model is developed for the proposed prototype development which is aimed to support the existing process.

7.3.2 Proposed Process Models for Prototype Development

This section describes the process models for the proposed prototype development. It illustrates the design of “*how* the problem will be solved or implemented” in a prototype.

7.3.2.1 The Orientation of the Proposed Process Model

The orientation has been established as follows:

(a) The Context

As in the previous section, the domain of the process model covers the process of developing the client’s brief. It does not take into account any predefined stage or phases in the development of the brief. The whole process is considered as one complete activity.

(b) The Viewpoint

The model was developed from the standpoint of any member of the design team who is responsible for preparing the brief. It is an abstract representation of the domain, adapted from the process model developed for the current operations presented in the previous section. It portrays the sequence of activities that take place during the development of the brief.

The models have been developed from two related viewpoints. They are in terms of:

- i) the information required to be obtained (compiled) in order to generate the brief, i.e. from the point of view of obtaining the information that forms the client's requirements. For this process model, the node begin with "AB/I", followed by the diagram number, where "I" represents information.
- ii) the system architecture of the proposed prototype, i.e. from the point of view of how the system and its components will function. The nodes for these models begin with "AB/", followed by the diagram number. "AB" is an abbreviation of "AUTOBRIEF", the name of the prototype.

(c) The Purpose

The purpose of the model is to observe the activities carried out by the client and the design team during the process of developing the brief. It aims to emulate within reason, and within the capability of information technology, the activities conducted by the client and the design team. The aim is to produce a client's brief which closely resembles and reflects the client's requirements.

7.3.2.2 The Diagram Tree

The diagram tree for the developed process models for the prototype development is depicted in Figure 7.5. It represents the hierarchy of diagrams for the proposed process models. As before, the number at the top of the process box represents the node number, with the name of the activity inside the corresponding box.

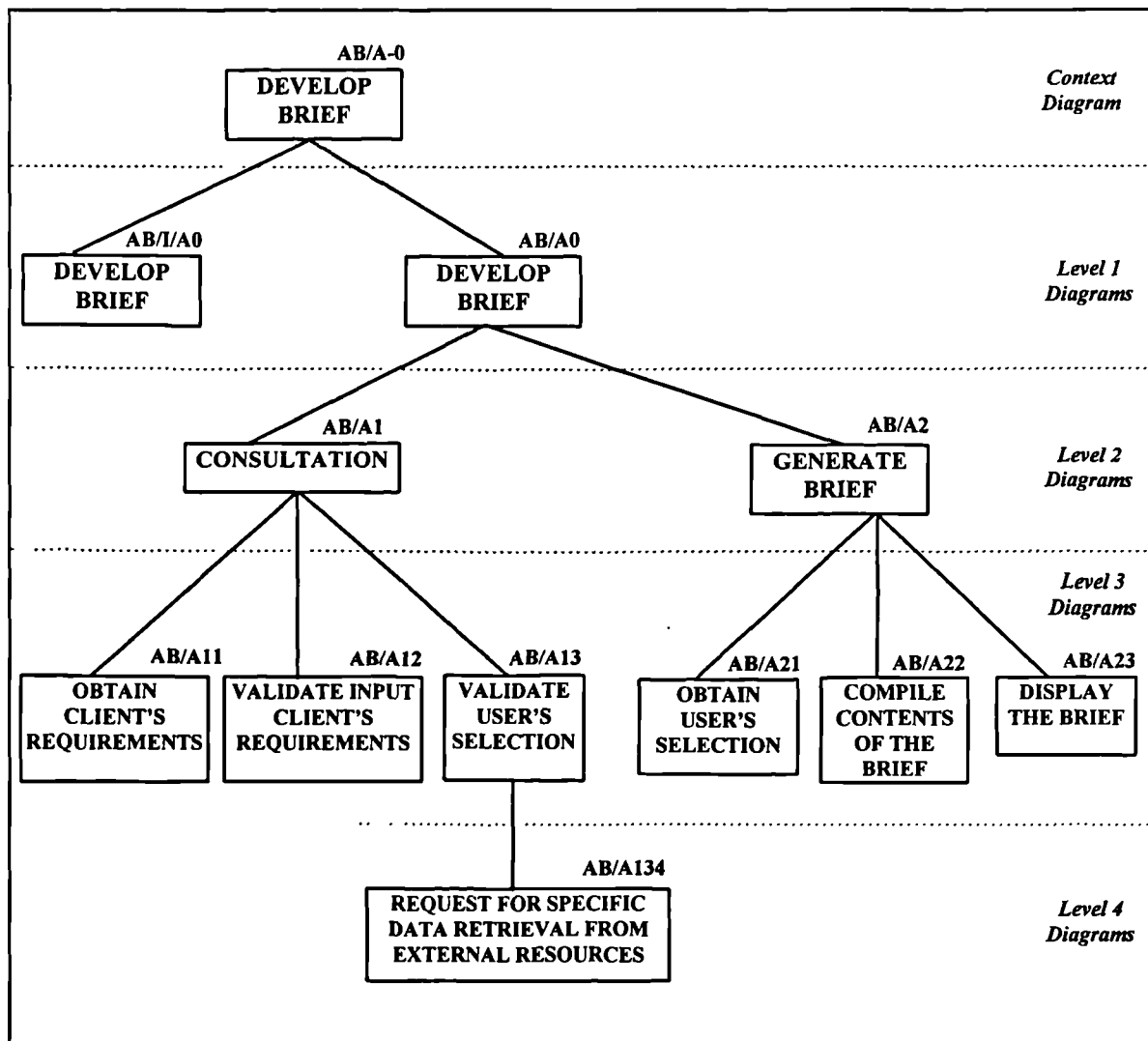


Figure 7. 5: The Diagram Tree (Process Models for the Prototype Development)

7.3.2.3 The Context Diagram

Based on the established orientation, the process models were created. Figure 7.6 depicts the highest level of the “Develop Brief” process, represented by the AB/A-0 node. The “Develop Brief” process was set within the context of the person who develops the brief. This diagram represents the context diagram for both viewpoints mentioned in 7.3.2.1 (b) above.

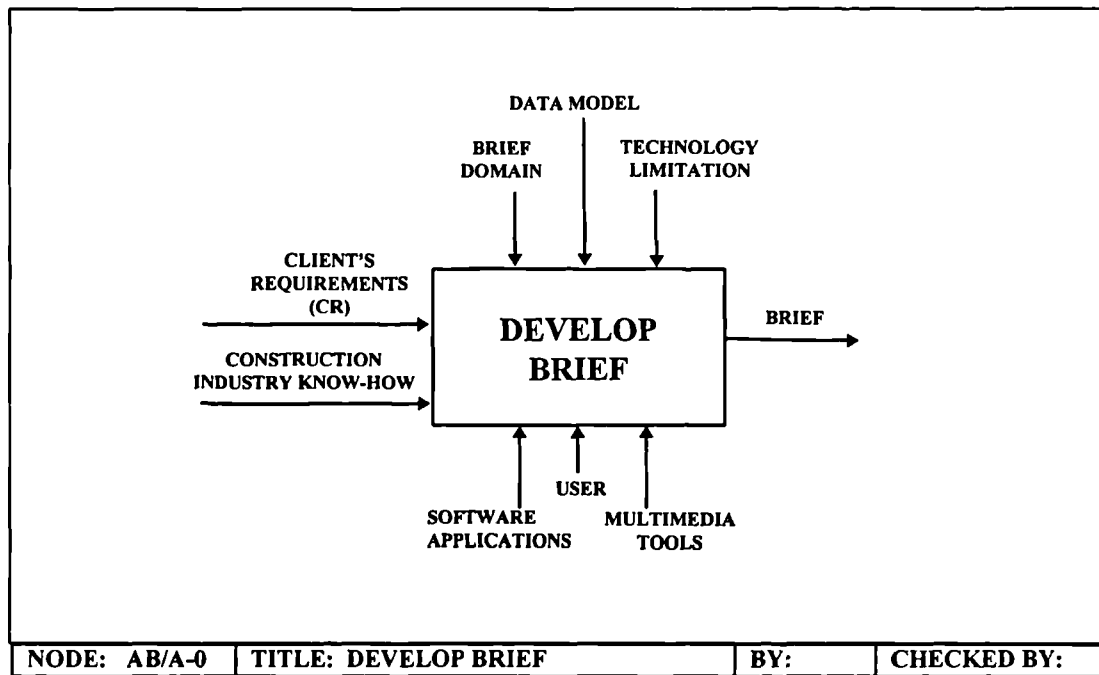


Figure 7.6 : Develop Brief (Context Diagram for Prototype Development)

“Develop Brief” process: As described in section 7.3.3 earlier, this refers to the process of eliciting the information or requirements from clients. The requirements are obtained from the user of the prototype system, interpreted, verified, checked for incompatibility or conflicts, stored and then organised and compiled to generate an output which can be viewed on screen, or documented in the form of the “Brief”. During the process, relevant information to the project or construction industry as a whole is presented to the user to assist in the identification of the client’s requirements.

“User” mechanism: This mechanism represents the user of the system. It can be any members of the design team, the client or both, working together to arrive at an agreed solution.

“Software Applications” mechanism: This mechanism refers to the computer environment utilised for the development of the prototype and any associated or required software applications.

“Multimedia Tools” mechanism: This refers to any software applications necessary to incorporate multimedia as one form of presentation medium for the prototype.

“Client’s Requirements” input: This represents the needs and requirements of the client, which can be input directly into the system by the user, or by selecting options presented to the user in the form of a menu.

“Construction Industry Know-how” input: The input represents project related information available within the construction industry. It can be referred to as supporting information. It can include aspects such as the availability of specific materials, technical product data, building regulations, design and performance information, etc. The presentation of such information would assist the user to decide on the most appropriate client’s requirements to be entered into the system.

“Brief Domain” Control: This control encompasses the subject matter or knowledge with regards to all aspects of the brief.

“Data Model” Control: This represents the object oriented data model implemented into the computer environment which will be presented in Chapter 8. The way in which the data model is developed controls the way in which the “Develop Brief” process is

performed. In essence, in comparison to the A-0 diagram (Figure 7.3) of the process model for current operations for brief development, the “Data Model” combines both the “DT’s Experience on Brief Development” and “DT’s Brief Formulation Guideline” controls. In other words, by ensuring that aspects of these two controls are covered by the data models, it will reduce the dependency of the “Brief” output on the experience and/or preference of the design team. In consequence, a standard way of developing the brief is achieved, while promoting a consistent and standardised form of the “Brief” output.

“Technology Limitation” Control: This control refers to the limitations encountered when using any forms of information technology.

“Brief” Output: This represents the final output of the “Develop Brief” process for the proposed prototype. The brief refers to a documented textual presentation of the needs and requirements of the clients. It can be described as a definitive written statement of client requirements. The “Brief” output may exist in various forms as shown by the AB/A2 diagram (Figure 7.10). This includes “Displayed Generated Brief”, “File of Generated Brief” and “Printed Brief”.

7.3.2.4 Level 1 Diagrams

The level 1 diagram is represented by the AB/I/A0 diagram (Figure 7.7) from the information viewpoint, and by the AB/A0 diagram (Figure 7.8) from the system’s architecture viewpoint.

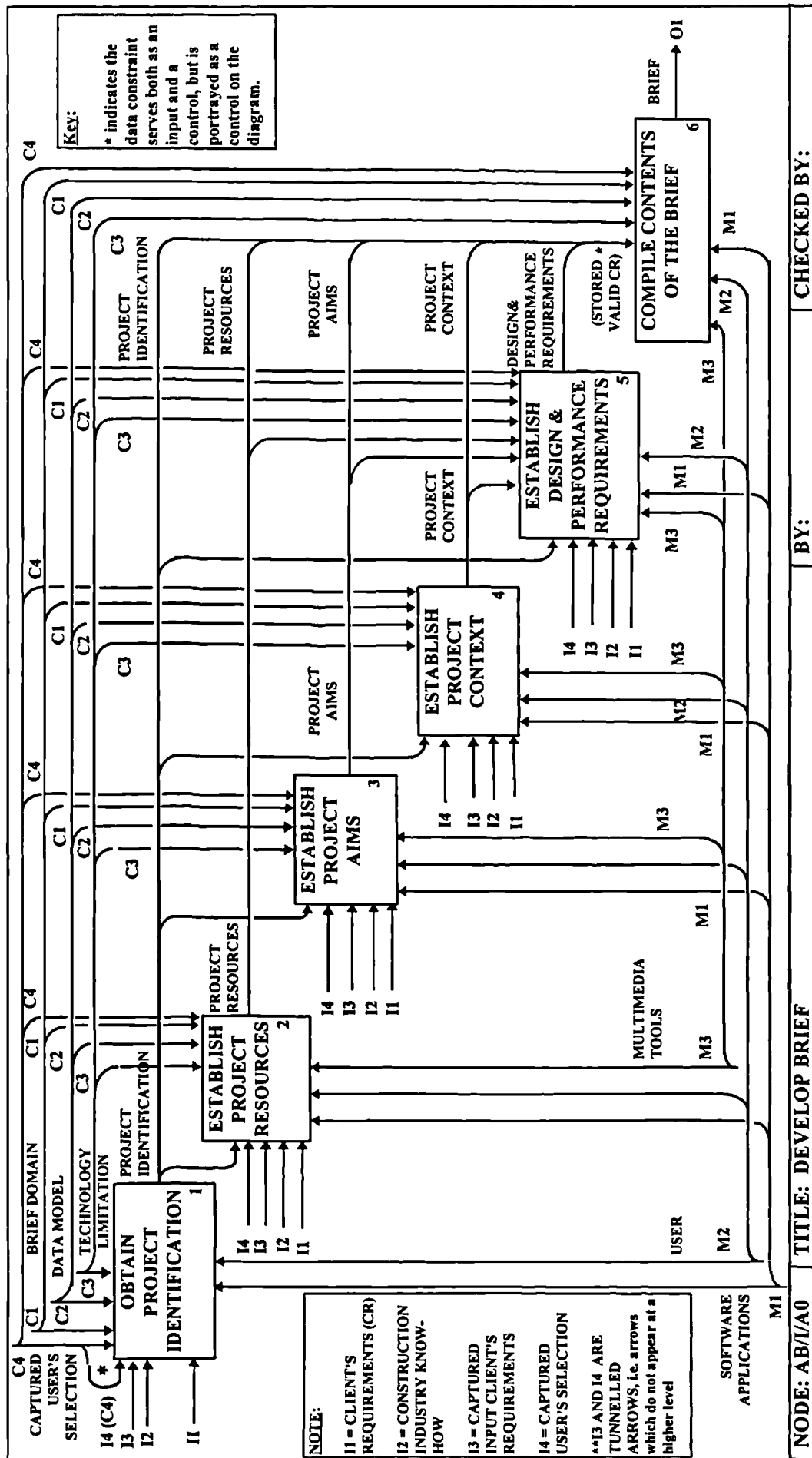


Figure 7.7: Develop Brief (Information Viewpoint)

(a) Level 1 Diagram - Information Viewpoint

As shown in Figure 7.7, the process model has been developed in terms of the information to be extracted from the user. The way in which this information is elicited depends on the EXPRESS-G information models described in Chapter 6. The “Develop Brief” process has been decomposed in such a way that its first five sub-activities correspond to the information to be obtained from the five main entities of the framework of the brief presentation, as described in Section 6.5 (Figure 6.5). Hence, the sub-activities represent a sequential way of acquiring information from the user, prior to the generation of the brief, which is represented by the last process, “Compile Contents of the Brief”.

Figure 7.7 decomposes the “Develop Brief” process into six sub-processes in order of precedence, namely; “Obtain Project Identification”, “Establish Project Resources”, “Establish Project Aims”, “Establish Project Context”, “Establish Design & Performance Requirements” and “Compile Contents of Brief”. “Client Requirements”, “Construction Industry Know-how”, “Captured Input Client’s Requirements” and “Captured User’s Selection” constitute the types of input into the first five processes. These are depicted on the diagram by I1, I2, I3 and I4 respectively, in order to avoid cluttering on the diagram. “Captured Input Client’s Requirements” and “Captured User’s Selection”, represented by the tunnelled arrows, refer to the user’s inputs or selections that have been captured by the system. These two arrows do not appear on the parent activity, indicating that they are necessary interfaces for this level 1 diagram only, but were not relevant (or supplied by) the parent “Develop Brief” activity. They

have been included to incorporate the second viewpoint, which will be presented in the AB/A1 diagram (Figure 7.9).

“Software Applications” and “User” maintain the mechanism for all six processes. The output of the “Obtain Project Identification” process, i.e. “Project Identification”, becomes the input into the next four processes. The output of the second, third and fourth processes, however, are transformed into the controls for the fourth process, i.e. “Establish Design & Performance Requirements”, thus highlighting their crucial role in determining the eventual product. “Multimedia Tools” represents part of the mechanisms of the fourth, fifth and sixth processes since it is essential to provide for information presentation and visualisation prior to decision making in terms of the output of the “Design and Performance Requirement” process.

The output of the first five processes then serves as both input and control for the final process, “Compile Contents of the Brief”. These five outputs exist in the form of “Stored Valid CR” which represents the stored valid client’s requirements to be presented in the next section and shown in Figure 7.8. They are portrayed as a control in order to emphasise the importance of the data being valid and stored within the system. The “Compile Contents of the Brief” process generates the brief by compiling all the necessary information essential for inclusion in the brief, i.e. the stored valid CR.

The analysis of the process models within the information viewpoint is carried out up to the AB/I/A0 node. It reveals the information to be acquired by the system from the user, prior to the generation of the brief. The contents of the generated brief are obtained by

classifying the information into distinct information sections which follow the structured framework established in Chapter 3. The processes at the lower levels of decomposition are not portrayed since these can be conveniently deduced from the EXPRESS-G information models.

(b) Level 1 Diagram - System Architecture Viewpoint

From the system architecture viewpoint, the “Develop Brief” process has been decomposed into two sub-processes. One of the rules of IDEF0 states that the decomposition of a parent activity should have no fewer than three activities, to make sure that enough detail is introduced to make the decomposition of significance. In spite of this, it was considered to be essential to decompose the above process into the “Consultation” and “Generate Brief” processes, as shown in Figure 7.8, in order for the former process to emulate the two-way communication between the client and the design team in a real world situation. The latter refers to the process of formulating and displaying the brief.

The two processes are described below:

“Consultation”: This refers to the act of consulting. It represents the two-way dialogue process between the client and the design team. During this process, requirements of the clients are captured, validated and stored within the system as “Stored Valid CR”. At certain points, specific data is presented to the user to assist with the user’s identification of requirements and understanding of the project and construction industry related information.

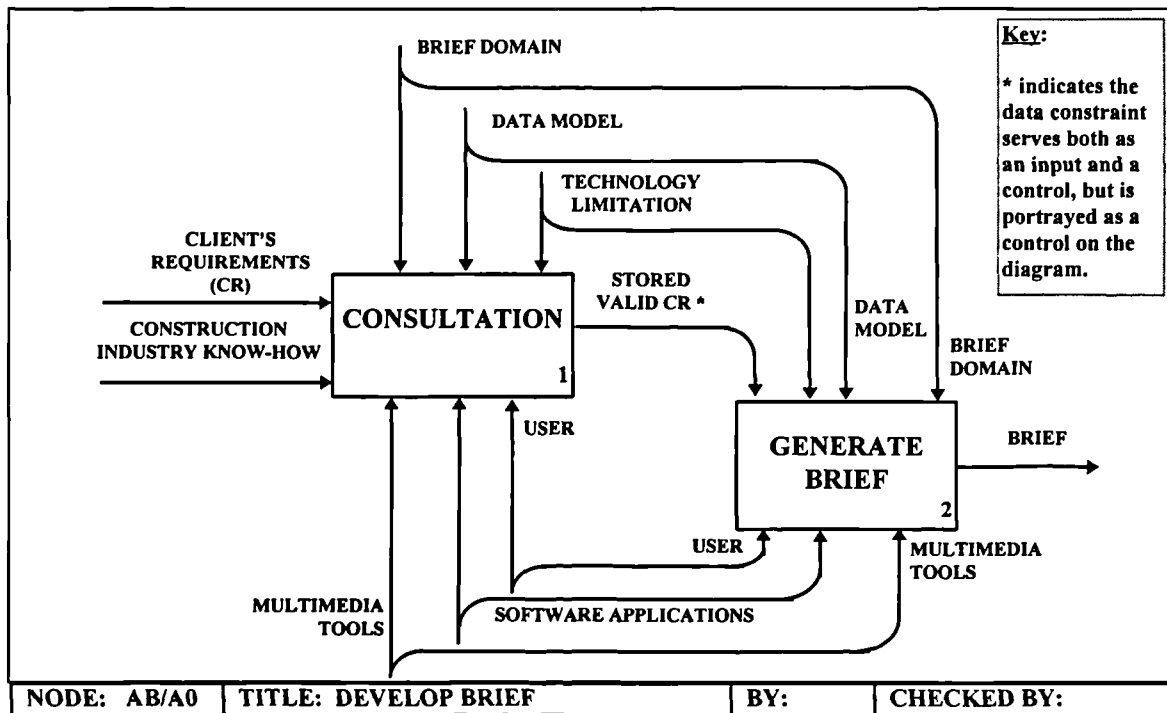


Figure 7.8 : Develop Brief (System Architecture Viewpoint)

“Generate brief”: This represents the process of compiling the relevant data that has been validated and stored within the system to produce the client’s brief. It also encompasses the way in which the brief can be presented, either as a screen display or as a printed document.

For both processes, the three controls, “Brief Domain”, “Data Model” and “Technology Limitation” apply, as do the three forms of mechanisms, “User”, “Software Applications” and “Multimedia Technology”. The inputs into the parent activity are portrayed as the inputs into the “Consultation” process, whilst the output is depicted as the output for the “Generate Brief” process. However, the output of the “Consultation” process, “Stored Valid CR”, is transformed into a control of the second process. In actual fact, this particular data constraint serves both as an input and a control for the

“Generate Brief” process. In such a situation the data constraint is reflected as a control on the IDEF0 diagram. In this particular case it aids to emphasise the importance of validation and storage of the input client’s requirements (CR) within the system, prior to the generation of the brief.

7.3.2.5 The Level 2 Diagrams

The level 2 diagrams involve the decomposition of the two processes in the AB/A1 diagram (Figure 7.9). Each process will be described individually.

(a) The “Consultation” Process

The decomposition of the “Consultation” process is depicted in Figure 7.9 as the AB/A1 diagram. The controls, inputs and outputs of the parent activity are maintained. The five processes are described below:

“Obtain CR”: This represents the process of obtaining the client’s requirements from the user. It bears similarities in functionality with the “Obtain CR” process of the A1 diagram for current operations. Nevertheless, the mechanisms for this process are the “User” and the “Software Applications”. The inputs for the process include “Client’s Requirements”, which is obtained from the client, and “Construction Industry Know-how”, which assists the process by inputting relevant information into the process. The three controls for its parent activity are maintained. The output, however, is the “Captured Input CR” and “Captured User’s Selection”, shown on the diagram as “O1a”. These outputs represent the captured client’s requirements obtained from the user, which then become the input into the second and the third processes, respectively.

“Validate Input CR”: The process uses the “Captured Input CR” and “Construction Industry Know-how” as input, and only “Software Applications” as its mechanisms. Depending on specific situations or controls, the process produces the following outputs; “Valid CR”, “Compatible Set of Valid CR”, “Conflicted CR” (“O2a”), “Confirmation of CR Invalidity” (“O2b”) and “Recommended Valid CR” (“O2c”). The specific situations will be described later in the AB/A11 diagram of the level 3 diagrams. The “Conflicted CR” output goes back into the process as a control. Other controls include the three which belong to the parent activity, along with “Stored Valid CR” which is an output of the fourth process.

“Validate User’s Selection”: This process interprets the captured user’s selection and validates the client’s requirements, if relevant. The inputs are “Captured User’s Selection” and “Construction Industry Know-how”, the outputs of which are “Valid CR”, “Specific Data” and “Confirmation of CR Invalidity”. The process retains the three controls and two mechanisms of its parent’s “Consultation” process.

“Store Valid CR”: The process is analogous to the “Record Suitable CR” of the A0 diagram shown in Figure 7.4. It stores the values of all the suitable client’s requirements (“Valid CR”) obtained from the previous two processes. “Valid CR” enters the process as an input and acts as a control. This is portrayed as a control to emphasise the validity of the data prior to storage. “Compatible Set of Valid CR” enters as an input. The output is represented by the “Stored Valid CR”. This process only utilises “Software

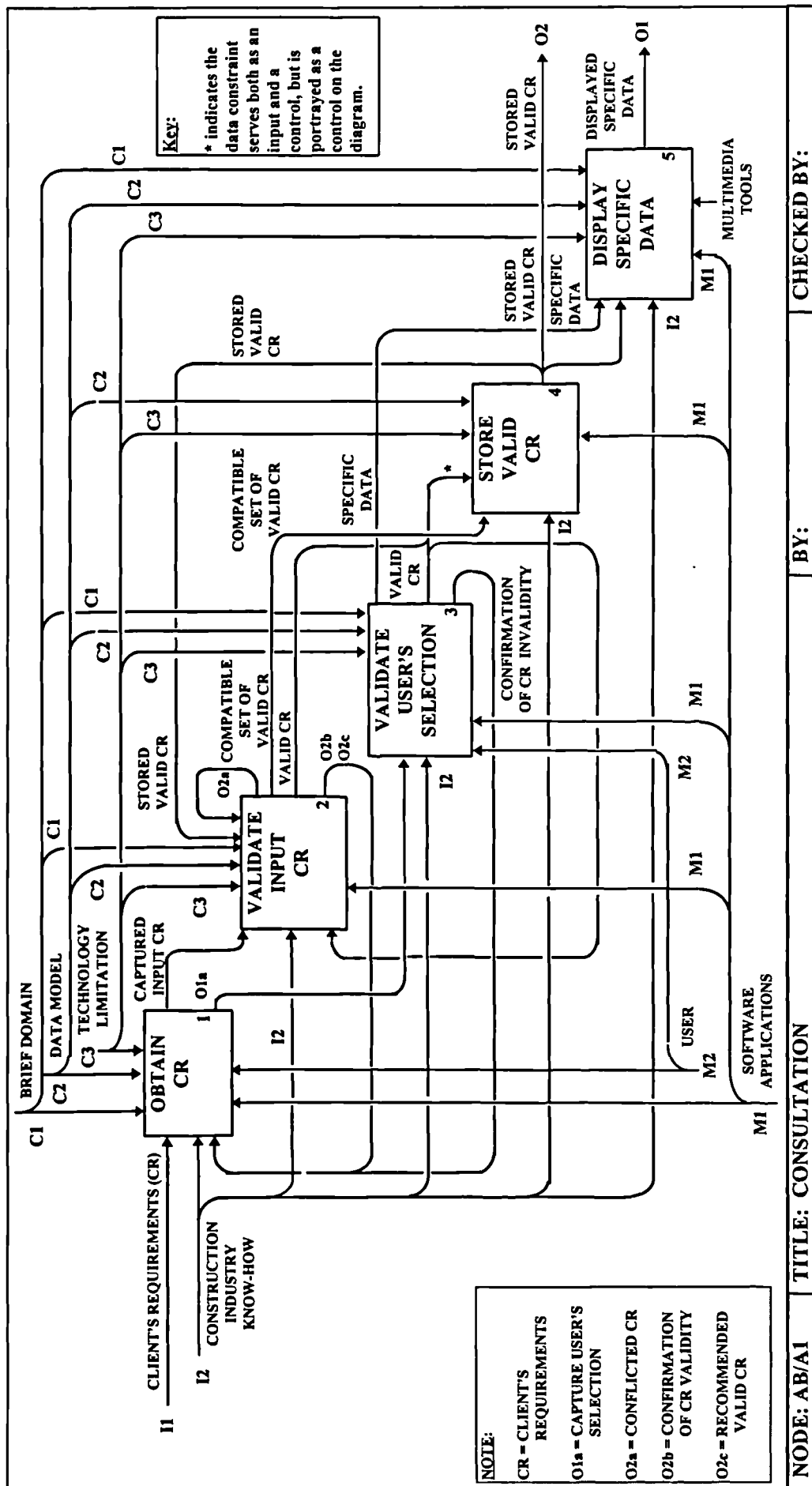


Figure 7.9: Consultation

Applications” as its mechanism, and is controlled by the “Data Model” and “Technology Limitation” controls.

“Display Specific Data”: This process serves the function of presenting relevant information in the form of specific data to the system’s user. It utilises “Software Applications” and “Multimedia Tools” to display the information to the user. “Stored Valid CR”, “Specific Data” and “Construction Industry Know-how” enter the process as inputs, after which the relevant information is presented in the form of the “Displayed Specific Data” output. The display or presentation of specific information to the user is aimed to promote knowledge enhancement with respect to project and construction industry related issues. With this knowledge in hand, it is envisaged that the user will be able to make a more accurate identification of his/her requirements.

As a whole, Figure 7.9 illustrates that the outputs of subsequent processes may be required to move backwards and enter into a preceding process as input(s) or control(s) for that process. This represents the iterative nature of the brief development process.

(b) The “Generate Brief” Process

The “Generate Brief” process is depicted in Figure 7.10 as the AB/A2 diagram. It is decomposed into three sub-processes. The controls, inputs and outputs of the parent activity are maintained. The sub-processes are described below:

“Obtain User’s Selection”: In order to generate the brief, firstly the system has to obtain the user’s selection. The “Captured User’s Selection” output refers to the section

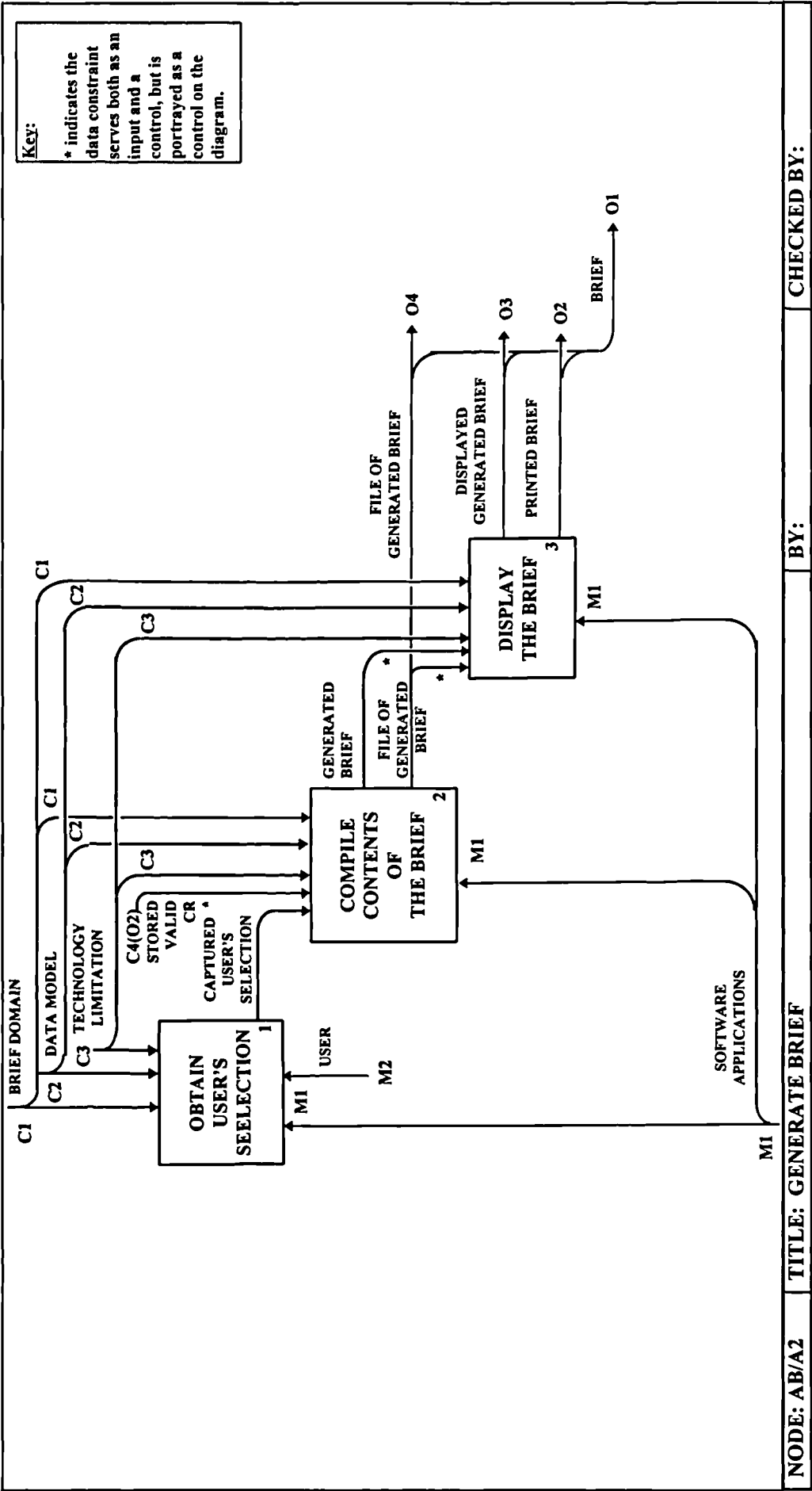


Figure 7.10: Generate Brief

of the brief to be generated. It represents any one of the main entities portrayed by the information models in Chapter 6, or the entire brief as a whole. The main entities are referred to as the main section of the brief in Chapter 10.

“Compile Contents of the Brief”: The “Captured User’s Selection” enters the process as an input and acts as the control which determines which contents of the brief are to be compiled. The result is the “Generated Brief” and/or the “File of Generated Brief” output.

“Display the Brief”: Both outputs of the above process enter this process as input and serve as controls for the process. In short, they control what brief is to be displayed by the prototype. By using “Multimedia Technology” as an additional mechanism, along with “Software Applications”, the “Brief” is presented to the user. This can be in one of two forms; “Displayed Generated Brief”, i.e. displayed on the screen, or “Printed Brief”, which can be in the form of a hard copy. In addition to this, the brief can also be in the form of the output of the previous process, i.e. as a “File of Generated Brief”.

7.3.2.6 The Level 3 Diagrams

The level 3 diagrams refer to the decomposition of the sub-processes that belong to the level 2 diagrams, i.e. the “Consultation” and the “Generate Brief” processes. The sub-processes of the “Consultation” process are “Obtain Client Requirements”, “Validate Input Client Requirements” and “Validate User’s Selection”. The sub-processes for the “Generate Brief” are “Obtain User’s Selection”, “Compile Contents of the Brief” and “Display the Brief”. These sub-processes are depicted and described in Appendix C.

7.3.2.7 The Level 4 Diagrams

The level 4 diagrams have been developed by decomposing a particular process that belongs to the level 3 diagrams. The only process affected at this level of abstraction is the “Request For Specific Data Retrieval From External Resources” process, which originates from the “Consultation Process” at the level 2 decomposition. The process is represented by the AB/A134 node depicted in Appendix C.

The decomposition of the processes is concluded at this point. The achieved level of detail is considered to be sufficient for the application of the model for the proposed prototype development.

7.4 Summary and Conclusions

This chapter has discussed the process of developing the activity models for the “Develop Brief” process. It began by introducing the IDEF0 modelling technique and the symbols used. This follows the portrayal of an abstract representation of a process model for current operations for the brief development.

This was followed by the presentation of the process models for the proposed prototype system. For the prototype development, the process models have been developed with two viewpoints in mind; in terms of the system’s architecture and the information to be obtained from the user during the brief development process. The result is two sets of models which, when combined together, form the basis of the system architecture and a systematic way in which the information for the generation of the brief is to be elicited from the user. The system architecture will be presented in Chapter 9.

For the purpose of implementation into the object oriented environment, the process models will be converted into methods or functions, whichever is appropriate. This conversion will be discussed in Chapter 8.

CHAPTER 8

IMPLEMENTATION INTO THE OBJECT ORIENTED ENVIRONMENT

8.1 Introduction

The previous two chapters have discussed the development of the information and process models for the development of the client's brief. These models have been implemented into an object oriented development environment. This chapter describes in depth the translation of these models into the relevant object oriented concepts within this environment, leading to the development of an information system prototype, **AUTOBRIEF** (**AUTO**ated **BRIEF** development). During the process, the prime consideration was the linking of these two models within this environment. This is necessary in order to achieve an object oriented data model which would form the basis for the system architecture of the prototype. The development of AUTOBRIEF will be described in detail in the next chapter.

This chapter begins by briefly describing the various ways of knowledge or information representation. Subsequent sections describe the selected object oriented development

environment and how the information models have been translated into their corresponding object structure representations (object oriented data model). The chapter continues by describing how the selected object oriented development environment associates reasoning and behaviour to the objects. Where appropriate the Coad and Yourdon's (1991) methodology was used as a guideline.

8.2 Knowledge/Information Representation

Before the actual implementation commences, the various ways of knowledge or information representation are examined. These are:

a) Logic

This approach can be described as an attempt to model the reasoning process involved by using a symbolic language whose symbols have precisely stated meanings and uses (Jackson, 1990). Examples of such languages include LISP (Charniak and McDermott, 1985) and PROLOG (Clocksin and Mellish, 1984).

b) Production Rules

Production rules are sometimes referred to as IF-THEN rules or antecedent-consequent rules. Fulfilment of the rules antecedents or conditions gives rise to the execution of the consequents or actions. The antecedent and consequent pair can be expressed as:

IF < antecedent is fulfilled or condition is true>

THEN < execute consequence or take action>

An example of such a system is the ELSIE system (Brandon et al, 1988).

c) Frames

This approach requires the grouping of information in terms of a record where related attributes or properties associated with an object or event are linked to the object. This will allow knowledge of certain stereotypical concepts to be represented (Minsky, 1975; Jackson, 1990). Frames can be in the form of object hierarchies. Frame systems provide a way of structuring the heuristic knowledge associated with the application of rules and the classification of objects. However, some form of external program or interface is required to get the frame system to do useful work.

d) Semantic Networks

Semantic networks or semantic nets represent an attempt to describe the concepts behind the meanings of words and the ways in which such meanings interact in the form of a network. The networks consist of nodes and links. The nodes represent concepts or meanings, or objects, which have various properties associated to them, and the links or lines, which represent the relationships between those concepts (Jackson, 1990).

e) Objects

Another approach to represent knowledge about a particular domain is by portraying the entities of interest as objects and defining the properties and behaviour associated to the objects. The emergence of the object-oriented paradigm enables objects to be regarded as independent entities where control of the system can be obtained by direct communication between objects, hence eliminating the need for an external control required by the frame system.

8.3 Object Oriented Development Environment

The development of the AUTOBRIEF prototype utilised KAPPA[®]-PC. KAPPA-PC is a Microsoft[®] Windows[™] knowledge based development environment and object-oriented programming tool. The KAPPA-PC Applications Development tools allow the developer to write applications in a high-level graphical environment and generate standard ANSI 'C' code and graphical user interface runtimes (Intellicorp, 1992). It provides the developer with a set of programming tools and techniques for constructing and using applications, where knowledge/information can be represented and manipulated. In KAPPA-PC, classes and instances are used to represent objects for a particular domain (problem area), object oriented programming is used to represent the behaviour of individual objects, whilst rules are used to represent if-then requirements. KAPPA-PC also provides tools for developing applications and for customising the user interface.

Such an environment provides the following features:

(a) Normal Representation

Object-oriented programming allows the creation of objects that are intuitive representations of their real-world counterparts. Such realistic representations allow KAPPA-PC applications to represent their knowledge clearly.

(b) Modularity

Object-oriented programming enhances the modularity of an application. When an application is composed of relatively independent parts or modules, one module can be changed without having to make corresponding changes elsewhere.

(c) Reusability

By organising the application into modules, those modules can be reused in other applications. Objects can also be built so that they can be customised. In other words, new systems can be built out of the existing objects. This leads to a high degree of reusability (Martin, 1993).

(d) Encapsulation

Packaging the properties and the behaviour of objects together is called encapsulation. Each object in the data model hides its data (slots and slot values) from other objects and allows the data to be accessed via its own methods (called information hiding). This protects an object's data from corruption.

Another advantage of encapsulation is the ease to modify programs because one object type is modified at a time. If an object type is changed, only the behaviour and data structures associated with that object type are affected. The behaviour of these object types can be modified and tested independently of other object types.

(e) Inheritance

Objects in the data model inherit methods (behaviour between objects) in much the same way that they inherit slots and slot values. The method inheritance can be used to organise the behaviour of an application in a simple and effective way. For example, by placing the “GetInput” and “GetBrief” methods in the “AUTOBRIEF” object, i.e. higher up in the object hierarchy, the behaviour of the prototype system can be organised in a more efficient manner.

(f) Polymorphism

Different objects can respond to the same message with different methods. Objects that handle the same message seem to have uniformity of interface, i.e., as if they perform the same procedure, even though they actually perform it in different ways. This is referred to as method specialisation (Intellicorp, 1992) or polymorphism. It is the ability for two or more objects to respond to the same message, each in its own way. This can be demonstrated by the “GetInput” method inherited by all the subclasses of the “AUTOBRIEF” object. Each subclass responds in different ways, by requesting the prototype’s user to input specific client’s requirements, different from any other objects.

8.4 Object Structure Representation in KAPPA-PC

The basic building blocks of KAPPA-PC’s knowledge based systems which represent the components of any particular domain are represented by data structures called *objects*. Objects can either be *classes* or *instances* within classes. The relationships between the objects in a model can be represented by linking them together into a structure called a *hierarchy*. A *subclass* is a class that is part of or a subset (type) of

another class; it is below the class in a hierarchy. The term *parent* is used to describe the class that is directly above a subclass in the hierarchy.

Each object embodies characteristics which are unique to itself. These are called *slots*. They can be considered as descriptions about a particular object which add detail, structure, list attributes and/or properties. To specify the characteristic, a value is assigned to the slot. Objects can have their own slots, inherit slots from parents, share slots and communicate with each other using *methods* (see 8.8.2).

8.5 Object Structure Representation of the Object Oriented Data Models

This section refers to the translation of the information models into the object oriented data models. The following describes the object structure representation implemented into the object oriented environment. The notations used to represent the class hierarchy are boxes which refer to objects (classes and subclasses). A straight line links an object to its subclass while a dotted line links an object to its instance.

1. The “AUTOBRIEF” Object Structure

By default, KAPPA-PC provides the “Root” class with “Menu”, “Image” and “KWindow” as its corresponding subclasses, together with “Global” which is an instance of the “Root” class. In order to distinguish the domain of the prototype development, as well as to accommodate for future integration of the prototype to other systems (see Chapter 11), the “AUTOBRIEF” object was created and added as a subclass of the “Root” object (Figure 8.1). All the necessary knowledge/information for the implementation of the AUTOBRIEF prototype is incorporated within this object and its

corresponding sub-classes and instances. Thus, the “AUTOBRIEF” class acts as a root object for the development of the prototype. Figure 8.2 shows the “AUTOBRIEF” object and its sub-classes.

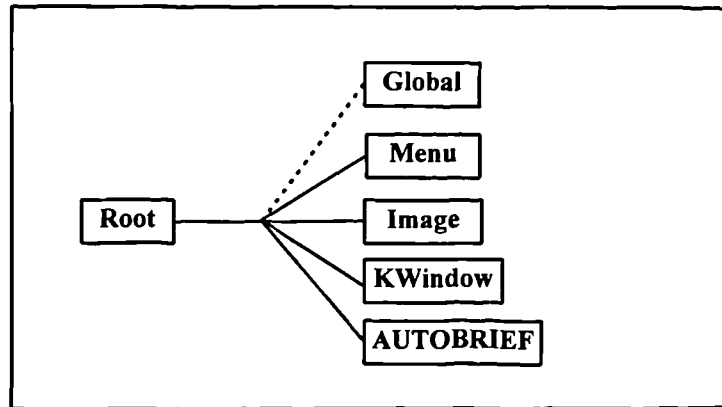


Figure 8.1: The “Root” Object Structure

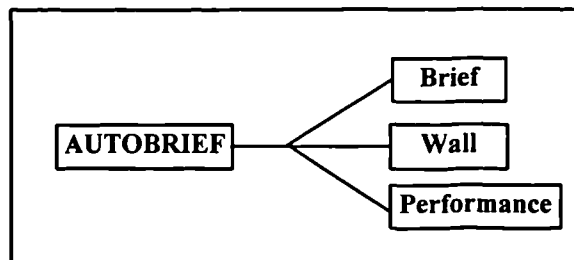


Figure 8.2: The “AUTOBRIEF” Object Structure

The “AUTOBRIEF” object structure comprises three subclasses as shown in Figure 8.2. These subclasses are linked to the “AUTOBRIEF” object by the “part of” structure. These sub-classes represent the main object structures of the AUTOBRIEF prototype. They form parts which are used to communicate the whole of the overall problem domain of the AUTOBRIEF prototype and the system’s responsibilities. These object

structures have been identified by grouping together objects related to three information categories :

1. the overall information required for the development of the client's brief and for the system's responsibilities or operations. The subclass for this object structure is called "Brief", and is the essence of the whole prototype system. The "Brief" sub-class is translated from the "Brief" entity in Figure 6.8.
2. the information required for the selection of the type of wall cladding. This information enables the prototype to deal with detail issues with respect to a given type of wall cladding. However, in view of future development for the prototype, the "Wall" sub-class has been incorporated to represent the main object structure, with the "WallCladding" object as a subclass further down the hierarchy (Figure 8.9).

the information required to express the performance requirements of specific design criteria. The "Performance" object structure represents the hierarchy of objects related to the performance requirements of whole buildings, parts of buildings or spaces within and around them. Performance requirement is defined as the user requirement (statement of need to be fulfilled by a building or part there-of), expressed in terms of the performance (behaviour of a product related to use) of the product (ISO, 1984). For simplicity during the implementation stage, the term performance requirement is shortened to performance, thus giving rise to the "Performance" sub-class. This information is necessary during the dialogue stage of the brief development process.

2. The “Brief” Object Structure

The “Brief” object structure corresponds to the information essential for the brief domain (Figure 8.3).

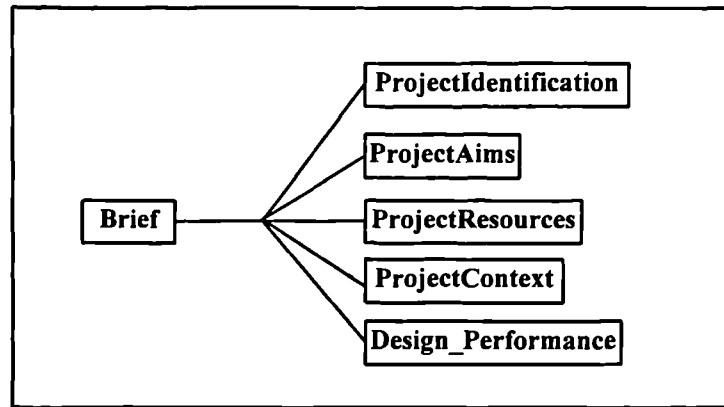


Figure 8.3 : The “Brief” Object Structure

The objects within the “Brief” object structure are associated with the contents of the brief. Thus, it corresponds to the “part of” structure, in which the sub-classes of the “Brief” class will form part of the final brief presentation. These main sub-classes correspond to the main entities of the “Brief” entity, which has the “composed of” relationship with its main entities, as shown in Chapter 6 (Figure 6.5). These are “ProjectIdentification”, “ProjectAims”, “ProjectResources”, “ProjectContext” and “Design_Performance”, which correspond respectively to the relevant entities described in Chapter 6. “Design_Performance”, however, has been shortened from its corresponding “Design and Performance Requirements” entity. These sub-classes and their respective sub-classes will represent the object oriented data model or the building block for the generation of the client’s brief.

3. The “ProjectIdentification” Object Structure

The three subclasses for the “ProjectIdentification” object (Figure 8.4) are obtained from the corresponding subtype/entities shown in Figure 6.6, i.e. “Project Purpose”, “Project Scope” and “Project Identification” entities. Therefore, these entities become the subclasses of the “ProjectIdentification” class. Similarly, the corresponding attributes of each subtype or entity mentioned are converted to objects which become the subclasses for the subclasses of the “ProjectIdentification” class as depicted in Figure 8.4.

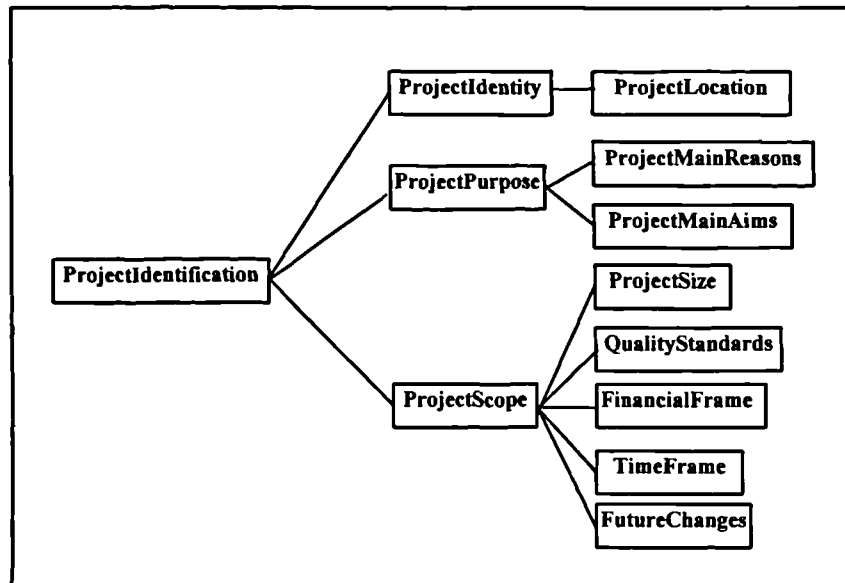


Figure 8.4: The “ProjectIdentification” Object Structure

4. The “ProjectAims” Object Structure

The object structure for the “ProjectAims” class maintains the “part of” structure of its parent’s class (Figure 8.5). Its subclass, “ProjectIntendedEffects” corresponds to the “Intended Effects of the Project” entity linked to the “Project Aims” entity depicted in Figure 6.7. The subclasses for the “ProjectIntendedEffects” object, however, are

obtained from the subtypes and the single attribute of the “Intended Effects of the Project” entity. The subclasses obtained from the subtypes are “EffectsOnClientEnterprise”, “EffectsOnUsers_Public”, “EffectsOnEnvironment” and “ControlOfUndesirable Effects”. “Priorities”, however, was translated from the attribute.

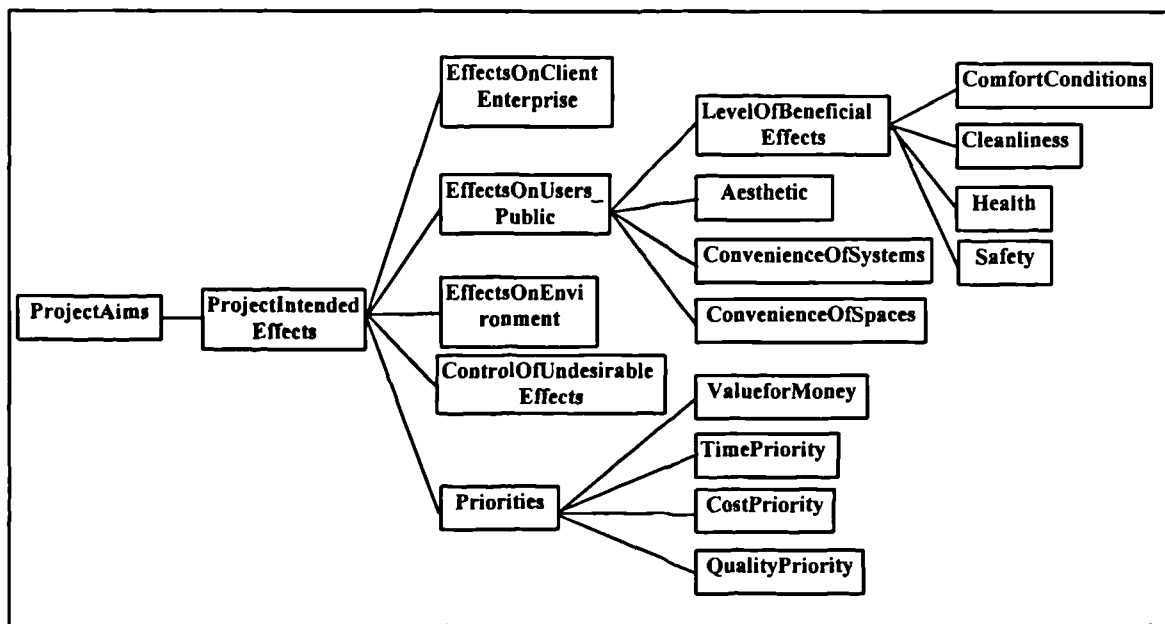


Figure 8.5: The “ProjectAims” Object Structure

Further down the hierarchy, only the subclasses for the “EffectsOnUsers_Public” and the “Priorities” classes have been implemented into the system, i.e. within the scope of the prototype development. Hence, all the subtypes and their corresponding subtypes or attributes of the “Effects On Users/ the Public” entity are translated into objects, or subclasses of the “EffectsOnUsers_Public” class. Similarly, the corresponding subtypes of the “Priorities” attribute become the subclasses of the “Priorities” class.

5. The “ProjectResources” Object Structure

Figure 8.6 illustrates the object structure for “ProjectResources”. It was maintained as the “part of” structure of its parent’s class. The “Financial”, “Time” and “ProjectMgmt” objects make up the subclasses for the “ProjectResources” class. These subclasses have been translated from the subclasses of the “Project Resources” entity shown in Figure 6.9. Following this, all the subclasses down the object structure have been converted from the attributes or subtypes of the sub-entities shown on Figure 6.9. The “ProjectMgmt” and the “TargetDates” subclasses have not been expanded any further since it is not required for this stage of prototype development.

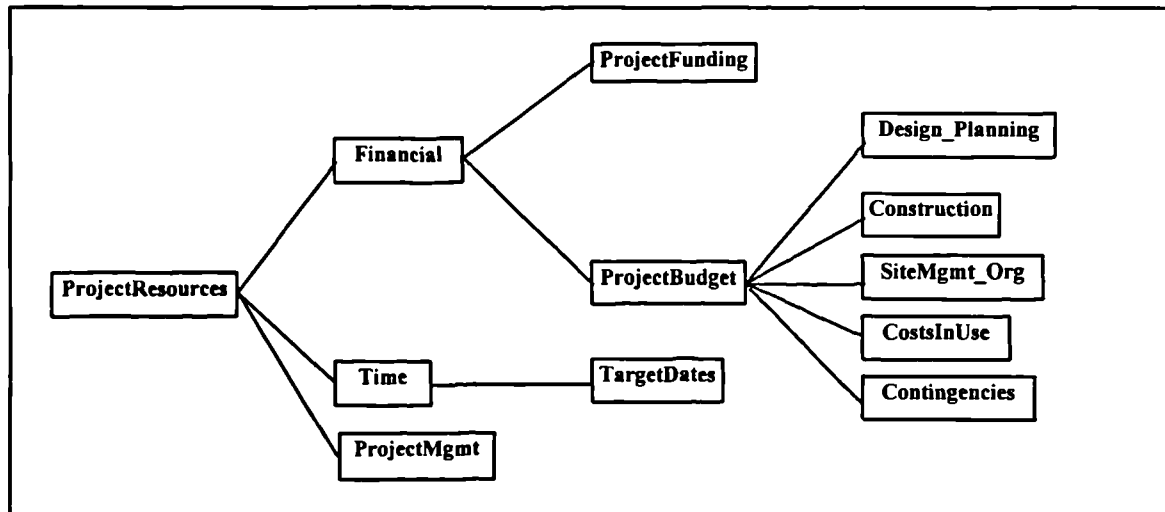


Figure 8.6: The “ProjectResources” Object Structure

6. The “ProjectContext” Object Structure

The five subclasses for the “ProjectContext” object (Figure 8.7) are obtained from the subtypes of the “Project Context” entity shown on Figure 6.10. These are “IntendedOccupancyInDetail”, “RegulatoryIssues”, “Background_HistoricalInf”, “Site_SurroundingInf” and “ClientFutureEnterprise”. The corresponding attributes, subtypes and/or sub-entities of the subtypes of the “Project Context” entity (Figures

6.12 through to 6.17) are converted to objects which become the subclasses for the subclasses of the “ProjectContext” class (Figure 8.7). In all cases, only those objects which fall within the scope of the prototype development have been translated from their corresponding entities in the information models.

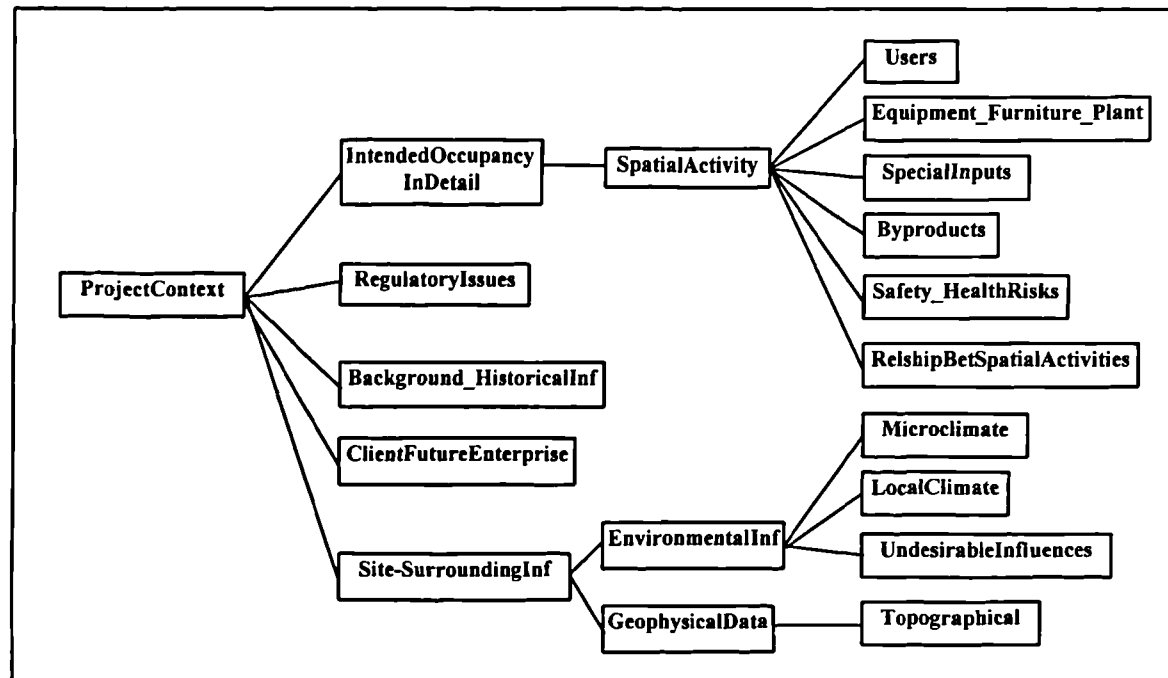


Figure 8.7: The “ProjectContext” Object Structure

7. The “Design_Performance” Object Structure

The object structure illustrated in Figure 8.8 is the main one for the prototype development. From Figure 6.10, the subtypes of the “Design and Performance Requirements” entity have been translated to the following objects which become the subclasses of the “Design_Performance” superclass. The subclasses are “Site_Surroundings”, “BuildingAsAWhole”, “BldgFabric”, “SpacesInDetail”, “GroupingOfSpaces” and “Plant_Equipmt_Furnishing”. The implementation was concentrated on certain aspects of three of the subclasses, namely “BuildingAsAWhole”, “BldgFabric” and “SpacesInDetail”.

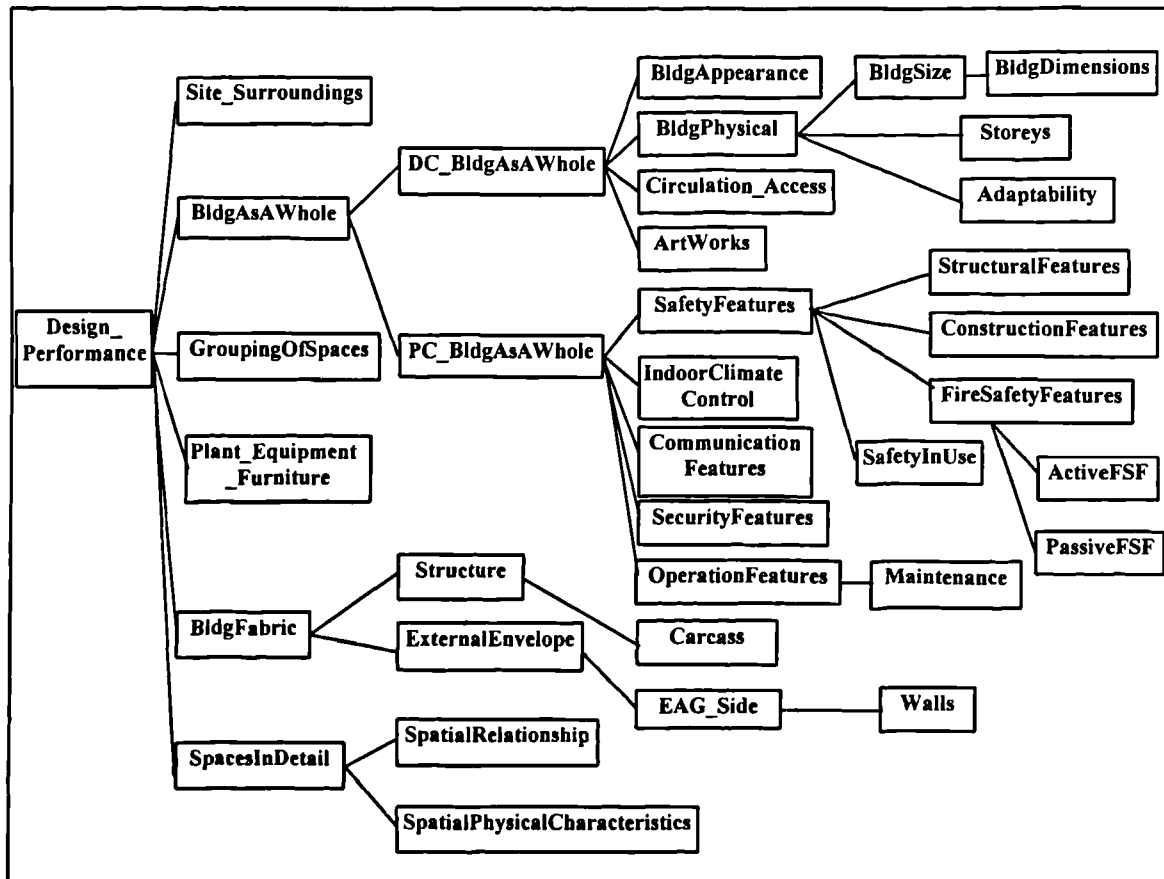


Figure 8.8: The “Design_Performance” Object Structure

a) The “BuildingAsAWhole” Object Structure

The object structure for the “BuildingAsAWhole” class was then implemented. Firstly, based on the “belongs to”, and the “requires” relationships between the “BuildingAsAWhole” entity and its attributes as shown in Figure 6.18, two criteria were identified; the design and performance characteristics of the building. Two objects were therefore created; “DC_BldgAsAWhole” and “PC_BldgAsAWhole”, whereby the letters “DC_” and “PC_” refer to ‘Design Characteristics’ and ‘Performance Characteristics’ respectively. Secondly, based on the above distinctions, the subclasses of the above two classes were implemented as shown in Figure 8.8.

Following this, three subclasses were added to the “BldgPhysical” class, i.e. “BldgSize”, “Storeys” and “Adaptability”, which have been translated from the corresponding attribute of the “Physical Characteristics” entity portrayed in Figure 6.20. Another subclass was also added to the “BldgSize” class, which corresponds to the “Dimension” attribute of the “Size” entity shown in Figure 6.20. Similar translation was carried out to the “PC_BldgAsAWhole” object structure as shown in Figure 8.8. In this case the subclasses were translated from the corresponding entities or attributes as shown in Figure 6.18.

b) The “BldgFabric” Object Structure

The “BldgFabric” object structure which is a subclass of the “Design_Performance” superclass (Figure 8.8), consists of objects which form parts of the building fabric. These objects have been translated from their corresponding attributes in Figure 6.21, i.e. “Structure” and “ExternalEnvelope”, which is within the scope of the prototype. Out of these subclasses, the “Carcass” subclass is added to the “Structure” class, and the “EAG__Side” subclass is added to the “ExternalEnvelope” class, which then has the “Walls” subclass attached to it. All these subclasses correspond to the attributes of the entities shown on Figure 6.21. Only the “ExternalEnvelope” and the subsequent “Walls” objects have been implemented in the object structure because of the scope limitation.

c) The “SpacesInDetail” Object Structure

As shown in Figure 8.8, two subclasses are linked to the “SpacesInDetail” superclass. These are “SpatialRelationship” and “SpatialPhysicalChar” which correspond to their

corresponding “Spatial Relationship” and “Physical Characteristics” depicted in Figure 6.20.

8. The “Wall” Object Structure

The “Wall” object structure has been created to accommodate for the wall cladding design, which the prototype is mainly developed for. This inclusion of detailed aspects of design requirements is not normally incorporated in current practice of the brief preparation. The aim is to emphasise that with the automation of the brief development process, the brief development can be extended further beyond the early design stage. This aspect is particularly useful if the prototype system is to be linked to Integrated Construction Environments (ICE), where actual design solutions can be perceived from the generated brief (see Chapter 12).

The “Wall” object structure corresponds to the “type of” or “kind of” structure. Figure 8.9 shows that “WallCladding” is the subclass of “NonLoadbearing” which is a subclass of the “Wall” class. These classes of objects have been derived from their corresponding entities and subtypes shown in Figure 6.5.

The “WallCladding” object is not a subclass of the root object, “AUTOBRIEF”, even though the prototype only manipulates wall cladding data. This is mainly done to accommodate for future development of other types of wall systems. Furthermore, the “WallCladding” object has been placed under the “AUTOBRIEF” object structure and not under the “Brief” object structure (Figure 8.2). This is mainly done to cater for the difference in the relationship between the “WallCladding” object and its subclasses,

which are of the “type of” structure and not “part of”, as for the subclasses of the “Brief” class.

Figure 8.9 depicts three types of wall cladding incorporated into the AUTOBRIEF prototype; “Curtain_Wall_System”, “Light_Infill_Panels” and “Precast_Concrete_Panels”.

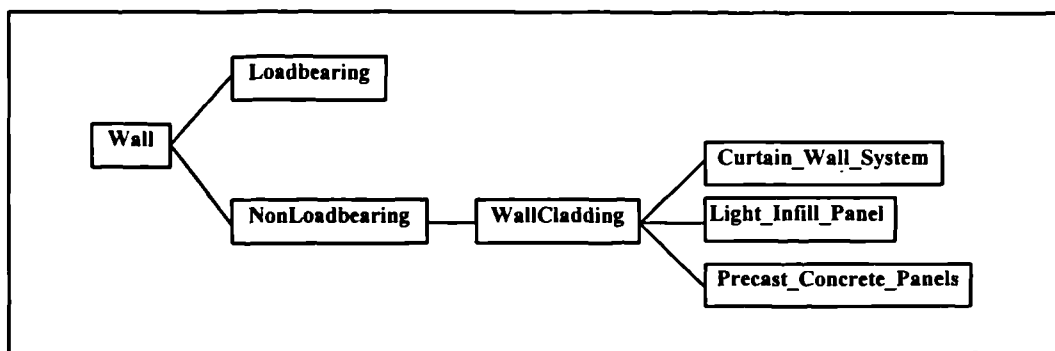


Figure 8.9: The “Wall” Object Structure

9. The “Performance” Object Structure

The “Performance” object structure contains information related to the performance requirements of parts of and/or whole buildings and spaces created by them (Figure 8.10). The types of performance requirements and their subtypes have been obtained from ISO (1984), and implemented into the object oriented environment. The object structure thus belongs to the “type of” structure, where the sub-classes of the “Performance” class are its subtypes. The subclasses of the “Performance” class demonstrate the types of requirements needed to achieve the desired performance. For simplicity, the word “requirements” has been excluded from the immediate subclasses name. Similar to the ‘Wall’ object discussed earlier, the “Performance” object is

attached to the “AUTOBRIEF” object and not to the “Brief” object, due to the difference in the object structure type.

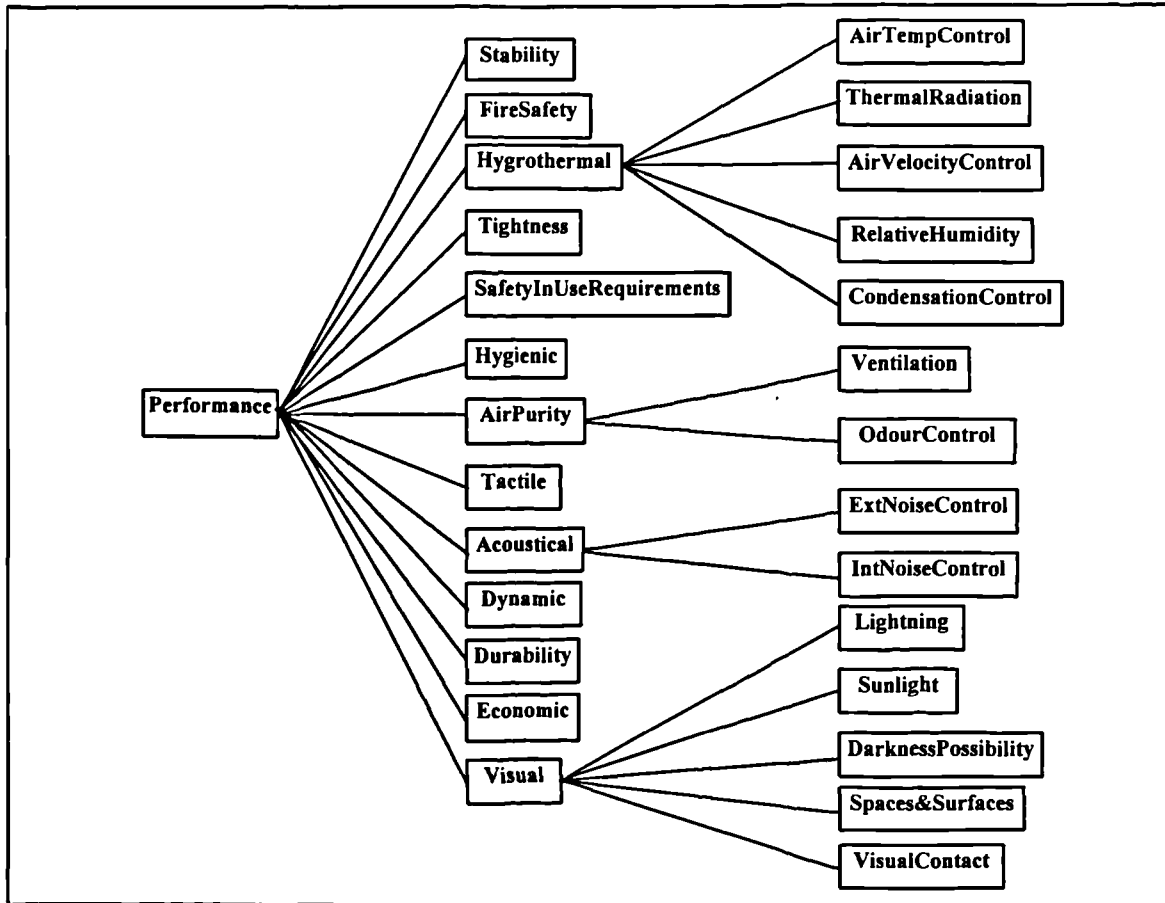


Figure 8.10: The “Performance” Object Structure

8.6 The Inclusion of Object Attributes

Once the structure of the AUTOBRIEF prototype has been achieved, properties, characteristics, or further details (static) are added to the objects by assigning attributes to the objects. By analysing the developed information and process models discussed in the previous two chapters, the relevant attributes of each object are identified and attached to the appropriate objects.

8.6.1 Identifying and Positioning the Attributes

In KAPPA-PC, attributes are called slots. Therefore, the addition of attributes to the objects involves the creation of slots.

Identifying the attributes for an object involves finding the responsibilities of the object in its class from the general to the specific, i.e. how the object is described in general, then, in the problem domain, and lastly, in the context of the system's responsibilities. This is followed by exploring the object's responsibilities in terms of what it should know, what state of information it needs to remember over time, as well as what states the object can be in over time (Coad and Yourdon, 1991). This process was made easier by referring to the developed information models presented in Chapter 6. In such a case, the attributes linked to a particular entity in the information models are transformed into attributes (slots) of an object in the data model.

The method of conversion of attributes from the information models into slots in the object oriented data models can be summarised as follows:

1. Direct translation of attributes linked to a particular entity in the information models into slots of the corresponding object in the data model.

In the majority of cases, the translation of attributes into slots within the objects in the data model fall under this category. As an example, with reference to the "Project Identity" subtype of the "Project Identification" entity depicted in Figure 6.6, the attributes "Project Name/ Title", "Project Reference" and "Building Type" have been

directly translated into attributes of the corresponding “ProjectIdentity” subclass of the “ProjectIdentification” class shown in Figure 8.4. Slots are therefore created for this purpose. Figures 8.11(a) and (b) show the attributes of the “Project Identity” and “Project Location” using Coad and Yourdon’s (1991) notations.

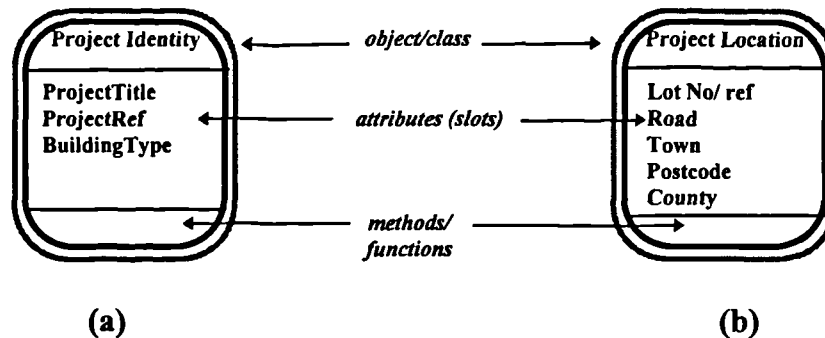


Figure 8.11: Objects and Attributes (Examples)

2. Translating the attributes of a particular entity in the information model to slots of another object in the data model, (i.e. not to its corresponding object in the data model) by using the connections or relationships between the entity to other entities and/or attributes of the information model.

As an example, Figure 6.6 features the “Project Size” entity. This is linked to the “Gross Floor Area” attribute by the composition symbol. When cross-referenced to Figure 6.20, the “Gross Floor Area” attribute is portrayed as a subtype of the “Area” attribute of the “Size” entity. During implementation, the “Size” entity has been translated into the “BldgSize” object, which is a subclass of the “BldgPhysical” object shown in Figure 8.8. In response to this, the “Area_GF” slot is therefore created and attached to the “BldgSize” object to represent the “Gross Floor Area”. During the identification of

slots for the “BldgSize” object, based on the “Size” entity and its attributes, this can be traced back to the previous link(s) described. This cross-referencing of entities and/or attributes of the information model serves as a checking mechanism for identifying and positioning slots in objects and their instance connections.

3. Combining two or more entities and/or attributes from the information model into a single slot in the data model.

Circumstances arise where the entities/attributes in the information model have been structured in such a way that they portray the sub-divisions, classification or links between the entities/attributes. However, during the translation process, these are found to be unnecessary in terms of their role within an object oriented environment. The situation can be demonstrated in the following example. Figure 6.25 illustrates “Cladding Panel” as an attribute of the “Wall Cladding” entity. “Type”, for example, forms one of the attributes of the “Cladding Panel” attribute. During conversion to the object oriented model, these two attributes have been combined to form “Cladding Panel Type”. For this purpose the “WC_PanelType” slot has been attached to the “WallCladding” object shown in Figure 8.9. Similarly, the other attributes of the “Cladding Panel” attribute depicted in Figure 6.25 has been transformed into their corresponding single slots. For example, the “WC_Weight”, “WC_PanelSize” and “WC_PanelMaterial” slots attached to the “WallCladding” object have been translated from the “Weight Category”, “Visual Size” and “Material” attributes of the “Cladding Panel” attribute.

4. Positioning of the attributes at the highest level object within a “type of” structure, which have been translated from an entity-subtypes relationship in the information model.

When an attribute is placed at the highest level object, then it remains applicable to each of its specialisations. This is applicable in the case of the “WallCladding” object and its subclasses, Figure 8.9. The object and sub-classes have been directly translated from the “Wall Cladding” entity and its subtypes shown in Figure 6.25. By virtue of the inheritance properties of the object oriented environment, these attributes are then inherited by all the subclasses within the hierarchy.

5. Positioning of common attributes in the “AUTOBRIEF” object

The attributes shown in Figure 8.12 have been attached to the AUTOBRIEF object. These attributes are found to be applicable to most of the objects down the hierarchy, either in the interest of the problem domain’s or the system’s responsibilities.

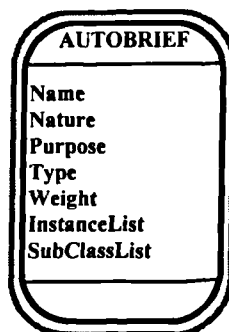


Figure 8.12: The “AUTOBRIEF” Object and Its Attributes

6. Localised Attributes

Slots inherited from the parent class can be localised within the subclass. This allows the slot options (see 8.6.4) for that particular slot to be set to serve its own requirements, which may differ from its parent's. For example, the inherited "Name" slot of the "SpacesInDetail" object when localised, allows the slot's values to be set to suit the object's requirements.

8.6.2 Identifying Instance Connections

Instance connection is defined as a model of problem domain mapping(s) that one object needs with other objects, so that its responsibilities could be fulfilled (Coad and Yourdon, 1991). In other words, instance connections add to the information represented by the attributes (object state), the problem domain and the system's responsibilities. Instance connections are identified from the relationships that exist between the entities and their attributes in the information models (Chapter 6).

8.6.3 Checking for Special Cases

The addition of attributes within the object oriented environment requires checking for special cases. The steps suggested by Coad and Yourdon (1991) have been adopted. These include:

1. *Check each attribute for a value of "not applicable".*

If a slot sometimes has a value of "not applicable", and yet at other times has some meaningful value, then the "type of" structure from which the attribute exists needs to be revisited. This is necessary to check whether another "type of" structure is required.

2. *Check each object with only one attribute.*

If such a situation arises, it needs to be checked to see which category it falls into:

- a) an abstraction of something in the problem domain in which the system's responsibilities include just one attribute. In this case, the attribute should remain within this object.
- b) an attribute of another object which is out of place in the model. In this case the attribute should be placed within an object which it actually describes.

3. *Check each attribute for repeating values.*

If an attribute has repeating values, then the developed objects should be revisited to uncover any additional objects corresponding to the problem domain reality, which is represented by the attribute with repeating values.

8.6.4 Specifying the Attributes and their Internal Structure

Each attribute or slot is carefully named using the vocabulary for the brief domain. The name selected is based on the attribute name or a combination of attribute names from which the slot is obtained during the translation process. In some cases, abbreviations are used to shorten an otherwise long attribute name. The attributes attached to a particular object are depicted in Figures 8.13 (a), (b) and (c). Objects which inherit attributes from their parents are not shown in the figure. For those shown, the inherited slots are not listed but are labelled "IS" to represent "Inherited Slots". Figures 8.13 (a) and (b) feature objects within the "Brief" object structure and their attributes, while Figure 8.13 (c) shows the objects within the "WallCladding" object and the "Performance" object structures.

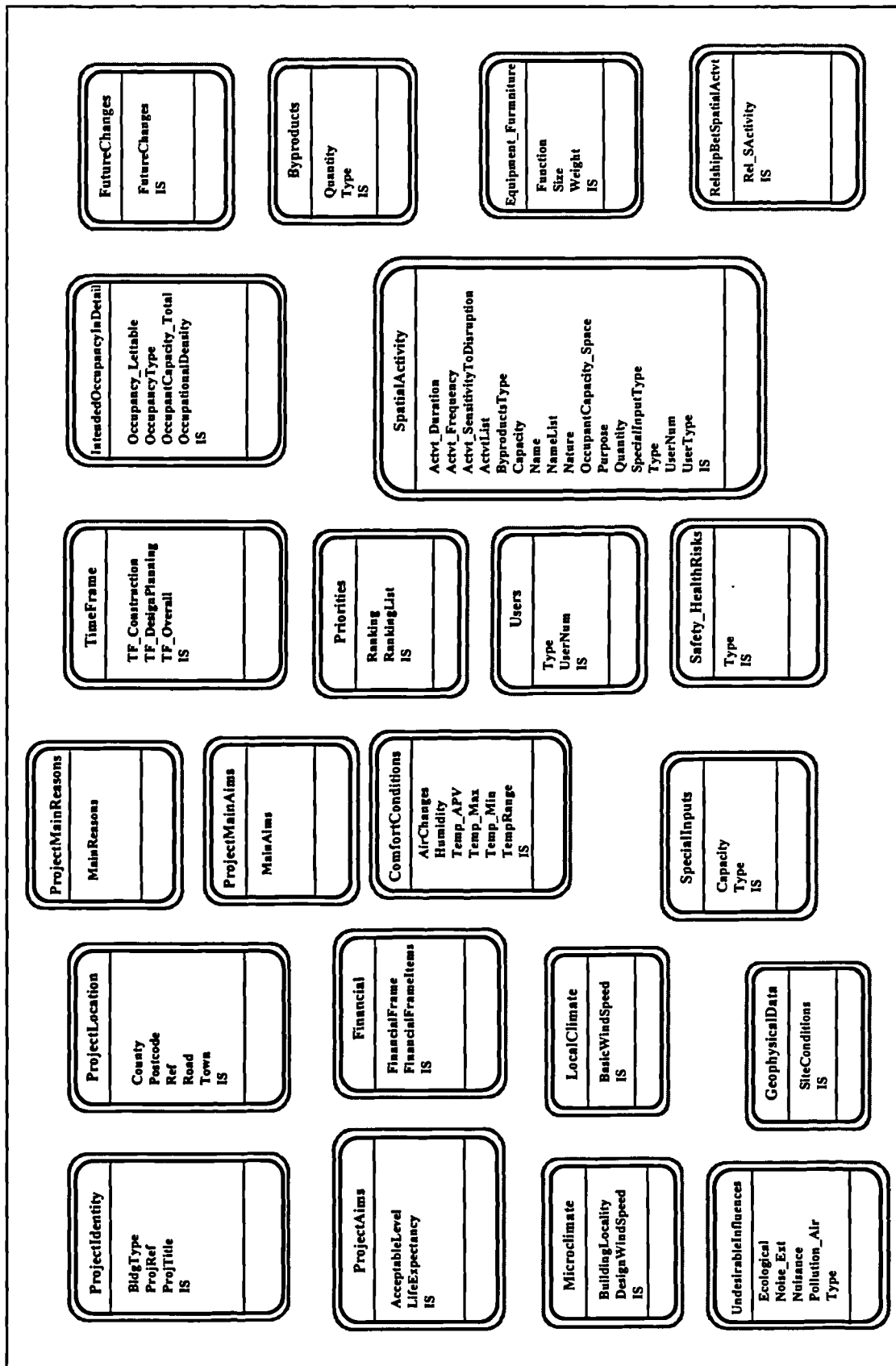


Figure 8.13 (a): Objects and Attributes (Brief Object Structure)

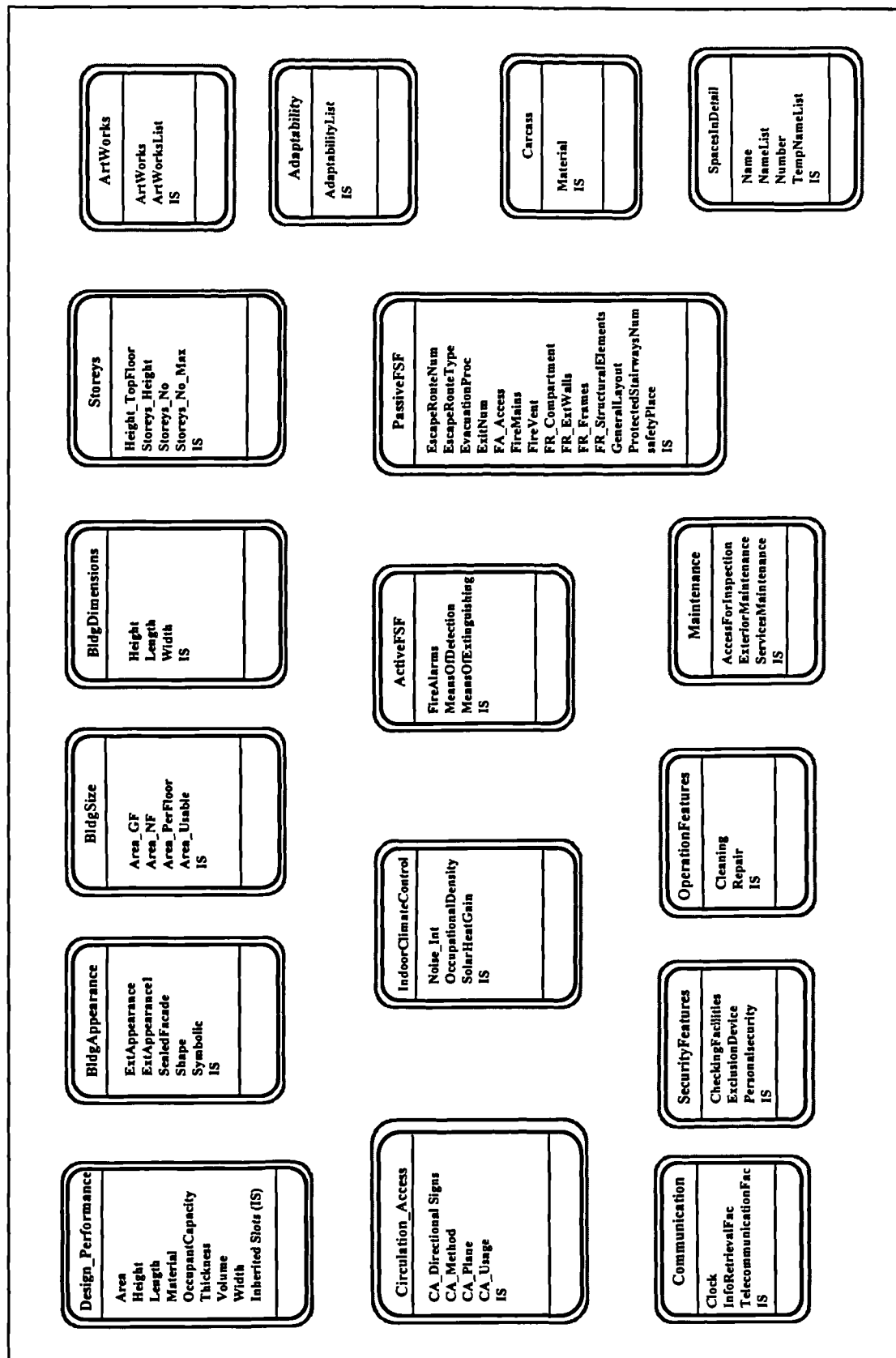


Figure 8.13 (b): Objects and Attributes (Brief Object Structure)

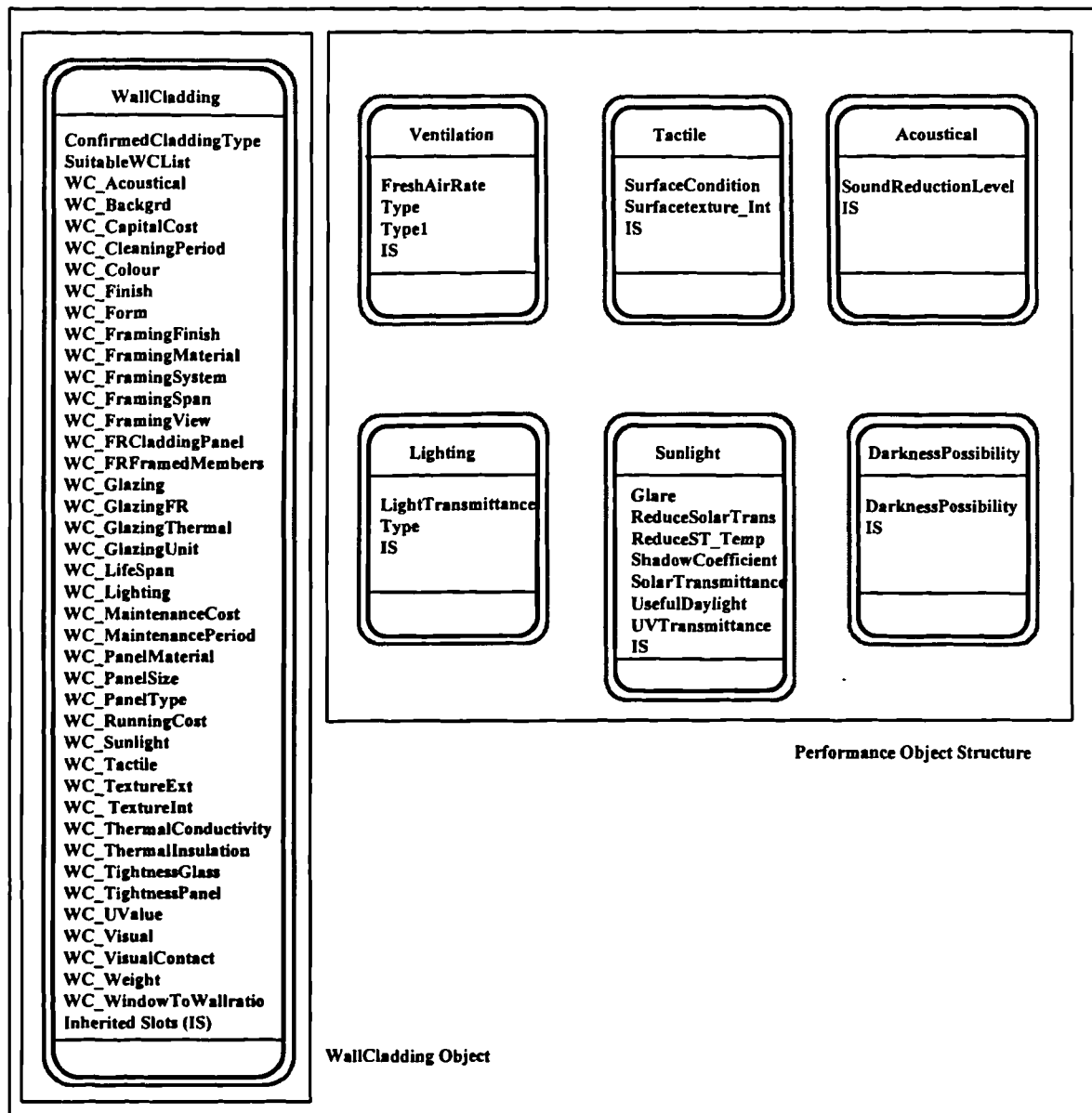


Figure 8.13 (c): Objects and Attributes

Slots can have an internal structure composed of *slot options*. KAPPA-PC provides a set of standard slot options for controlling the type and number of slot values. For each slot attached to a particular object, the relevant slot options are selected. They include:

- **Cardinality** - Cardinality refers to the number of values allowed in a slot; *single* or *multiple*. For example, the “WC_Weight” slot which refer to the weight of the wall cladding system can only have one value at any one time, i.e. either “lightweight” or

“dense”, while “WC_PanelMaterial” can have any combinations of the values listed; “glass”, “composite_material” and “precast_concrete”.

- **Value Type** - The value type of a slot can be any one of the following; Text, Number, Boolean (TRUE or FALSE) or Object.
- **Allowable Values** - This refers to the value limits of a particular value type. If the value type is a Text, the limits can be any list of strings. If the value type is Number, then the Allowable Values field becomes the Numeric Range Field, with “Min Value” (minimum value) and “Max Value” (maximum value) options.
- **Prompt Line** - The prompt line allows the developer to specify the question to be asked to the user, which may be required to obtain user input information.
- **Slot Inheritance** - This field provides two options: “Full Inheritances to Subclasses and Instances” and “No Inheritance”. These options are designed for the developer to utilise inheritance effectively. The benefits include ease of designing, modifying and understanding of knowledge bases.
- **Monitors** - Monitors are methods that are linked to slots. These will be described in more detail in 8.7.1.

8.7 Reasoning and Behaviour in Object Oriented Environments

Following the addition of attributes to the object structure of the AUTOBRIEF prototype, the dynamic information (object behaviour) was implemented in the KAPPA-PC object oriented environment.

8.7.1 Object Behaviour Representation in KAPPA-PC

The behaviour of objects associated with a particular domain can be represented in three different ways in KAPPA-PC. They are methods, functions and rules. These are written in KAPPA-PC's Application Language (KAL).

(a) Methods

In the first approach, the behaviour of objects are represented in KAPPA-PC as *methods*. Methods are used to specify the behaviour of slots in objects. In other words, each action that is carried out by an object is represented by a method.

Monitors are methods that are linked to slots and are triggered whenever an object and/or a slot is accessed. They can be defined as private functions or functions that change the value of slots (Intellicorp, 1992). Monitors are triggered either by changes in the slot value or by a request for a slot value that is not known. There are four types of monitors; "If Needed", "When Accessed", "Before Change" and "After Change".

(b) Functions

The second approach to representing object behaviour in KAPPA-PC involves *functions*. A library of more than 300 functions is provided that allows the knowledge

base to be manipulated. Functions can also be created by using KAL or the 'C' language.

(c) Rules

The third approach to representing the behaviour of objects in KAPPA-PC involves the use of rules to represent the relationships between causes and effects. A rule thus specifies the conditions under which a particular action/consequence or inference can occur.

8.8 The Inclusion of Object Methods and Functions

This section describes the translation of the process models into object methods and functions of AUTOBRIEF. By analysing the developed IDEF0 models described in Chapter 7, and with reference to the developed EXPRESS-G models in Chapter 6, the dynamic information portrayed by the models is translated into methods which represent the behaviour of objects. These methods are then linked to the appropriate objects in the object structure.

8.8.1 Identifying the Required Object Behaviour

Two types of object behaviour are identified; (1) Simple and (2) Complex. These have been adapted from Coad and Yourdon's (1991) Algorithmically-Simple Services and Algorithmically-Complex Services

1. Simple behaviour applies to each object in the model and they follow the same basic pattern repeatedly. They are represented by methods which are “implicit”. Such methods can be classified as follows:

(a) create - the method creates and initialises a new object in a class.

For example, part of the codes in the “GetInput” method attached to the “SpacesInDetail” object contains procedures which create instances of the “SpacesInDetail” class.

(b) connect - the method connects (or disconnects) an object with another.

The methods used for resolving conflicts between valid client requirements within the data model fall into this category. For this purpose, the slot values which are attached to one or more objects are compared and checked for compatibility.

(c) Access - the method gets or sets the slot values of an object.

The two principal methods within the object oriented data model fall into this category. They are “GetInput”, which is used to obtain input from the prototype’s users, and “GetBrief”, used to generate the brief based on the users’ previously entered inputs.

(d) Release - the method disconnects and deletes an object.

An example of such a method is the “NoSpacesLeft” method attached to the “SpacesInDetail” object. This method is used to confirm the deletion of a particular space requirement within the proposed building. If the deletion is confirmed by the user,

then the method proceeds by deleting the instance of the “SpacesInDetail” class which corresponds to the space requirement.

2. Complex behaviour applies to methods which go beyond the four classifications described. These methods are “explicit”. Two categories are identified :

(a) Calculate - this method calculates the result from the slot values of an object.

For this purpose, values of relevant slots from the same and/or different objects are used to calculate the value of a particular slot in an object. An example of such methods include the “GetHeights”, “GetHeight_TopFloor” and “GetNewStores_Height” methods which are attached to the “Storeys” object.

(b) Monitor - this method monitors an external system or device. Within the developed system there is no method which functions solely for this purpose. The closest a method gets to this category is to establish connections from the object oriented environment to an external system, referred to as an external resource in the system architecture (Chapter 9). The methods which function for this purpose include the “GetBldgRegs” method which establishes connections to relevant building regulations documented in Windows Notepad. Another example is the “GetInternet” method which links the system to relevant web sites on the internet.

8.8.2 Identifying Message Connections

A *message connection* maps one object to another. It occurs when a “sender” sends a message to a “receiver” to get some processing or action done. The “sender” specifies

the required processing, i.e. the name of the method within the “receiver”, and the “receiver” defines the processing, i.e. the action specified in the method. The process of activating a method in a particular object is called *sending a message* or *message passing*. When an object (the “receiver”) receives a message that corresponds to one of its methods, that method is invoked and the object carries out the procedure or action as specified by the method.

a) Strategy for Identifying Message Connections

The strategy for identifying message connections between objects requires three useful activities to be carried out on each object (Coad and Yourdon, 1991):

(1) Identify the objects that an object under consideration needs services from, and draw an arrow to each of the identified objects. For example, the arrows that flow out of the “ProjectIdentification” object shown in Figure 8.14 indicate that services are required from these objects.

(2) Identify the objects which need one of the services from the object under consideration, and draw a line from each of these objects to the focal object. As an example, the arrow from the “ProjectMainAims” object to the “ProjectAims” object denotes that services are needed from the former to the latter.

(3) Follow each identified message connection to the next object, and repeat the above processes for each object.

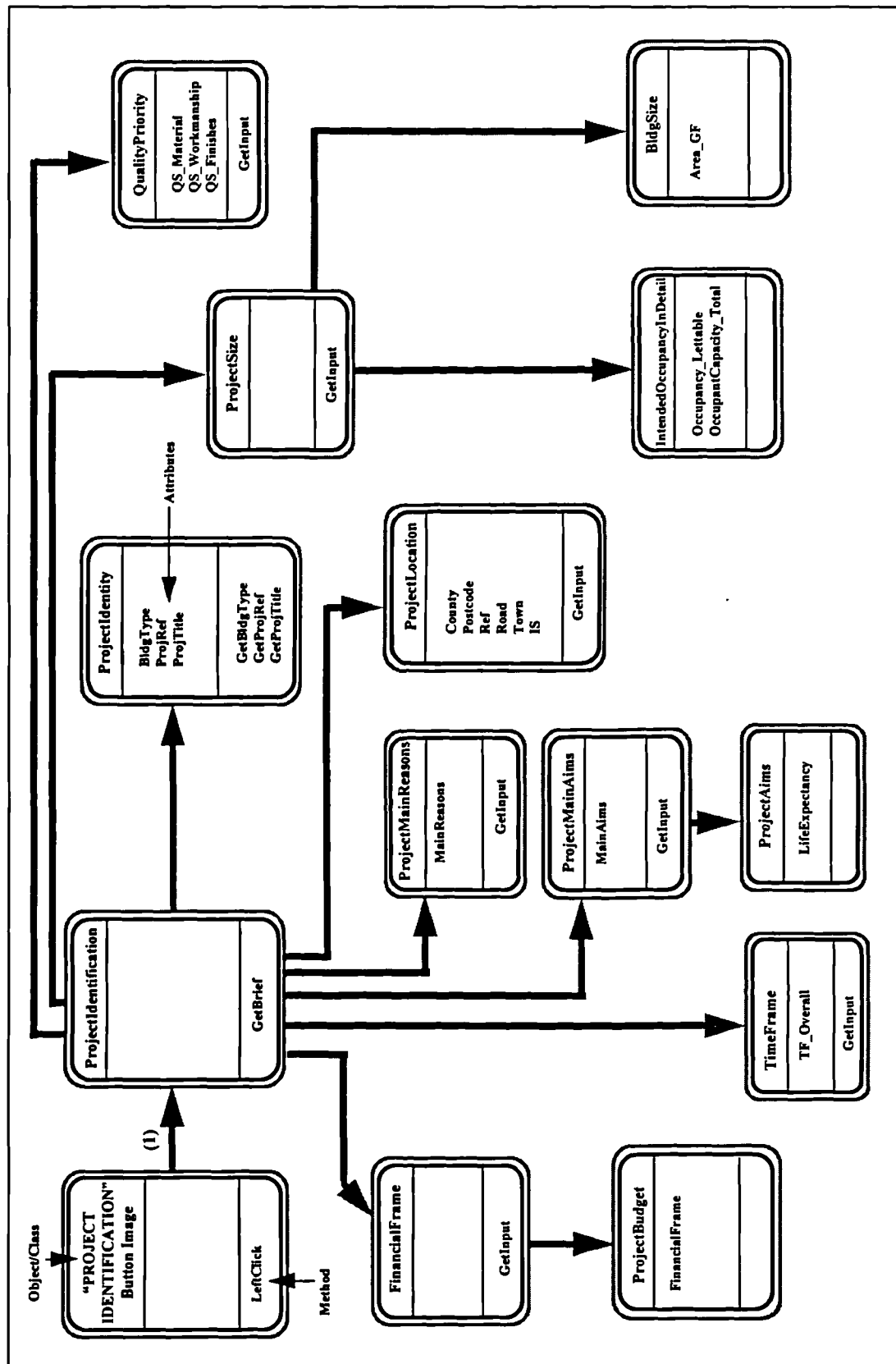


Figure 8.14: Message Connections (to Generate Brief for "Project Identification")

b) Communication Between Objects

Communication between objects within the prototype occur through message passing, i.e. through the identified message connections. These messages are embodied within the user functions (functions created by the developer) or the methods encapsulated within a particular image object. Messages can be triggered in one of two ways. Firstly, by the user or *user-driven*, by performing an action on the user interface, e.g. clicking a button object or selecting a menu option and/or a sub-option. In this case, the application is *functionally-driven* rather than data-driven. Secondly, messages may be generated by the system, i.e. *system-driven*, as a consequence of a set of stored attribute values based on previous user selections or inputs. This corresponds to the instances where the system checks the compatibility of a group of related data. Hence, in this case the application is *data-driven*.

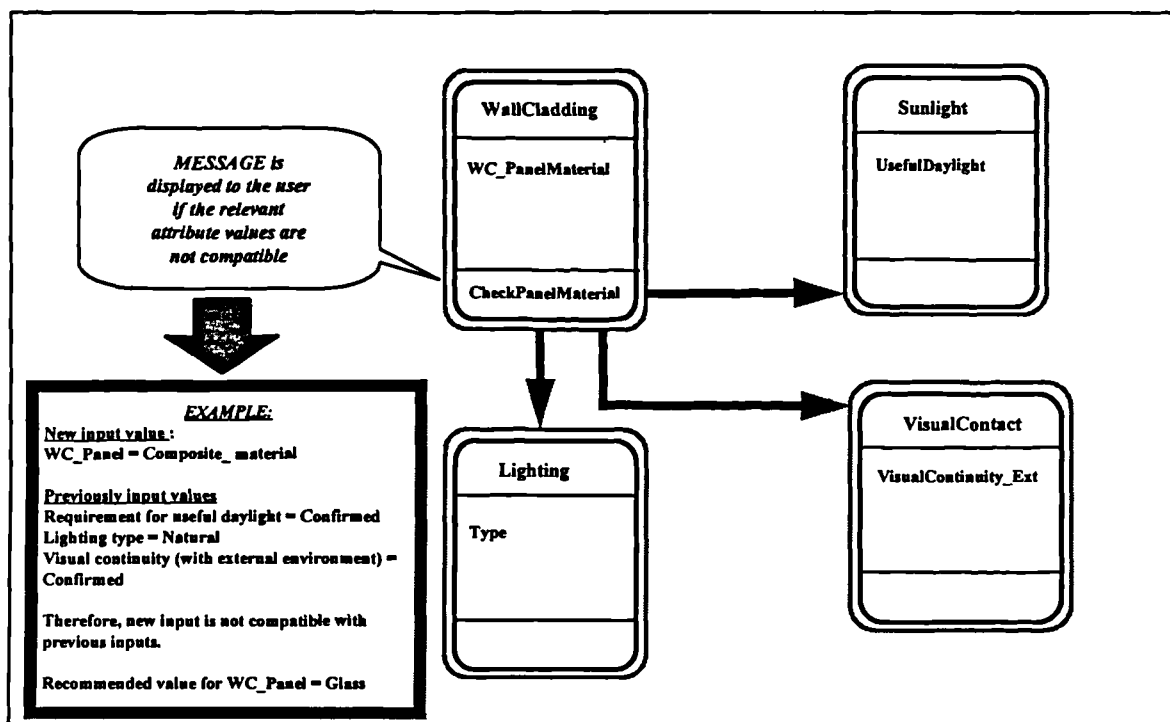


Figure 8.15: Message Connections for “WallCladding” Object (An Example)

As an example, Figure 8.15 shows the message connections between the “WallCladding” object and the “Sunlight”, “Lighting” and “VisualContact” objects. When a value is entered for the “WC_PanelMaterial” slot in the “WallCladding” object, the “AfterChange” monitor, “CheckPanelMaterial” is invoked if the value entered is not compatible with the stored values of the relevant attributes in the other three objects, as shown in Figure 8.15. A message is then displayed to the user.

8.8.3 Specifying the Methods and Functions

The name selected for each method or function is based on the action or behaviour it is meant to perform. The methods attached to a particular object in the data model are depicted in Figures 8.16 (a), (b) and (c). Objects which inherit the methods from their parents are not shown in the figures. Figures 8.16 (a) and (b) depict objects within the “Brief” object structure and their methods, while Figure 8.16 (c) shows the objects and their methods within the “Performance” object structure and the methods for the “WallCladding” object.

Apart from the above, user functions have also been created. These functions are mainly attached to the instances of the “Button” subclass of the “Image” class depicted in Chapter 9. The user functions are used to control the user interface.

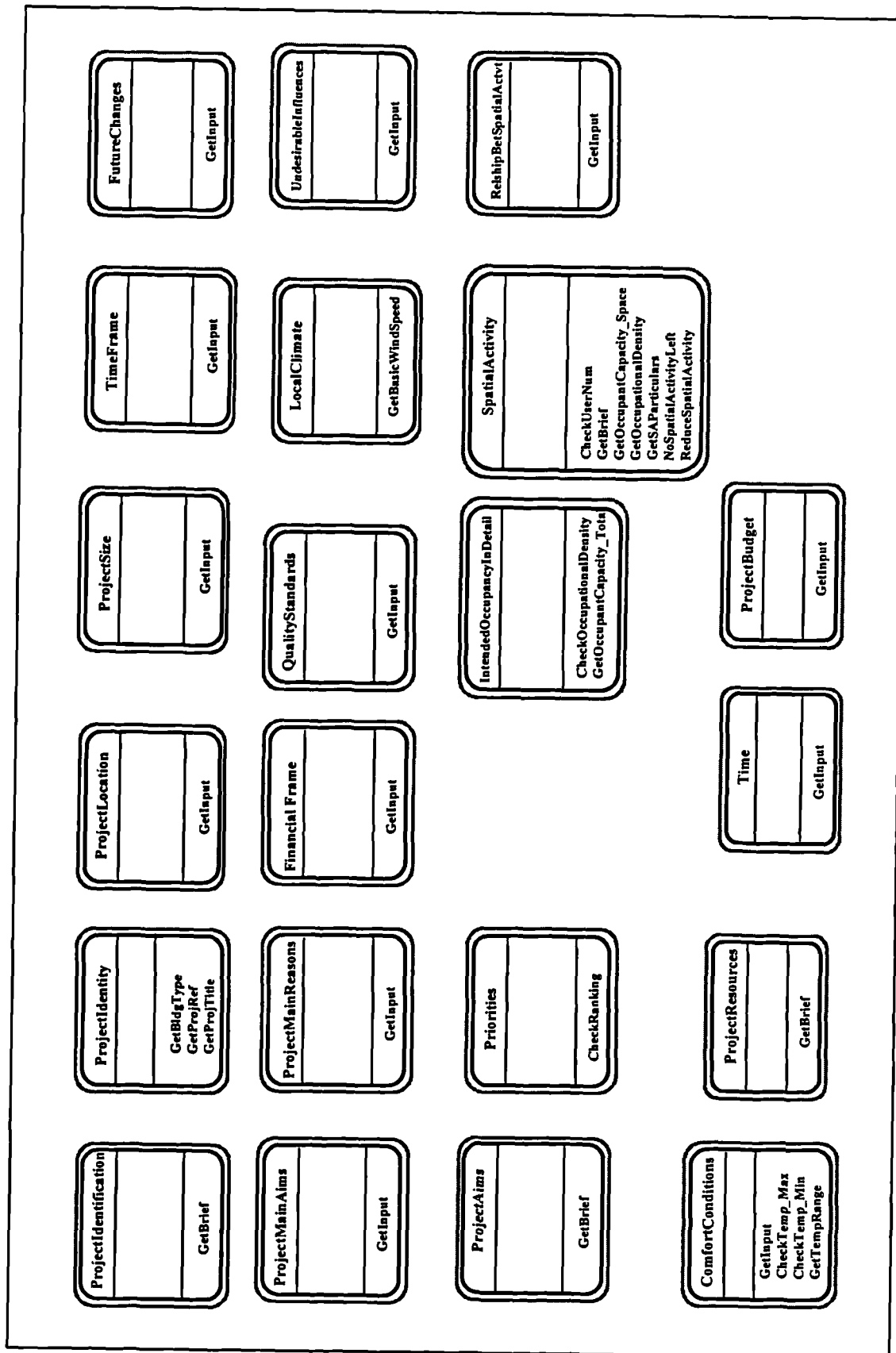


Figure 8.16 (a): Objects and Methods (Brief Object Structure)

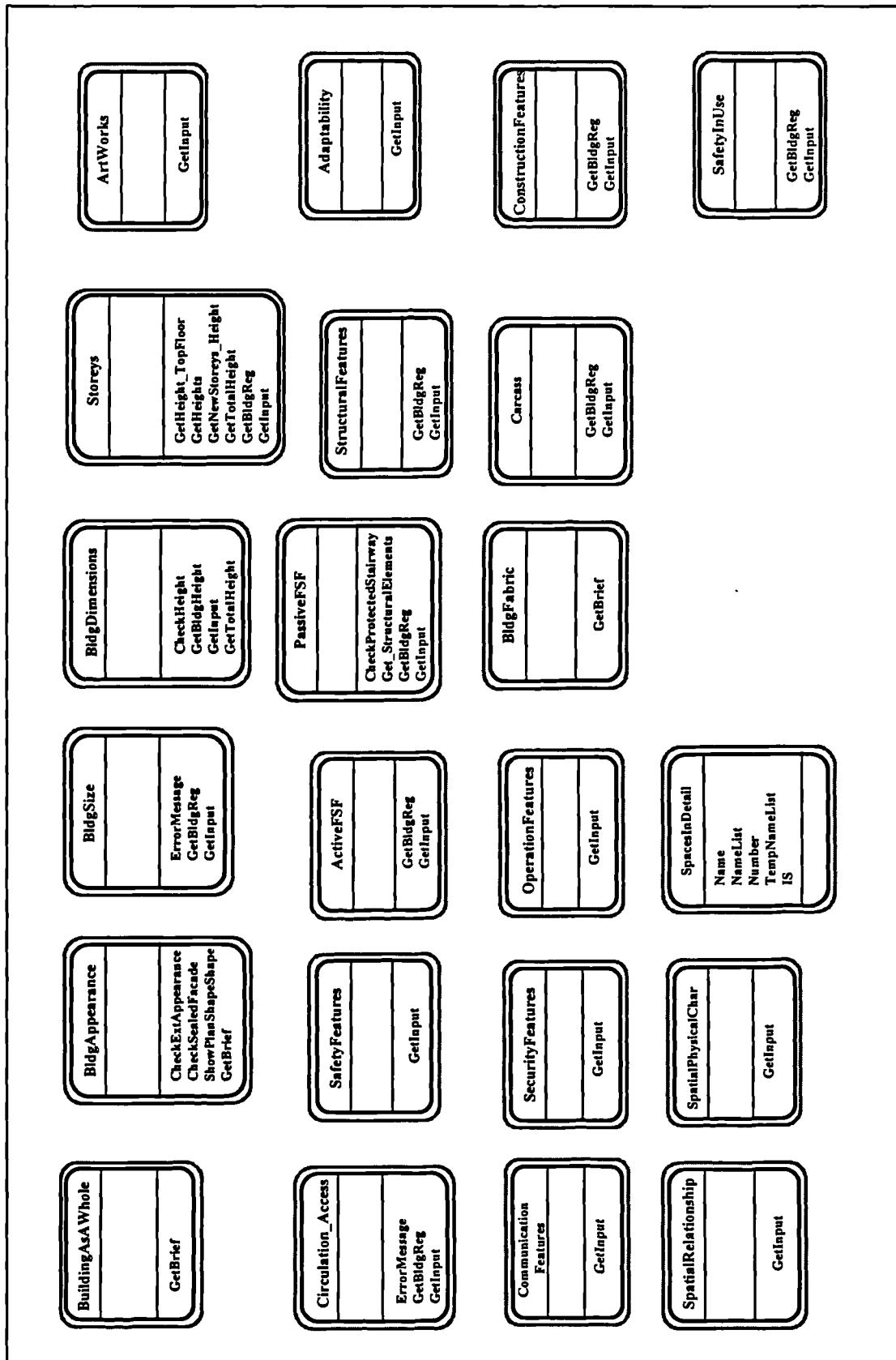


Figure 8.16 (b): Objects and Methods (Brief Object Structure)

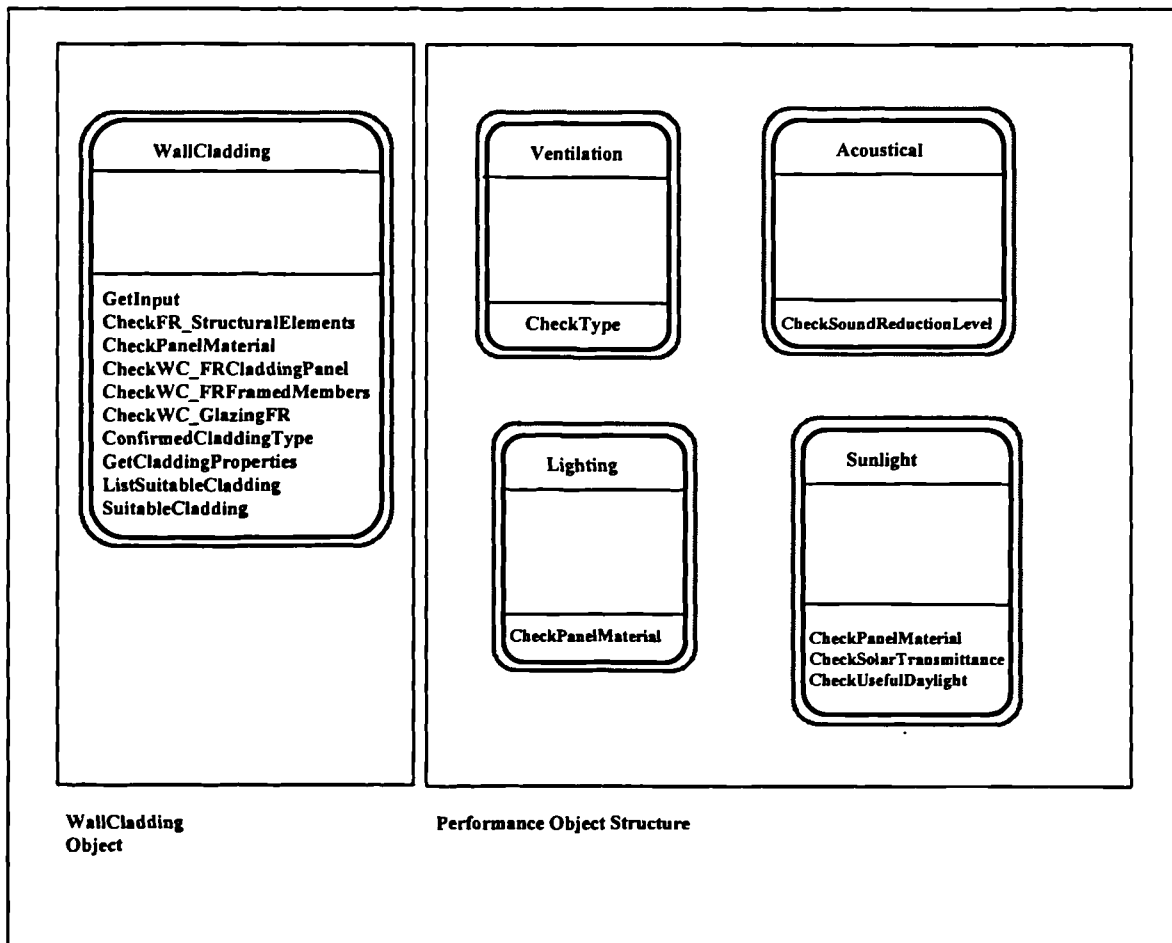


Figure 8.16 (c): Objects and Methods

8.9 Summary and Conclusions

This chapter has described the implementation of the developed information and process models into the object oriented environment. The translation of these models into the relevant object oriented concepts within the object oriented environment have been illustrated. This forms the basis for the prototype development, which will be presented in the next chapter.

This chapter has emphasised the necessity to link the developed information and process models together during the implementation process. It has described how the relevant

constructs in the information models have been translated into their corresponding object structure representations in the object oriented data model.

Once the object structures or object hierarchies have been established for the object oriented data model, the attachment of attributes or slots to the appropriate objects have been carried out. This chapter has described the systematic translation of the entities/attributes from the information model into slots of objects in the data model. The smooth running and relative ease of the translation process confirms the suitability of the EXPRESS-G as the selected information modelling technique for this purpose.

This chapter proceeds by describing how the selected object oriented development environment associates reasoning and behaviour to the objects. The discussion on how the process models have been translated into the behaviour of objects and implemented into the object oriented environment follows. The conversion of the process models into methods and user functions have been illustrated. The use of the IDEF0 modelling technique for modelling the processes described in Chapter 7, has enabled the translation process to be carried out with relative ease, thus demonstrating its suitability for this purpose.

Furthermore, by linking both the developed information and process models, and by mapping these models into the KAPPA-PC object oriented environment, an object oriented data model has been accomplished. The achieved conceptual model forms the basis for the development of the system architecture for the proposed prototype which will be discussed in the next chapter.

CHAPTER 9

PROTOTYPE DEVELOPMENT ("AUTOBRIEF")

9.1 Introduction

The previous chapter has described the implementation of the developed information and process models into the object oriented environment, which leads to the development of an information system prototype, AUTOBRIEF. This chapter presents the AUTOBRIEF prototype. The prototype utilises an object-oriented development environment (KAPPA[®]-PC), with access to external databases and other resources such as textual files, image files and the internet. The prototype functions within the Microsoft[®] Windows[™] environment while utilising the support of multimedia technology to enhance the presentation of its output and visual display. The AUTOBRIEF prototype aims to generate the client's brief based on the user's input data (client's requirements). To assist in this process, access to project and construction industry related information are also made available.

This chapter begins by describing multimedia technology along with its applications and benefits to the construction industry. Its application is then extended to the process of

developing the brief, which leads to its use in the development of the prototype. This section is followed by the description of the components of the system architecture of the prototype and their functions. The overall process of the system architecture is then described, followed by the development of the user interface and the external resources. Finally, the real time integration of AUTOBRIEF with external resources is presented.

9.2 Multimedia Technology

There have been various definitions put forward to describe multimedia. They include the following:

- “the integration of two or more different media with the personal computer” (Burger, 1993)
- “the seamless integration under computer control of any text, sound, still and animated images, and motion video” (Jacobs, 1992)

In general, therefore, multimedia can be regarded as any experience or application that utilises two or more media to convey a message or achieve a specified purpose. The types of media used can be in the form of text, numbers, graphics, sound, photographic images, computer-generated animations, simulations, recorded motion video, and any type of computer application or computer-generated document, along with the normal output media of display screen and printed hard copy (Jamsa, 1993; Burger, 1993; Luther, 1994; Bunzel, 1994; Badgett and Sandler, 1994).

One way to view multimedia technology is by the way the computer is used; either as a *controller* or as an *integrator* (Vanegas and Smith, 1994). In the first case, the computer

is used as a controller of a variety of other external equipment or media devices, such as still-images or video cameras, VCR's, CD-ROM's, laserdiscs, music, lasers or lights. In the second case, the computer is used as an integrator that combines multiple audio and visual media into a single presentation without an emphasis on the use of additional external equipment.

Another way of classifying multimedia applications is by the manner in which the user interacts with the applications; *passive* or *interactive*. Passive multimedia refers to applications whereby materials in different types of media are presented to a user in a linear or sequential way. In contrast, interactive multimedia occurs when the user can navigate through the subject matter in a non-linear, random-access environment (e.g., hypertext and hypermedia) according to his/her own interests, needs or pace (Vanegas and Smith, 1994).

The use of multimedia technology in the construction industry can come about in any form or combination. In most cases though, the main objective of a multimedia application is to assist designers and other project participants in the presentation of design and construction technical and management data, their products and the processes or activities involved.

9.2.1 Applications and Benefits of Multimedia Technology

The benefits that can be gained from multimedia technology are endless. Its introduction into various aspects of everyday life tasks and strategies has given rise to various myths and realities. However, the benefits that can be gained from its use far outweigh the

disappointments that may arise due to over-expectations of its capabilities. Therefore, in order for its benefits and potential to be fully realised, the limitations of the technology should be recognised and the development of the multimedia applications should not be based upon unrealistic expectation of its applicability.

Multimedia computing can be effectively utilised in various applications. These encompass information delivery, education and/or training, telecommunications, publishing and broadcasting as well as home usage. In the construction industry, the first two applications are most acknowledged. Here, multimedia technology can be employed for the purposes of presentation, consultation and documentation of construction industry related information, as well as for group or individual education and/or training, such as those in undergraduate programme of studies or for continuing professional development.

The use of multimedia technology in information delivery has paved the way towards more effective ways and means of accessing, communicating and delivering of information in a more effective manner to suit specific situations and conditions. The use of multimedia applications in the construction industry can be categorised as follows (Vanegas and Smith, 1994):

1. Development of marketing presentations and technical reference materials.

In this case, several types of multimedia databases can be created using documentation of performances of past projects. The multimedia databases can be in the form of photographs of finished products, photographs of the construction works

prior to completion, video clips of selected situations, events or processes, audio clips of interviews with the project participants, original plans, specifications and as-built drawings, cost and programme performance record and many other databases related to the finished projects. Then, using multimedia technology, customised presentations to suit specific audiences can be developed. These databases can be used for marketing purposes, whereby potential clients will be able to visualise actual design and performance data of past projects that are relevant to their specific interests. This information can be used by them as technical reference materials for current and future decision making.

2. Development of technical support systems for project planning and design.

Various types of multimedia databases can be created encompassing technical data. The multimedia databases can be in the form of design and building regulations, standards and codes, product specifications, libraries of design and construction details, photographs or videos of potential design problems and possible solutions, etc. The technical data can be obtained from design and building regulatory agencies, past projects, manufacturer's or supplier's technical product data, or any other relevant data sources. By using multimedia technology, customised technical support systems or reference materials can then be developed. These databases can be tailored to suit specific uses such as project type, building type, building element type, etc. The availability of these technical support systems and reference materials would benefit all the stakeholders of the construction industry.

3. Documentation of construction processes, progress, events and/or lessons learned.

The actual performances of on-going or completed projects, in terms of construction activities, progress, events and lessons learned aspects, can be stored in the form of multimedia databases. Based on this, constructability knowledge can be generated throughout the lifecycle of a project. A multimedia-based constructability lessons learned system can then be developed. This includes on-going constructability analysis, analysis of possible improved project performance based on proven and new technologies, and actual project performance results such as cost, schedules, quality, productivity, etc. The knowledge of the constructability learned system can be in the form of written reports, photographs and slides of construction details or situations, description of problems, videos of construction operations and many others. The output of the system can be in the form of electronic constructability manuals that can be queried, retrieved, manipulated and displayed in various media. The availability of this kind of information to designers and constructors alike would greatly influence their decision making process, especially in selecting the best possible alternatives of any design solution in terms of its constructability.

During the brief development stage of a construction project, multimedia technology can be used to support the documentation and presentation of project and construction industry related information. This information is meant to improve the client's or other project participant's knowledge and understanding of the project related concepts required for the development of the brief. Multimedia can deal with information which includes technical reference materials such as building regulations and standards,

technical product data, design and performance data, and products specifications, as well as data of past project performance in any media, photographic images and/or videos of construction activities, events, etc. If the development of the brief can be emulated and conducted in a stand-alone or self-contained system with easy access to all the relevant multimedia materials, the benefits that can be gained by clients, designers and other project participants are substantial. The clients will be able to communicate their requirements more accurately to the designers. The designers, in turn, will be able to interpret the clients' requirements more accurately. The designers can also enhance their creativity and problem-solving skills. They can communicate more effectively and accurately with clients as well as with other project participants. It is with this notion in mind that the prototype development is envisaged.

9.3 System Architecture

AUTOBRIEF is an information system prototype which aims to capture the client's project requirements, provide easy access to project and construction industry related information as and when required, and generate the client's brief. The system architecture comprises three main components. These are the Interface, the Core Engine and the External Resources (Figure 9.1).

9.3.1 The Interface

The first component of AUTOBRIEF is the Interface. The Interface allows the user and the system to communicate and interact with each other. The graphical user interface includes windows and images. Windows are of two types; session windows and dialogue windows. Session windows are locations on the screen where images (e.g. text,

bitmap, button and transcript images) are displayed which allow communication between the user and the knowledge base. The dialogue windows, on the other hand, are small windows which aims to prompt the user for input, to select a set of options or to present instructions or messages to the user.

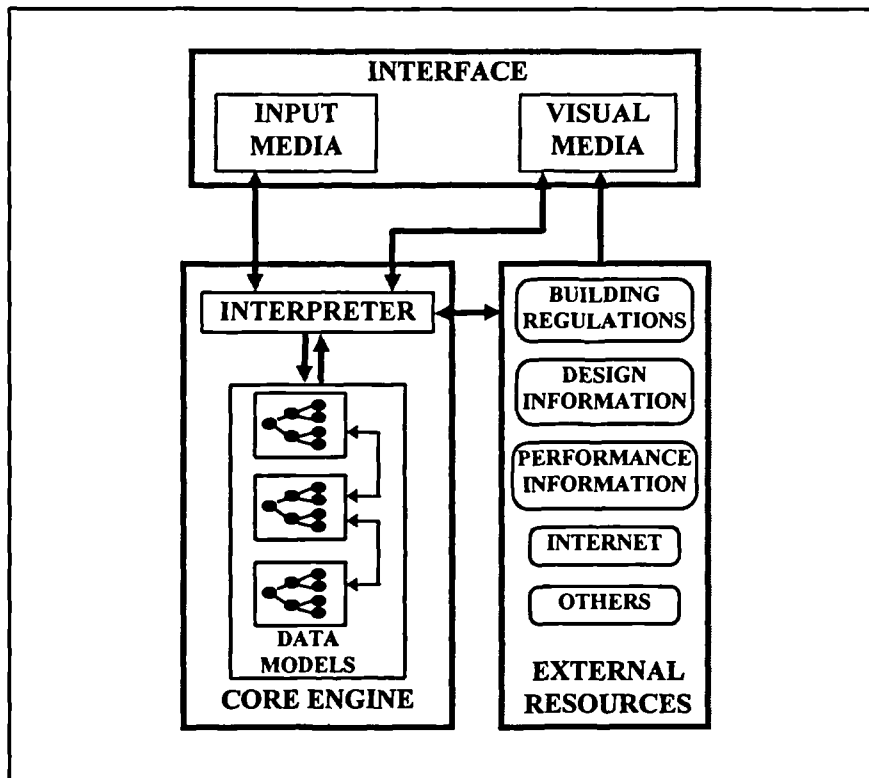


Figure 9.1: System Architecture of AUTOBRIEF

The Interface component of the system architecture controls the graphical user interface of AUTOBRIEF. This is divided into two modes, namely; the “consultation” mode and the “generate brief” mode. In the first mode, the Interface component provides a platform for the user to input and select project requirements prior to the generation of the brief. To assist the user in identifying his/her actual requirements, related or relevant information is presented as and when required. In the second mode, the Interface component enables the user to select a section of the brief or the whole brief to be generated in the form of a textual report.

In both modes, the Interface is supported by its two sub-components; namely the Input Media and the Visual Media. The Input Media captures the user’s input data (client’s requirements) during the “consultation” mode. Data may be captured in two ways. The first method is by direct input, as a direct response to the system request. In this case, the data involved is external, i.e. user’s specific data. The second method is the selection of an option(s) or sub-option(s) from the system’s menus. In this case, the data is retrieved by the system and presented to the user in the form of a menu. In both cases the framework of the data to be presented to the user during data input is dominated by the data models in the Core Engine. Data consistency is thus maintained in both cases.

During the “generate brief” mode the Input Media captures the user’s selection in terms of which section of the brief is to be generated. A section of the brief can be any one of the five main sections or its sub-sections, which form part of the structured framework of the brief presentation derived in Chapter 3. Once the user’s input or selection has been captured, the Input Media passes the message to the Core Engine so that it can respond accordingly.

The Visual Media allows the user to visualise specific information, instructions or messages related to user’s specific input or selection of option(s) during the “consultation” mode. During the “generate brief” mode, the Visual Media displays the generated brief which can be visualised within the system as transcript images or linked to the External Resources component of the system architecture, such as Notepad or Microsoft Word.

The Visual Media utilises a limited number of multimedia presentations. They include the normal output media of display screen and printed hard copy, together with text, recorded audio, still images/graphics and computer-generated documentation. The Visual Media displays the appropriate information in the media or format as defined in the Core Engine.

The Visual Media can be initiated in two ways; either system-driven or user-driven. System-driven is achieved when information is presented or displayed without the user's direct request. This can be triggered by a user's specific selection of an option or a sub-option, or as a response to previously stored inputs. User-driven, on the other hand, is activated as a result of the user's specific request.

9.3.2 The Core Engine

The Core Engine is the main component of AUTOBRIEF. It represents the central core for the overall system. It is an object oriented knowledge based system where all the object oriented data models and knowledge of the brief domain are stored. The data models are mapped directly from those developed in Chapter 6. The objects within the data models communicate with each other via methods or functions incorporated within the Core Engine. These methods or functions are devised from the process models (Chapter 7), which determine the necessary procedures which are required by the system. By incorporating the data models with the process models the total behaviour of the system is defined. This behaviour is controlled by the Interpreter, a sub-component of the Core Engine. The Interpreter thus serves as an intelligent front end to the system.

It assists the Core Engine to perform its interrogative process of extended discussion, investigation and requirements analysis. At the same time, it controls the Interface by deciding on the exact data the Input Media will prompt the user for and the specific data or information that the Visual Media will display in a timely manner.

The Interpreter is so named to emulate the real world process of identifying and interpreting the client's requirements (referred to as input data in AUTOBRIEF) during the brief development stage. At the same time it checks the compatibility between the client's requirements and resolves conflicts, i.e. checks the compatibility of input data and previously stored data in AUTOBRIEF and ensures that these requirements are suitable for the development of the brief (referred to as valid data in AUTOBRIEF). Thus, the main function of the Interpreter is to interpret and verify the validity of the data input in terms of its suitability for the development of the brief.

The methods and functions incorporated within the Core Engine enable the Interpreter to emulate the dialogue between the client and the designer (and/or other project participants) during the process of developing the brief. The Interpreter performs in one or a combination of the following ways:

- a) Direct acceptance of the user's input or selection, i.e. for data that does not need verification (valid input). Valid inputs are directed to (or stored in) the appropriate objects and slots in the data models, while invalid inputs are displayed for the user's confirmation. Messages are displayed to get direct confirmation of data validity from the user.

- b) Checks the compatibility of the captured input data, with a group of related input data. If a group of input data contradict each other, or they do not conform to specific regulatory issues, then the Interpreter will attempt to resolve this conflict. Certain methods or functions in the Core Engine will be invoked in this case to highlight all the relevant previously entered data. The Interpreter will then request the user to correct or confirm the input. This serves as a checking mechanism for the input data, hence preventing data inconsistency and promoting data validity and accuracy within the system. For example, when the user inputs the number of storeys and the average height of a storey, the Interpreter will automatically calculate the approximate building height for the purpose of checking the allowable building height for the selected location, say Manchester. This is done by prompting the user to input two related data, i.e. the building locality (either city outskirts or city centre) and the site conditions (either normal site, slightly sloping site or steeply sloping site). Once these data have been entered the summary of the previously entered data and the corresponding instruction will be presented to the user as shown below:

<p>Building Location: Manchester Building Locality: City_Centre Site Conditions: Normal_Site</p> <p>Maximum building height allowed = 15m (Approved Document A1/2 Table 8)</p> <p>Calculated height = 18m Please make the necessary changes</p>

- c) Recommends to the user a relevant valid input or a selection of valid inputs, based on previously stored data or based on the interpreted request for specific data

retrieval as expressed in (d) below. For example, assuming the user has reached the stage of entering the detailed requirements for the wall cladding. When the user selects an option for the cladding panel material (say, "precast_concrete", "composite_material" or "glass") this input will be checked against all the relevant previously stored data (compatibility check as in (c) above). If the values conflict, then a message will be displayed; first summarising the related previously stored data, then recommending the valid input for the cladding panel material. The message below depicts the message presented to the user if "Glass" is not one of the selected options for the cladding panel material:

Useful daylight requirement = Yes
 Lighting type includes Natural
 Visual continuity (with external environment) = Yes

 Recommended type of cladding panel material = Glass

After displaying the above message the user will be prompted to enter "Glass" in the list of cladding panel material. In this way, the conflicts between input data are resolved. Once this has been resolved the valid data are stored in the corresponding object in the Core Engine.

- d) Interprets specific or a group of related input data as a request for specific data/information retrieval prior to the user's actual data input. Access to the relevant information resources will be established by the Core Engine. This facility of presenting and highlighting relevant construction industry related information is aimed at facilitating the user's understanding and knowledge of the problem in hand, which will assist in the decision making process.

- e) Stores valid data in the appropriate object/slot within the relevant data model in the Core Engine ready for the generation of the brief.

The Interpreter also has a key role to play during the "generate brief" mode. It reacts to the captured user's selection by activating all the relevant stored valid data which contributes to the generation of the brief, compiles this data and generates the required brief. The generated brief will then be viewed in the Visual Media.

9.3.3 The External Resources

The last component of AUTOBRIEF is the External Resources. This component supports the object oriented environment in terms of providing projects and industry related information which form part of the audio-visual display for the interface. It comprises a number of external resources/databases which contain specific information such as building regulations, specifications and specific design or performance related information in the form of textual or graphical information, audio/sound databases, picture/image databases, etc. Access to the Internet is also provided to allow the user to access up-to-date information at certain pre-determined stages during the consultation process. This presentation of information not only increases the user's knowledge and level of awareness, but also facilitates the user's understanding which is essential for the decision making process.

The External Resources component is linked to the Core Engine which in turn determines the specific type of information or material that is required to be presented to

the user. Once this has been determined, the necessary link to the information source is established and the information is displayed by the Visual Media. For example, if the Core Engine identifies that the building regulations which reside in Notepad (a *.txt file) need to be presented to the user at a particular point in time, then the necessary link to the relevant Notepad file will be made. The relevant building regulation is then displayed by the Visual Media.

9.4 The Overall Process of the System Architecture

This section presents the main processes that take place within the overall system architecture of the developed prototype. Figures 9.2 and 9.3 portray the three main components of the system architecture with their corresponding functions and processes. In Chapter 7, Figure 7.8 has decomposed the "Develop Brief" process into two sub-processes; namely the "Consultation" process and the "Generate Brief" process. In order to emulate these two processes into the system architecture, these two sub-processes have been transformed into two interface modes, which have been respectively called the "consultation" mode and the "generate brief" mode.

Figure 9.2 shows the processes involved during the "consultation" mode, which correspond to the "Consultation" process. Figure 9.3 depicts the processes that take place during the "generate brief" mode, which correspond to the "Generate Brief" process. The key processes of the Core Engine and the External Resources components of the system architecture are depicted as white rectangles on these components, which are themselves shown as grey shaded background rectangles. The rectangles outside them, however, represent the processes that take place within the Interface component.

To differentiate between the processes carried out by the system and the user, those for the user have been shaded in grey. These processes and their respective inputs and outputs have been presented earlier in Chapter 7 in the form of IDEF0 models. These two diagrams have been derived from a combination of the IDEF0 diagrams at different levels of abstractions. However, the term "data" is used instead of "CR (Client's Requirements)" and where the inputs also serve as controls on the IDEF0 models, they are shown as inputs in Figures 9.2 and 9.3. The controls and mechanisms of each process are not shown in these diagrams since the aim here is to project the overall process for the system architecture. The inputs and outputs of each process are shown by the direction of the arrows.

a) The "Consultation" Mode

With reference to Figure 9.2, the overall process of the system architecture begins with the "User commences "consultation" mode" process. The output can either go into the "User terminates "consultation" mode" process, during which the "consultation" mode ends, or into the "Request for data" process. The output, "Data request", can either flow into the "User inputs data" process or the "User selects option/sub-options" process. The first process corresponds to the direct input by the user, and the second, the selections made by the user from the menu presented, which has been described in 9.3.1. For both processes, the respective "User's input data" and "User's selection" outputs, are in turn captured by the next respective process. Up to this point, the processes mentioned are performed by the Interface component of the system architecture.

The output of the "Captures user input data" process, the "Captured Input Data", then becomes the input for the "Interprets & Verifies data" process. At this juncture the Core Engine component begins its role. Two outputs may be produced by the "Interprets & Verifies data" process; the first one is "Valid data", referring to the input data which is suitable for the generation of the brief, and the second one, "Confirmation of data invalidity". This implies that the "Captured input data" is not appropriate for the brief, and is thus rejected. The "Confirmation of data invalidity" output is therefore sent back to the "Requests for data" process. Alternatively, this confirmation is channelled to the "Recommends valid input" process, the output of which is the "Recommended valid input". The "Recommends valid input" process corresponds to the function (c) of the Interpreter, as described in 9.3.2 earlier. Under certain circumstances, for example, to comply to specific Building Regulations, the Core Engine will decide to automatically send this "Recommended valid input" to the "Stores valid data" process.

Where the user's discretion is required, the "Recommended valid inputs" will be forwarded to either the "User inputs data" process or the "User selects option/sub-options" process. If, on the other hand, "Valid data" is the outcome of the "Interprets & verifies data" process, it will be forwarded to the "Stores valid data" process. Simultaneously, the "Valid data" output is also sent to the "Resolve conflicts between valid data" process. This process corresponds to the function (b) of the Interpreter. For this process to take place "Stored valid data", an output of the "Stores valid data" process, is also required as input. Once the conflicts between the valid data have been resolved by the Core Engine, the "Compatible set of valid data" becomes the output of

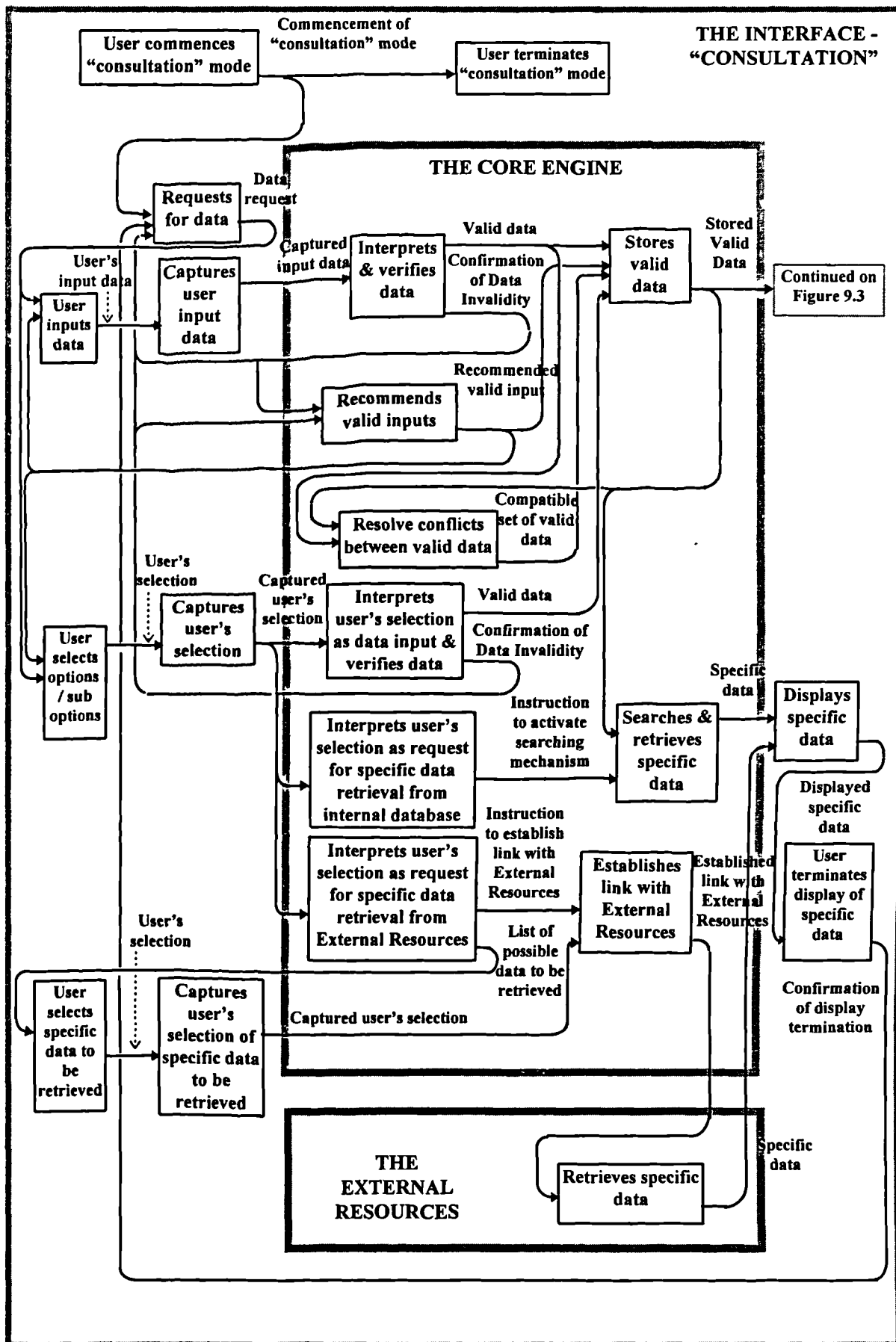


Figure 9.2: Overall Process of the System Architecture - The "Consultation" Mode

the "Resolve conflicts between valid data" process. This, together with "Valid data" and "Recommended valid input" becomes the input for the "Stores valid data" process. As the consultation process continues, the stored valid data is being continually re-assessed and examined by the Core Engine to ensure that the data is not only valid (suitable) for the generation of the brief, but that they are also compatible with each other. In terms of the generated brief, this ensures consistency in the client requirements and the final brief produced.

The output of the "Captures user's selection" process of the Interface, i.e. "Captured user's selection", has three alternative directions to proceed:

1. It becomes the input for the "Interprets user's selection as data input and verifies data" process. This process is similar to the "Interprets & verifies data" process described earlier, whereby the outputs are "Valid data" and "Confirmation of data invalidity". Again, these outputs take the similar path as described previously.
2. It becomes the input for the "Interprets user's selection as request for specific data retrieval from internal database". The output for this process is the "Instruction to activate searching mechanism", which then, together with "Stored valid data", become the inputs for the "Searches & retrieves specific data" process. Once the relevant data have been retrieved, "Specific data", which is the output of the process, transforms into the input of the "Displays specific data" process. Prior to this process, all the activities occur in the Core Engine component of the system architecture. The "Displays specific data" process, however, takes place in the Visual Media of the Interface component, the output of which is the "Displayed specific data".

3. It becomes the input for the "Interprets user's selection as request for specific data retrieval from External Resources". If the Core Engine finds that there is only one data source, then the output of the process is the "Instruction to establish link with External Resources". This input goes into the "Establishes link with External Resources", whereby the Core Engine executes and opens the necessary data source, for example a Microsoft Word File or a bitmap file. The output of the above process, "Established link with External databases", moves into the External Resources component of the system architecture, where it becomes the input for the "Retrieves specific data" process. The "Specific data" output flows into the "Displays specific data" process and the output of which, the "Displayed specific data", is displayed in the Visual Media of the Interface component. When the "User terminates display of specific data" process has been carried out, the "Confirmation of display termination" is transferred back to the "Request for data" process.

The process continues until the user decides to end the "consultation" mode, i.e. the "User terminates "consultation" mode". Even though it is not shown in Figure 9.2, the "User terminates "consultation" mode" can lead to either the "User commences "generate brief" mode" or "User exits system" process. If the former is opted by the user, the "generate brief" mode commences.

(b) "Generate Brief" mode

Figure 9.3 illustrates the processes that take place during the "generate brief" mode, which correspond to the "Generate Brief" process described in Chapter 7. During this

mode, the overall process of the system architecture functions in the following way. It begins with the "User commences "generate brief" mode" process. The output has three alternative processes to go to:

1. the "User terminates "generate brief" mode" process, which ends the "generate brief" mode.
2. the "User selects section of brief (or whole brief) to be displayed" process, the output of which is the "User's selection". The user's selection can be in the form of any one of the main sections of the brief, e.g. the "Project Identification" main section or the whole brief.
3. the "User selects section of brief (or whole brief) to be viewed in Notepad or Word", which has the same output as alternative (2) above.

The "User's selection" output for alternative (2) becomes the input for the corresponding "Captures user's selection" process, while the output for alternative (3) becomes the input of the "Captures user's selections" process. The difference is that, for alternative (3), the "Captures user's selections" process captures two sets of user's selections. Firstly, it captures the medium for brief presentation, i.e. in either Notepad or Word, and secondly, it captures the brief sections to be presented.

For alternative (2) above, the "Captured user's selection" output moves into the "Activates all relevant stored valid data based on user's selection" process. From this point onwards, the Core Engine component of the system architecture takes over from the Interface component. For this process to take place, "Stored valid data" is also required as input. In other words, based on the user's selection, the relevant valid data

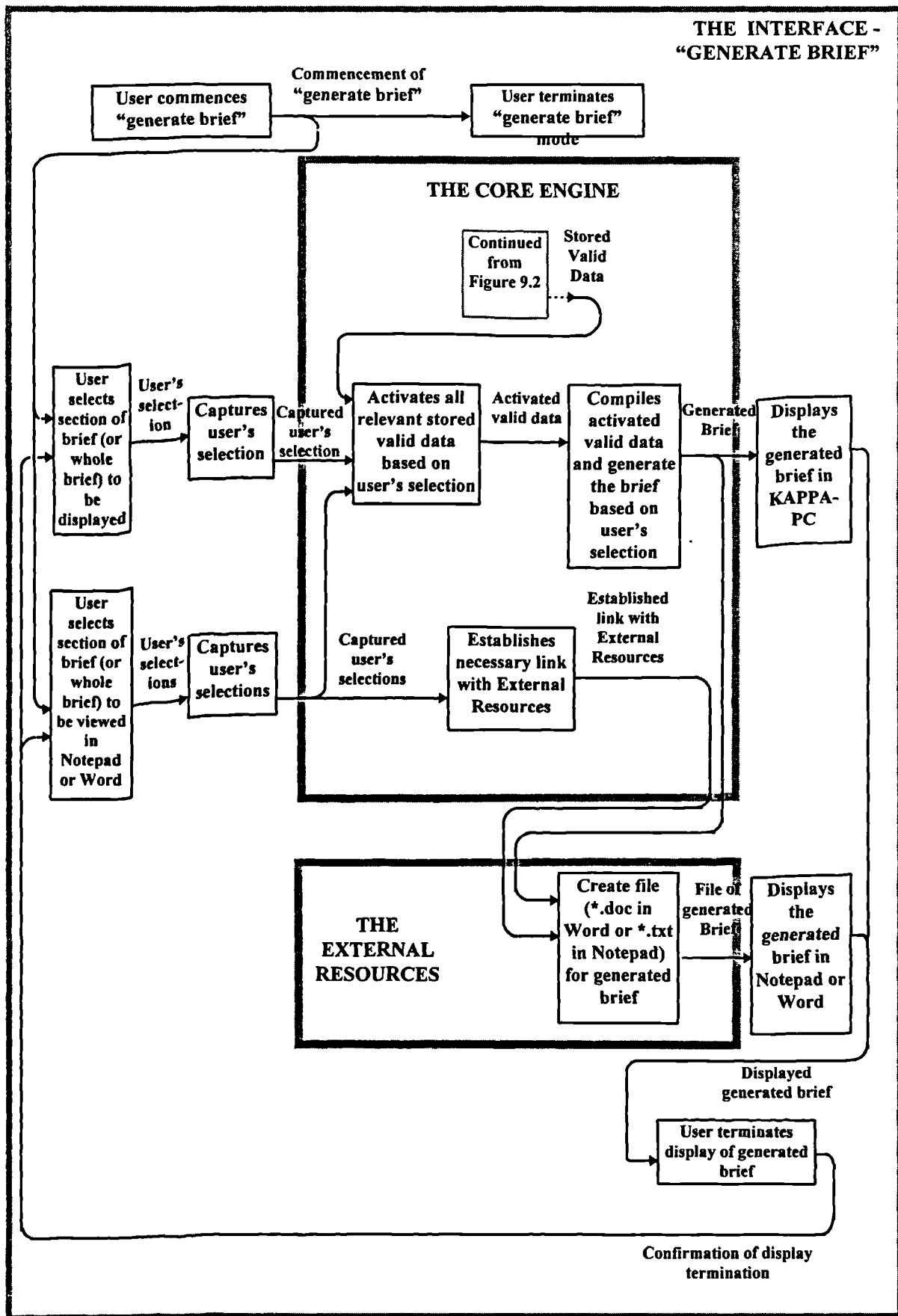


Figure 9.3: Overall Process of System Architecture -
The "Generate Brief" Mode

stored in the Core Engine will be activated ready for the next process. The "Activated valid data" becomes the input for the "Compiles activated valid data and generate the brief based on user's selection". This process, therefore combines all the relevant data and generates the brief for the captured user's selection. The output of this process is the "Generated Brief". The "Generated Brief" then moves into the "Displays the generated brief in KAPPA-PC", whereby it is displayed as a transcript image in KAPPA-PC by the Visual Media sub-component of the Interface component of the system architecture.

For alternative (3) above, the "Captured user's selection" output has two further alternatives. It can either enter the:

- i. "Activates all relevant stored valid data based on user's selection" process, in which case, the same path is followed as for alternative (2) above until the "Generated Brief" output is obtained.
- ii. "Establishes necessary link with External Resources" process. This produces the "Established link with External Resources" as the output. This output, together with the "Generated Brief" output, becomes the input for the "Create file (*.doc in Word or *.txt in Notepad) for generated brief" process. This process opens the relevant file in the relevant External Resources component and saves the contents of the "Generated Brief" in it. The output is therefore the "File of generated brief". From this point onwards, the Interface component takes over from the External Resources component. The "File of generated brief" output flows into the "Displays the generated brief in Notepad or Word" process, after which the "Displayed generated brief" output is displayed in either Notepad or Microsoft Word, as selected by the user earlier on. The display continues until the "User terminates display of generated

brief" process is carried out, the output being the "Confirmation of display termination", which can flow to either the "User selects section of brief (or whole brief) to be displayed" process or the "User selects section of brief (or whole brief) to be viewed in Notepad or Word".

The overall process of the system architecture follows the same routine every time the user selects a new section for the brief to be generated. The process continues until the user terminates the "generate brief" mode. Even though this is not depicted on Figure 9.3, the user can end this mode by returning to the "consultation" mode or by exiting the system.

As a whole, the system architecture incorporated into the prototype development has enabled the prototype system to achieve its objectives and to function smoothly during both the "consultation" mode and the "generate brief" mode. The next sections of this chapter will describe the development of the end user interface which correspond to the Interface component of the system architecture, and the development of the external resources materials for the External Resources component, and how the necessary links from the Core Engine component to the External Resources component are established.

9.5 The Development of the End User Interface

KAPPA-PC provides tools for developing and customising the user interface. It allows communication to take place between the KAPPA-PC system and the developer (during development stage) and the end user (during its use).

As described earlier in section 9.3, the graphical user interface for AUTOBRIEF is divided into two modes, namely; "consultation" mode and "generate brief" mode. In both modes, a large window appears as the background and is referred to as a session window. Small windows may appear in the middle of the screen to request for input or selection of options by users, or to display some form of messages to users. These are described as dialogue windows. More importantly however, are the image objects which are made visible on the screen or hidden from the screen at pre-determined periods. These together with the background screen form the end-user interface of the AUTOBRIEF prototype.

The end user interface is controlled by the relevant methods incorporated within the objects in the Core Engine and/or the functions linked to particular image objects. The following sections discuss how the session windows and their associated images are implemented into the prototype system.

9.5.1 Session Window Objects

For the end user, the session window is the basic component of the KAPPA-PC interface. Session windows are areas on the screen in which images are displayed. These images can be in the form of text, buttons, bitmaps, etc. Encapsulation hides the details of the system's internal implementation from the end user.

In KAPPA-PC, session windows are treated as objects. They appear in the object hierarchy and they inherit characteristics from their parent. New session windows can be created in the "KWindow" class or its subclass, "KSession". For the AUTOBRIEF

prototype, the instances to the "KSession" object serve as the key session windows or background for its interface, and provides the means to develop and to display the images and features associated with AUTOBRIEF. Two instances to the "KSession" class, which correspond to the two main session windows, have been developed as shown in Figure 9.4. They are "Session1" and "SESSION" and are connected to the "KSession" class with dashed lines.

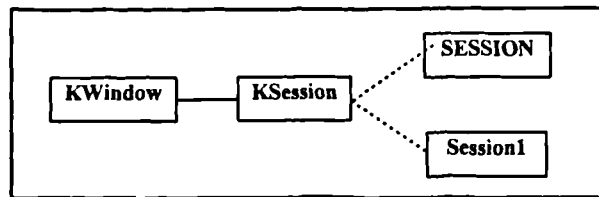


Figure 9.4: The "KWindow" Object Hierarchy

The "Session1" instance corresponds to the introductory window of AUTOBRIEF (Figure 10.1) and is given the title "AUTOBRIEF". This is the window that the user will be presented with when the prototype system is initiated. The second instance, "SESSION", represents the main session window of AUTOBRIEF (Figure 10.2). The title given to the session window is "AUTOBRIEF IN SESSION". The title aims to communicate to the user that whenever this window is displayed, the user is in session with AUTOBRIEF. This means that the user can begin, continue or exit the session at any time. This session window thus serves as the background for the user interface during both the "consultation" and the "generate brief" modes.

9.5.2 Image Objects

Figure 9.5 depicts some of the types of images that can be created on a session window. Each image object created is associated with a particular session window. Whenever an

image is created on a session window, KAPPA-PC automatically adds this as an instance of that particular image type in the "Image" object hierarchy. Images have been used in AUTOBRIEF to enhance its user interface as well as to serve as control to specific system functions. The types of images incorporated within AUTOBRIEF include text, bitmap, button and transcript images. The image objects and their respective functions are outlined below.

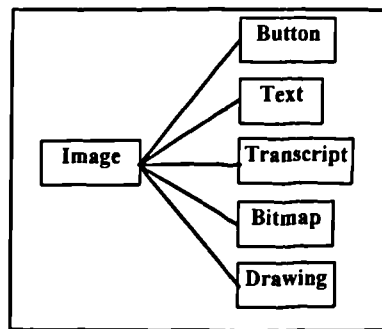


Figure 9.5: The "Image" Object Hierarchy

9.5.2.1 Functionality of the Image Objects

The image objects play a crucial role in the development of the end user interface. The functions associated with each image object are described below:

a) Button Images

In KAPPA-PC a button image is a rectangular area that can activate a method or a function. If the user clicks the mouse over a button image, it calls the method or function associated with that button. The button images are principally used as a means of controlling the main system operations such as to commence a session, to select an option, to activate other images, such as bitmap and transcript, and to establish the necessary links with internal and external resources in a timely manner.

b) Text Images

KAPPA-PC allows text images, which are static pieces of text, to be displayed on the session window. They can be in the form of a label or title or even a file. Text images are used in AUTOBRIEF, mainly as labels to the rectangular button images, which are placed on the bitmap images with tree-like structures to enable some form of hierarchy to be visible to the user during run-time (See Figure 9.6). A text image can also exhibit text from a file. Whenever this occurs, the text image is linked to the relevant source in the External Resources component of the system architecture, such as Notepad.

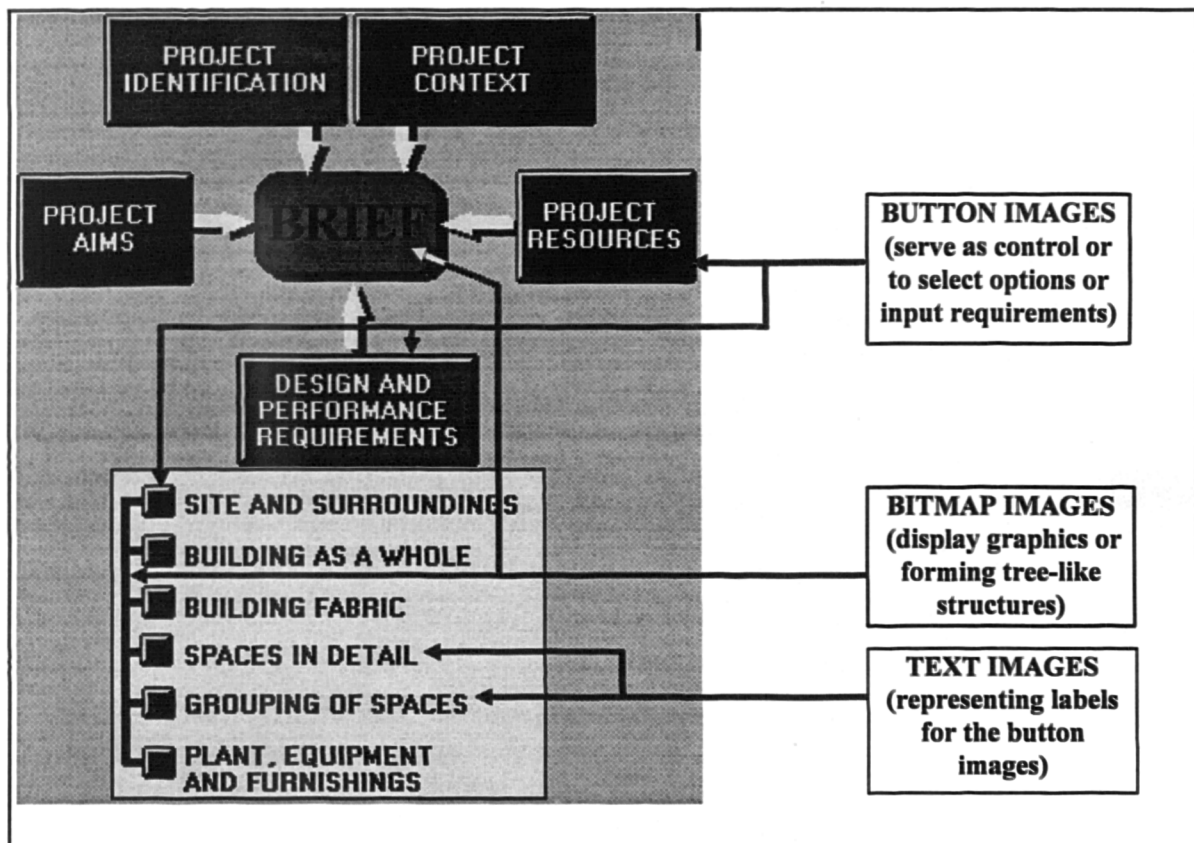


Figure 9.6: Examples of Types of Images on Part of a Session Window

c) Bitmap Images

In KAPPA-PC, bitmap images allows a bitmap file (*.bmp) to be displayed on the screen. The development of AUTOBRIEF utilises bitmap images as a means to display pictures and graphics. Bitmap images are also used to portray the structure of the brief and its contents, and tree-like structures which reflect the branches of the tree associated with the contents of the brief. These tree-like structures, together with the button and text images, form an object hierarchy for the selected section or sub-sections of the contents of the brief (Figure 9.6).

d) Transcript images

A transcript image is a text window into which text can be displayed at any time while the application is running. The user can scroll the text in the transcript image. Text can be displayed by using either the "DisplayText" or the "DisplayFile" functions. The "DisplayText" function displays a piece of text on a transcript image. The "DisplayFile" function allows all the text from a file to be read into a transcript image.

In AUTOBRIEF, the "DisplayText" functions are used to create textual display of information which is dynamic in nature. Its prime use is for the textual presentation of the generated brief. The content of the textual display changes when the slot values of the slot corresponding to the textual information are changed, Figure 9.7 (a). On the other hand, the "DisplayFile" function is used to display large pieces of information which are static in nature. Examples of such text files include those which contain further information on a specific issue and relevant building regulations (Figure 9.7 (b)).

<div> <div>BRIEF PRESENTATION</div> <div>EXTERNAL ENVELOPE</div> <div>EXTERNAL WALL CLADDING</div> <div>Cladding type: CURTAIN WALL S</div> <div>CLADDING BACKGROUND</div> <div>Cladding Background/Support: Fr</div> <div>FRAMING MEMBERS</div> <div>The framing material: Aluminium</div> <div>The span of frame (m): NULL</div> <div>The view of framing members: Exp</div> <div>The finish to framing members: NU</div> <div>CLADDING PANEL</div> <div>The cladding weight category: Lig</div> <div>The cladding panel visual size: La</div> <div>The cladding panel material: Glass</div> <div>The cladding panel type: Flat_She</div> <div>GLAZING MATERIALS</div> <div>The type of glazing unit (glass she</div> <div>The type of glazing unit (thermal p</div> </div>	<div> <div>INFORMATION</div> <div>CLADDING PANEL</div> <div>MATERIAL</div> <div>Flat sheets</div> <div>glass, aluminium, p steel, timber, comp materials,grp, pvc</div> <div>Composite Panels (face material)</div> <div>aluminium, concret plastic, steel, grp, timber</div> <div>Profiled sheets</div> <div>Opaque: aluminium plastic, asbestos-c</div> <div>REGULATORY ISSUES</div> <div>BUILDING REGULATIONS</div> <div>MATERIALS AND WORKMANSHIP OF</div> <div>* Regulation 7. 7(1). 7(2)</div> <div>* Approved Document to Support Reg [AD Regulation 7]</div> <div>AD Reg. 7 Guidance (0.1 to 0.4)</div> <div>AD Reg. 7 Fitness of Materials (Sec 1.1 to 1.2)</div> </div>
(a) Transcript Image displayed using "DisplayText" Function	(b) Transcript Image displayed using "DisplayFile" Function

Figure 9.7: Examples of Transcript Images

9.5.3 Communication Between Image Objects

Communication between image objects occurs through message passing. These messages are embodied within the user functions (functions created by the developer) or the methods encapsulated within a particular image object. As an example, if the instruction to display a particular transcript image is included in the "DoubleClick" method of a button image, this transcript image will be displayed whenever the button image is clicked twice with the button of a mouse.

9.6 Linking the External Resources to the Core Engine

As described earlier in 9.3.3, the External Resources component serves as a support to the AUTOBRIEF prototype in terms of providing access to project and construction industry related information. Textual information which can be in the form of building regulations, specific project information, tables or even the brief report, are stored in either Notepad or Microsoft Word. The links to this information are established through the "Execute" function of KAPPA-PC. Links to graphics files and the internet are also accomplished through the "Execute" function. Links to sound files, however, are obtained through DLL. Links to video files and CD-ROM packages can be made through the "Execute" function.

9.6.1 Notepad

Notepad is a text editor in Microsoft Windows (Microsoft Corporation, 1994). In AUTOBRIEF, Notepad is used to create text files which contain selected information on particular building regulations, and relevant information on specific design or performance related issues. The main use of Notepad, however, is to produce the associated files for the brief to be generated.

9.6.2 Microsoft Word

Microsoft Word Version 6.0a is used to create part of the external resources. Similar to Notepad, files are created in Microsoft Word to contain specific information related to building regulations and design and performance related issues. In addition to that, relevant tables from the building regulations have also been reproduced to highlight

certain aspects of the regulations. As for Notepad, the main use of Microsoft Word is to produce the corresponding files for the generated brief.

9.6.3 The Internet

The link from KAPPA-PC to the internet is established by using the "Execute" function. Here, the complete path to the internet provider is used together with the exact web site address for a particular selected source of information or resources. This is shown in the example below:

```
Execute( "x:\netscape\netscape.exe", "http://cig.bre.co.uk/biw/bcd/fabric.htm" );
```

A limited number of web site addresses have been incorporated into the prototype system. An example includes access to a wall cladding supplier/manufacturer, in which the user can explore and obtain information on the types of cladding available, their detailing and their suitability to be used under certain conditions. Another example is direct access to the Building Regulations on-line, which currently provide certain provisions of the Building Regulations. Once the main link is established to these sites, the user can surf around the internet to access more information. The main aims of incorporating this capability into AUTOBRIEF are twofold. Firstly, to emphasise that technology is available to allow this kind of link with the object oriented environment. Secondly, the information that can be acquired from the internet serves as an alternative and up-to-date material that can be accessed from the prototype system. This information can be extremely valuable and helpful to the user in understanding and identifying his/her actual requirements.

9.6.4 Images and Pictures Databases

This database contains images, i.e. graphics and pictures. They are stored in the form of *.bmp files. These files are linked to specific bitmap images in the Core Engine component of the system architecture. Suitable pictures which can highlight or improve the user's understanding during the input process are first scanned and then saved. Images or graphics are first drawn, for example in Microsoft Word, and then copied and pasted into Windows Paintbrush. These images are then edited and saved as a bitmap file with 256 colours. The main use of these graphics is for the creation of the background and the tree-like structure which represent the hierarchy for the main sections of the brief and their respective sub-sections.

9.6.5 Sound Database

In AUTOBRIEF, the sound database contains *.wav files. This includes those for recorded audio and music. Recorded audio is used as an alternative to textual representation, as an instruction to the user or as a reminder or warning to the user. The music files are used as audio support to certain parts of the system during runtime.

Access to these files from the Core Engine component of the system architecture is via the DLL (Dynamic Link Libraries) functions in KAPPA-PC. KAPPA-PC's DLL capability enables the existing off-the-shelf Dynamic Link Libraries such as Microsoft Windows' own set of DLLs (for example user.exe, kernel.exe, etc.) to be employed. KAPPA-PC also gives the ability for the developer's own developed DLL to be used directly in KAL.

9.7 The Real Time Integration with External Resources

Figure 9.8 demonstrates the real time integration of KAPPA-PC with the external resources. For illustrative purposes the External Resources have been divided into two forms: Windows Accessories and Windows Applications. The former refers to accessories that are readily available in Microsoft Windows operating system, while the latter is associated with applications or other resources/sources of information that utilise the Windows environment.

Figure 9.8 also attempts to illustrate the direction and transfer of data between AUTOBRIEF which resides in KAPPA-PC, and the components of the External Resources. Where there are two arrows between AUTOBRIEF and a particular component of the External Resources, either in the Windows Accessories or the Windows Application box, the thin arrow indicates the request by AUTOBRIEF to that component for the transfer of specific data. These arrows carry the request from AUTOBRIEF for the component to be executed, i.e. for the application and/or a specific file to be opened. The actual transfer of data into AUTOBRIEF is shown by the thick arrow. Such components are represented in Figure 9.8 by Sound Files, Bitmap Files and the Internet, whereby the data transferred will be in the form of sound, graphics or text.

For components such as Notepad and Microsoft Word, where three arrows flow into and out of AUTOBRIEF, the thin arrow serves a similar function as before. Once the application and the specific file have been opened, two responses may be expected. The first one is similar to the one mentioned above where specific data is transferred directly

into AUTOBRIEF (represented by the thick arrow into AUTOBRIEF). This instance is associated with data in the form of regulatory issues and specific information.

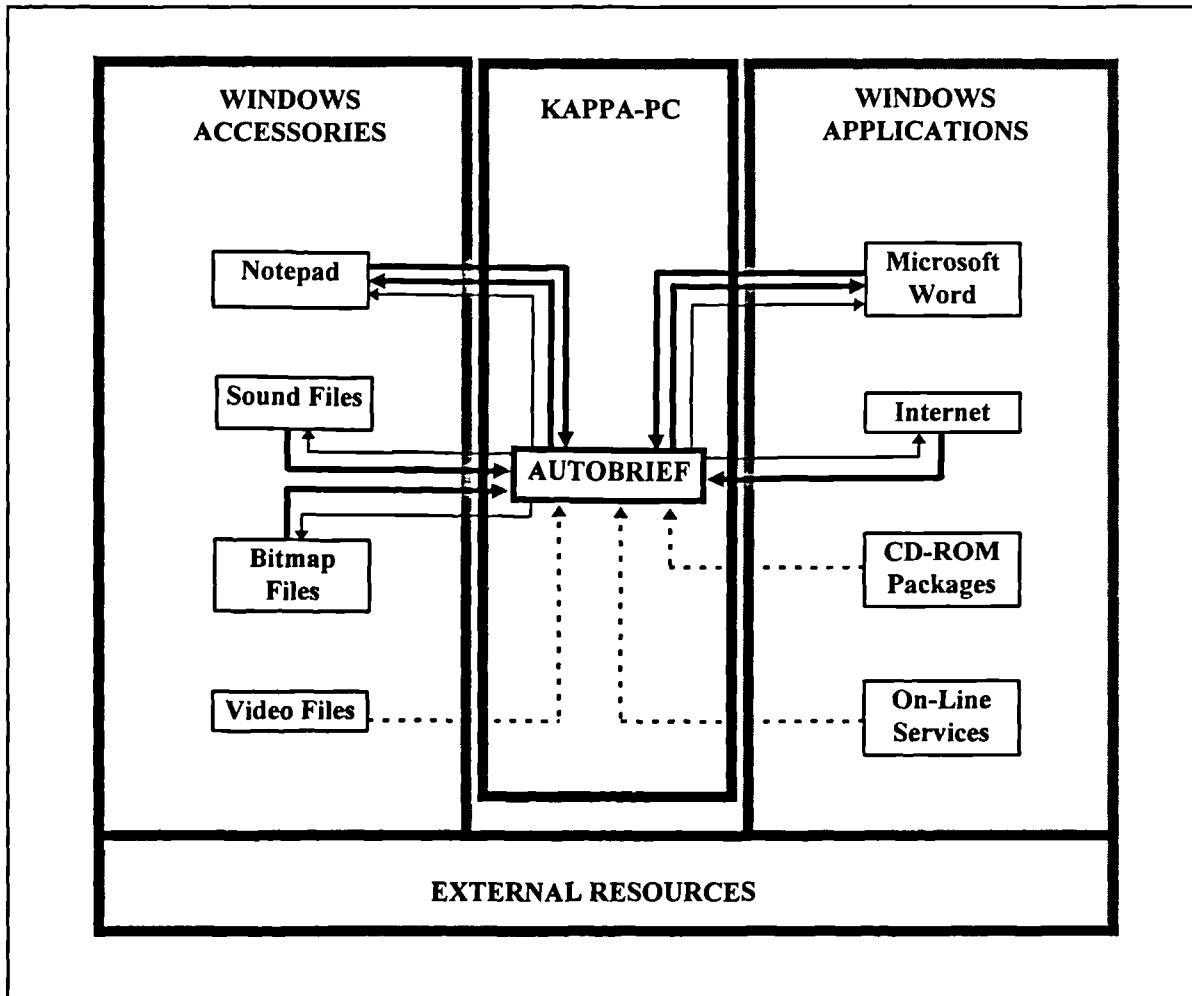


Figure 9.8: The Real Time Integration of AUTOBRIEF

In the second instance, the thick arrow flowing out of AUTOBRIEF transfers data out of AUTOBRIEF into the respective component. This involves data associated with the generated brief. This data is transferred and saved into the respective files in either Notepad or Microsoft Word. The return thick arrow from these two components into AUTOBRIEF, therefore, represents the saved data. This data flows out in the form of the contents of the file, encompassing details of the generated brief.

Finally, the dotted lines leaving the remaining components, e.g. Video Files, represent data that can flow out of these components into AUTOBRIEF once the links to these resources are made available.

9.8 Summary and Conclusions

This chapter has initially described multimedia technology and how it can be applied to the briefing process. The development of an information system prototype which aims to generate the client's brief based on the captured user requirements was then presented. The user interface was developed by using the development tools provided by KAPPA-PC. This comprises the session windows which form the background for the images; text, bitmap, transcript or button images. External resources materials which exist in the form of building regulations, specific design and performance requirements, sound and images/pictures have been developed and stored in text, sound and bitmap files. Access to specific web sites on the internet is also provided which presents up-to-date information relevant to the development of the brief. The object oriented development environment, which is referred to as the Core Engine, together with the Interface and the External Resources are then put together to form the system architecture of AUTOBRIEF.

The Core Engine component is represented by its sub-component; the Interpreter, while the Interface component is made up of two sub-components; the Input Media and the Visual Media. The graphical user interface of the Interface component has been divided into two modes; the "consultation" mode and the "generate brief" mode. Finally, the

real time integration of KAPPA-PC and the External Resources component was illustrated.

The system architecture incorporated into the prototype development enables the prototype to provide advice, consultancy and visualisation of project information to clients and other users, as well as to generate the brief in whole or in part at any time during the briefing process.

CHAPTER 10

“AUTOBRIEF” - THE RUNNING PROTOTYPE

10.1 Introduction

The preceding chapter discussed at length issues related to the development of the system architecture for the AUTOBRIEF prototype. This chapter will describe the display screens (or session windows) and the main operations of AUTOBRIEF.

10.2 The Introductory Screen

Figure 10.1 depicts the introductory screen of AUTOBRIEF. The title for the screen is AUTOBRIEF. The screen has a label that displays the words “WELCOME TO AUTOBRIEF” at the top edge of the screen. Also displayed is the “AUTOBRIEF” label (in italics) at the top right hand corner of the screen. When this label is clicked, it will reveal the logo for AUTOBRIEF. At the centre of the screen is a graphical presentation of the system architecture. The “SYSTEM ARCHITECTURE OF AUTOBRIEF” button is positioned below it. On clicking this, a textual presentation of the system architecture of the prototype will be displayed.

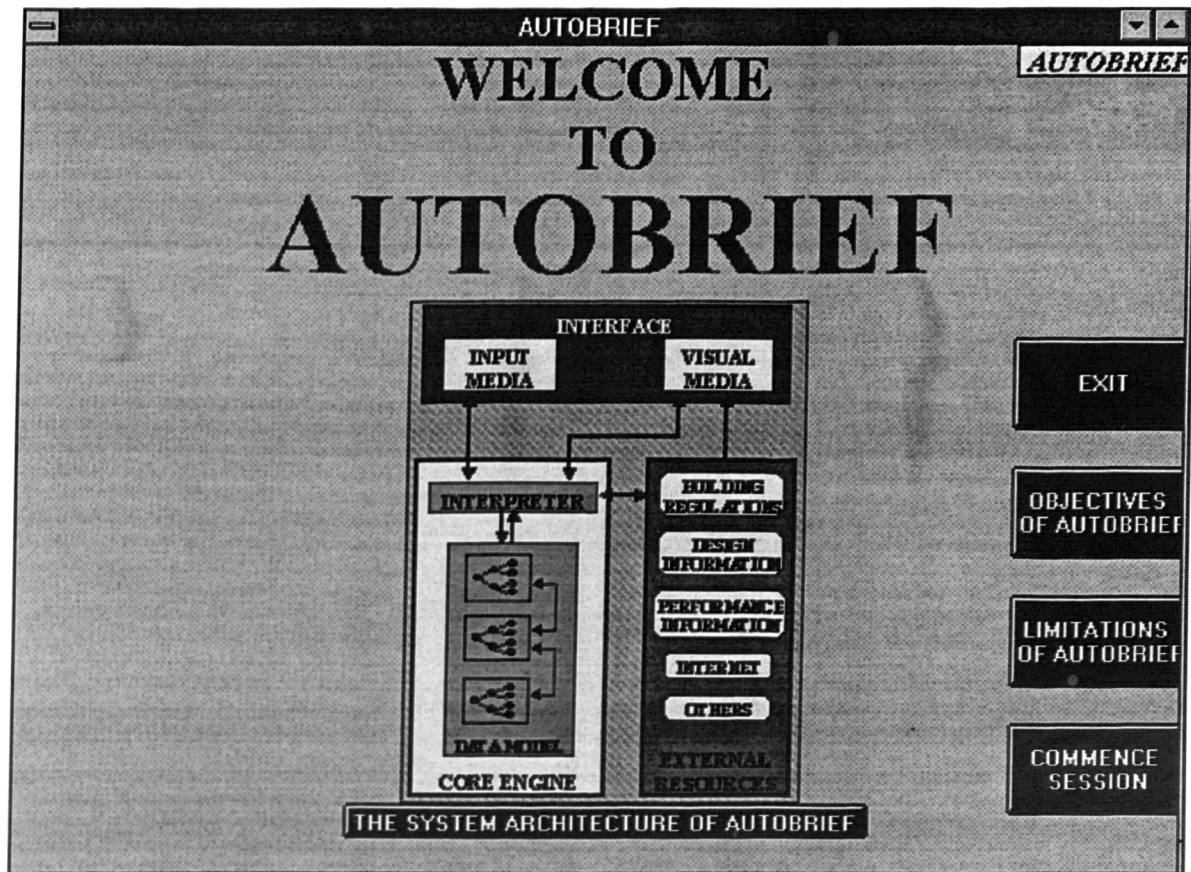


Figure 10.1: The Introductory Screen of AUTOBRIEF

Also visible are four buttons along the right edge of the screen. Their titles and functions are:

1. "EXIT" button - allows the user to quit the system at any time.
2. "OBJECTIVES OF AUTOBRIEF"- displays textual information on the aims and objectives that AUTOBRIEF seeks to accomplish.
3. "LIMITATIONS OF AUTOBRIEF" - displays textual information on the limitations of AUTOBRIEF.
4. "COMMENCE SESSION" - allows the user to exit the introductory screen and commence session with AUTOBRIEF, i.e. by entering the main screen of AUTOBRIEF.

10.3 The Main Screen

Figure 10.2 depicts the main screen, with illustrations added (in white boxes) for explanatory purposes. It is titled "AUTOBRIEF IN SESSION". This is the screen where the user and the prototype interact with each other throughout the "consultation" and the "generate brief" modes. Image objects are designed to appear and disappear on this screen to create a friendly, informative and professional interface.

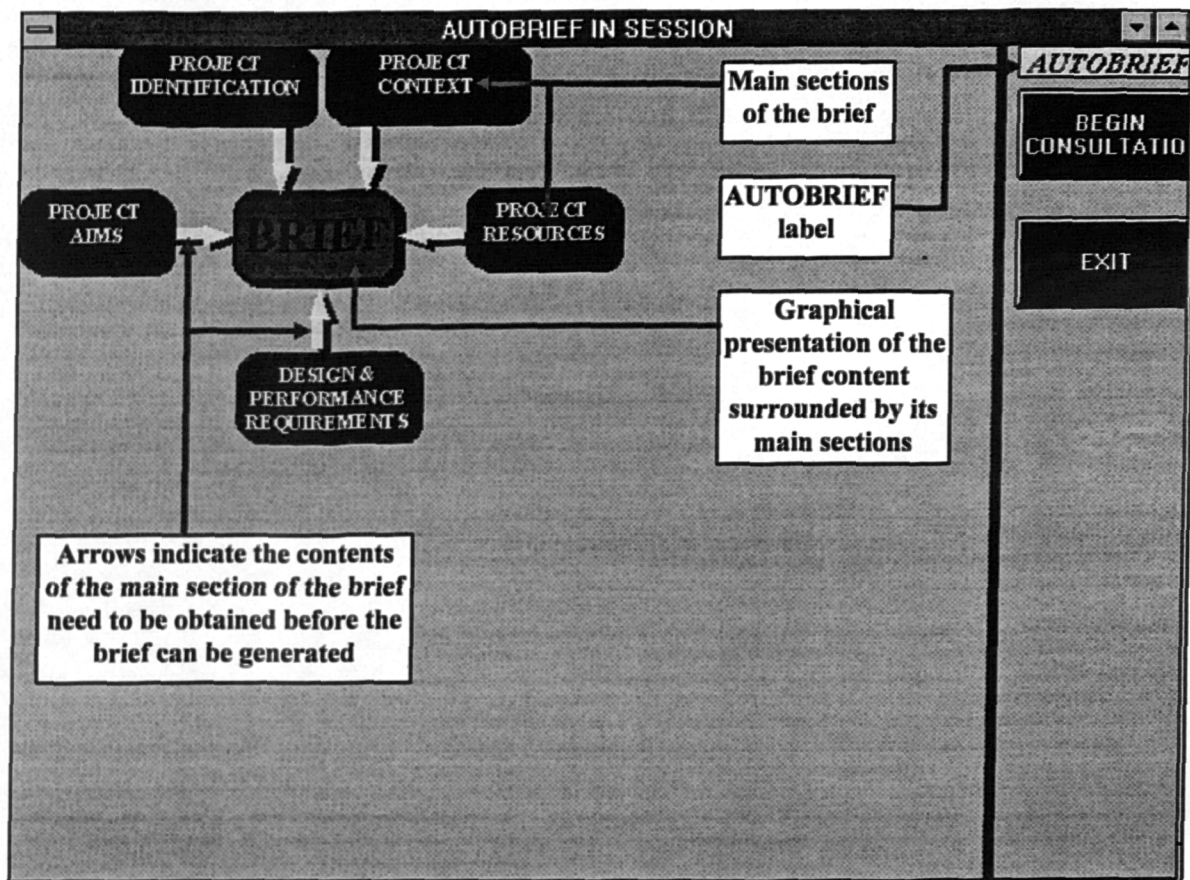


Figure 10.2: The Main Screen of AUTOBRIEF (with Illustrations)

When the main screen is displayed a message is presented, first welcoming the user to AUTOBRIEF, followed by a set of instructions to the user. When the message ends, the user is confronted with the presentation of the full main screen. Again, at the top right hand corner of the screen is the "AUTOBRIEF" label in italics, which serves the same function as the one on the introductory screen. This text image moves from one screen

to another to have the effect of being present at the same place all the time. On the top left hand corner of the screen is a graphical presentation of the brief and its main sections. The arrows from the main section boxes into the "BRIEF" box are meant to indicate to the user that the contents of the main sections are required before the brief can be generated. This image, when double clicked, will reveal to the user a short explanation of the graphical presentation and a set of instructions.

Also present on the main screen are two buttons along the right edge: the "EXIT" button and the "BEGIN CONSULTATION" button. The former allows the user to quit the system at any time. The latter, however, allows the user to begin the consultation process with AUTOBRIEF. On clicking it, the "BEGIN CONSULTATION" button will be hidden and five buttons which correspond to the main sections of the brief will be displayed in blue colour. At the same time, the "CONSULTATION MODE" indicator appears at the top edge (against a blue background), next to the word "AUTOBRIEF" (Figure 10.3), indicating the state of "consultation" mode.

10.4 The System's Main Operations

The system's main operations revolve around the mode which the user is in. The succeeding sub-sections will highlight the system's operations with reference to:

1. the "consultation" mode, and
2. the "generate brief" mode.

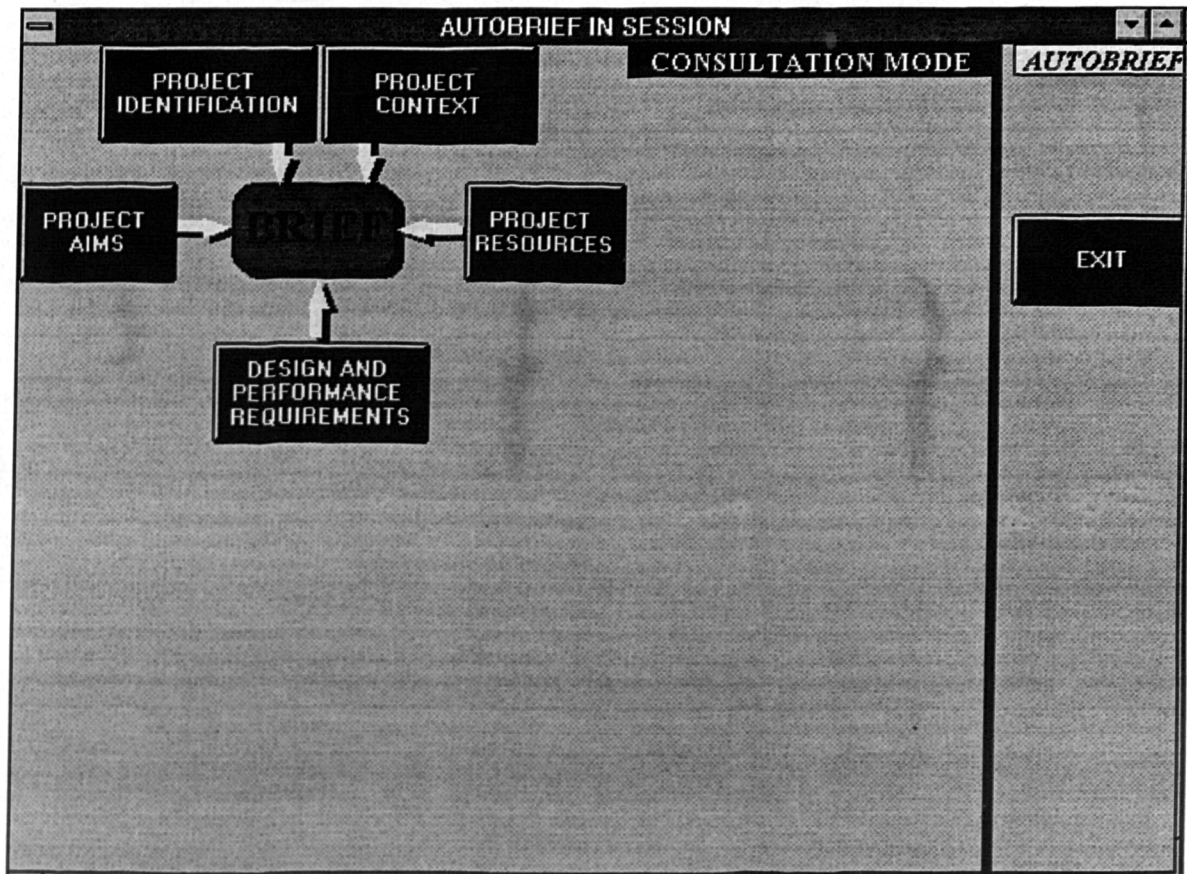


Figure 10.3: The Main Screen of AUTOBRIEF (Initial Stage of “Consultation” Mode)

10.4.1 The “Consultation” Mode

Consultation commences firstly at a high level, i.e. obtaining information and/or inputting the general requirements of the brief. Where required or requested by the user, this is continued at the lower levels where detailed issues of the brief are narrowed down from the main section(s) to the sub-sections and so on. In this mode, valid data inputs will be guided to the relevant data models in the Core Engine. Invalid data will either be rejected or new valid ones recommended and displayed to the user for confirmation. Where appropriate, supporting information will be presented to the user in the form and media available. The necessary links to internal and external information resources will be made available to the user in a timely and efficient manner.

During the "consultation" mode, five buttons which correspond to the main sections of the brief are displayed to the user. On choosing any of these buttons, the "GENERATE BRIEF" button will be displayed (in green) indicating that the user has two options:

- (i) to continue with the consultation process for that particular main section, or
- (ii) to proceed to the "generate brief" mode by clicking on the "GENERATE BRIEF" button.

Throughout the "consultation" mode all the buttons are displayed in blue, except the "GENERATE BRIEF" button. Whenever a main section button is selected, a hierarchy of items representing the data for that main section is displayed. This list is portrayed as sub-section buttons with their respective labels. When any of these buttons are selected, the user has to input data or select an option. Simultaneously, or at the request of the user, supporting information related to the selected sub-section will be presented or displayed. At the end of the dialogue, the relevant buttons will change from blue to red. This is an indication to the user that these items have been dealt with. Users may either continue with the consultation process by clicking on other blue buttons, or may return to the red ones if they wish to make changes or additions to previously entered data.

During the "consultation" mode, three buttons may appear whenever the necessary link is established with the relevant sources. They include :

- a) "INTERNET" button - links to specific web sites on the internet.

- b) "REGULATORY ISSUES" button - present relevant building regulations in relation to specific data within the system.
- c) "VIDEO" button - to accommodate for future development.

At any one time, bitmap images may be presented to the user in the form of pictures or graphics. Textual descriptions for the bitmap may appear at the same time. Transcript images may also appear at pre-determined moments or when requested by the user if further textual information is required. This information may also be presented in Microsoft Word. As the consultation progresses, all the main components of the system architecture play their respective roles and functions to assist users in identifying and establishing their actual requirements for the brief development.

The step by step operation of the AUTOBRIEF prototype for each main section of the brief is described below:

1) The "PROJECT IDENTIFICATION" button

Figure 10.4 depicts part of the main screen with illustrations. During the "consultation" mode, when the "PROJECT IDENTIFICATION" button is chosen, a set of items hierarchy is displayed on a rectangular background to the right of the brief structure (Figure 10.4).

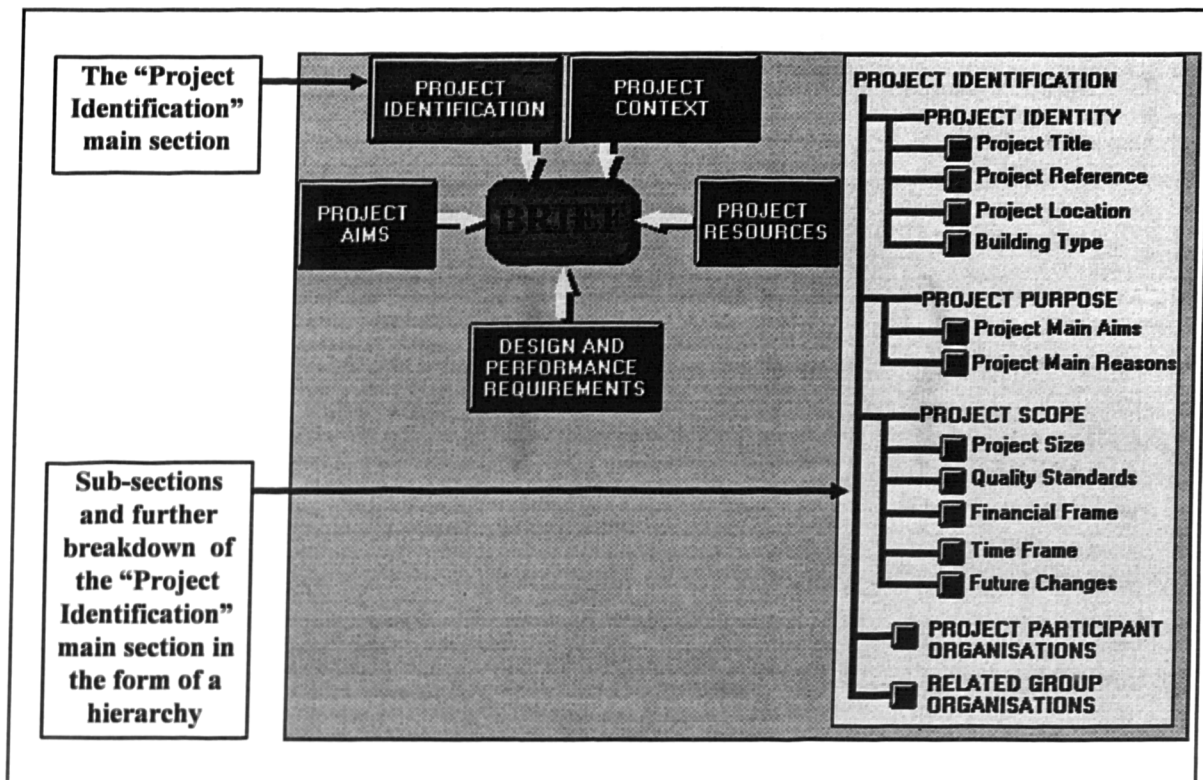


Figure 10.4: The "Project Identification" Sub-sections

The items portray the sub-sections and their corresponding sub-sub-sections. When each item is selected, the user is confronted with an input form. This enables him/her to enter the specific information which is related to the identification of the project. For example, when any of the following buttons are selected, the corresponding response will take place:

- "Project Title" - the user is required to enter the project title
- "Project Main Aims" button - three sub-items are displayed for entry. These are "Project Main Aims", "Type of Occupancy" and "Building Life Expectancy".

The current prototype only accommodates the first three sub-sections of "PROJECT IDENTIFICATION"; namely "Project Identity", "Project Purpose" and "Project

Scope". The remaining two sub-sections, as shown on Figure 10.4, are outside the scope for this study. Buttons are provided to allow for future development.

2) The "PROJECT AIMS" button

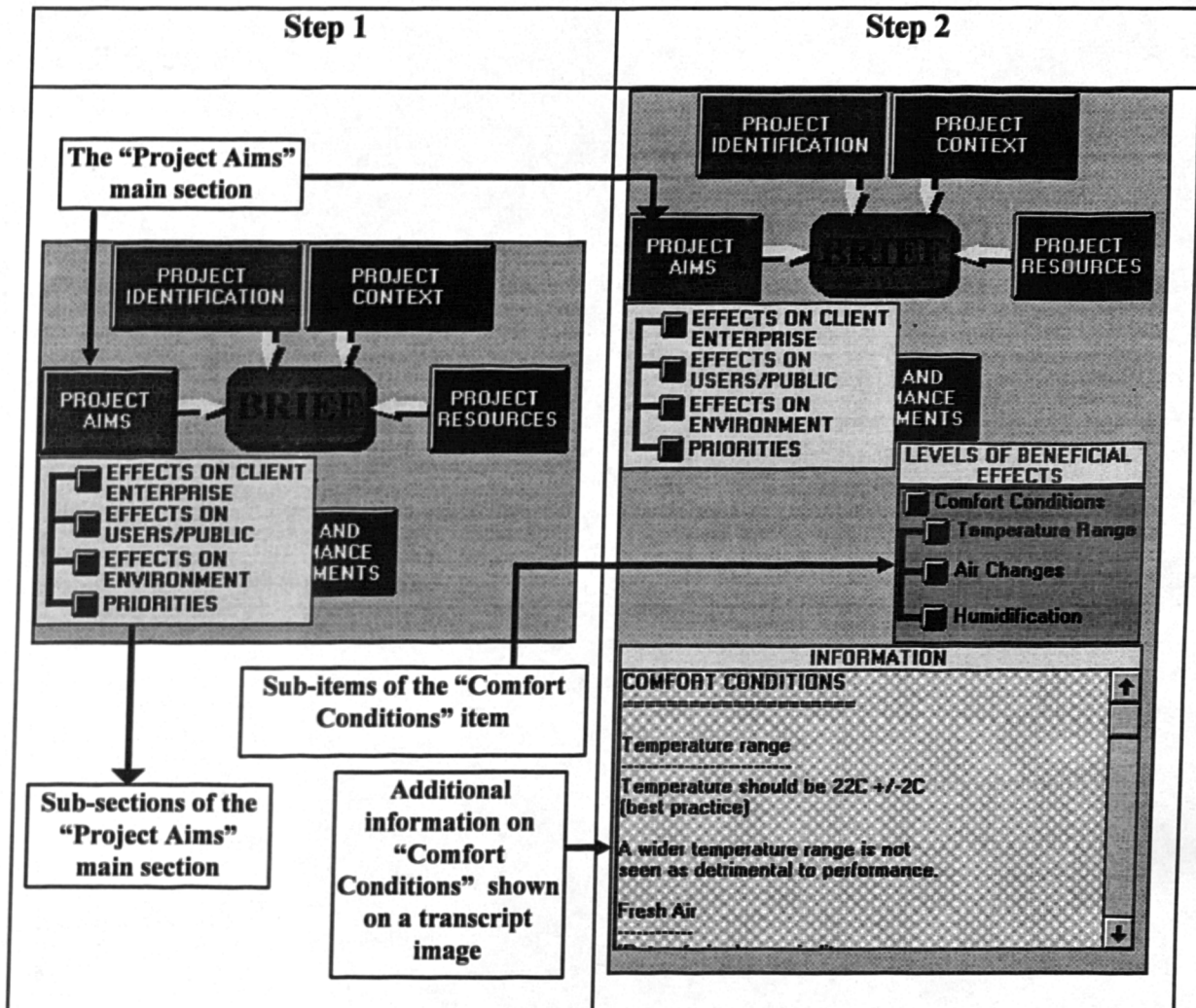


Figure 10.5: The "Project Aims" Sub-sections (Steps 1 and 2)

When the "PROJECT AIMS" button is selected, its sub-sections are displayed on a small rectangular background below the button, as depicted on Figure 10.5 (Step 1). AUTOBRIEF provides further information on selected items under the second sub-section, i.e. "Effects on Users/Public". When this sub-section is selected, its label turns

red and another hierarchy appears showing the "Comfort Conditions" item, which is a sub-section of the "Levels of Beneficial Effects" (Step 2 of Figure 10.5). The corresponding buttons and labels for the sub-items of "Comfort Conditions" are also displayed. At the same time a transcript image is displayed presenting additional information on these three sub-items. This information is required for decision making under the "Design and Performance Requirements" main section. The remaining sub-sections of "PROJECT AIMS" are outside the scope of this study.

3) The "PROJECT RESOURCES" button

The "PROJECT RESOURCES" button is the third main section of the brief. When this button is chosen, its three sections are displayed in a hierarchical tree next to the "PROJECT RESOURCES" button, as shown in Figure 10.6.

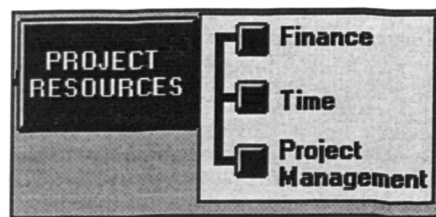


Figure 10.6: The "Project Resources" Sub-sections

The following take place when each of the buttons are selected:

- a) "Finance" button - the user is prompted to select the items to be included in the project budget (referred to as the "Financial Frame" under the "Project Identification" main section). These are "Design/Planning", "Construction", "SiteMgmt_Org", "CostsInUse" and "Contingencies". The system then requests the user to enter the relevant budgets for each selected item. If the project budget has been entered earlier under the "Project Identification" main section, this figure is

displayed so that it can be modified as necessary. Otherwise the user can input a new total figure.

- b) **"Time" button** - the user is prompted to enter or confirm the time frames for **"Design/Planning"**, **"Construction"** and **"Overall Time Frame"**. The user can enter a new time frame for the first two items, and confirm/modify the third one accordingly if he has done so under the **"Time Frame"** sub-section of the **"Project Identification"** main section. The reason for this is to make sure that the user is able to check his previous input while entering a new related input.
- c) **"Project Management" button** - the message **"For future implementation"** is displayed. This aims to convey to the user that this item is outside the scope for the prototype development. It is related to the project counterparts, i.e. the **"Project Participant Organisations"** and **"Related Group Organisations"** which are the sub-sections of the **"Project Identification"** main section.

4) The "PROJECT CONTEXT" button

Figure 10.7 depicts part of the main screen layout portraying the **"Project Context"** sub-sections. The hierarchy is made up of five sub-sections. Each has its own button with the exception of the second one, the **"Building Regulations"** sub-section, whereby the button is replaced by an icon. This icon aims to differentiate between a request for input which is represented by a button, and information presentation which is signified by the icon.

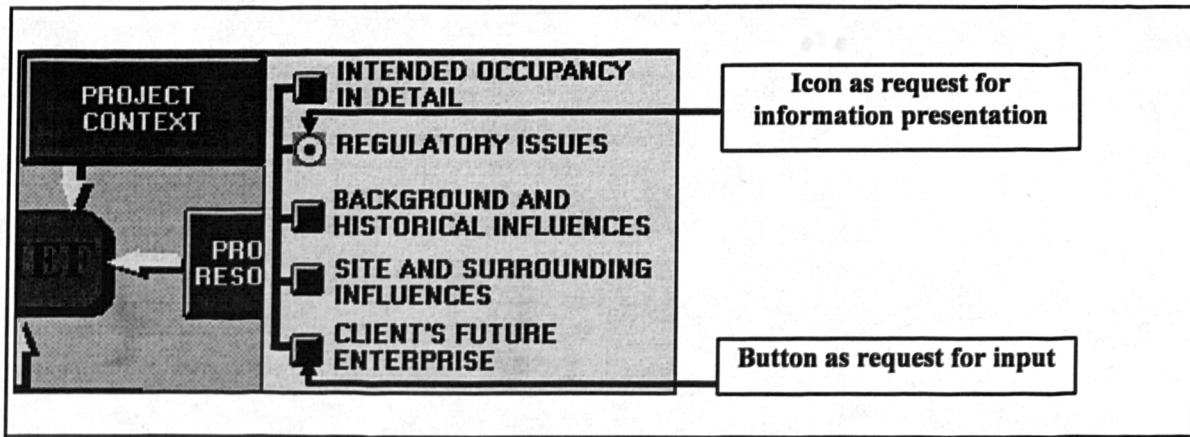


Figure 10.7: The "Project Context" Sub-sections

When the "Building Regulations" sub-section is chosen, the user is confronted with a menu, to select "The Building Regulations", "New and Amended British Standards" or "Cancel". The first option will present the user with the whole library of Building Regulations that have been stored in Notepad. The second option, however, will establish the link to "Building Regulations On-line" on the internet. The user will be able to gain extra information on the latest amendments made to particular Building Regulations or British Standards, and will be able to use this information in his decision making process.

The third, fourth and fifth sub-sections of the "Project Context" main section are incorporated for future development of the prototype. Again, these sub-sections do not play an active role for the decision making process of the "Design and Performance Requirements" main section, and have been excluded from the scope for the prototype development.

When the button for the first sub-section, "Intended Occupancy in Detail" is chosen, a rectangular background is displayed to the right of the sub-sections hierarchy. It

represents the hierarchy for "Spatial Activity", "Particulars of Spatial Activity" and "Relationship Between Spatial Activities" (Figure 10.8). The hierarchy has a button which corresponds to the item "Spatial Activity" only. This indicates that the user can only proceed to the second and third item after the relevant information has been obtained under the "Spatial Activity" item. When this is done, the button for the next item is displayed. This facility guides the user through the consultation process and ensures that enough information is entered before it is possible to proceed to the next stage.

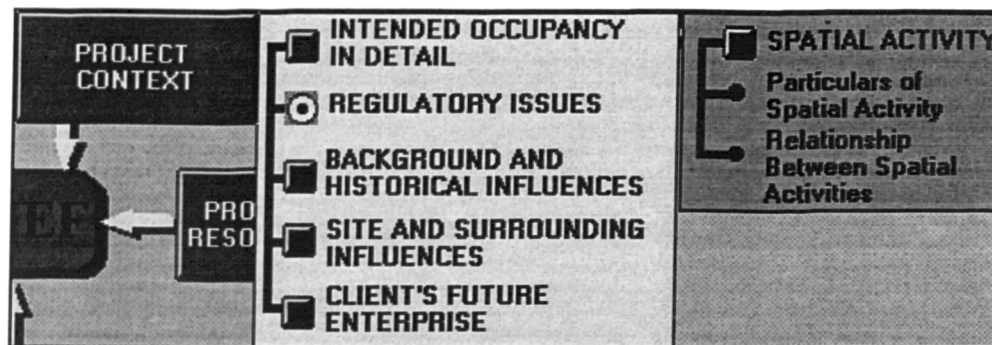


Figure 10.8: The "Intended Occupancy in Detail" Sub-section

When the "Spatial Activity" button is selected, users are prompted to select the types of "Spatial Activities" to be carried out within the building. Eight options have been included in the prototype development as shown in Figure 10.9. They are "Meeting", "Conference", "Hygiene", "Catering", "Storage", "General_Office_Works", "Circulation" and "Service". Users are allowed to select any number of types of spatial activities for the intended building. To assist users in making their selection, a transcript image is also displayed which presents additional information on the relationship between the "Spatial Activity" and the "Spaces in Detail" items. The user's selection(s)

is/are stored in the relevant object and slots in the Core Engine component of the system architecture.

Once the user has made the selection for the type of spatial activity, the button for the "Particulars of Spatial Activity" item will appear. When this button is clicked the list of buttons and labels which correspond to the user's earlier selection is displayed below the "Spatial Activity" rectangle. Figure 10.9 shows this portrayal where all the eight options provided have been selected by the user. Whenever each of these buttons is chosen, the user is prompted to input the particulars for the spatial activity concerned. These include "Activity frequency", "Number of users", "Types of users", "Types of special inputs", such as electricity which is required by the spatial activity and "Types of by-products", such as heat or waste products that may be produced by the spatial activity.

As soon as any of these buttons have been chosen, the button for the "Relationship Between Spatial Activities" item is displayed to allow the user to enter the relationships between the selected spatial activities. The options provided to the user for the types of relationship include "None", "Similar_Activities", "Related_Activites", "Communication & Transport" and "Others". This is meant to facilitate the design process, in which the relationships between individual spatial activities and the corresponding "Spaces in Detail" are required prior to arriving at a design solution for the spatial layout of a floor.

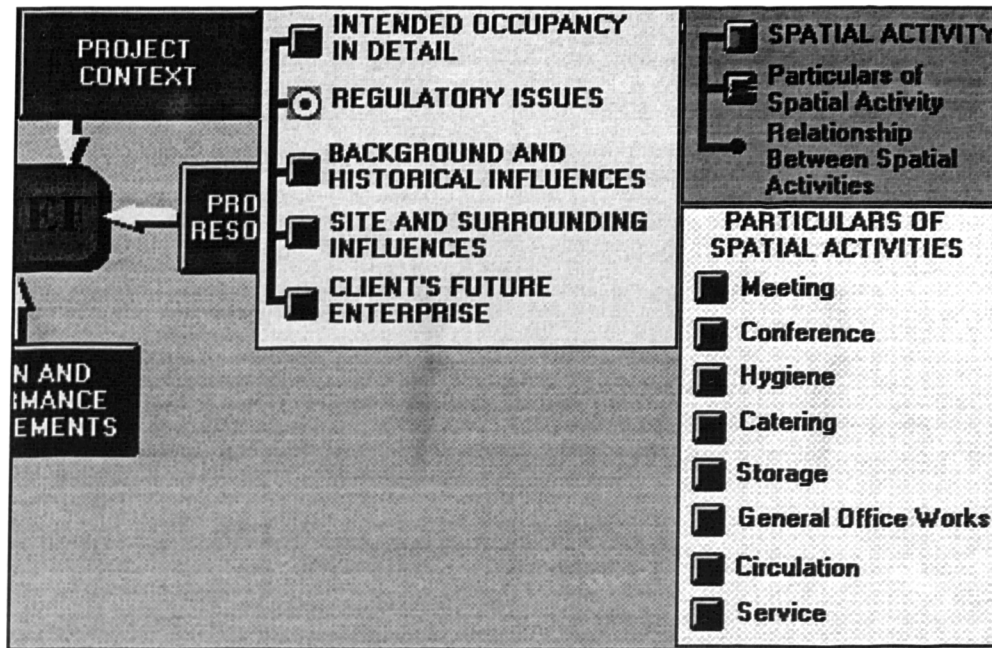


Figure 10.9: The "Spatial Activity" Item Showing the "Particulars of Spatial Activities"

5) The "DESIGN AND PERFORMANCE REQUIREMENTS" button

When the "DESIGN AND PERFORMANCE REQUIREMENTS" button is chosen by the user, the six sub-sections will be displayed below the button (Figure 10.10). When any of these sub-section buttons are selected, the labels are highlighted by turning from blue to red. Three of the sub-sections, "SITE AND SURROUNDINGS", "GROUPING OF SPACES" and "PLANT, EQUIPMENT AND FURNISHINGS", are reserved for future development. Current development of the AUTOBRIEF prototype concentrates on the other three remaining sub-sections, i.e. "BUILDING AS A WHOLE", "BUILDING FABRIC" and "SPACES IN DETAIL".

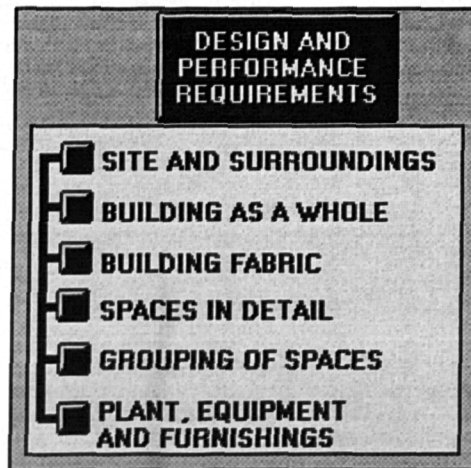


Figure 10.10: The "Design and Performance Requirements" Sub-sections

a) The "BUILDING AS A WHOLE" Button

When the "BUILDING AS A WHOLE" button is selected, a hierarchy of items emerges on a green rectangular background to the right of the sub-sections rectangle, as shown in Figure 10.11. This hierarchy has been divided into "Design Characteristics" and "Performance Characteristics". Users can enter data with either characteristics.

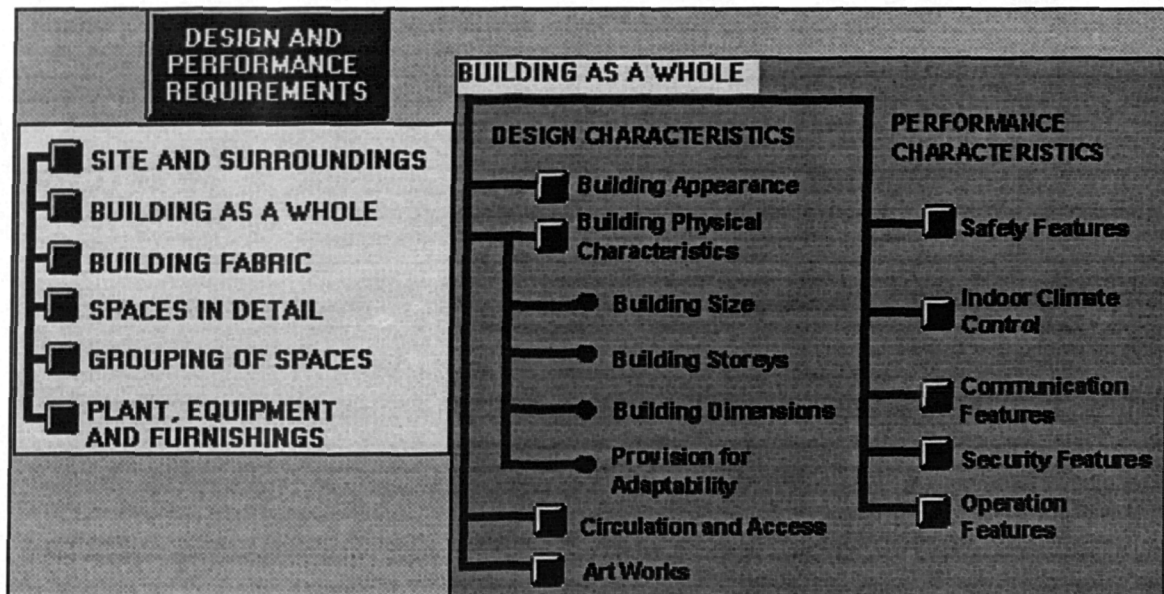


Figure 10.11: The "Building as a Whole" Sub-section

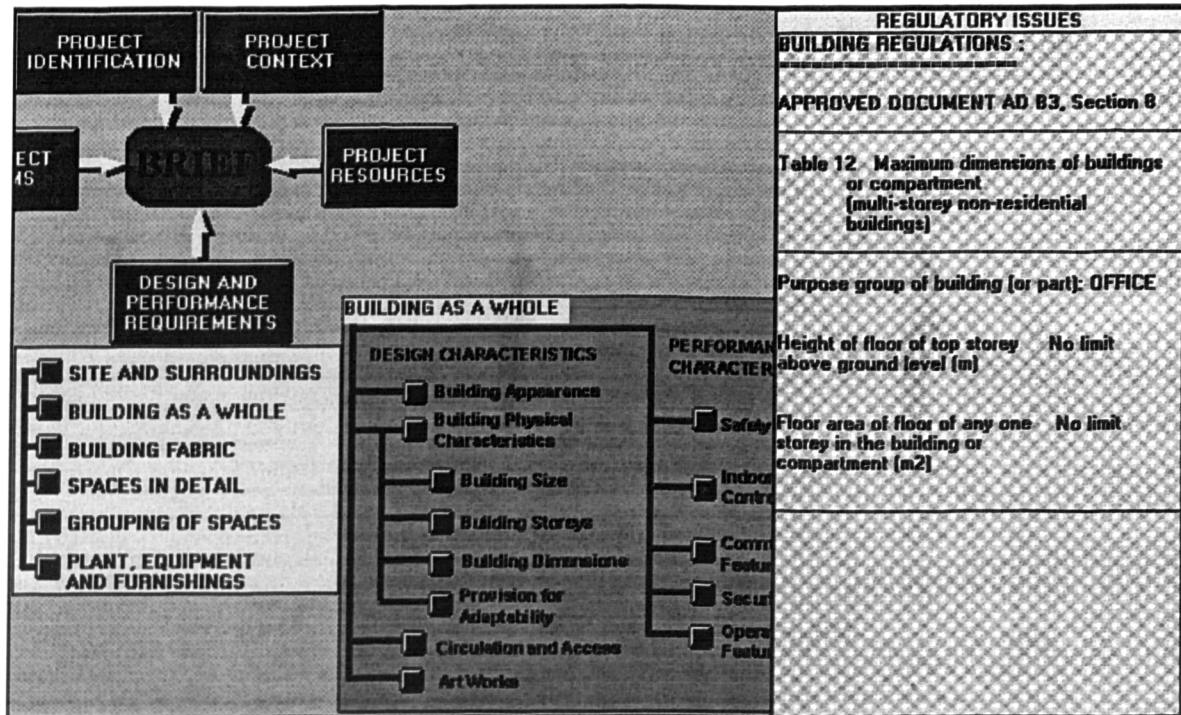


Figure 10.13 The "Building Size" Button

The "Building Storeys" button requests the user to input the average storey height and the number of storeys of the proposed building. When these have been entered, the compatibility of the new input is checked with previously stored data. The example given in Chapter 9 (Section 9.3.2 (b)), which describes the functions of the Interpreter, makes use of these two inputs as examples.

The "Building Dimensions" button prompts the user to enter the length, width and height of the building. These figures are optional and can be left blank. For the height of the building, however, if the number of storeys and the average storey height have been entered earlier, the system will automatically calculate the height and display it to the user.

The "Provision for Adaptability" button aims to record the possibility that the building will vary its use during its life (i.e. to incorporate flexibility for its future use). A few options have been incorporated in the prototype for the user to select from, for example, to "Infill_Atrium".

c) *The "Circulation and Access" button* - This refers to the provision for movement and access within the building. The user is requested to input three types of data. The first is "Usage", which refers to the purpose of the provision, such as "People_Able", "People_Disabled" and "Goods". The second input is the "Method of circulation and access" which refers to either "Mechanical" or "Non_Mechanical". The last entry item is "Plane of circulation and access", in which the system provides the user with three options including "Horizontal", "Vertical" and "Sloping". For all three of these inputs the system carries out a compatibility check and makes recommendations to the user. As an example, if the user selects all three options given for "Usage", but does not make any selection for the other two items, the system will check the number of storeys entered earlier (say, 5) and displays this message:

No. of storeys = 5
Circulation and access recommended:
- horizontal and vertical
- mechanical and non-mechanical

These values will be input for you.

In the above case, the system is making recommendations based on previously entered data, i.e. the "Recommends valid inputs" process shown in Figure 9.2 in the previous chapter. The above message is then followed with another:

If the building is also meant for disabled people,
circulation and access recommended:
- sloping (e.g. ramp).
This value will be input for you.

This is then followed by the appearance of the "REGULATORY ISSUES" button, which when pressed will reveal the Building Regulations for Access and Facilities for Disabled People.

d) *The "Art Works" button* - The user has to decide whether any art works are going to be incorporated in the building. If the user selects "No" or "Unknown", the consultation proceeds to the next stage. If "Yes" is selected, the user is requested to input the types of art works.

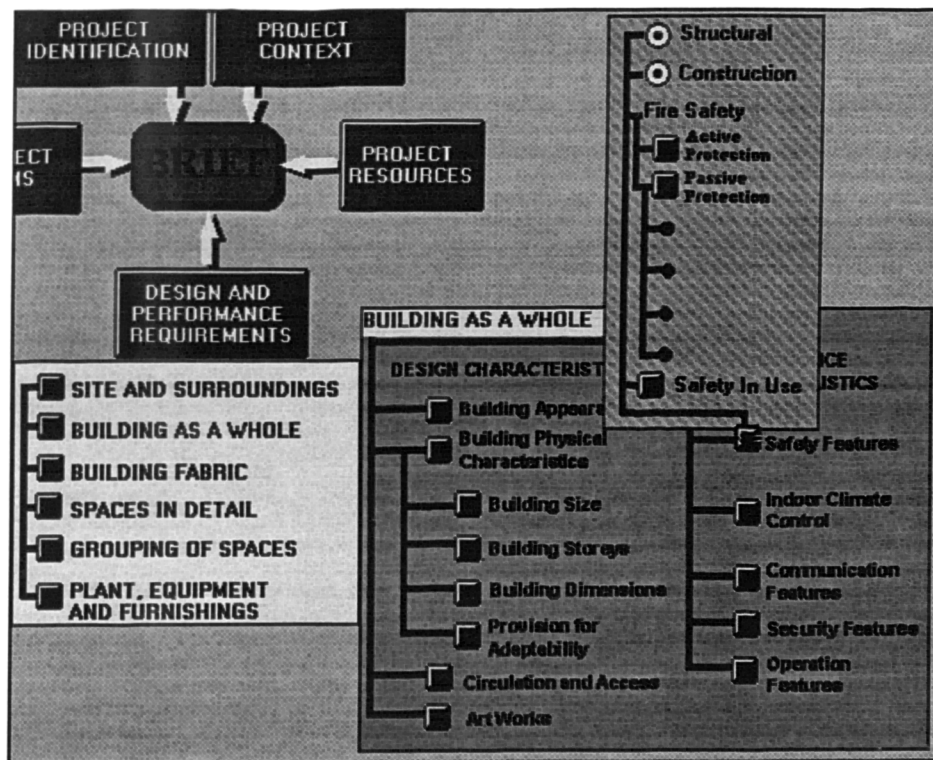


Figure 10.14: The "Safety Features" Button

(ii) Performance Characteristics

Under the Performance Characteristics heading of the "Building as a Whole" section, there are five items which the user can select to input.

a) *The "Safety Features" button* - A hierarchical tree is displayed just above the "Safety Features" button as depicted in Figure 10.14. The first two items display the information icon. When either one is selected, the relevant building regulations will be presented.

Under the "Fire Safety" heading, when the "Active Protection" button is chosen, the user is confronted with the input form which requests the user to select the type of "Fire Alarms", the "Means of Detection" and the "Means of Extinguishing" the fire, together with the presentation of the Building Regulations on Fire Safety. The "Passive Protection" button reveals its sub-items (Figure 10.15). Simultaneously, the Building Regulations on Fire Safety and information on "Passive Fire Protection" are presented to the user for information purposes.

The hierarchy for "Passive Protection" consists of two items with buttons and another two with the information icons. The first information icon is for the "Spread of Flame" item. When the icon is selected two sets of Building Regulations are presented; "Spread of Flame" and "Minimise the Spread of Flame". The second icon displays the Building Regulations on "Access and Facilities for the Fire Service".

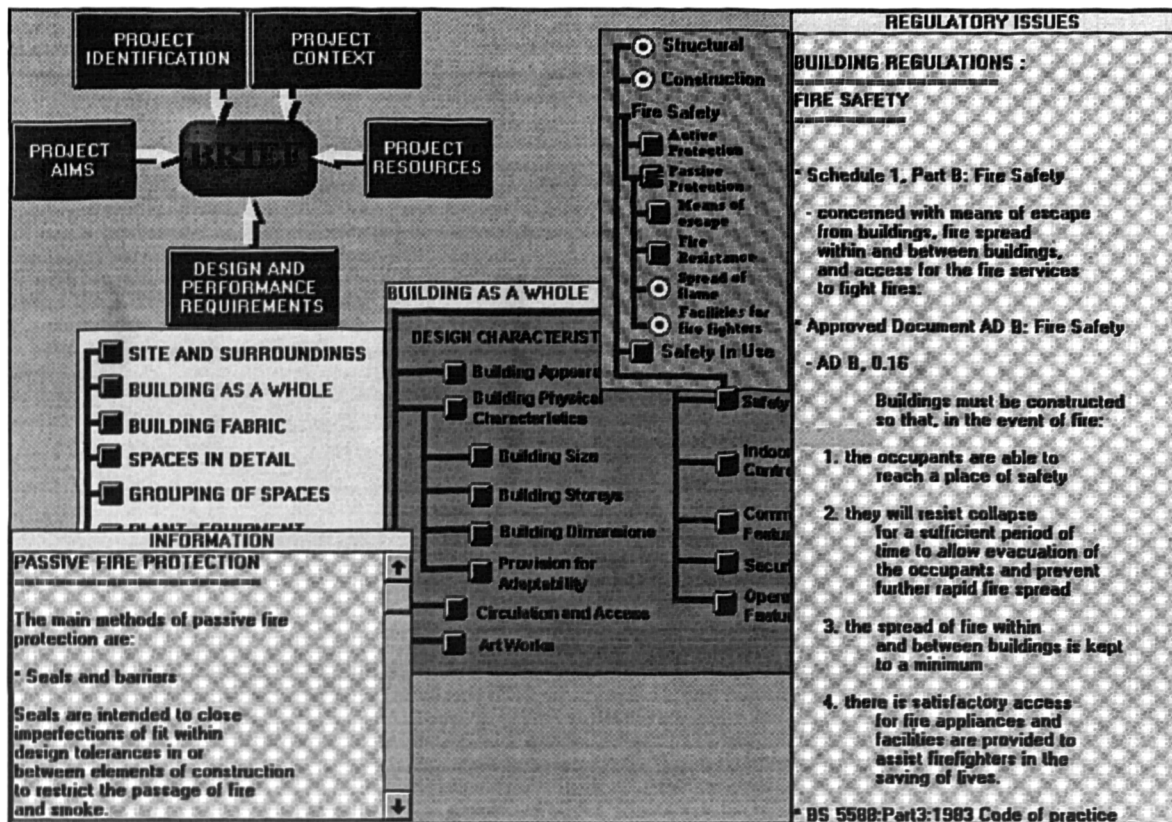


Figure 10.15: The "Passive Protection" Button

The "Means of Escape" button prompts the user to enter information related to the facilities for means of escape, such as general floor layout and number of protected stairways. The latter will be checked with the number of storeys and the storey height of the building. The "Fire Resistance" button enables the system to establish the link with Microsoft Word, and opens the relevant file which contains the table of the minimum periods of fire resistance for office building of certain heights, extracted from the Building Regulations. At the same time, the system checks the compatibility of the height of the building and the type of active fire protection entered earlier, and calculates the minimum period of fire resistance for the user. The user can change the recommended minimum period as long as it is within the range recommended. If, for example, the user did not input any value for the means of extinguishing fire in the active fire protection earlier on, the system will prompt him/her to do so before

recommending the minimum period of fire resistance. Finally, the "Safety in Use" button requests the user to enter the safety, health and emergency facilities for the building.

b) The "Indoor Climate Control" button - When this is selected, a rectangular box appears just above the "Indoor Climate Control" button as shown in Figure 10.16.

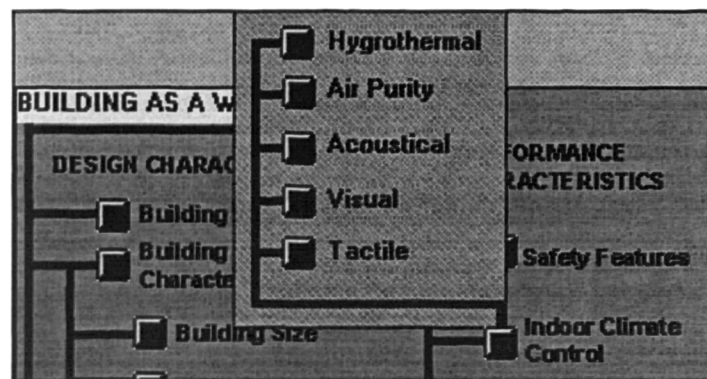


Figure 10.16: The "Indoor Climate Control" Button

The "Hygrothermal" button prompts the user to input/confirm the values for the items of "Comfort Conditions", i.e. the temperature range, the air changes and the humidity requirements for the building. If these items have been entered earlier under the "Project Aims" main section, the input values will be displayed. Otherwise, the user has to select the values from the options provided. The "Air Purity" button requests that the user enters the air pollution level and the type of ventilation required. When the type of ventilation is selected, the system checks this with previously related entered data. For example, assuming the user selects "Natural" for the type of ventilation, and that the option of "Sealed External Facade" has been selected for the "Building External Facade" item under the "Building Appearance" heading, the following message will be presented: "The choice of sealed external facade requires a ventilation system other than

natural. Please select another." The user is therefore required to select another type of ventilation.

The "Acoustical" button refers to the requirement for the control of external and internal noise. The user has to enter the external and the internal noise level; "Acceptable" or "High". To assist the user in deciding on which option to select, information and regulations related to noise level and sound insulation in building are simultaneously presented. The "Visual" button reveals a long list of items for the user to input. These items are similar to the "Visual" item under the performance characteristics of the wall cladding section, which will be described at a later stage. The last item, "Tactile", refers to the surface properties of the indoor climate. When the button is selected, the user is requested to input the internal surface texture and the surface condition of the indoor climate from a number of provided options.

c) *The "Communication Features" button* - This button requests that the user inputs information on telecommunication facilities, information retrieval facilities and clock facilities. Options are provided to assist in this process.

d) *The "Security Features" button* - This button prompts the user to input data for the exclusion device, checking facilities and personal security features for the building. Again, options are provided as an aid to the user's decision making process. If the user is unsure of any of these items, he can leave them blank and return at a later stage. This issue of security is sometimes left to the expert to decide. By highlighting this as a requirement for the brief content, it will ensure that its requirements and implications

are taken into consideration during the design process, and not after the design has been completed, causing major changes in design.

e) *The "Operation Features" button* - This button requires the user to input the facilities for cleaning, repair, access for inspection, exterior maintenance and services maintenance. Options are provided. Again, a decision on this matter is required at the briefing stage because it may have drastic implications on the design solution.

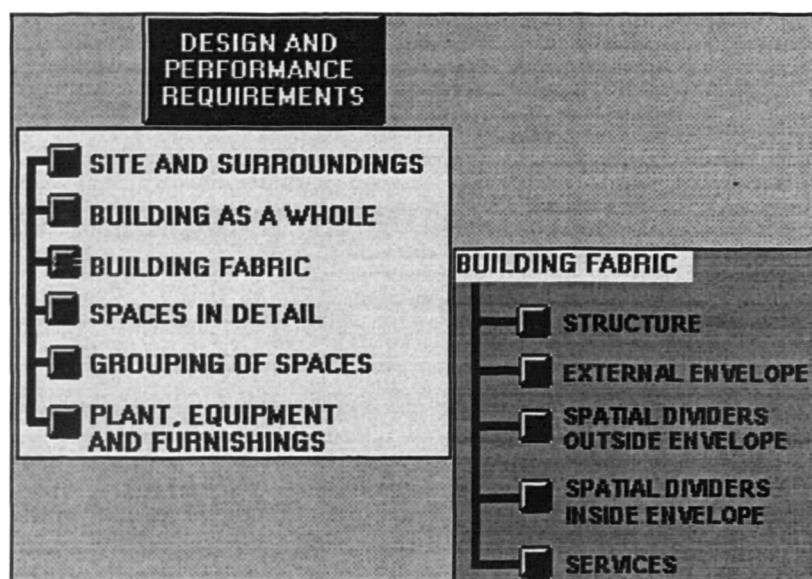


Figure 10.17: The "Building Fabric" Button

b) The "Building Fabric" button

The "Building Fabric" sub-section of the "Design and Performance Requirements" main section is one of the major parts of the prototype development. It concentrates on the selection of wall cladding system for the building. The wall cladding item comes under the "External Envelope" heading. When the "Building Fabric" button is selected, the user is presented with the hierarchical tree for the "Building Fabric", i.e. "Structure", "External Envelope", "Spatial Dividers Outside Envelope", "Spatial Dividers Inside

Envelope" and "Services" (Figure 10.17). The last three items are not included in the scope for the prototype development.

If the "Structure" button is selected the user is prompted to select the material for the structural frame of the building. Only two options have been provided, i.e. "Concrete" and "Steel". When the next button, "External Envelope", is chosen, the user will be confronted with a menu from which to select, i.e. either "View Types of Cladding", "Input Design and Performance Characteristics" or "Cancel". The first option presents another menu which requests that the user select the type of cladding to be viewed. When any one of the options is selected, access to the appropriate web site on the internet will be provided. The second option reveals a rectangular box at the top of the "Building Fabric" hierarchy as shown in Figure 10.18. When the button for "Design Characteristics" is selected, the corresponding items are displayed on another rectangular background as depicted in Figure 10.19.

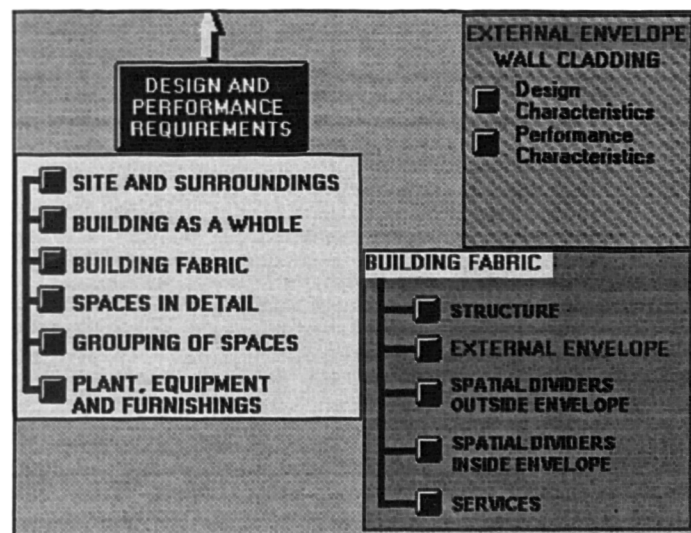


Figure 10.18: The "External Envelope" Sub-section

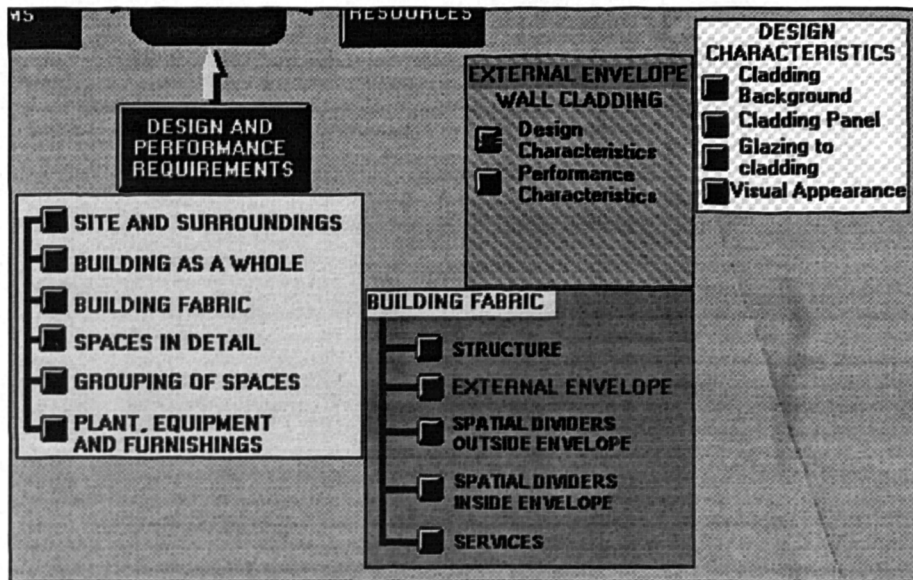


Figure 10.19: The "Design Characteristics" Button for "Wall Cladding"

(i) The Design Characteristics of "Wall Cladding"

The following describes the consequences of selecting any of the design characteristics buttons of "Wall Cladding":

a) *The "Cladding Background" button* - This refers to the background support for the proposed wall cladding. This button prompts the user to select the background support from two options; the "Structural_Frame" and "Framed_Members". The first option requests the type of material for "Structure" if it has not been input earlier, or displays the type of material if the value has been entered. The second option requests the particulars of the framing members for wall cladding, such as the type of material; either aluminium, steel or concrete. All this information is required in order for the system to recommend the most suitable type of wall cladding for the building.

b) *The "Cladding Panel" button* - This button presents information on the type of material available for specific types of cladding panel, and the Building Regulations on Materials and Workmanship of Wall Cladding. Simultaneously, the system prompts the user to input four items; the cladding weight category, the cladding panel visual size, the cladding panel material and the cladding panel type. Two options given for the first item include "lightweight" and "dense", and for the second item include "large" and "small". AUTOBRIEF accommodates three options only for the cladding panel material. These are precast concrete, glass and composite material. The options provided for the cladding panel type include flat sheet, composite panels and tiles or slabs. For the two final items the user can refer to the information presented prior to making any decision.

c) *The "Glazing to Cladding" button* - The user is requested to input particulars for glazing such as whether or not glazing is required, and the type of glazing, if required. At the same time the "INTERNET" button becomes visible. When this button is clicked, the user will be connected to a web site which provides information on glazing.

d) *The "Visual appearance"* - This button requests the user to input the form of the cladding panel, and the types of finish if known.

(ii) The Performance Characteristics of "Wall Cladding"

The user can then proceed by clicking on the button for the "Performance Characteristics" of "Wall Cladding". This will display another rectangular background below the "Design Characteristics" rectangle (Figure 10.20). Simultaneously, the button and label for "Suitable Cladding" appear below those for "Performance Characteristics".

The user is advised to proceed by entering values for the items of the "Performance Characteristics" before selecting the "Suitable Cladding" button.

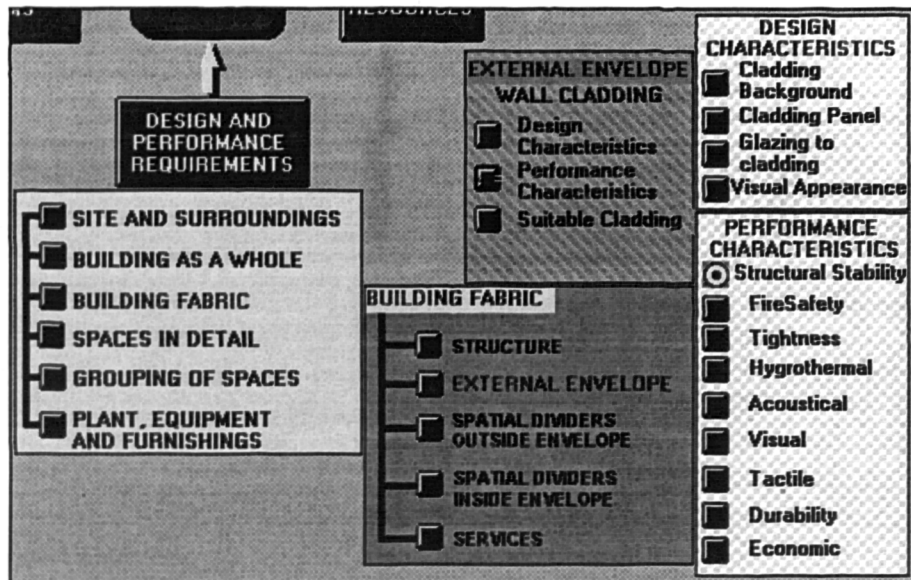


Figure 10.20: The "Performance Characteristics" Button for "Wall Cladding"

The following describes the buttons/icons under the "Performance Characteristics" section.

a) *The "Structural Stability" icon* - This icon presents the user with the same information (Building Regulations on Structural Stability of Wall Cladding) in two formats, a transcript image and in Microsoft Word. The aim is to demonstrate the capability of AUTOBRIEF to provide access to two sources of information.

b) *The "Fire Safety" button* - This button displays the Building Regulations on Fire Safety of Wall Cladding. At the same time, the user is prompted to input values of the minimum fire resistance for the framing members, cladding panels and glazing units,

whichever is applicable. Once the values have been input, the system will check them for validity. For example, if the value entered for the framing members is 30 minutes and for cladding panels is 60 minutes, a message will be conveyed to the user indicating that the value for framing members should be equal to or higher than that for cladding panel. This is followed by a request for the user to enter new values for these items.

c) *The "Tightness" button* - This button presents one of two possibilities. If "Glass" has not been selected earlier as one of the cladding panel materials, then only the Building Regulations for Tightness Requirements is presented. Otherwise, this is presented together with the request for the user to input the tightness requirements for the glazing, such as the jointing principles for the cladding panels and the glazing units.

d) *The "Hygrothermal" button* - This button presents the Building Regulations on Hygrothermal Requirements of Wall Claddings. Simultaneously, it prompts the user to input the thermal conductivity (if known) and the U-Value of the cladding system. For the second item, a minimum value is recommended.

e) *The "Acoustical" button* - This button displays the Building Regulations on Sound Insulation along with extra information on sound reduction and noise levels assumed in AUTOBRIEF. The user is also required to input or confirm previously entered values under "Indoor Climate Control", i.e. the external and internal noise levels. In addition to this, the system also requests the value of the sound reduction level required for the wall cladding. When these values have been entered, a compatibility check is carried out. For example, if the user inputs the values "High" for the external noise level,

"Acceptable" for the internal noise level, and "Minimum" for the sound reduction level, the user's previous inputs are summarised and displayed. The value of "High" is then recommended for the sound reduction level, and automatically entered by the system.

f) *The "Visual" button* - This button presents a picture sample for visual requirements with the corresponding explanation below it. Concurrently, the user is prompted to input the values for any requirement of useful daylight, the percentage of solar transmittance, the type of lighting requirement, percentage of light transmittance and whether there is any requirement for visual continuity with external environment (external view). To assist the user with the input process, simple options are provided from which the user can select. For example, for the first item, i.e. requirement of useful daylight, the options are "Yes" and "No". For the third item, the type of lighting requirement, the options are "Natural" and "Artificial". In this case, a compatibility check is also performed by the system. If the user enters "Yes" for the requirement of useful daylight, but does not include "Natural" as one of the types of lighting required, the system will display a message. This message will summarise the previously entered values and recommend "Natural" to be added to the list, and adding it automatically.

g) *The "Tactile" button* - This button requests the user to enter the surface properties for the external and internal surfaces of the wall cladding.

h) *The "Durability" button* - This button prompts the user to enter information on the lifespan of the wall cladding, the minimum cleaning and maintenance periods for the

cladding. At the same time, the Building Regulations on Materials and Workmanship of Wall Cladding is presented to the user.

j) *The "Economic" button* - This button requires that the user enters the preferred levels for capital, running and maintenance costs. The options provided for each item are "High", "Average" and "Low". This is rather a simplified view taken during the prototype development. The idea is to have some form of identification for costing of these items without going into much detail of the actual costs, which is beyond the scope of the prototype development.

Once all the design and performance requirements for the wall cladding have been entered, the user can click on the button for "Suitable Cladding". This button presents a message which recommends the most suitable type of wall cladding based on the user's previous selections or input. For example, the message displayed is: "The type of wall cladding that matches your selections is Curtain_Wall_System". At the same time, the "CURTAIN WALL SYSTEM" button will be revealed below the "Performance Characteristics" box. When this button is selected, a summary of all the requirements that the user had selected earlier is presented. The user can make changes to the requirements and return to the "Suitable Cladding" button again when he/she is satisfied with the new selections. If the system cannot find a suitable cladding based on the user's selections, then these messages will be displayed in sequence:

a) "No suitable cladding for the previously entered values or not enough information entered. The summary of the previously entered values will be displayed."

- b) "Make all necessary changes to the Design and/or Performance Characteristics and click on the "Suitable Cladding" button again."

Following this, the summary of the previously entered values is displayed, and the user is free to make changes to suit his requirements until a suitable cladding type is found.

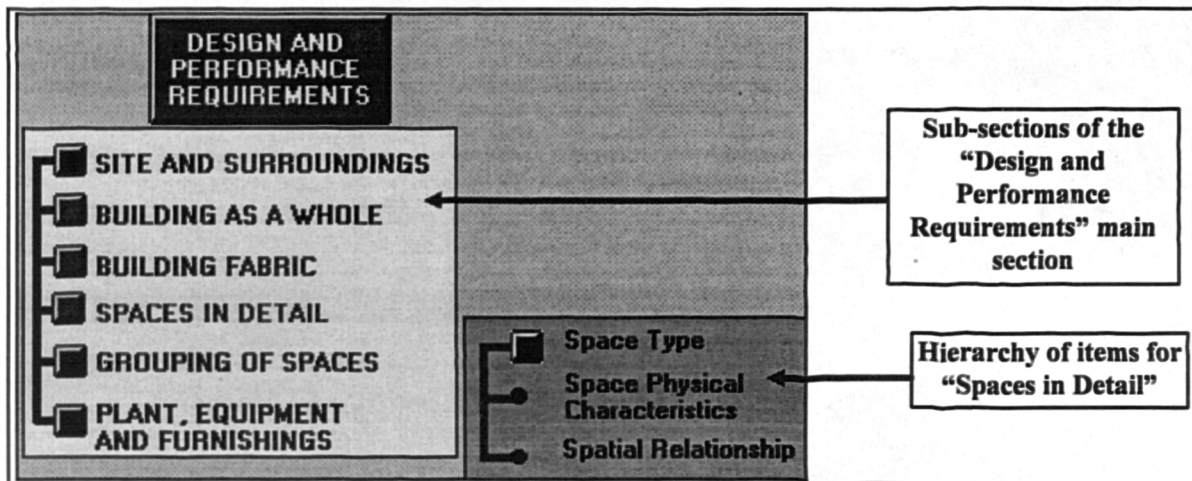


Figure 10.21: The "Spaces in Detail" Button

c) The "Spaces in Detail" Button

"Spaces in Detail" is one of the sub-sections of the "Design and Performance Requirements" main section depicted in Figure 10.10. It refers to the requirements of individual spaces in the building. When the "SPACES IN DETAIL" button is selected by the user, a rectangular background with a hierarchy for the items to be included under "Spaces in Detail" is displayed next to it, as shown in Figure 10.21.

When the "Space Type" button is selected by the user, information on the types of spatial activities and the corresponding space types is presented. Simultaneously, two outcomes may occur:

1. If the user has not entered any value for the type of "Spatial Activity" under the "Project Context" main section, the user will be directed to do so before he is able to input any value for the "Space Type". For this purpose the rectangular box for "Spatial Activity" will be displayed to allow the user to enter the relevant inputs before returning to the "Space Type" button. The user will then be prompted to select/confirm the types of spaces to be included in the building.
2. If the user has entered values for the type of "Spatial Activity" at an earlier stage, then the user will be prompted to select/confirm the types of spaces to be included in the building.

At this instance, the user is presented with the types of spatial activities that had been selected earlier, together with the corresponding types of spaces. The user can confirm earlier selections or make any additions or deletions to the list of spaces. Any addition or deletion to either list of spaces or its corresponding spatial activity will be checked by the system. For example, if the types of "Spatial Activity" entered earlier are "Conference" and "Meeting", the corresponding values for the "Space Type" will be entered by the system. These are "Conference_Room" and "Meeting_Room" respectively. If the user decides to add "General_Office" to the list of "Space Type", a message is displayed to the user informing him/her that this space does not correspond to the "Spatial Activity" selected earlier. The user is then requested to confirm. If "No" is selected, then "General_Office" is not added to the list of "Space Type". If, however, "Yes" is selected, then "General_Office" will be added to the list of "Space Type" and

the corresponding "Spatial Activity", which is "General_Office_Works", will automatically be included in the list of "Spatial Activity". Following this, the input form for the particulars of "General_Office_Works" will be presented to the user. This checking mechanism between the "Space Type" and the "SpatialActivity" works both ways whenever any item is added or deleted from the previous stored list.

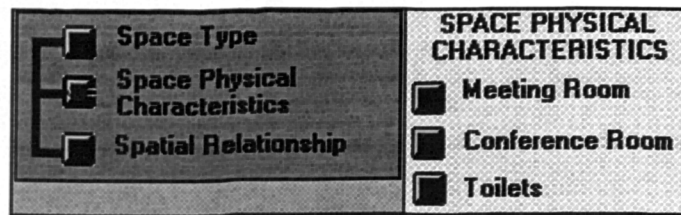


Figure 10.22: The "Space Physical Characteristics" Button

When the user selects the "Space Physical Characteristics" button, a rectangular background appears next to the "Space Type" rectangle as shown in Figure 10.22. It displays the buttons and labels for the selected "Space Type". When any of these buttons is selected, the particulars are prompted for that particular space. At the same time, the button and label for "Spatial Relationship" is displayed on the "Space Type" rectangle. This button requires that the user enters the relationships between the selected spaces.

The current stage in the development of AUTOBRIEF only incorporates a one to one relationship between the "Space Type" and the "SpatialActivity". This means that the system does not accommodate for more than one instance of a space type for each type of spatial activity, for example, "Meeting Room 1" and "Meeting Room 2" for the

"Meeting" spatial activity. However, it allows the number of spaces for each type to be entered by the user.

The previous sections have described the operations of AUTOBRIEF during the "consultation" mode. The next section will present its operations during the "generate brief" mode.

10.4.2 The "Generate Brief" Mode

While in the "consultation" mode, if the user clicks on the "GENERATE BRIEF" button, the "CONSULTATION MODE" indicator will be hidden and the "GENERATE BRIEF MODE" indicator will be displayed in its place (Figure 10.23). All the buttons that appear during the "generate brief" mode are displayed in green with the exception of the "CONTINUE CONSULTATION" button (in blue). This button is displayed throughout the "generate brief" mode to allow the user to return to the "consultation" mode whenever required.

At the beginning of the "generate brief" mode, the user is again presented with the main section buttons (Figure 10.23). When any one of these main section buttons is selected, the user is presented with the brief report for that particular section. The AUTOBRIEF prototype enables the user to view eight versions of the generated brief. Table 10.1 lists the eight versions.

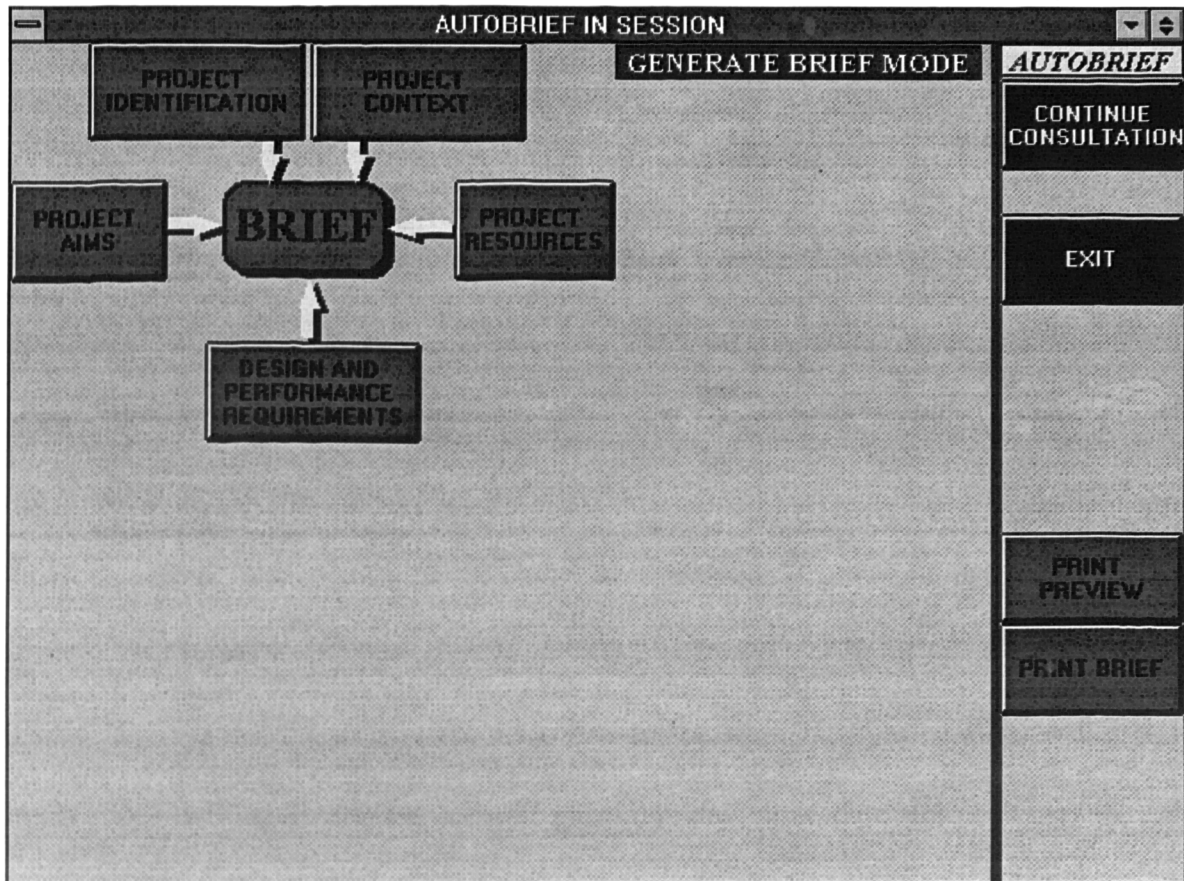


Figure 10.23: The Main Screen ("Generate Brief" Mode)

	Versions of the Generated Brief	Contents
1	"Project Identification"	A main section
2	"Project Resources"	A main section
3	"Project Aims"	A main section
4	"Building as a Whole"	A sub-section of "Design and Performance Requirements"
5	"Building Fabric"	A sub-section of "Design and Performance Requirements"
6	"Spaces in Detail"	A sub-section of "Design and Performance Requirements"
7	"Spatial Activities"	A sub-section of "Project Context"
8	"Complete Brief"	A combination of all the above

Table 10.1: Versions of the Generated Brief

For the "DESIGN AND PERFORMANCE REQUIREMENTS" main section, a list of its sub-sections is displayed. When any of these sub-section buttons is selected, e.g.

"Building as a Whole", the brief report for that particular sub-section is displayed in textual form (Figure 10.24).

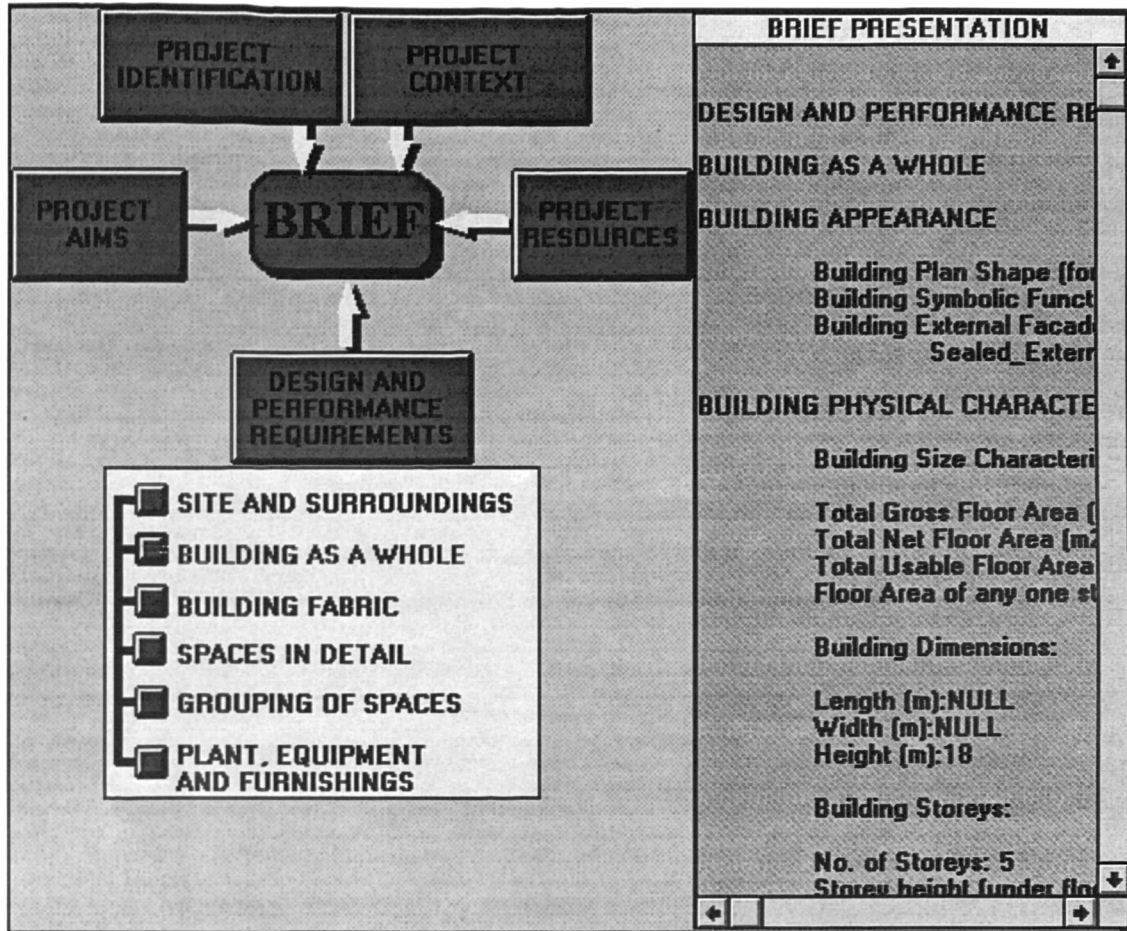


Figure 10.24: The Generated Brief for the "Building as a Whole" Main Section

Another button which is also visible in the "generate brief" mode is the "PRINT PREVIEW" button. This button provides the user with the option of viewing the brief report in Notepad or Microsoft Word. When either is selected, the user is given the option of selecting any of the above versions (Table 10.1) for viewing. When the report is presented in Notepad or Microsoft Word, the user is able to view and format the developed brief in their preferred form, and subsequently save and/or print these as

documents. In this way he/she is able to personalise these documents while maintaining the consistency of the information presented in the generated brief.

Changes to the contents of the generated brief can be made by returning to the "consultation" mode via the "CONTINUE CONSULTATION" button. This button allows the user to return to the previous consultation page prior to the "generate brief" mode, with all the relevant buttons and other object images being displayed in the previous colour (blue or red). In this way the user is able to resume the consultation process, and return to the "generate brief" mode when he/she is ready. In other words, this facility enables the user to toggle to and fro between these two modes easily and freely. This will facilitate the user in checking the input data and making all the necessary changes or modifications to ensure that the information to be presented in the brief will genuinely reflect the client's requirements.

Finally, another button displayed in the "generate brief" mode is the "EXIT" button. This button allows the user to save the current investigations into a file before quitting the system.

10.5 Summary and Conclusions

This chapter has presented the accomplished and running prototype with the help of screen displays obtained from the interface. Firstly, the display of the introductory screen and the main screen were described. This was followed by a detailed description of the main operations that take place during its two modes; "consultation" and "generate brief".

The "consultation" mode emulates the "Consultation" process that takes place prior to the generation of the brief, described as the "Generate Brief" process in Chapter 7. During the "consultation" mode, the user can proceed by choosing any one of the main sections. The main sections are "Project Identification", "Project Aims", "Project Resources", "Project Context" and "Design and Performance Requirements". Each main section will guide the user from a high level to lower and more detailed issues relevant for that particular section. When the user selects a main section, the main operations can be summarised as follows:

1. The system captures the user's input data (client's requirements) by direct input or by selection of options presented by a menu. The input data is interpreted and verified to ensure it is suitable for inclusion in the brief. The accepted data is called valid data and is stored within the system. Invalid data is rejected by the system.
2. The system recommends valid input to replace invalid data that has been rejected by the system.
3. The system resolves conflict between new valid data and related valid data stored in the system (previously acceptable input data) by checking their compatibility with each other, for example in terms of design and/or performance requirements.
4. The system provides access and presents the user with specific information related to the input data being investigated. Specific information can be obtained from the

internal database or from external resources. Information is presented in the form of text, images, pictures, sound and computer-generated documents, with the support of multimedia technology.

The above operations or processes repeat themselves every time a new input is captured by the system. Once the user is satisfied with all the inputs, he/she can proceed to the "generate brief" mode. In this mode the user can select, one after another, any of the sections for the brief to be generated and presented. The generated brief can be in the form of a main section, a sub-section of a main section, or the complete brief, which currently accommodates seven sections of the brief. The user can also view the selected generated brief outside the object oriented environment, i.e. in either Notepad or Microsoft Word. In this way the format of the brief can be customised to the user's preference. Hard copies of the generated brief can also be made.

Previously entered data can be modified by returning to the "consultation" mode. The system allows the user to toggle freely between the two modes, to ensure that he/she is convinced that the generated brief reflects the client's actual requirements. When satisfied, the user can exit the system and save the contents of the system into a file.

The top-down approach of addressing information from a high level downwards enables the user to focus specific issues from the general to the more specific. The format of the generated brief follows the structured framework of the brief presentation (Chapter 3), in line with this top-down approach.

The running prototype is able to generate a documented brief for the client. Prior to that, it is able to investigate and capture the client's requirements, provide access to relevant sources of information, and present such information in an appropriate format and media in a timely and efficient manner.

CHAPTER 11

TESTING

11.1 Introduction

The preceding chapters have described the development of an information system and the running prototype, AUTOBRIEF. The aim of AUTOBRIEF is to generate a documented brief for the client and to provide an easy access to project and construction industry related information during the briefing process. This chapter describes the limited testing process to which this prototype has been subjected.

11.2 Scope of Testing

Testing of the prototype was chiefly aimed towards demonstrating how effective the implementation of the prototype is in support of the briefing process using IT as a tool. To achieve the desired aim, the prototype has been tested on the following aspects, in order of importance:

1. the approach adopted (whether it is appropriate for the briefing process)
2. the flexibility of the adopted approach for future development
3. limited testing/debugging

A limited number of construction professionals (Architect, Client, academics and researchers) have been invited to view the prototype. Based on their comments and suggestions, subsequent amendments and additions were incorporated which led to further refinement of the prototype. In addition, potential or alternative recommendations raised which could improve the effectiveness or usefulness of the prototype, but have not been carried out, are also described.

11.3 Evaluation of the Prototype's Approach

Since this study is an initial step towards supporting the briefing stage with IT, it is important to develop an effective approach to the prototype implementation. Such testing was directed to the approach adopted for eliciting or acquiring the requirements of the client from the user, and the final generation of the brief.

The evaluation on the approach is carried out based on the following criteria:

1. The method of eliciting/obtaining requirements from the user prior to the generation of the brief

This involves:

- a) the identification of the precise point at which the system should begin interacting with the user and vice versa. This concerns the identification of the most appropriate level of detail of information that the user is expected to begin to interact with the system. For example, whether to begin at the highest level and proceed top-down to more detailed levels, as implemented into the prototype, or to begin from a lower

level of detail upwards, or to allow users to select their own route. Preferences of those invited to view the prototype (subsequently referred to as the “testers”) and their comments were noted and recorded. In general, the preference amongst the testers was the top-down approach. This approach was seen to allow the user to begin at the most general level, and with guidance from the system, the user is being led to more detailed issues related to the previous level. In that way all related issues are covered. It has been suggested that this is the most appropriate approach for an inexperienced client as the user.

The bottom-up approach is not particularly preferred to by the testers in view of the possibility of getting into too much detail prior to establishing the objectives and needs of the clients which can be found at the high level of analysis. Indeed, over-enthusiasm at the detailed level might conflict with the client’s objectives. However, moving up and down the levels of detail with emphasis on using the top level as the starting point was considered useful to allow the user to return to previously entered requirements. Although the prototype does not allow the user to move step by step upwards in the level of detail, it does allow the user to return to previously entered requirements in a top-down fashion. In view of this, the approach adopted by the prototype implementation is considered to have met the requirements of the user.

- b) the approach of allowing easy access to supporting information during the elicitation process. This entails covering aspects related to the quality of information presented, the timing of information presented and the medium of presentation. In general, access to such information is considered as a means to increase the user’s

understanding and knowledge on relevant aspects of a construction projects. The quality of information with regards to relevant building regulations, performance and design related information were considered to be useful and serve to facilitate the decision making process.

The timing of information presentation was considered to be appropriate to suit the specific items of information. Where this was found to be inappropriate or untimely by the testers, the necessary measures were undertaken to overcome this. The medium of presentation of information within the prototype is generally textual, apart from a limited number of tables and images. It was generally thought that the use of more multimedia materials could enhance the presentation of such information. However, access to the internet allows multimedia presentations of relevant information to be available within the prototype. Overall, this approach of allowing access to sources of information was considered to be extremely useful.

2. The method of presenting the brief

This entails the evaluation on whether the method used for presenting the brief (the format, the contents and the means of presentation) are appropriate.

a) Contents of the brief

In general, since the information structure has been derived from published guidelines, the contents can be considered as acceptable within the limits of such guidelines.

b) Format of the brief

The structured framework of the brief presentation is examined. Since the levels of details of information to be acquired from the user prior to the generation of the brief follows the structured framework, it is considered to be beneficial and resourceful in terms of facilitating the user's understanding and comprehension. The fact that the structured framework is an adaptation from current guidelines reinforces its usefulness and comprehensiveness.

c) Means of presentation

The prototype facilitates the brief presentation as either a transcript image within the prototype, as a file within Notepad or in an external word processor, or as a hardcopy. All these methods of presentation are considered to be useful. The presentation within the word processor is particularly useful since its word processing capabilities enable the format of the brief to be tailored to suit particular audience and/or specific purpose.

d) Functionality as a brief

This questions the functionality of the generated brief as a whole in terms of whether it (i) reflects the actual client's requirements, and (ii) serves as the conceptual basis for design interpretation. At the current stage of development, the prototype covers only certain aspects of the brief. Therefore, it is not able to allow the designer to arrive at a complete design solution as yet. Even so, it encompasses enough information to reflect the client's requirements and to illustrate the various concepts of design and their relationships. Once the whole brief is incorporated into the prototype, its functionality should be extremely useful.

3. The User Interface

The user interface was not meant to be evaluated. However, a general opinion was sought from the testers to investigate its suitability and to highlight features which correspond to its applicability. The following incorporated features were considered to have enhanced the system's appeal and user-friendliness:

- a) the hierarchy of objects in the form of tree structures for each section of the brief.

This feature not only guides the user from one level of detail to another, but also provides an overview of each section's contents.

- b) the use of colours to differentiate the two modes of operation ("consultation" and "generate brief" modes) as well as to denote items that have been tackled with was generally useful.

- c) the presentation of explanations or summary of previously entered values whenever necessary adds to the userfriendliness of the prototype.

As a whole, the general outcome of the testing process for items 1, 2 and 3 were extremely encouraging. A general opinion amongst the testers was that the prototype would be useful to all project participants, in particular, the clients and designers. It was suggested that it not only provides a tool to support the briefing process, but also has the potential of providing an avenue for continuous professional development and training. Hence, this tool not only leads to the generation of the client's brief in an appropriate format with relevant and comprehensive contents, but also presents useful and supporting information in a timely and effective manner. Such supporting information would enhance the user's knowledge related to particular information items and

provides a means for the user to identify the client's true requirements which are not in conflict with each other. The result is not only a systematic approach to developing the brief, but also a useful and effective mechanism to aid the decision making process and to improve the communication channel between the project participants. Thus, such a feedback towards the system can only suggest that the adopted approach is effective.

11.4 Prototype Flexibility Evaluation

This evaluation was carried out to explore the flexibility of the adopted approach for future development of the prototype. Future development cover aspects of :

1. inclusion of all the brief contents into the generated brief. This can be considered as the next phase in the prototype development. Further development will require the implementation of the relevant knowledge into the system.
2. increase the multimedia support to the prototype. This include additional audio capabilities, access to video files, CD-ROMs, a bigger collection/database of pictures, images and graphics, etc. The development of the prototype has been carried out in such a way that it is open-ended. This means that it allows the system to be linked to other systems or external resources with relative ease.
3. to integrate with existing integrated construction environments (ICE) with the aim of achieving concurrent engineering. The prototype has been developed with the intention of becoming one of the construction applications of SPACE (see Chapter 12). The modularised framework of the SPACE environment allows each application

module (which possesses its own data and process models) to be implemented into a core object oriented knowledge based system where the project information is controlled, maintained and manipulated. This possibility is considered to be very encouraging. Further discussions can be found in the next chapter.

4. to explore the possibility of using a different approach to the system interface, such as dividing the overall briefing process into predefined stages as proposed by Spekkink and Smits (1993). Based on these stages, users would not be allowed to proceed to the next more advanced stage until all the requirements for that particular stage had been established. The knowledge gap for that preceding stage would be highlighted to the user. If such an approach is considered to be useful, the prototype can be adapted to suit such requirements.

In summary, the approach adopted for the development of the prototype is considered to have the flexibility for future development.

11.5 Prototype Testing/Debugging

Limited testing/debugging was carried out for the prototype since the testing emphasis was on the previous two aspects of evaluation. However, sufficient testing was undertaken to ensure smooth running of the prototype. The object-oriented nature of the prototype environment, which constructs the overall system from individual parts (methods and functions) facilitates with the testing and debugging process.

The testing/debugging process mainly cover code testing to ensure that the system carries out the necessary functions. Code testing was carried out at three different levels: unit testing, link testing and system testing.

a) Unit testing was performed on each individual object's behaviour (method or function), which once coded, was tested and debugged independently of the rest of the system (other object's methods or functions).

b) Link testing was carried out on particular object's behaviour which involves attributes and/or methods or functions of other objects. In other words, two or more program modules that depend on one another were tested to check that the codes or modules work together with one another as planned. Any error or irregularity encountered were duly debugged.

c) Finally, the overall system testing was conducted. This involved a series of system tests to be performed on the entire system, as a working whole to ensure the smooth running of the overall prototype. This entails undergoing through all the system options, testing the interface and the correctness of output and system response. The test analysis aimed to identify major problems, such as incorrect or inconsistent answers or output and to determine whether the problem lay in the methods or functions, or some other factors. Once the source of the problem was identified, the system was debugged.

11.6 Comments and Suggestions

The following comments and suggestions had been highlighted by the invited testers but have not been implemented. Such an implementation would enhance the prototype's capabilities, its appeal and usefulness:

1. The options provided by the system menu may be rigid since a set of options is prompted for selection. This has been carried out to ensure that the prototype implementation is within the scope of the research. However, in a larger system, more options can be incorporated for each attribute value, for example, with the capability of the system to expand its database of options by accepting user's recommendations. In such cases, caution should be exercised to ensure data integrity and consistency.
2. Concern was expressed about some of the options presented to the user in situations where the user is not familiar with the terms used. A suggestion was to include "Not Known" as a choice. Another concern was regarding the use of "Other" as an option. In such cases, it was recommended that if this option was selected, then the system should request the user to enter a new input which subsequently would be added as an additional option. Again, due to the scope of the research and the question of controlling the validity of the new data, these issues have not been implemented at the current stage of the development.
3. When a main section of the brief is selected, the user will be presented with a box of hierarchy of items of information. At a lower level of detail, another hierarchy box is

displayed, and so on. A suggestion was made that the user interface could be improved by dimming the box for the previous level of detail. In this way, a new user would not be partially confused with items associated with the different levels. In relation to this, a comment was also expressed with respect to the number and arrangement of the hierarchy boxes visible on the screen at certain times which could be rather confusing. Based on the comment, the number of boxes have been minimised unless absolutely necessary and arranged in such a way that it reduces confusion.

4. The prototype allows space requirements to be entered in association with the spatial activity to be performed within each space requirement. At the current stage of development, it does not, however, accommodate for more than one item of space requirement to be entered, e.g. meeting room 1, 2, etc. for a specific spatial activity, meeting. It has been suggested that it would be more practical to accommodate for this within the prototype.
5. A suggestion was made to link the space requirements and/or spatial activities to an organisation's personnel database as a means of allocating the space requirements for an organisation. When the overall prototype is carried out, this is certainly a useful suggestion.
6. A suggestion was made to link the prototype to the internet and made it accessible to other internet users as a way to get feedback on its usability and applicability.

11.7 Summary and Conclusions

This chapter has described the scope of the testing process that has been subjected to the prototype. A number of construction professionals have viewed the system and comment on the usefulness of its approach and the applicability of the prototype as a tool to support the briefing process. The prototype was also tested on the flexibility of its approach to future development. In addition, it has been also been subjected to a limited debugging process.

The general outcome of the overall testing process was extremely positive. The following summarises the conclusions derived from the testing process:

1. The prototype was considered to be useful to all project participants during the briefing process, in particular the clients and designers. It also has the potential to be used for continuous professional development and training.
2. The approach adopted by the prototype which allows the user to begin at the highest level of detail and proceed top-down was considered to be the most appropriate. This approach guides the user in a systematic manner while covering issues which relate to specific items of information.
3. The approach of providing easy access to sources of information while identifying the client's requirements was considered to be useful in terms of facilitating the user's understanding and enhancing the user's knowledge which leads to effective decision making.

4. The method of presenting the generated brief is generally acceptable since the format and contents follow those recommended by published guidelines. The alternative means of presentation of the generated brief was considered to be useful and practical. The facility of presenting the brief in Microsoft Word in particular was seen to be constructive in terms of meeting the user's preference. The functionality of the generated brief to reflect the client's actual requirements and in providing the conceptual basis for design formulation was seen to be reasonable within the limit of the current stage of prototype development.
5. The interface allows the user to interact with the system with relative ease. The user interface was considered to be user-friendly and suitable for the approach adopted.
6. The adopted approach for the prototype development has the flexibility for further and future developments.
7. The limited testing/debugging process carried out on the prototype in the form of unit testing, link testing and overall system testing has given rise to a smooth running prototype which generate the brief and allow access to information sources in a timely and efficient manner.

As a whole, the testing process has indicated that the prototype has achieved its objectives. The testing process has also confirmed the suitability of the adopted approach and the usefulness and applicability of the prototype as an effective tool to support the briefing process. With more rigorous testing and further development to the

prototype, it would accomplish its full potential of serving as the main tool for the briefing process or as an integral part of an ICE.

CHAPTER 12

SUMMARY AND CONCLUSIONS

12.1 Introduction

This study is concerned with modelling the information and processes at the briefing stage with the aim of developing an IT system to support its main processes. This chapter summarises the overall study and draws the main conclusions in relation to the achievement of its aims and objectives. Finally, recommendations are made for further research with respect to the prototype development as a stand-alone system and as a part of an integrated construction environment.

12.2 Summary

The term briefing is currently used either to describe a stage(s) in the design or construction project, or as a systematic method of enquiry by which the client's requirements are made explicit. The study has adopted the second description which considers the briefing process as one whole process. Hence, briefing involves the gathering, organising, analysing, identifying, interpreting, compiling and documenting or presenting all the information required for a construction project. The output of this briefing process is called the client's brief.

The client's brief comes in varying lengths and in many forms depending on the detail of its contents, the aspects which it focuses on, or its purpose. It is also referred to as outline brief or strategic brief, design brief, functional brief, financial brief, facility management brief, etc. This study, however, considers the brief as the document which expresses the client's requirements in terms of his/her real need and feasibility within the overall budgetary constraints. It should specify the relevant aims, the resources and the context of the project, and any appropriate design and performance requirements within which all subsequent briefing can take place. In short, in whatever name it is referred to, it should provide a functional basis for design interpretation.

The briefing process normally encounters a number of problems. These include:

1. The huge amount of project information that has to be addressed during the briefing process. Inability to acknowledge and provide access to such information frequently leads to poor interpretation of the client's needs.
2. Clients often lack the ability to identify and communicate their true requirements to designers, either through their lack of experience or the lack of sufficient and useful information to support them during this process.
3. Misunderstanding of each other's intentions on the part of the clients, designers and other project participants.
4. The lack of mutual trust and understanding between all the project participants.
5. The lack of common objectives between the parties involved in a project. This is especially prominent in a multi-faceted client organisation.

6. The tendency of designers to rely on previous experience. They tend to act within a pre-determined set of rules and a fixed course of action acquired from past experience. This leads to a variety of ways of conducting the briefing process and a non-standardised way of formulating and presenting the brief.

Above all, the lack of communication between the various parties concerned is the key to all the problems associated with the briefing process. This can lead to a brief that fail to meet the client's requirements, which consequently could lead to cost and time overrun, as well as contractual disputes.

The following suggests ways to improve or facilitate the briefing process:

1. Encourage clients to participate fully or in an increased capacity during the briefing process.
2. Educate and inform inexperienced clients by raising their level of awareness through effective presentation and manipulation of project and construction industry related information, as well as by exposing them to a range of initial design concepts.
3. Designers should exercise effort to understand the overall client organisation in terms of its characteristics as well as the needs and requirements of the client and the users.
4. Briefing, as an iterative process, should be given adequate time to evolve to ensure a thorough analysis of the client's requirements is conducted.
5. The formulation of the brief and its contents should be kept generic and abstract so that design alternatives are not limited.
6. The use of standard briefs by repeat developers or regular clients, e.g. those involved in frequent capital development as well as supermarket and chain store developers

leads to greater consistency and a degree of uniformity in meeting the client's requirements. This practice is usually coupled with a commitment to a continuous development programme. However, their use by owner-occupier clients are limited. Here, the emphasis is on value for money in terms of how the design accommodates the activities of the client's organisation.

7. The development of the brief can run concurrently with the design process depending on the method of procurement selected or with the emergent of integrated construction environments.
8. The use of IT to support the briefing process is still under-utilised. With further research in this area the potential of IT can be further explored.
9. Improved presentation of information during the briefing process can be achieved by structuring the relevant information in such a way that it enables existing technologies to capture and manipulate this information quickly and efficiently.

A review of currently available publications and guidelines to brief formulation was carried out to identify the types of information required for inclusion in the brief. A number of guidelines were examined to ascertain their emphasis, the structure of information and the format of the contents of the brief. Based on a comparative analysis, a new framework for the brief presentation was proposed, which was adapted from these guidelines. Following this, the role of IT within the briefing process was investigated. Currently, there are not many IT systems available which specifically support the briefing process.

An examination of the various techniques available for organising project information was undertaken. A number of information and process modelling techniques were evaluated, which led to the selection of EXPRESS-G for the task of information modelling, and IDEF0 for the process modelling.

Based on the literature, the guidelines for the brief formulation and presentation, a full analysis of the required information was carried out. This has resulted in a set of EXPRESS-G models representing various levels of information details. These models also portray the relationships and cardinality constraints between the information entities as well as their attributes. These information models form the basis for the presentation of the brief.

The IDEF0 technique was adopted to model the brief development process. The process was subjected to a functional decomposition to reflect the various levels of detail of the activities concerned. A two step modelling process was conducted. The first step was to model the process within the context of current briefing operations in an abstract form. The second step involves the modelling of the activities within the context of the prototype development; firstly, in relation to the information required for inclusion in the brief and secondly, based on the system architecture of the prototype. In other words, the former is indirectly linked to the constituents of the information models.

The information and process models were then linked and implemented into an object oriented environment. The tool utilised for this purpose is KAPPA-PC, which is a knowledge based development environment. The constructs of the information and

process models were transformed into their equivalents in the object oriented environment. During the implementation process, object structures and object's behaviour and reasoning were incorporated into the system. This involved the creation of objects, attributes (slots), methods and functions.

The system architecture of the prototype, i.e. AUTOBRIEF, was then established. It comprises three main components; the Interface, the Core Engine and the External Resources.

- The Interface allows the user and the system to interact with each other. It has two sub-components; the Input Media, which captures the user's input data, and the Visual Media, which allows the user to visualise specific information, instructions or messages in the form of text, images, pictures or sound.
- The Core Engine, which is the main component of AUTOBRIEF, is the central core of the overall system. It is an object oriented knowledge based system where all the data models and knowledge of the brief domain are stored. The Core Engine has a sub-component, the Interpreter, which serves as an intelligent front end to the system. The Interpreter assists the Core Engine to perform the consultation process of identifying the user's requirements. It interprets and verifies the data input (client's requirements) in terms of its suitability for the development of the brief. It controls the Interface by deciding on the exact data to be captured and the specific information to be displayed at the required time.
- The External Resources component supports the Core Engine in terms of providing projects and construction industry related information. It comprises a number of external resources or databases which contain specific information such as building

regulations, specifications, design and performance requirements in the form of textual or graphical information. Access to the Internet is also made available to allow users to access up-to-date information at certain predetermined instances.

Finally, a prototype was developed which has a two-mode user interface:

- the “consultation” mode, where the client’s requirements are investigated and captured, and access to information sources are made available.
- the “generate brief” mode, where the brief is generated and presented to the user based on the captured client’s requirements.

The developed prototype was subjected to a testing process. The testing procedure was aimed towards evaluating the overall conceptual approach of the prototype implementation in terms of how effective it is in support of the briefing process using IT as a tool. The flexibility of the approach for future development was also evaluated. Finally, the prototype was subjected to a limited testing/debugging process.

12.3 Main Conclusions

The main conclusions derived from this study are itemised below:

1. Over the last three decades, little has been achieved in terms of improving or innovating the briefing process. This is mainly due to the inherent problems encountered during the briefing process, many of which stem from the communication gap that exists between clients, designers and other project participants. The study has identified the main problem areas and proposed ways to

improve/facilitate the briefing process. The study reaffirms the benefits that can be gained from active client's participation during the brief development process. Such participation would enhance the client's understanding of the needs and objectives of the organisation and widen his/her overall knowledge of the construction industry. The outcome is a more accurate brief which meets the client's expectations.

2. The review of available publications and guidelines has indicated that, even though the brief structure or format may differ, they all share the same emphasis, that is, (i) to ensure that the brief is comprehensive, i.e. overcome the aspect of being inadequate or not explicit enough, and (ii) to reflect the true requirements of the clients. Even though the format and wordings differ, the essence of the contents are more or less similar. Based on the analysis of this study, a structured framework was established for the contents of the brief which encompasses five major sections. They are :

- Project Identification
- Project Aims
- Project Resources
- Project Context
- Design and Performance Requirements

3. The modelling of the briefing information based on the above structured framework proved to be flexible and manageable. The EXPRESS-G modelling technique also emerged as an excellent technique for depicting static data. It enables the information to be portrayed in the form of entities, and their subtypes and attributes. The links

between the entities are established by their relationships and their cardinality constraints. Moreover, the fact that EXPRESS-G allows information entities to be decomposed into various levels of detail, leads to a better understanding of the overall briefing process, along with the precise item of information that need to be acquired at every stage of the brief development process. This set of models provide an excellent graphical presentation of the structured framework for the brief presentation.

4. The IDEF0 technique proved to be successful in depicting the activities (or dynamic data) involved at various levels of detail. The initial modelling of the process within the context of an abstract representation of the briefing practice led to the identification of the activities to be performed by the prototype. These activities were identified within two viewpoints. The first viewpoint relates to the information to be acquired from the system's user. The second viewpoint models the activities in relation to the system architecture of the prototype. Hence, by considering these activities within two viewpoints, the overall system process of the prototype was conceptualised.
5. The selection of the EXPRESS-G and IDEF0 modelling techniques have proved to be effective and useful during the transformation of the information and processes into the object oriented environment. The use of the Coad and Yourdon's (1991) methodology as a guideline where appropriate, has enabled this process to be carried out effectively and with relative ease.

6. The use of KAPPA-PC as the object oriented development environment for quick prototyping proved to be appropriate. It permits the information and process models to be linked and allows the implementation of both static (entities and attributes) and dynamic (methods and functions) data to be carried out simultaneously. The resulting object oriented data models form the basis for the development of the system architecture for the prototype. This, together with item (5) above demonstrates the viability of the developed information and process models.

7. The developed prototype, AUTOBRIEF has many features which include:

- an introductory explanation of the objectives, system architecture and limitations of AUTOBRIEF
- identifies, interprets and captures the requirements of a particular client
- resolves conflicts between the client's requirements
- provides access to sources of information (internal and external resources, e.g. the internet)
- presents useful project and construction industry related information in the form of text and graphics (building regulations, specifications, design and performance related information, product and technical data, etc.) in a timely and efficient manner
- generates a brief (in whole or in part) which is clear, consistent and organised, and reflect the client's actual requirements
- presents the brief in textual form in a suitable format which can be viewed from within the prototype, Windows Notepad or Microsoft Windows
- presents a pleasing and user-friendly interface

8. The generated brief provides a conceptual basis for design interpretation. Its contents can lead to the development of design alternatives which suit the client's requirements.
9. The testing process, although conducted within a limited capacity has established the viability of the approach adopted for the prototype implementation. The prototype is considered to provide a systematic approach to developing the brief, and hailed as a useful and effective mechanism to aid the decision making process and to improve the communication channel between the project participants during the briefing process.
10. The prototype would be useful to all project participants, in particular, the clients and designers. It not only has the potential to serve as a tool to support the briefing process, but also, to provide an avenue for continuous professional development to construction professionals as well as training to new architects or designers.
11. The approach adopted to the prototype implementation has given rise to a prototype which is open-ended. It has the flexibility to accommodate future development. Hence, AUTOBRIEF has the potential to be used as a stand-alone system or as part of an integrated environment.

Finally, it can be concluded that this study has achieved its aims and objectives which have been stated in Chapter 1. This would pave the way towards improved communication between clients and designers, and other project participants, which in

turn would bridge the gap between clients and the key players of the construction industry.

12.4 Recommendations for Further Research

A number of recommendations concerning further research work and development is highlighted below:

1. Further developments to the prototype with the aim of improving its functionality and applicability. This includes the following:
 - a) include all the brief contents into the generated brief. This would involve the complete object oriented data models and knowledge to be implemented into the knowledge based development environment. The final result would lead to a complete system which would have the potential of serving as the main tool to support the briefing process.
 - b) increase multimedia support to the prototype. This include additional audio capabilities, access to video files, CD-ROMs, a bigger collection/database of pictures, images and graphics, appropriate animations or simulations of construction activities, past project performances, etc.
2. To explore the possibility of using a different approach to the system's interface by dividing the overall briefing process into predefined stages. This approach was not incorporated into the development of AUTOBRIEF since the adopted approach aims

to accommodate concurrent engineering over the entire briefing process. Based on these stages, users would not be allowed to proceed to the next more advanced stage until all the requirements for that particular stage had been established. The knowledge gap for the preceding stage would be highlighted to the user prior to moving on to the next pre-determined stage. Alternatively, the system could check with all the available information or data input by users for a particular stage in design. In this way, any gaps in the information could be identified and users could be prevented from proceeding to another advanced section until the gaps had been dealt with. This approach could provide an alternative to the approach adopted in the prototype development.

3. To integrate AUTOBRIEF with integrated construction environments (ICE) with the aim of achieving concurrent engineering. A number of such environments have been developed or still under development. They include SPACE (Alshawhi and Faraj, 1995; Alshawhi and Sulaiman, 1995; Alshawhi and Hassan, 1994; Underwood and Alshawhi, 1996), COMBINE (Parand, 1996), COMMIT (Rezgui et al, 1996), OSCON (TIME, 1997), etc.

In view of the current research being conducted within the university, AUTOBRIEF has been implemented to become an integral part of the integrated environment, SPACE (Simultaneous Prototyping for An integrated Construction Environment). SPACE is a PC based integrated environment prototype currently being conducted by the AIC (Automation and Integration in Construction) Research Group at the University. One of the aims of SPACE is to accommodate concurrent engineering

where various construction applications over the project life cycle are incorporated together within an integrated environment, thus enabling project information to be shared between these applications. Within the SPACE environment, AUTOBRIEF could step in at the point before design is initialised. Here, the client's needs or requirements would be identified after a rigorous consultation and dialogue process. Users would also gain the benefits to be offered by AUTOBRIEF, such as the presentation of useful and knowledgeable information. These input requirements would then be transformed into a complete brief.

As part of the overall integrated environment, the resulting brief (with all its properties and parameters) would then be fed into an AI tool which would be linked to SPACE and would have the capability of retrieving the best matching design plan based on previous design cases. Users would then be able to adapt the retrieved drawings to their own requirements. This would enable users to experience various design and construction activities without worrying about the stages or phases involved in the traditional staged controlled approach (Alshawi, 1995). Based on the input requirements, users would be able to document and visualise the actual design for the project, the simulation of construction works, the site layout of the construction work, the project estimates, etc.

Such an integrated environment would allow the identified client's requirements to be transformed directly into a workable design solution. Changes made to the client's requirements could be dynamically transformed into alternative design solutions.

Substantial benefits could be gained in terms of exploring alternative design solutions which can meet the client's requirements within a short timescale.

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APPENDIX A

THE STRUCTURED FRAMEWORK FOR THE BRIEF PRESENTATION

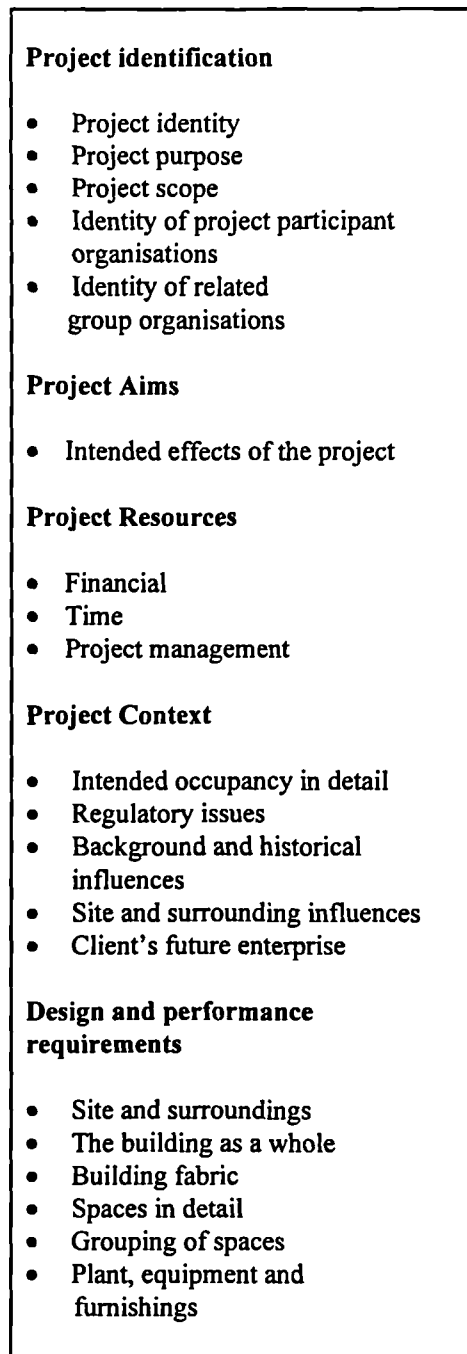


Figure A.1: The Structured Framework for the Brief Presentation

APPENDIX B

EXPRESS-G MODELS

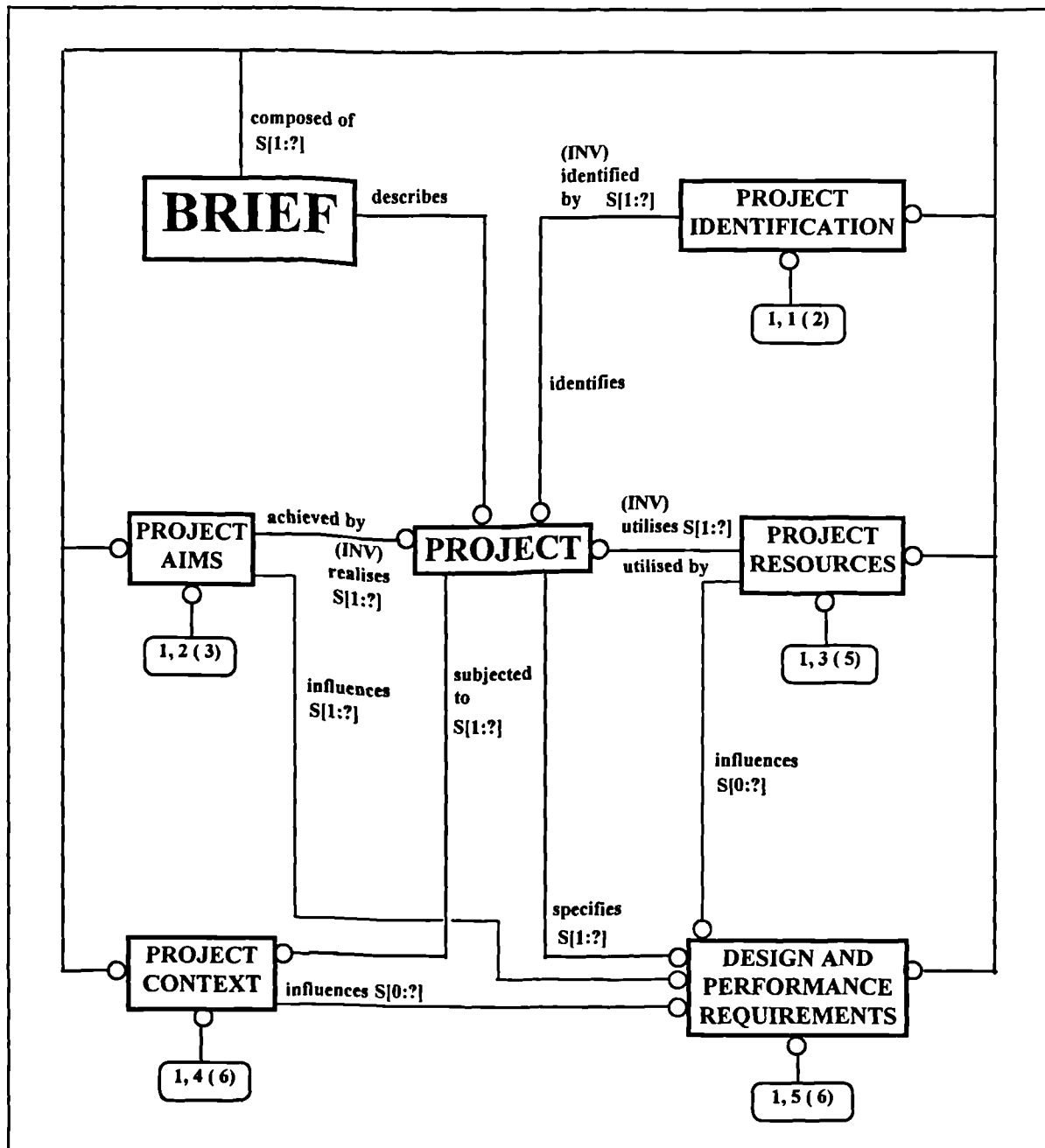


Figure B.1: Context Diagram - The Framework of the Brief Presentation
(Page 1 of 22)

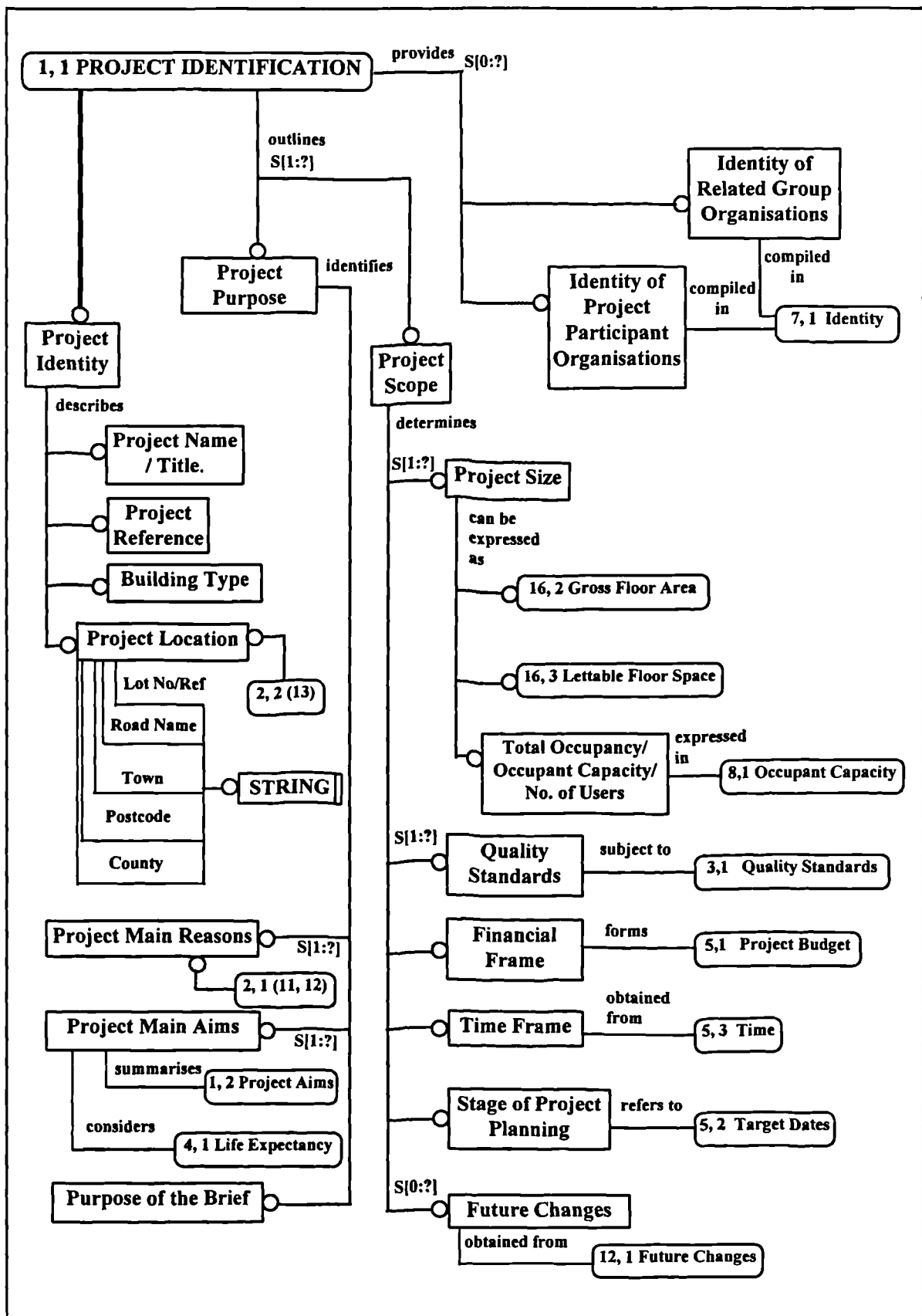


Figure B.2: Level 1 Diagram - Project Identification (Page 2 of 22)

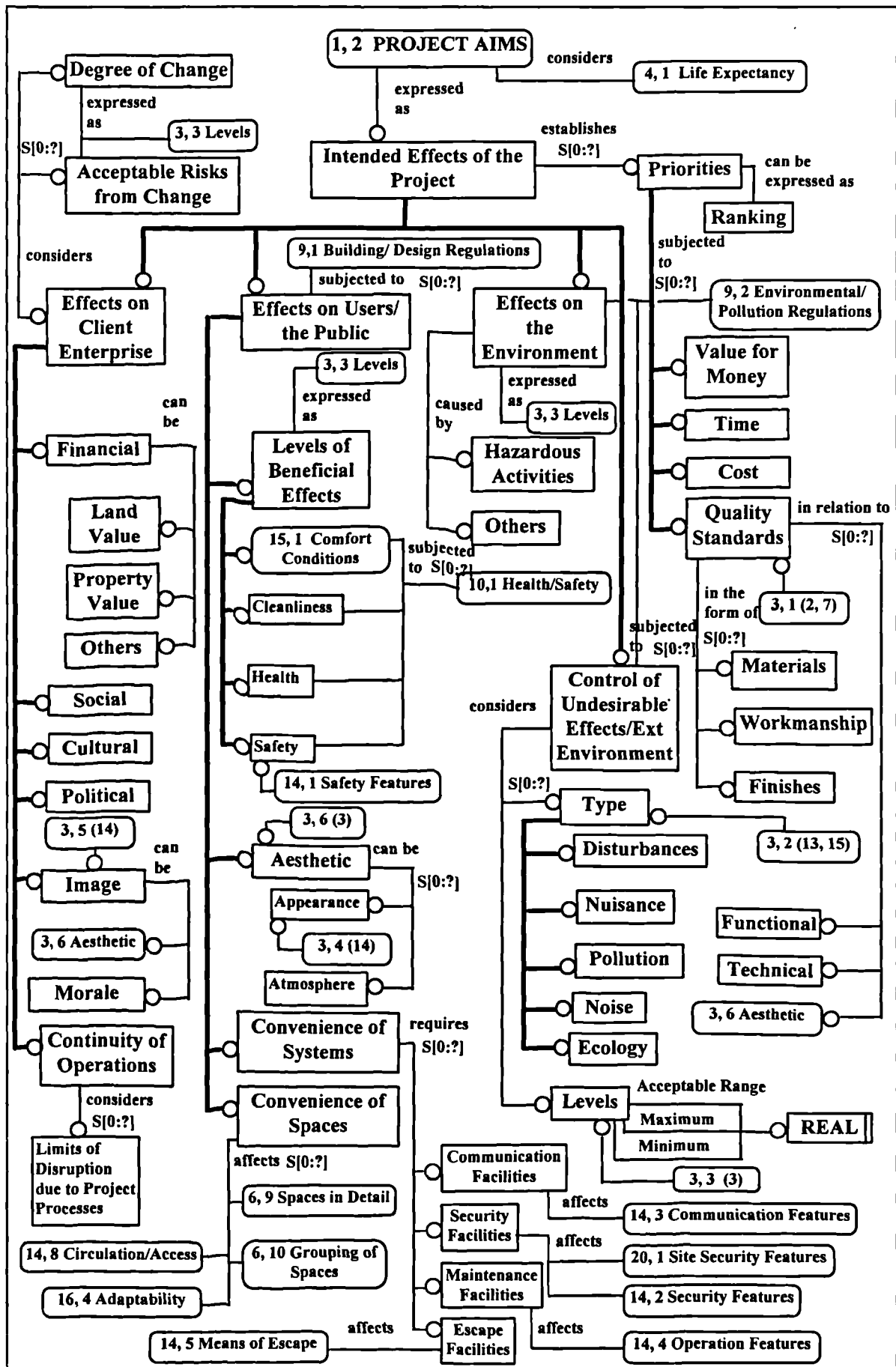
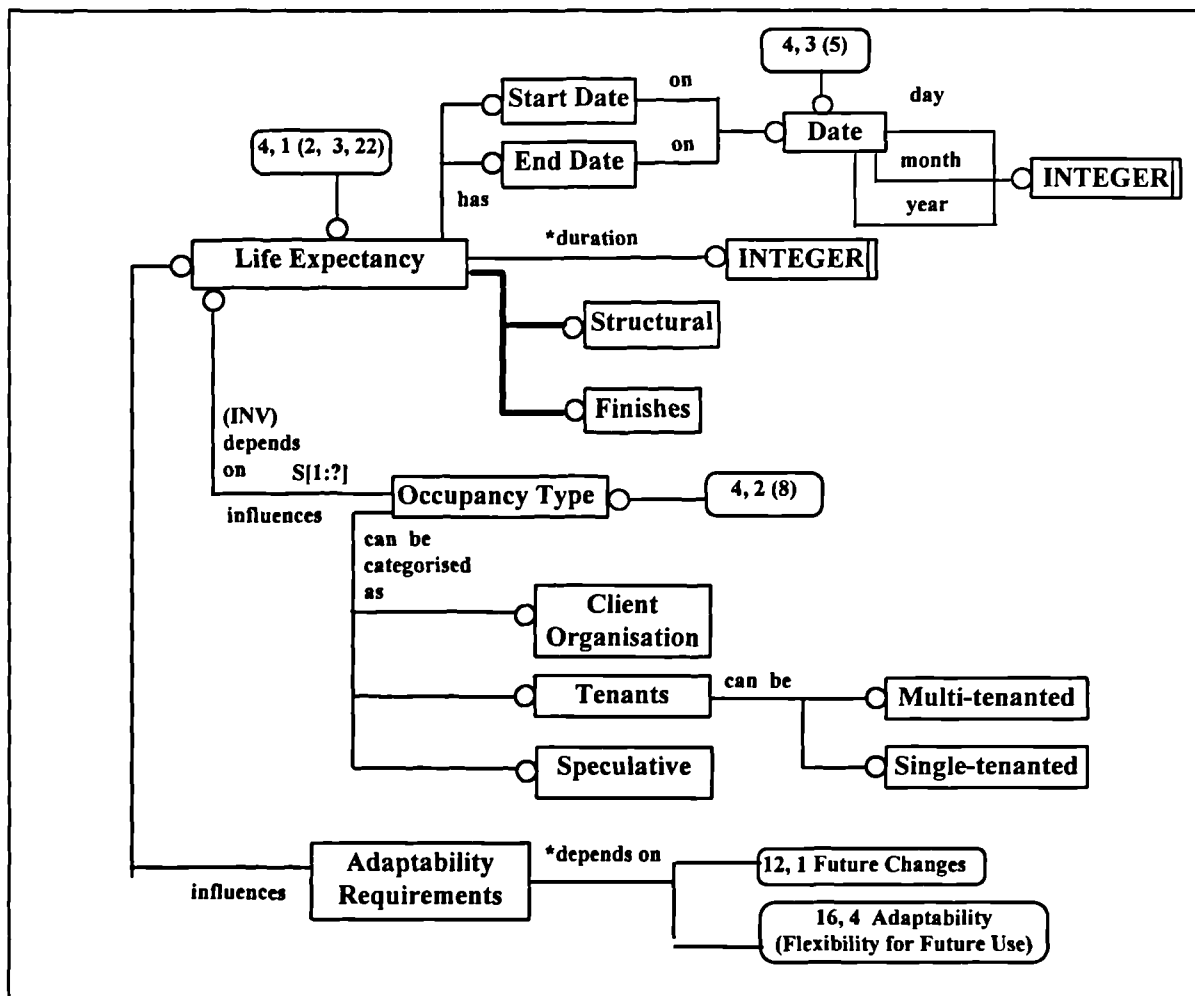


Figure B.3: Level 1 Diagram - Part Entity-Level Model of Project Aims
(Page 3 of 22)



**Figure B.4: Level 1 Diagram - Part Entity-Level Model of Project Aims
-Life Expectancy (Page 4 of 22)**

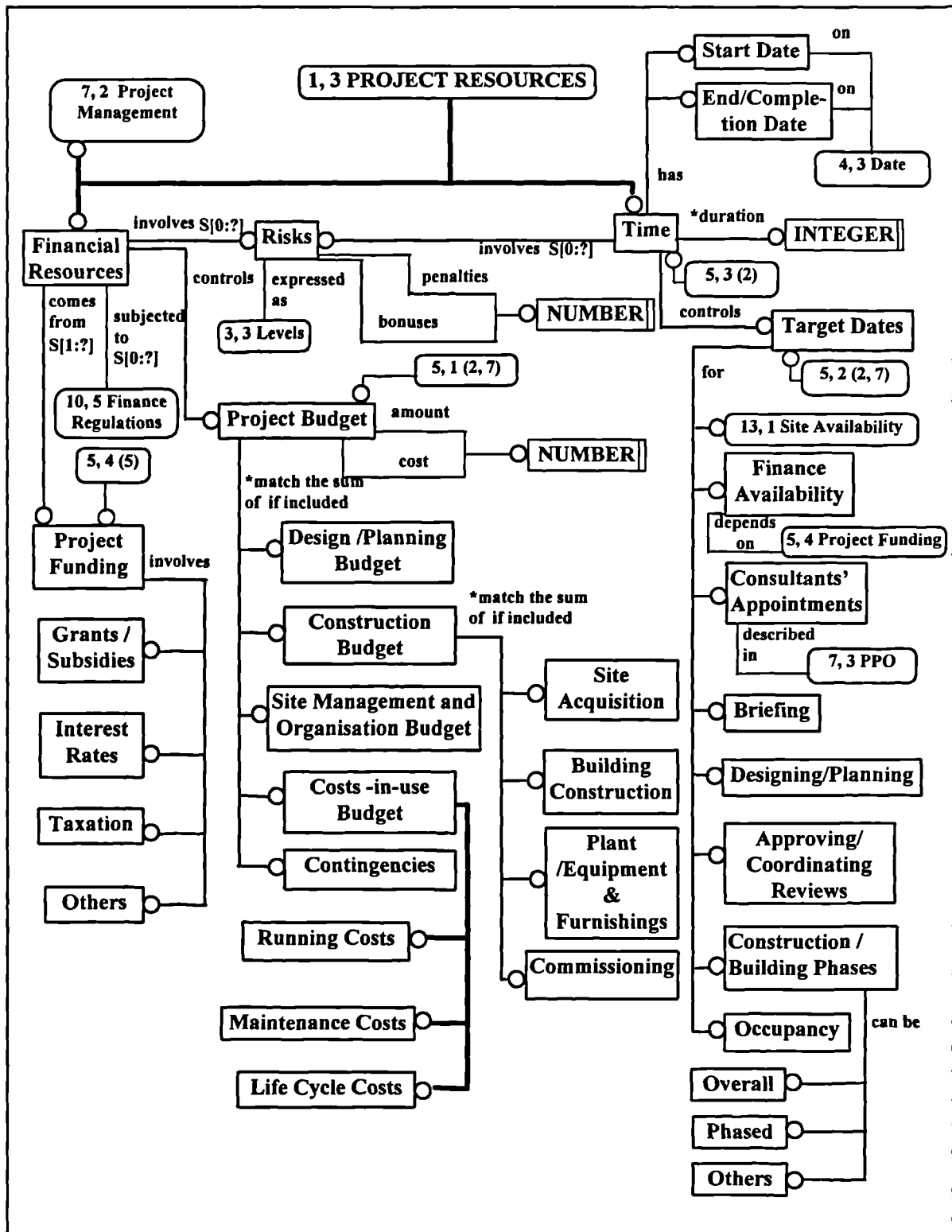


Figure B.5: Level 1 Diagram - Project Resources (Page 5 of 22)

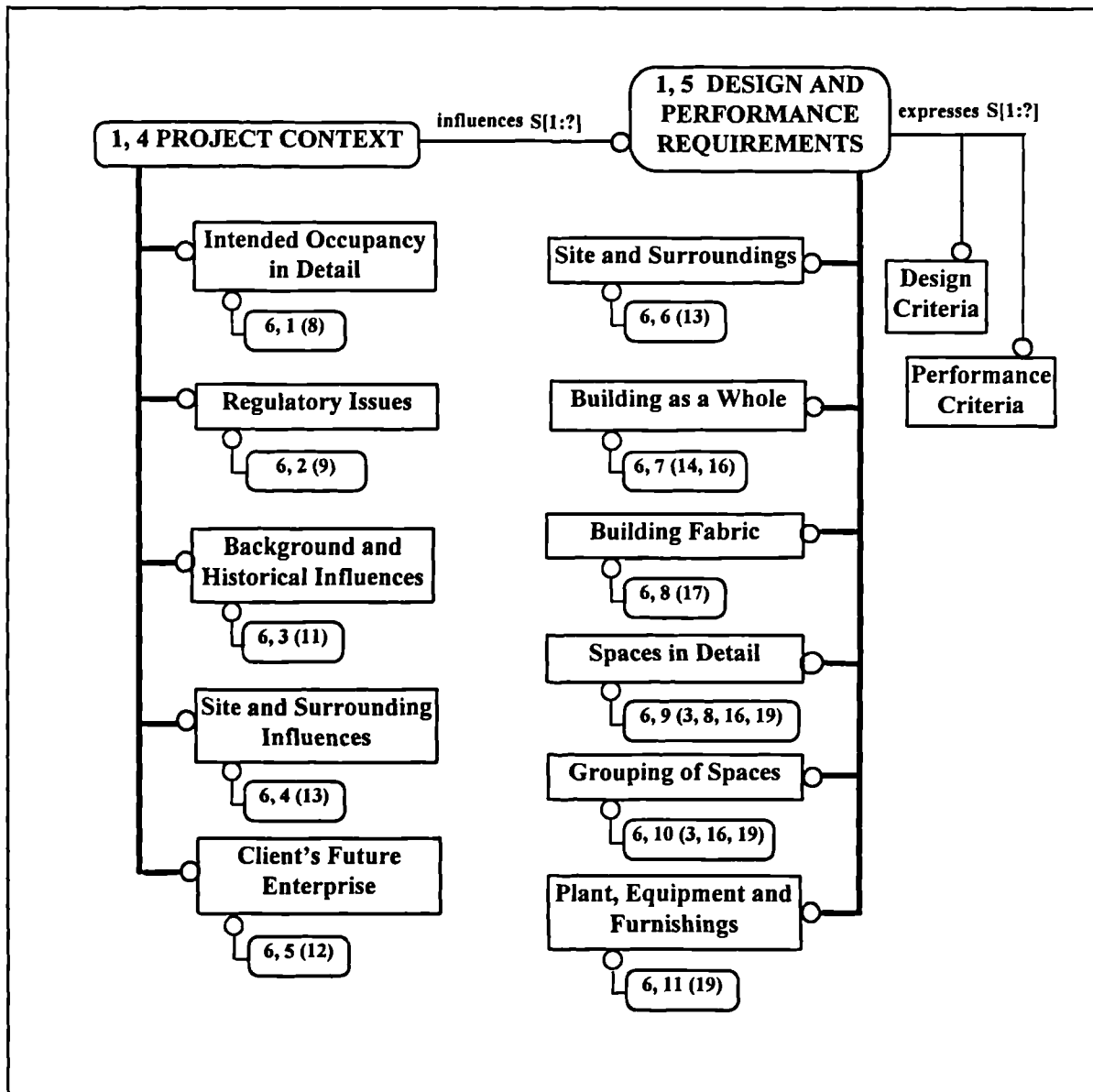


Figure B.6: Level 1 Diagram - Project Context and Design and Performance Requirements (Page 6 of 22)

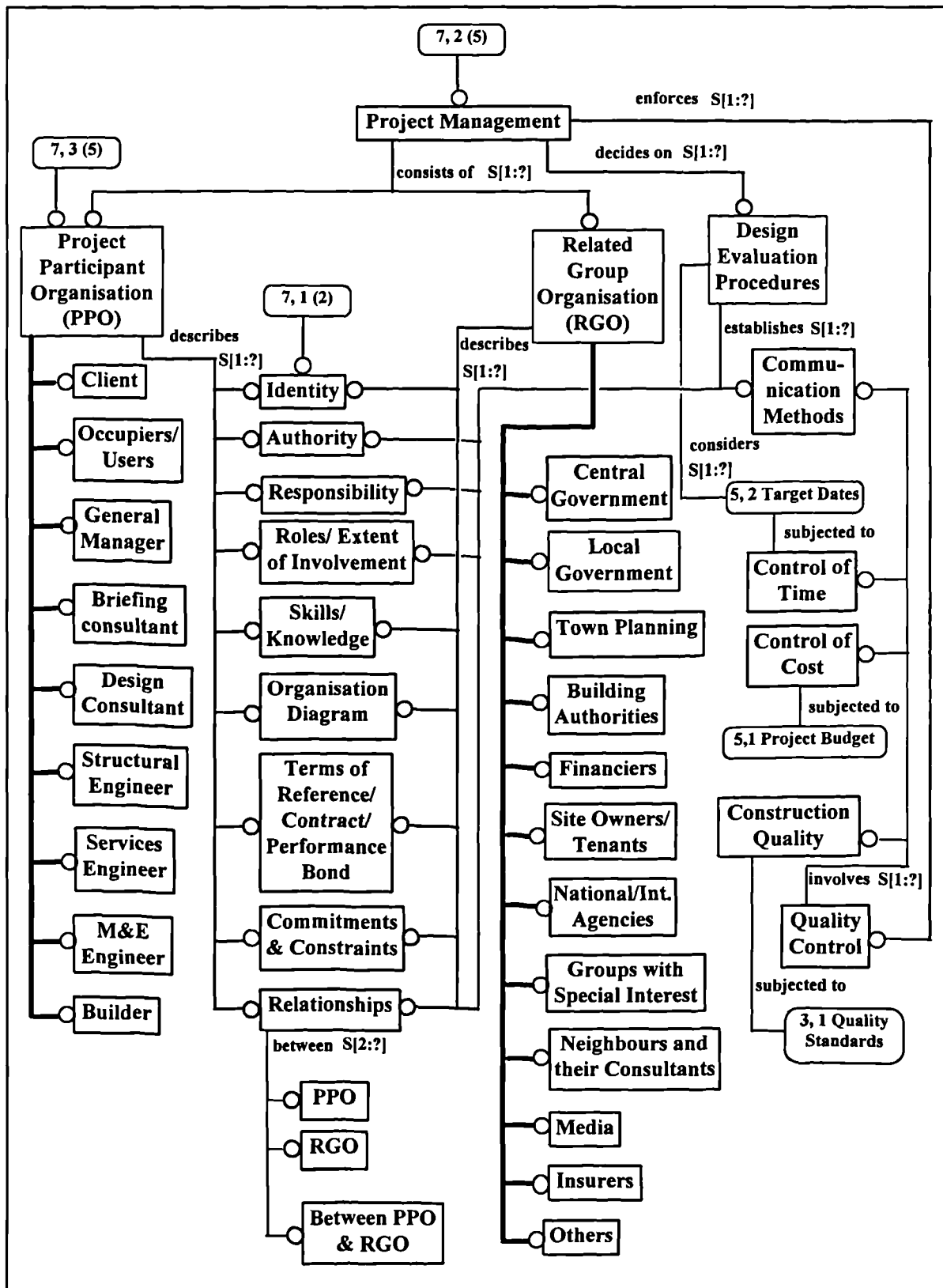


Figure B.7: Level 2 Diagram - Project Management (Page 7 of 22)

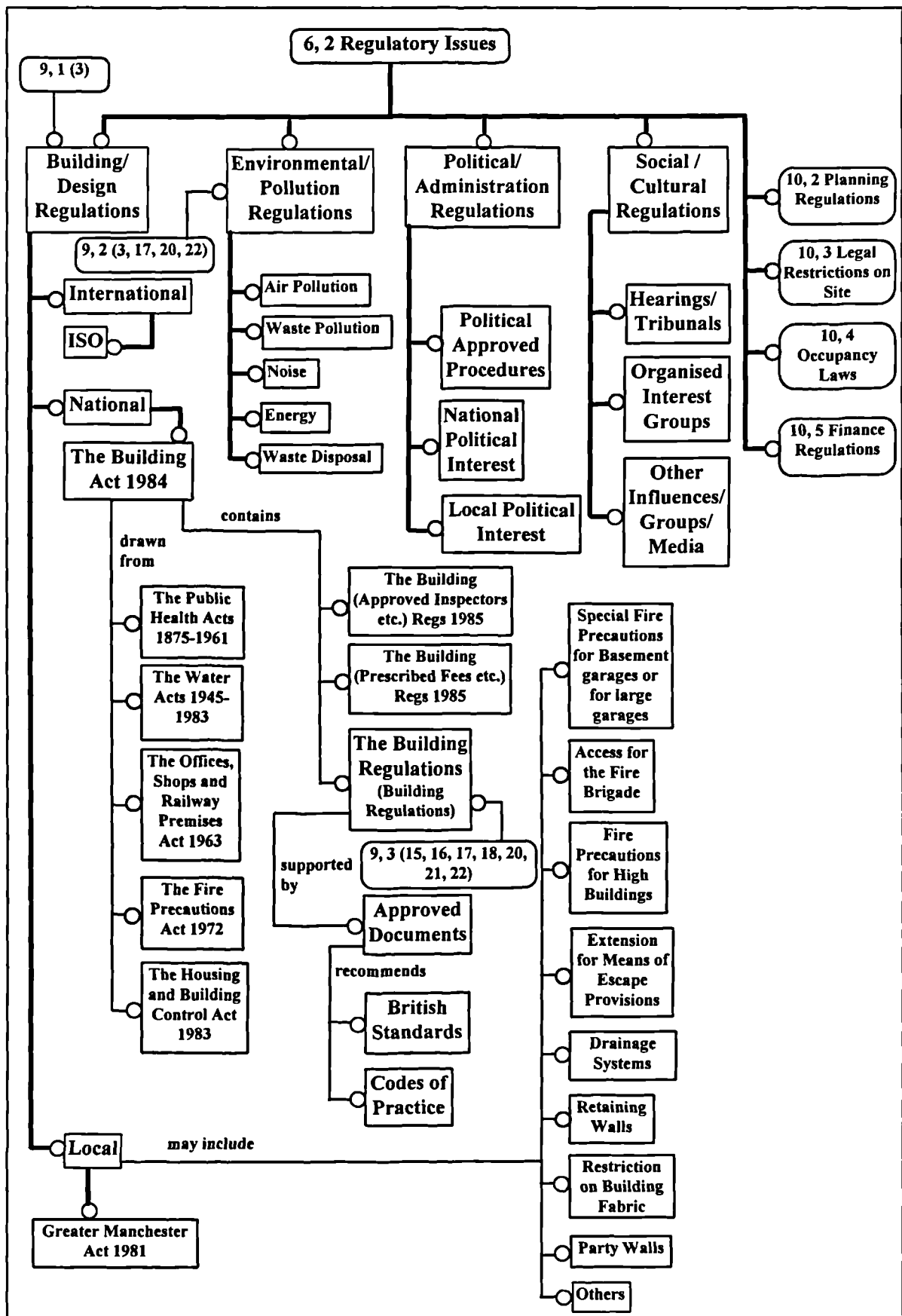


Figure B.9: Level 2 Diagram - Part Entity-Level Model of Regulatory Issues
(Page 9 of 22)

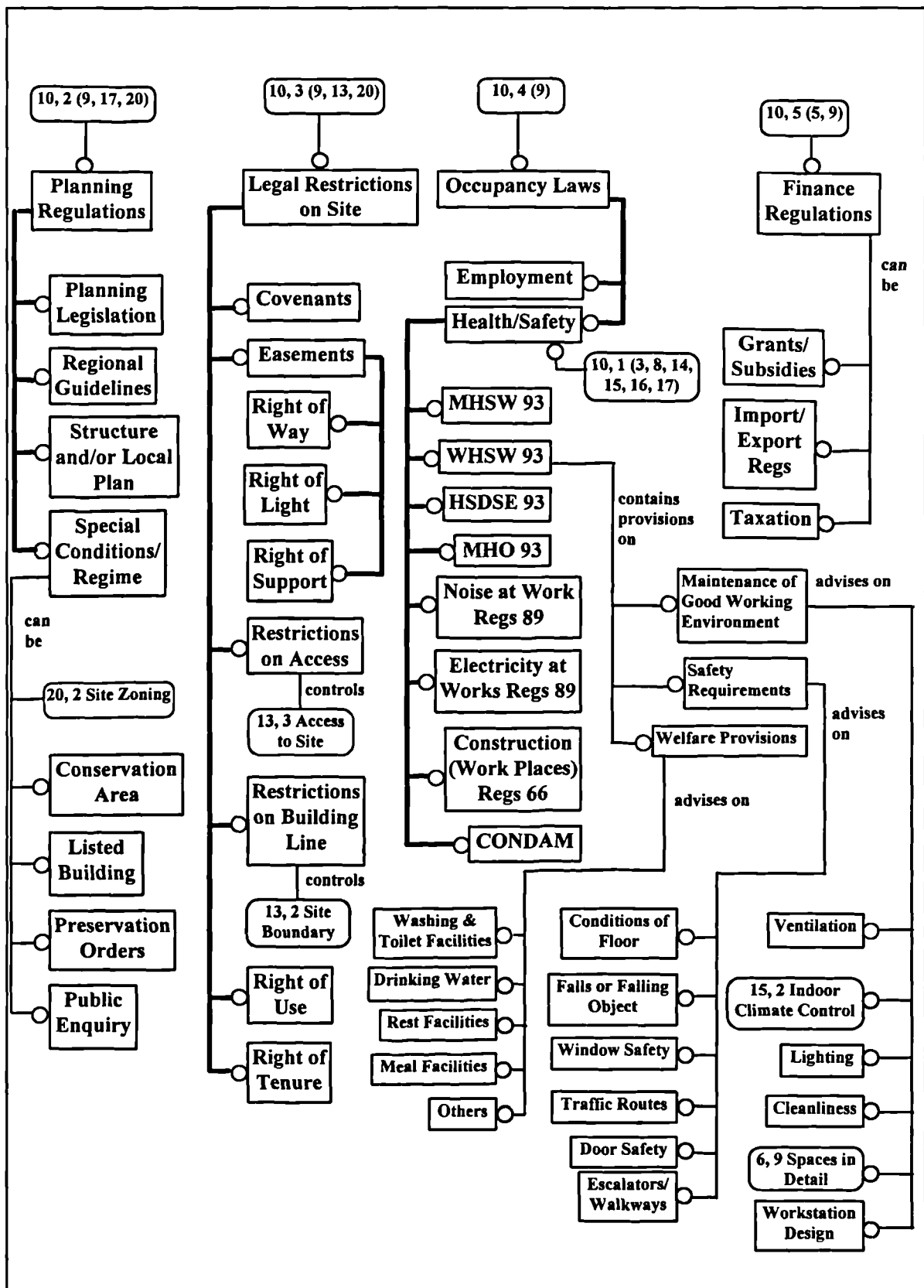


Figure B.10: Level 2 Diagram - Part Entity-Level Model of Regulatory Issues
(Page 10 of 22)

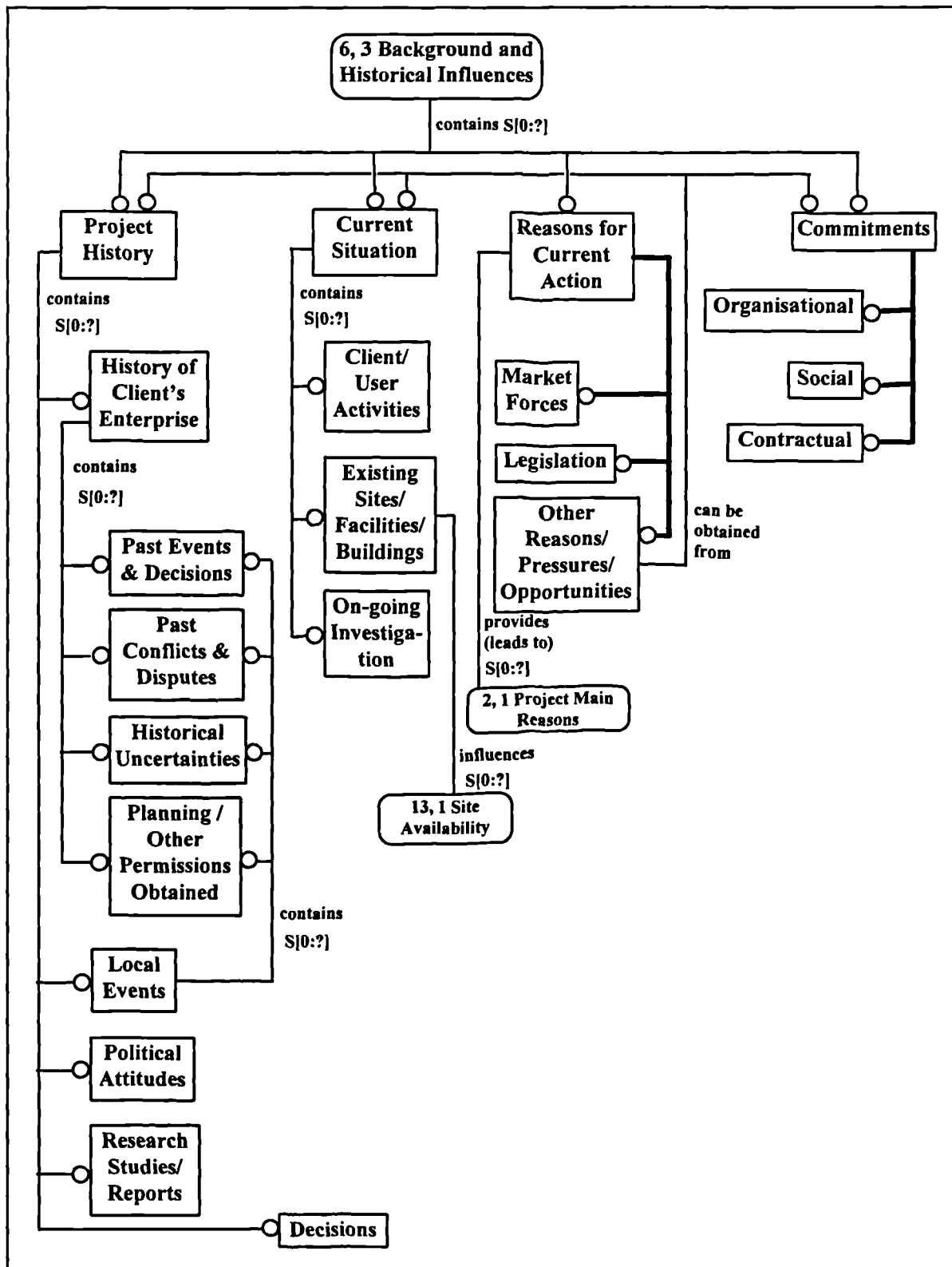


Figure B.11: Level 2 Diagram - Background and Historical Influences
(Page 11 of 22)

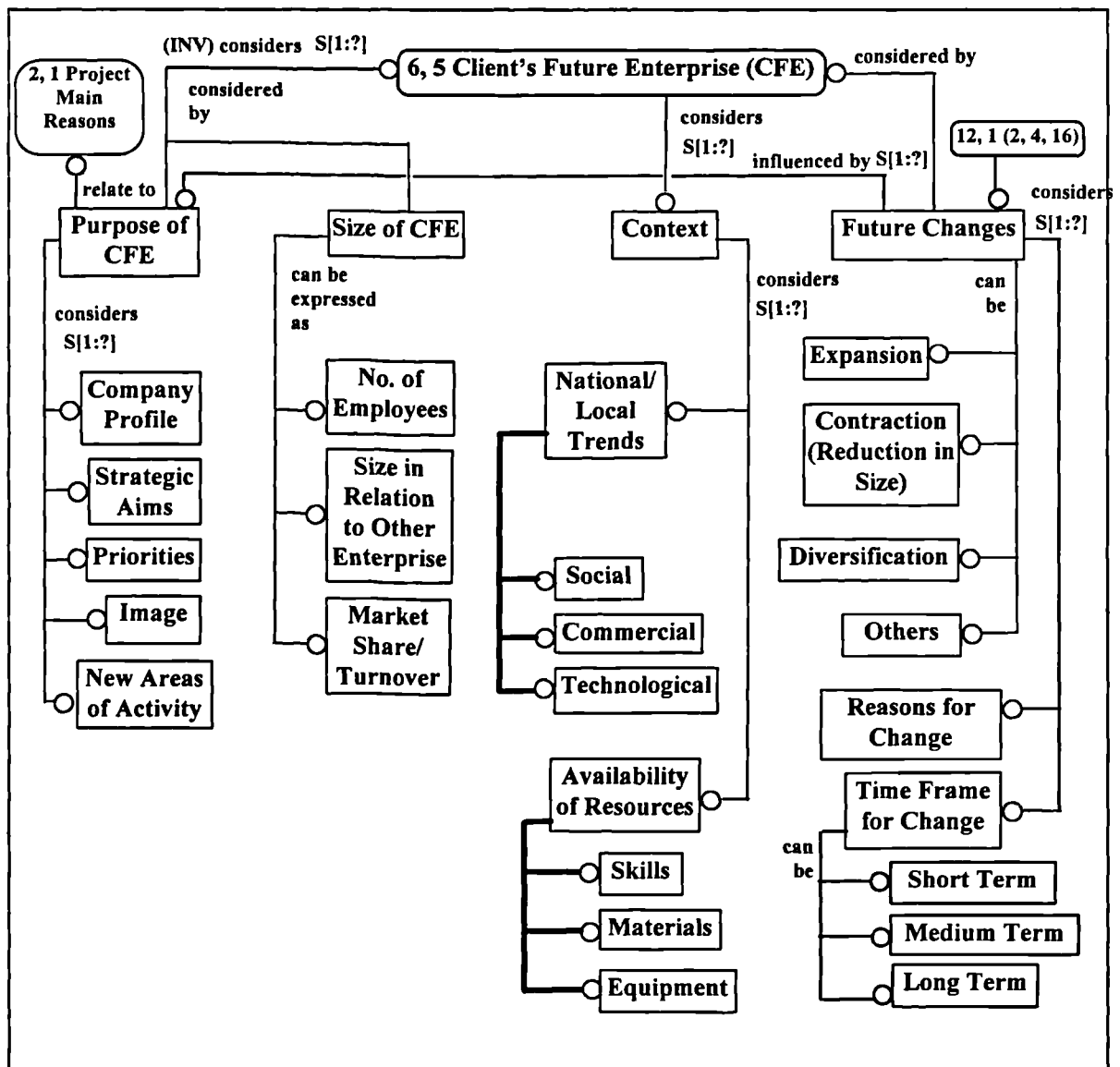


Figure B.12: Level 2 Diagram - The Client's Future Enterprise (Page 12 of 22)

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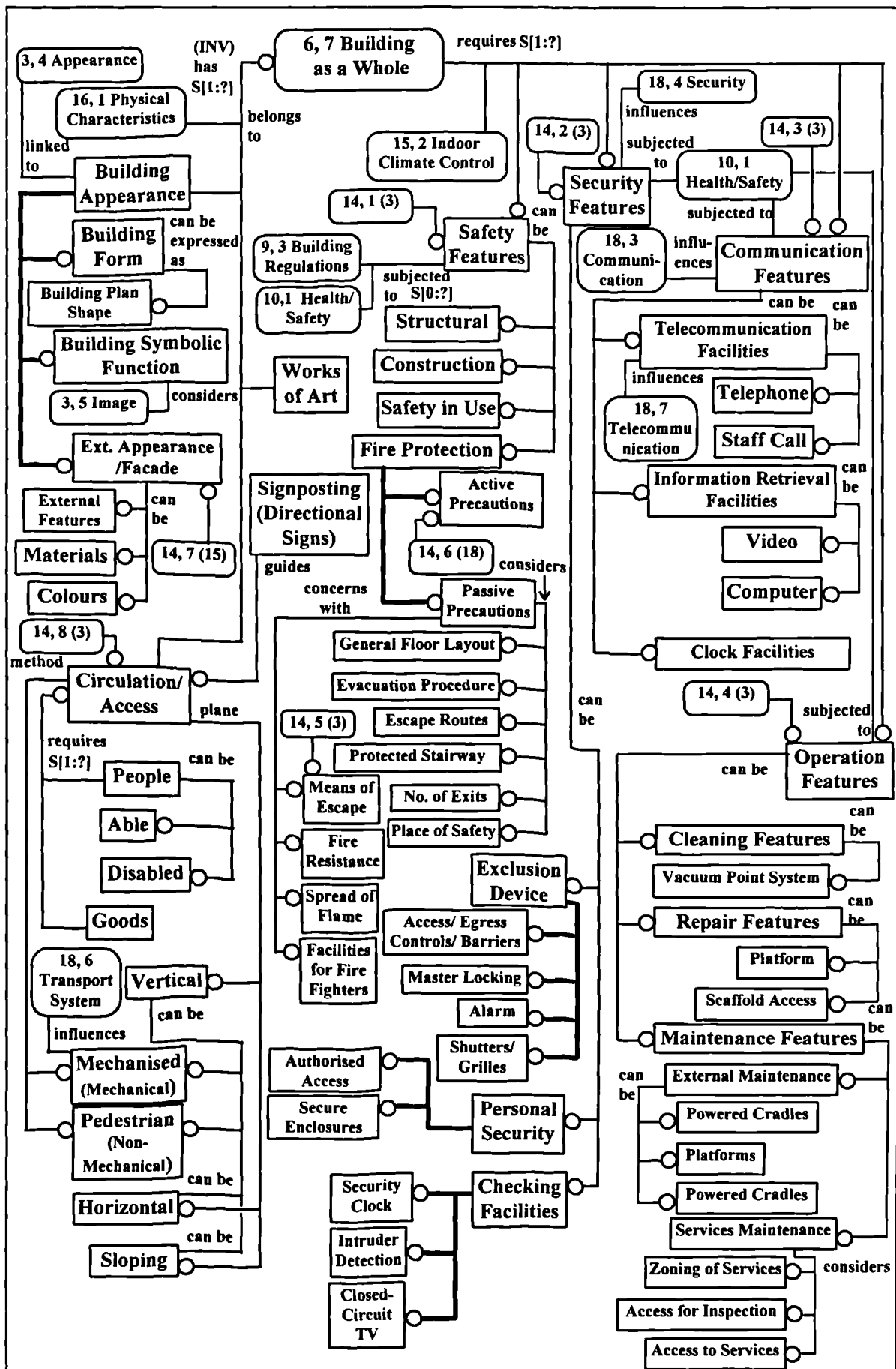


Figure B.14: Level 2 Diagram - The Building as a Whole (Page 14 of 22)

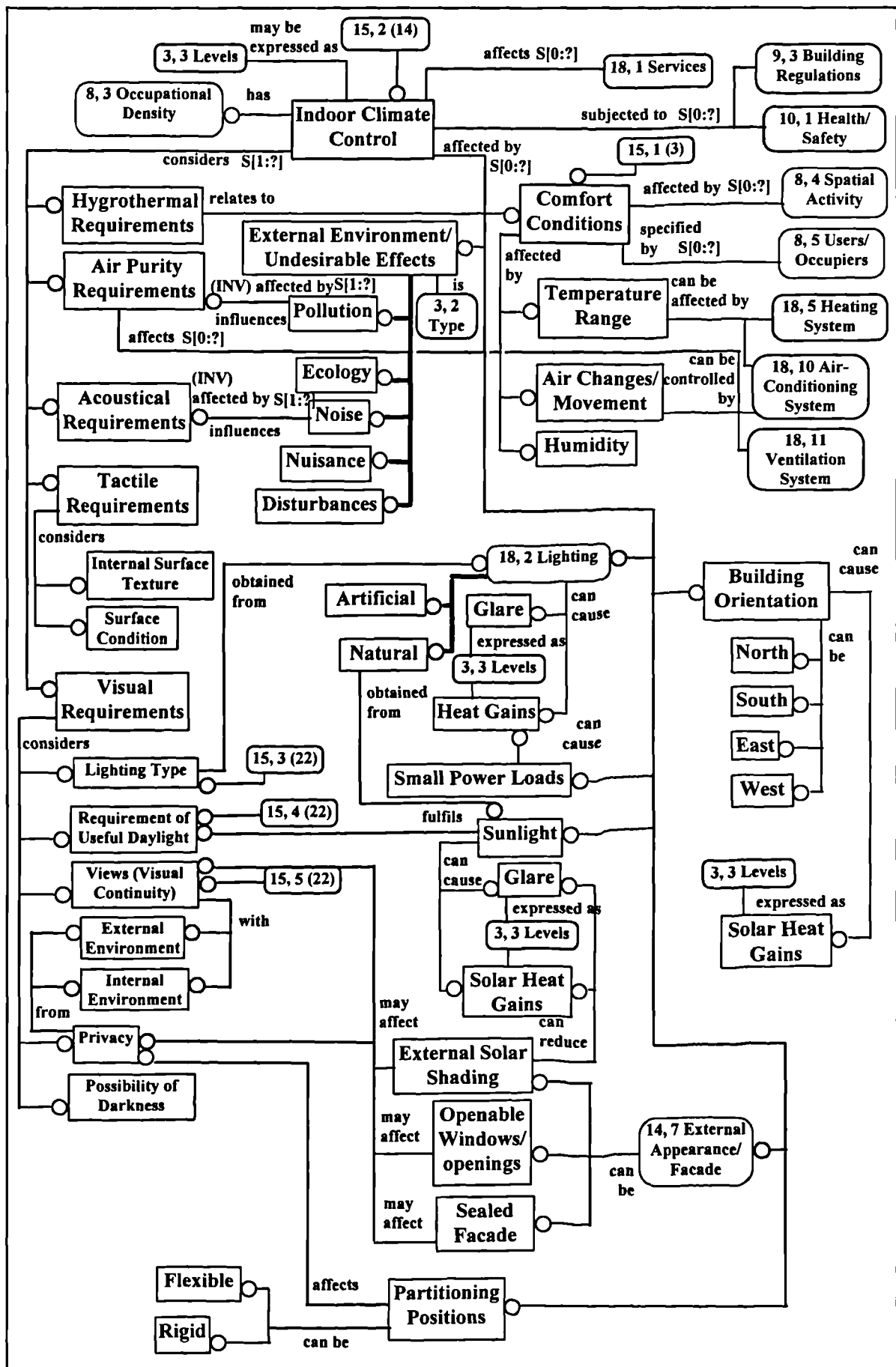


Figure B.15: Level 2 Diagram - Indoor Climate Control (Page 15 of 22)

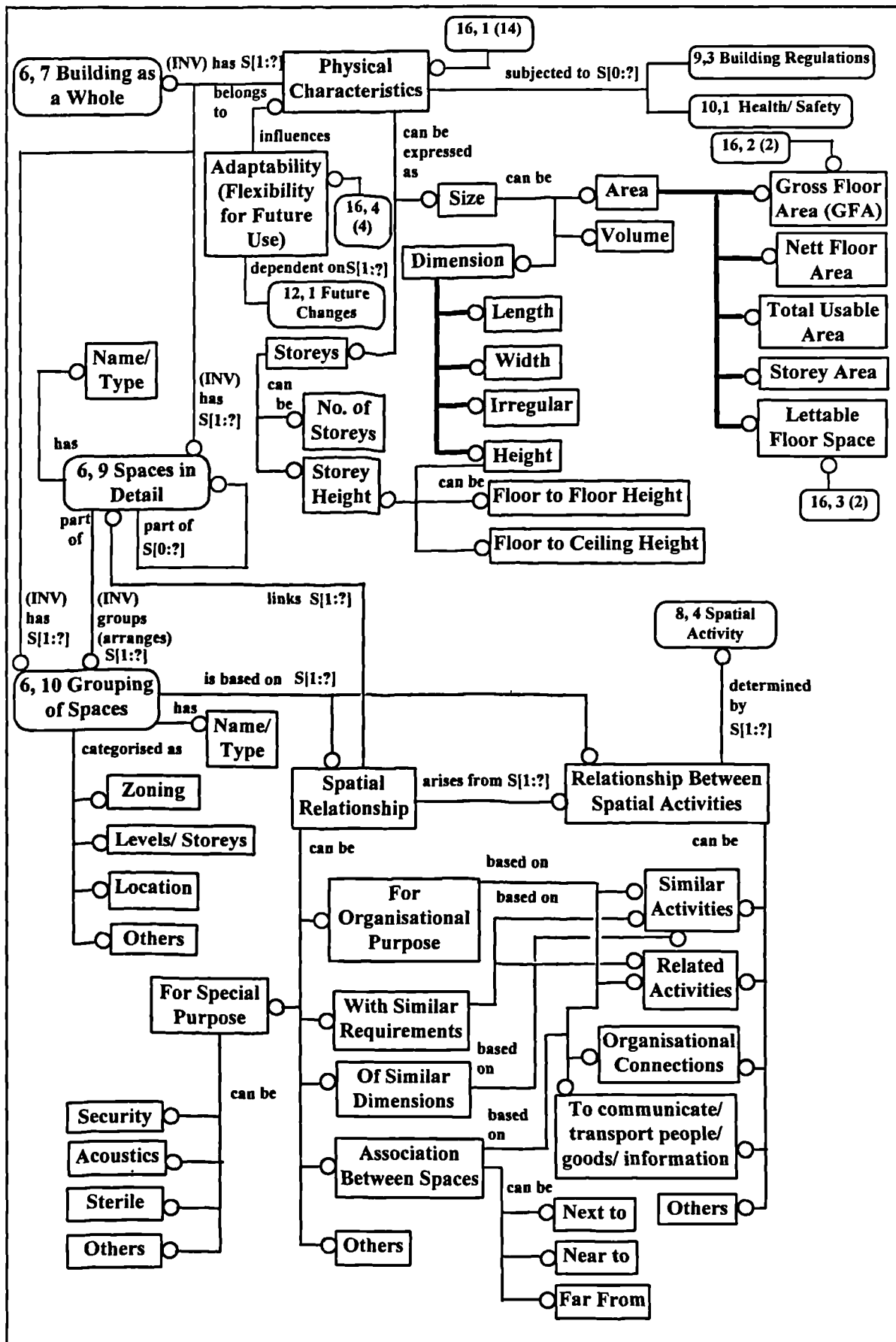


Figure B.16: Level 2 Diagram - "Physical Characteristics" in relation to Building as a Whole", "Spaces in Detail" and "Grouping of Spaces" (Page 16 of 22)

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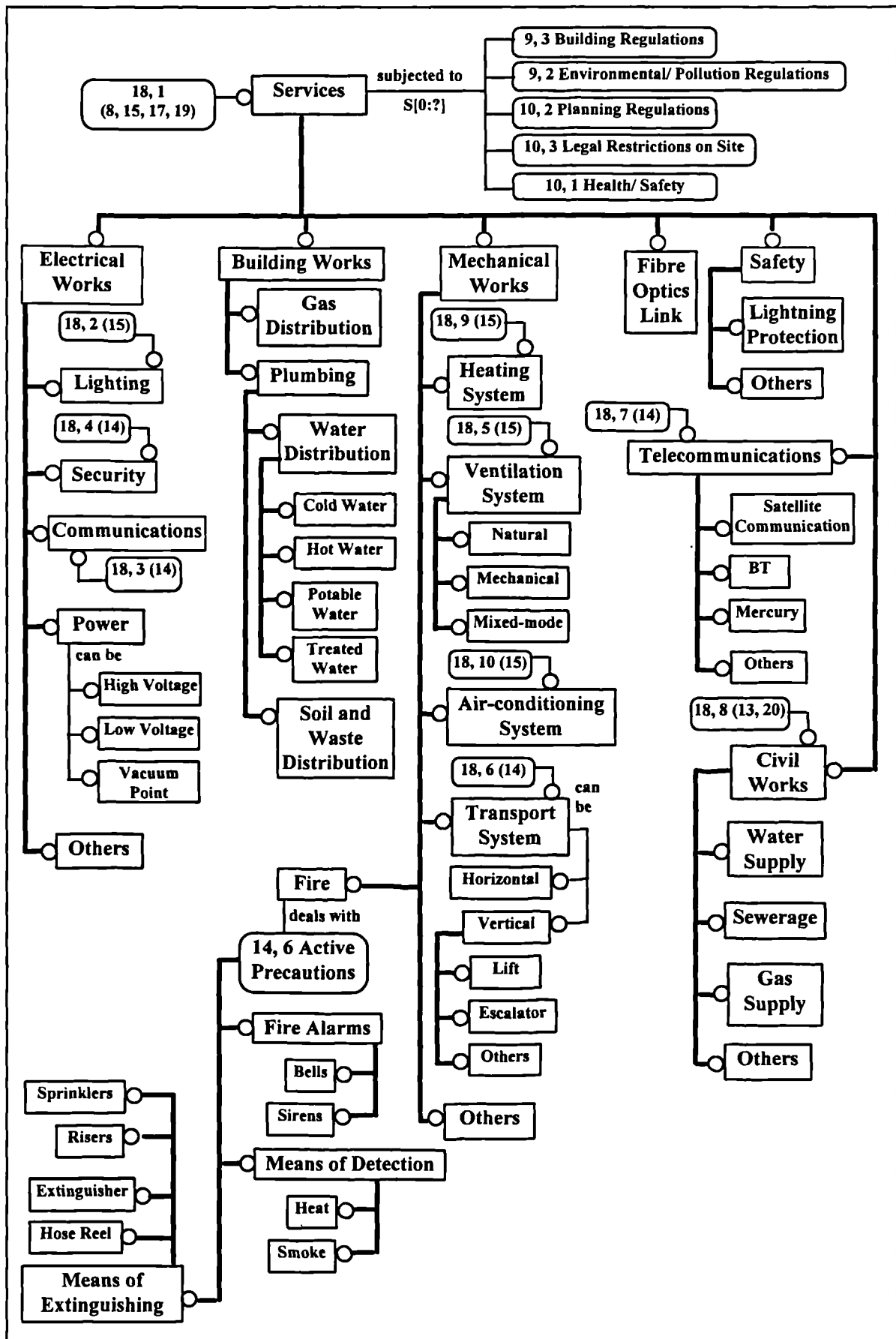


Figure B.18: Level 2 Diagram - Services (Page 18 of 22)

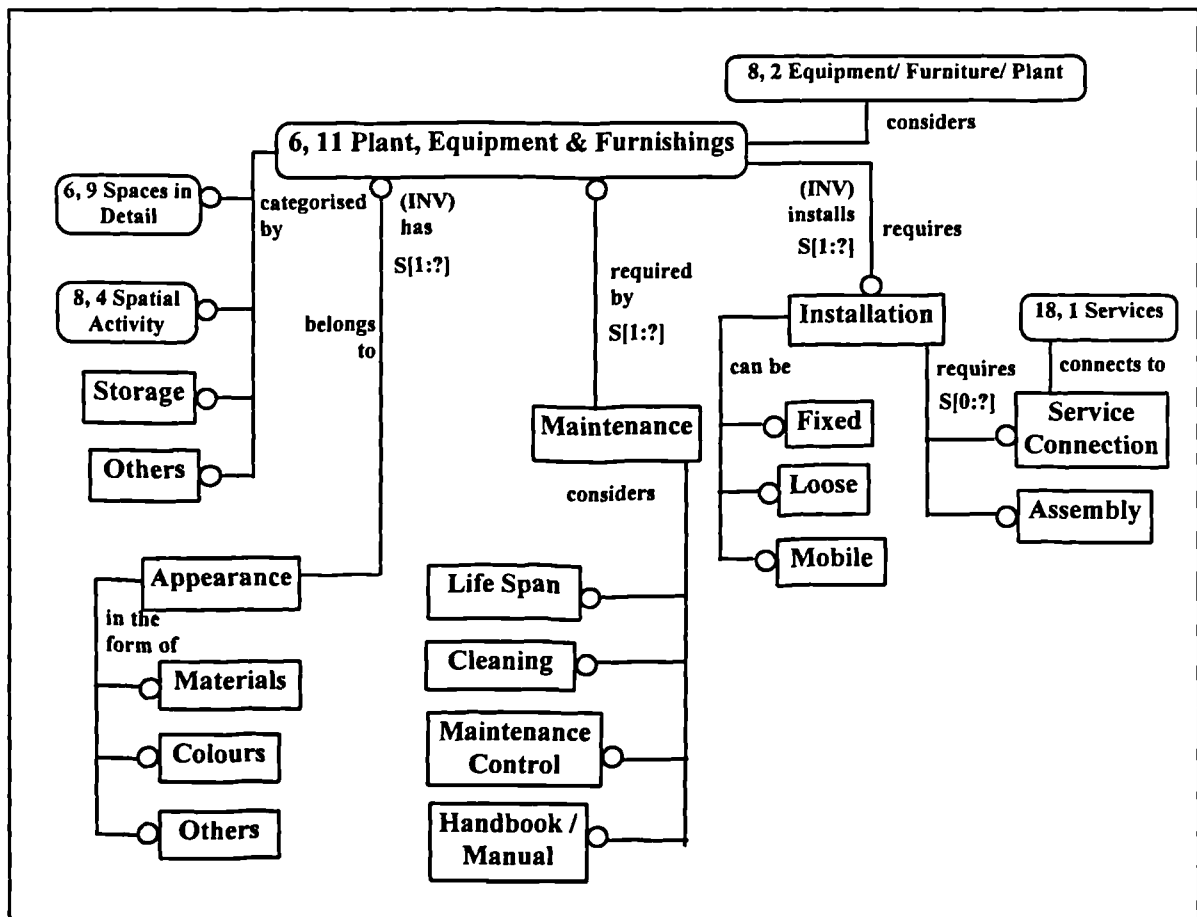


Figure B.19: Level 2 Diagram - Plant, Equipment & Furnishings (Page 19 of 22)

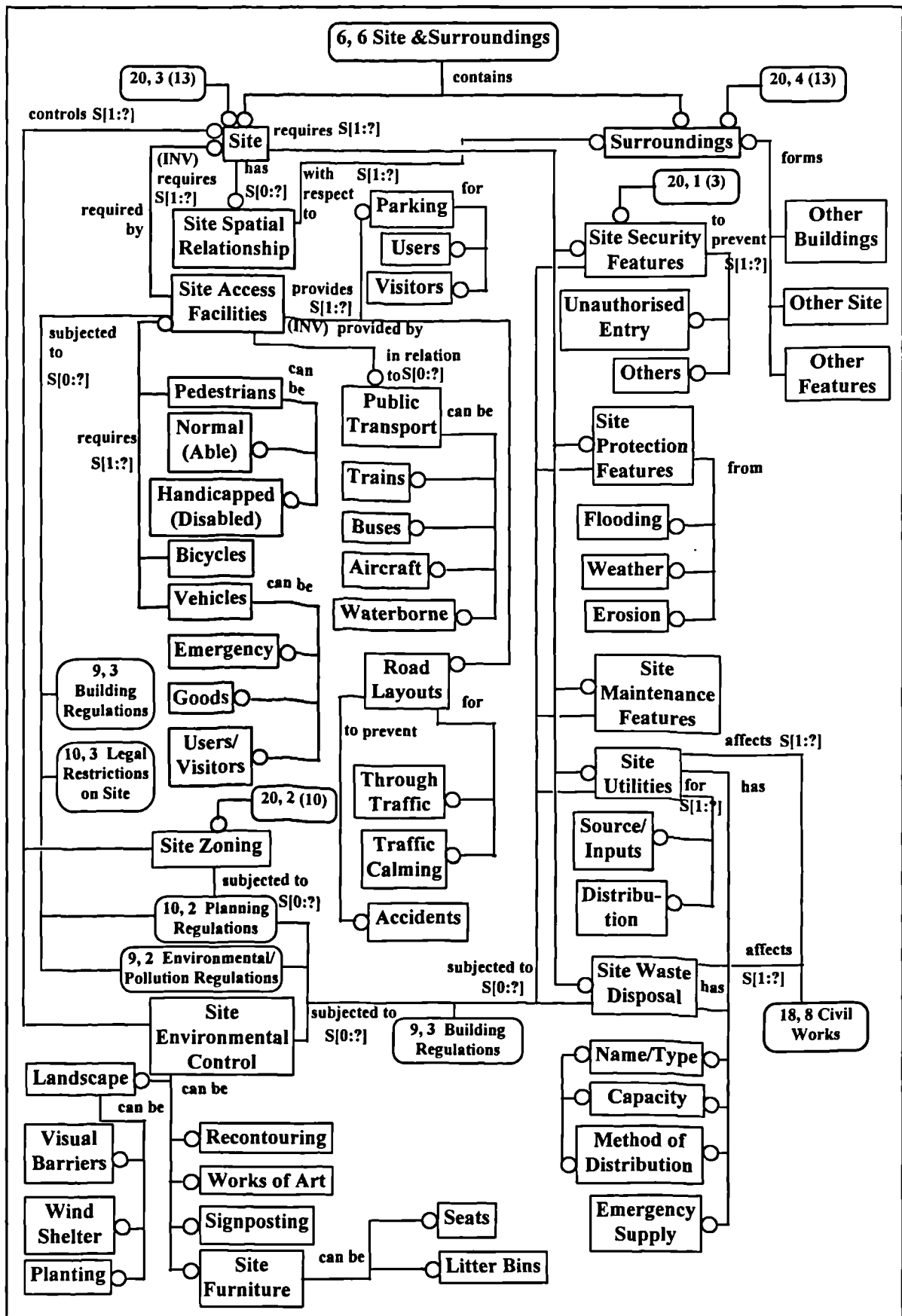


Figure B.20: Level 2 Diagram - Site and Surroundings (Page 20 of 22)

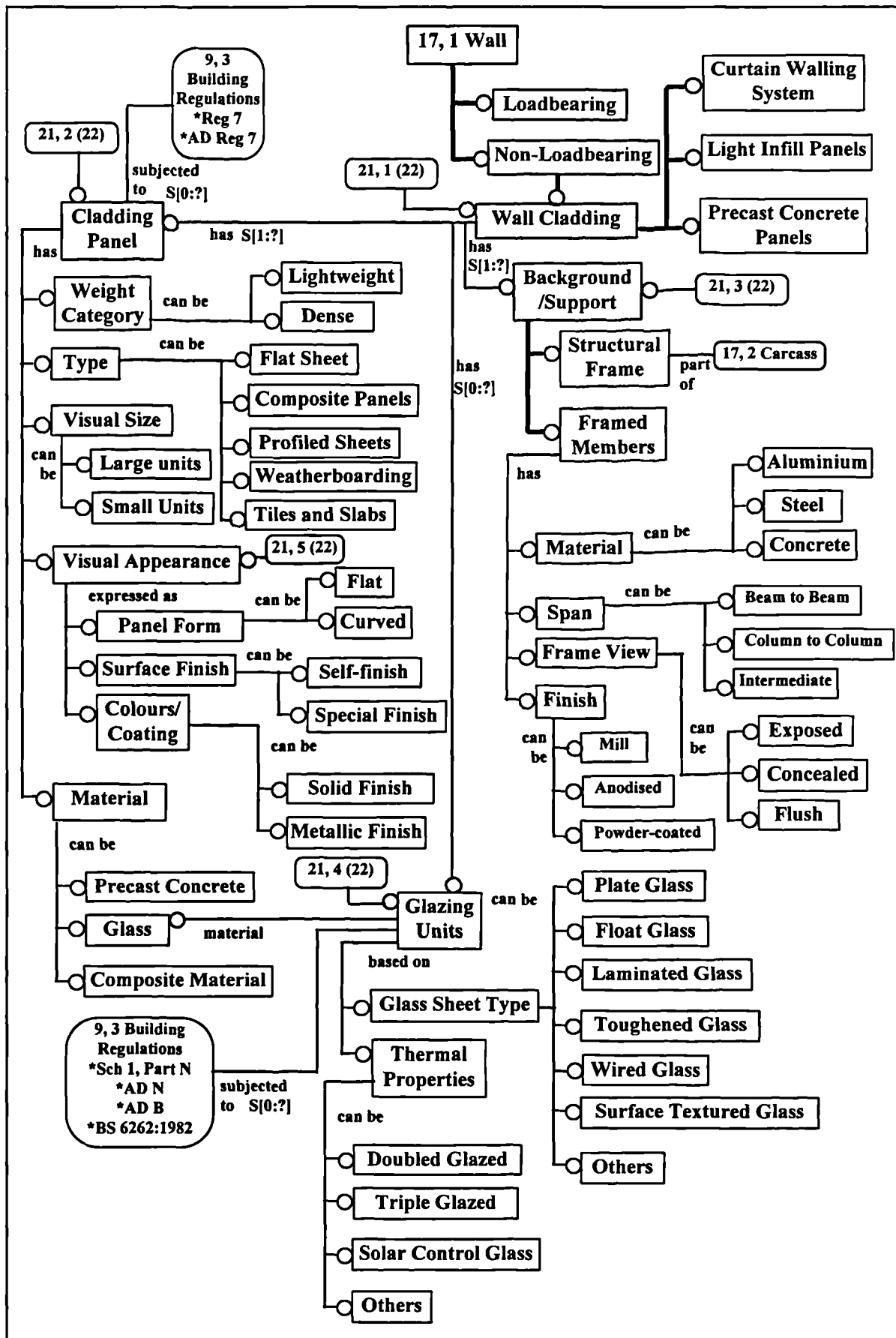


Figure B.21: Level 3 Diagram - The "Wall Cladding" Entity in Relation to the "Wall" Entity (Page 21 of 22)

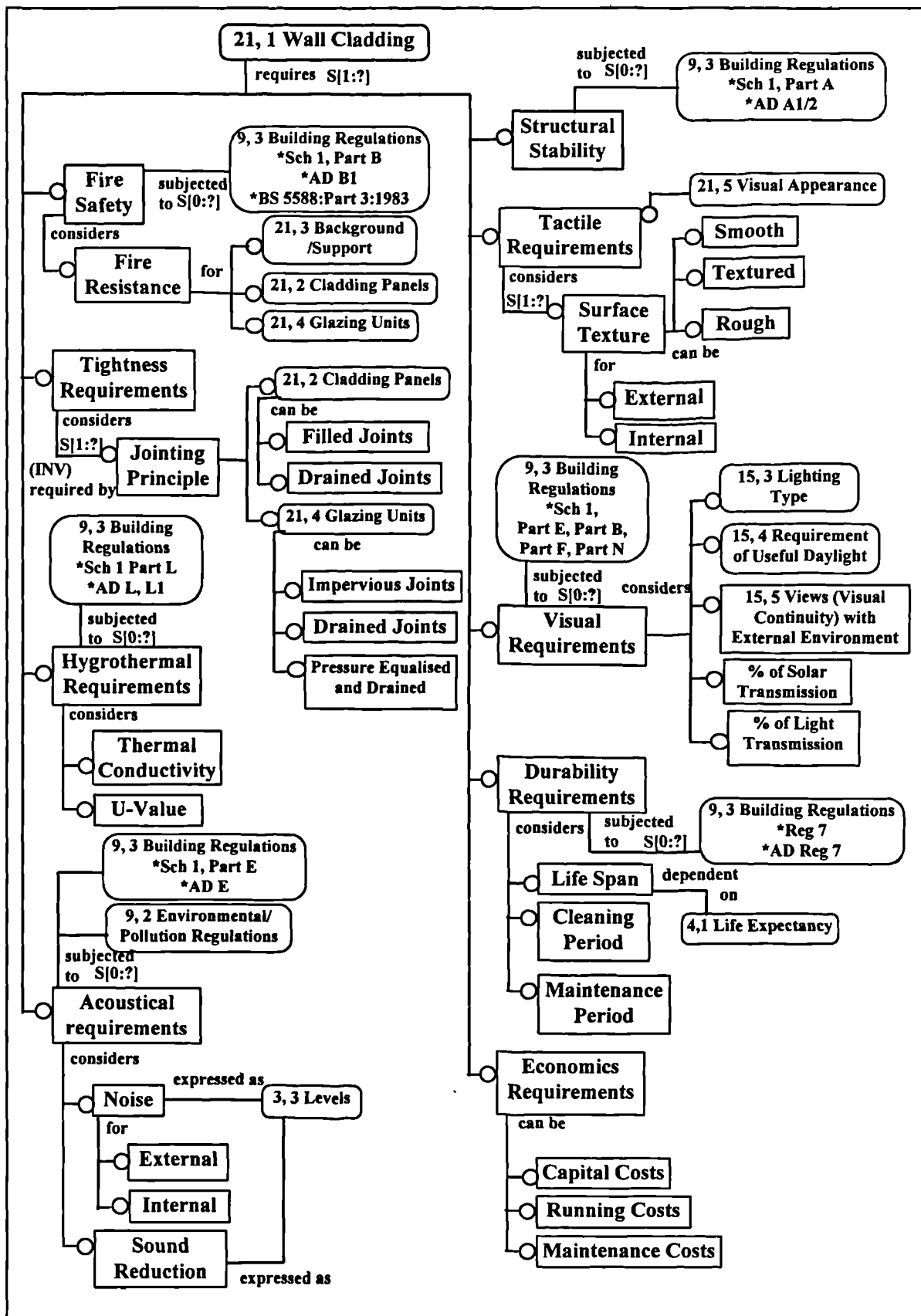


Figure B.22: Level 3 Diagram - The "Wall Cladding" Entity (Page 22 of 22)

APPENDIX C

IDEFO MODELS

C.1 PROCESS MODELS FOR CURRENT OPERATIONS IN BRIEF

DEVELOPMENT

C.1.1 Diagram Tree

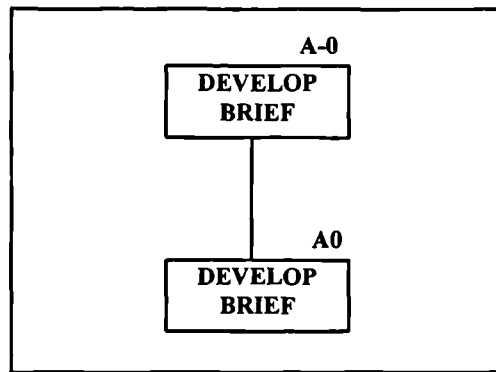


Figure C.1: The Diagram Tree (Process Models for the Current Operations in Brief Development)

C.1.2 Context Diagram

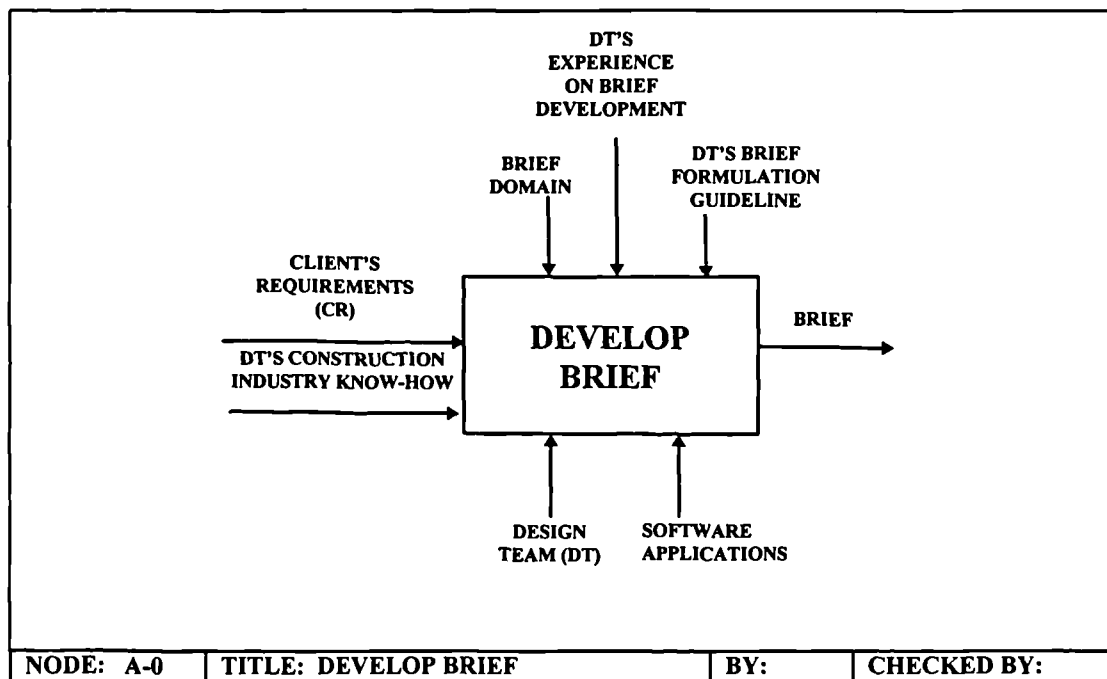


Figure C.2 : Develop Brief (Context Diagram for Current Operations)

C.1.3 Level 1 Diagrams

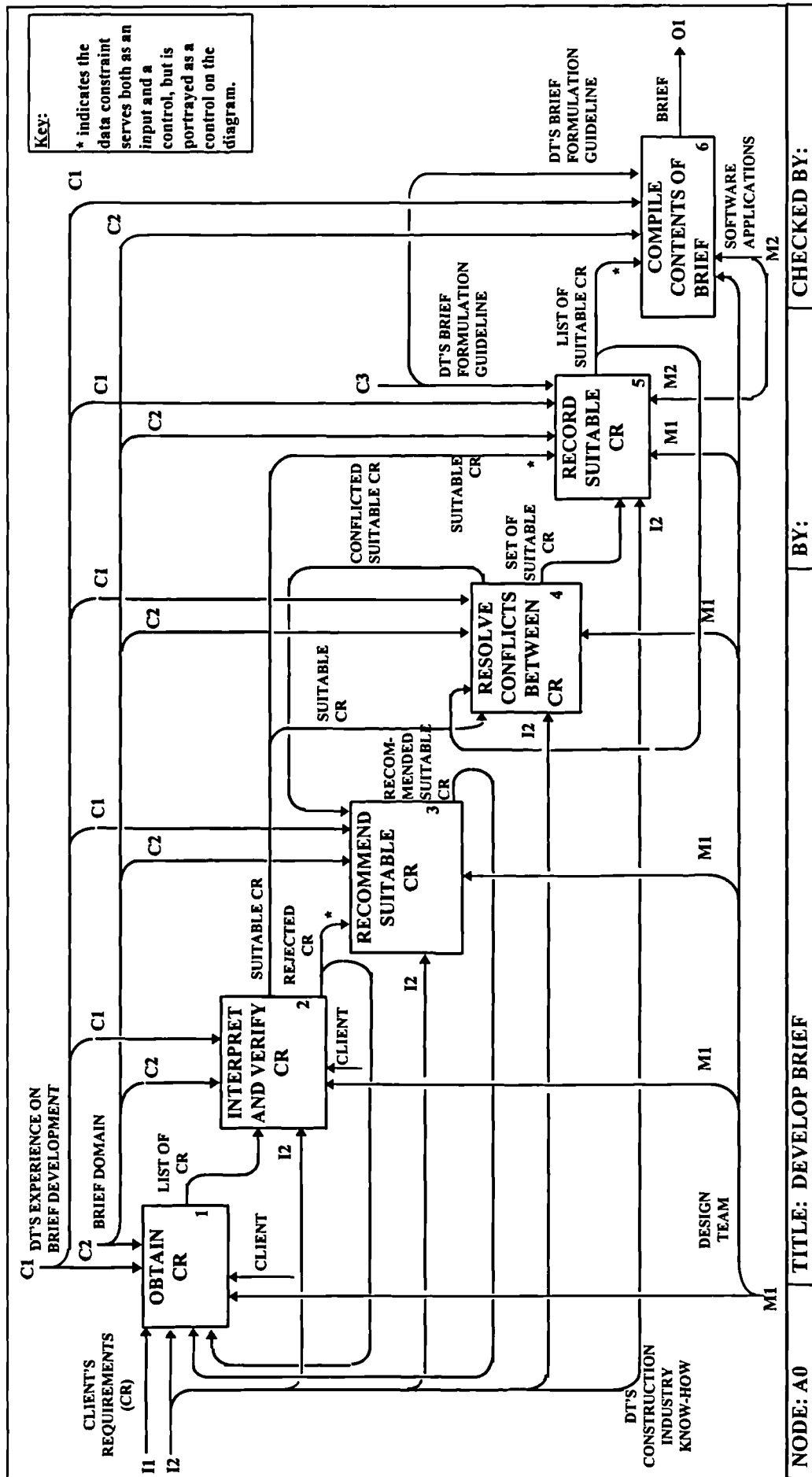


Figure C.3: Develop Brief (Level 1 Diagram for Current Practice)

C.2 PROPOSED PROCESS MODELS FOR PROTOTYPE DEVELOPMENT

C.2.1 Diagram Tree

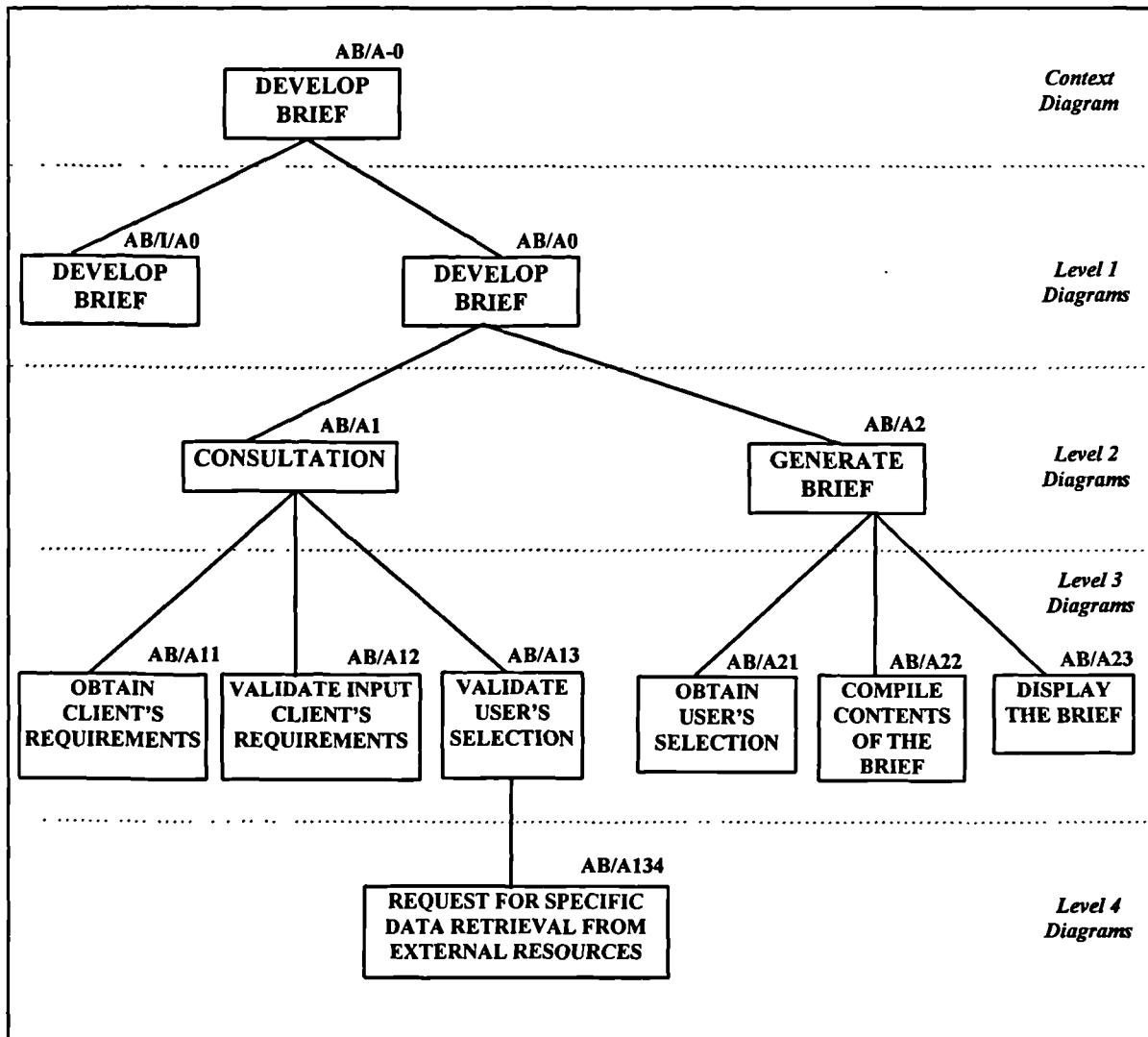


Figure C.4: The Diagram Tree (Process Models for the Proposed Prototype)

C.2.2 Context Diagram

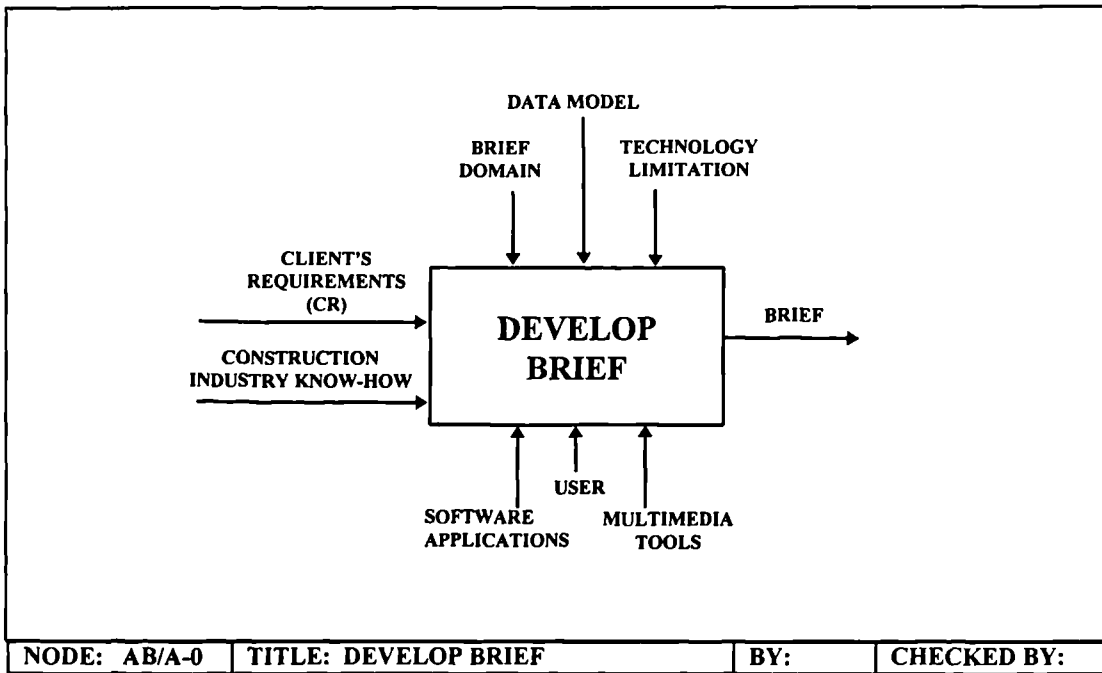


Figure C.5 : Develop Brief (Context Diagram)

C.2.3 Level 1 Diagrams

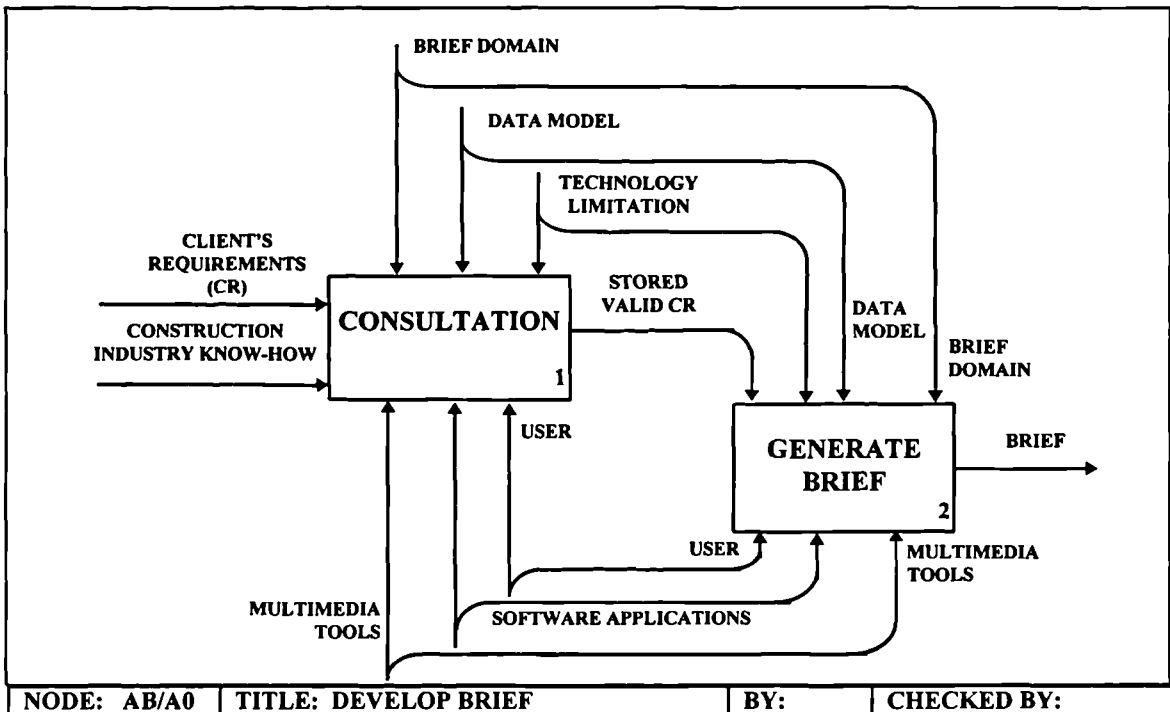


Figure C.6 : Develop Brief (System Architecture Viewpoint)

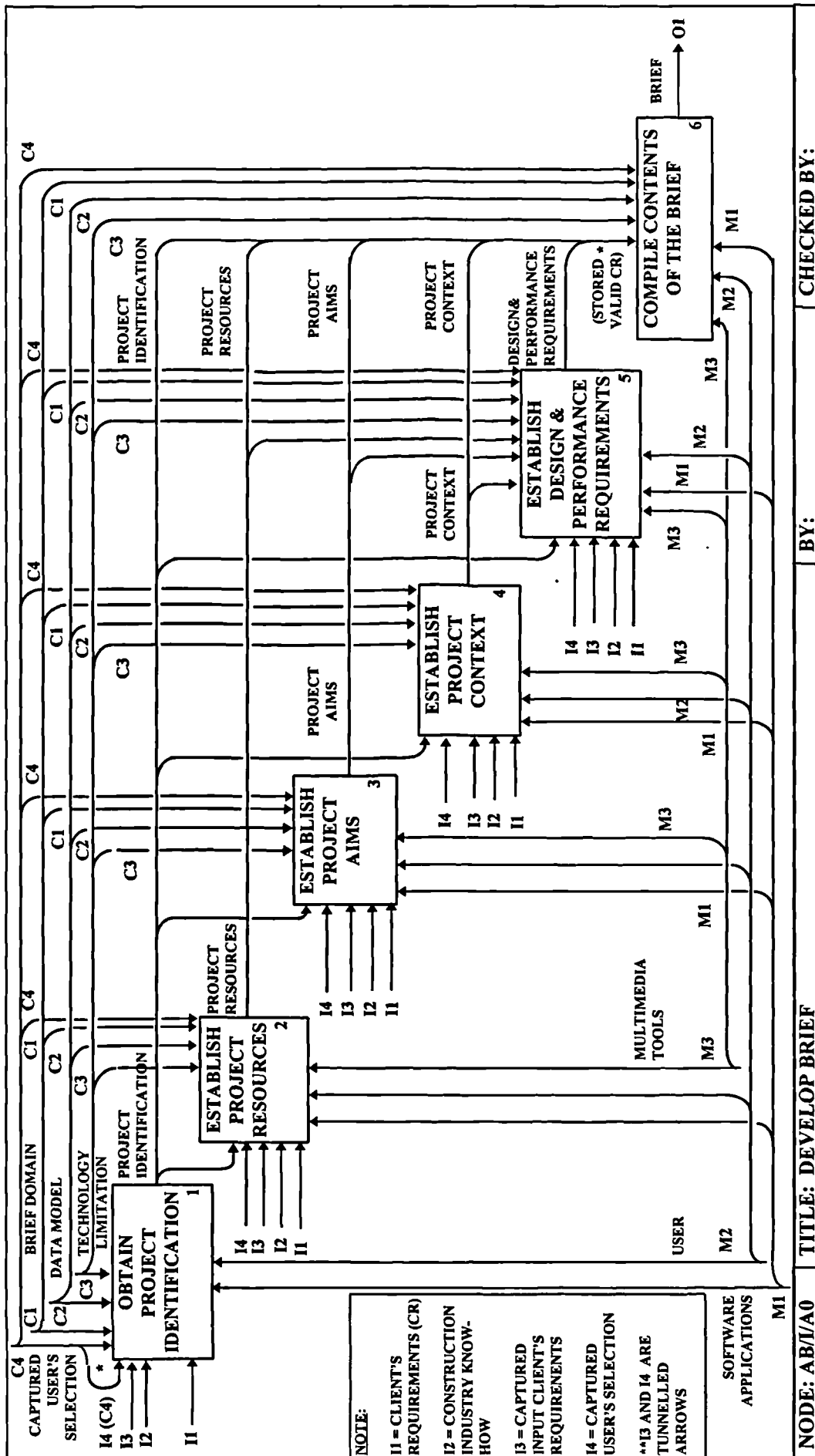


Figure C.7: Develop Brief (Information Viewpoint)

C.2.4 Level 2 Diagrams

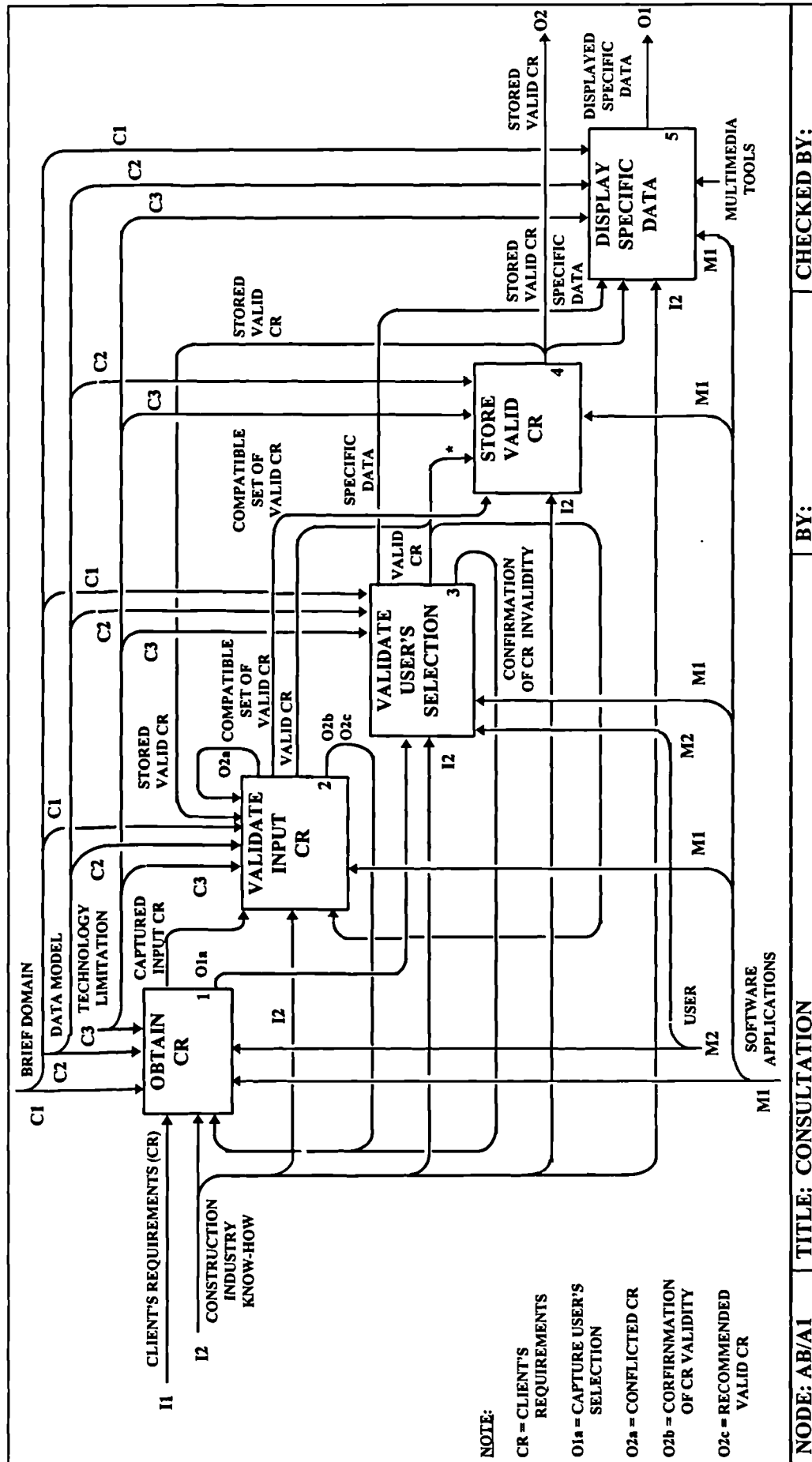


Figure C.8: Consultation

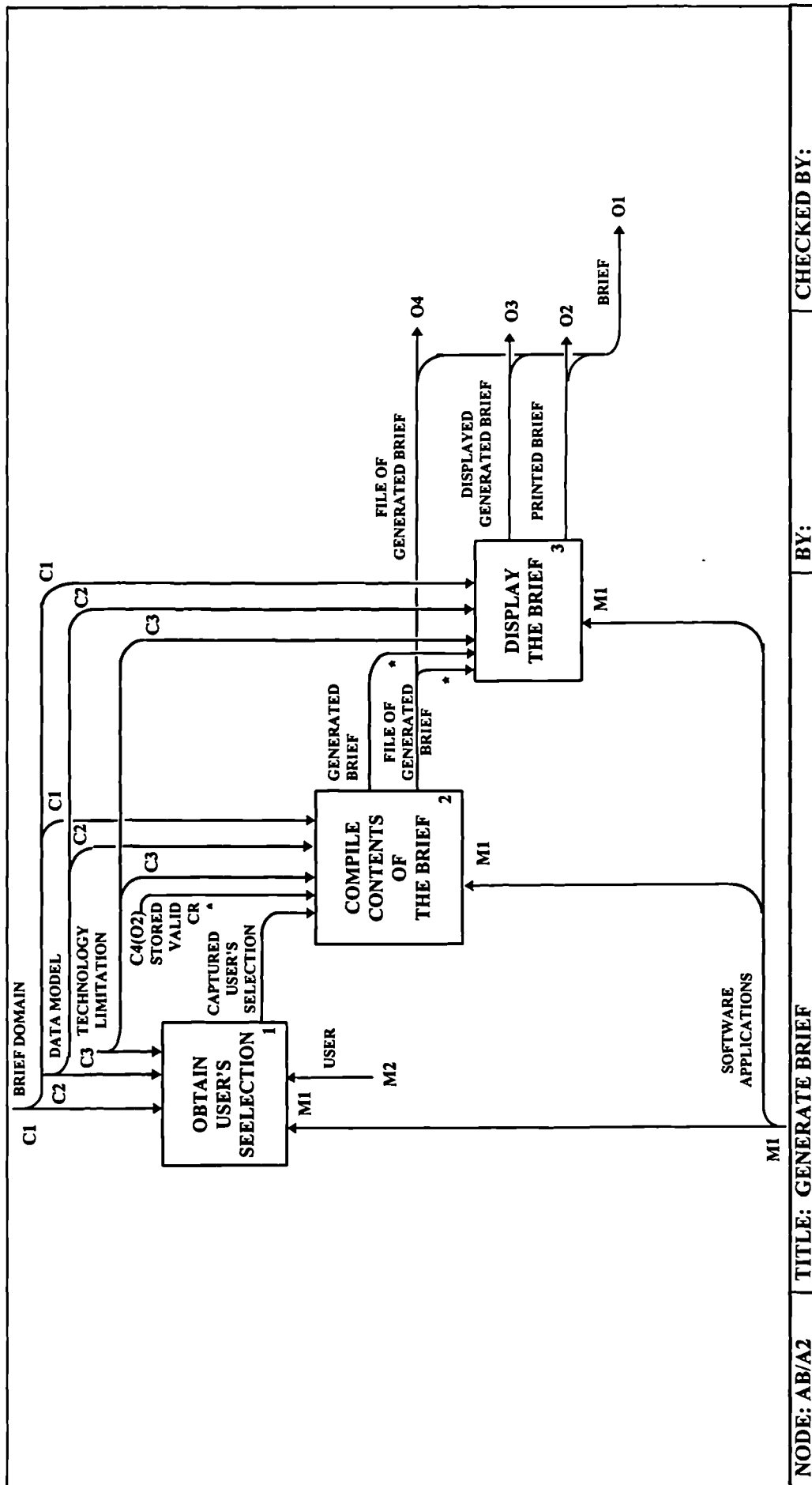


Figure C.9: Generate Brief

C.2.5 Level 3 Diagrams

The level 3 diagrams refer to the decomposition of the subprocesses that belongs to the level 2 diagrams, i.e. the “Consultation” and the “Generate Brief” processes. Such decomposition are presented below:

C.2.5.1 Sub-Processes of “Consultation” Process

(a) The “Obtain Client’s Requirements” Process

Figure C.10 illustrates the decomposition “Obtain Client’s Requirements” process into five sub-activities; “Request for Data”, “Input(V) CR”, “Capture Input CR”, “Select Options/Sub-Options” and “Capture User’s Selections”. “Software Applications” are utilised as the main mechanism for all the sub-processes. For the second and fourth process, however, the “User” is required to perform the process. “Construction Industry Know-how” serves as input into the first, second and fourth process, while the “Client’s Requirements (CR)” enters the second and fourth process as a response to the “Data Request” control which originate from the output of the “Request for Data” process. The “Request for Data” process is triggered by the system, either when the system is initiated or when a particular client’s requirement is rejected from the level two processes earlier, “Validate Input CR” and “Validate User’s selection”.

“Recommended Valid CR” which originate from “Validate Input CR” process (Figure 7.9; Figure C.11), enters the second process, “Input (v) CR” as one of the inputs. The letter “v” within parenthesis denotes the tense of the word “Input”, i.e. a verb, as oppose to the output of the process, “Input CR”, in which “Input” is an adjective. This output then becomes the input of the third process, “Capture Input CR”. During this process, within the constraints of “Technology Limitation”, the input client’s requirement is captured to transform into the “Captured Input CR” output.

The “Select Options/Suboptions” process allows the “User” to choose an option from a presented menu, which is represented by the “Data Request” control. The “User’s Selection” output is then transformed into the input of the last sub-process, “Capture User’s Selection”. The output of this process is “Captured User’s Selection”.

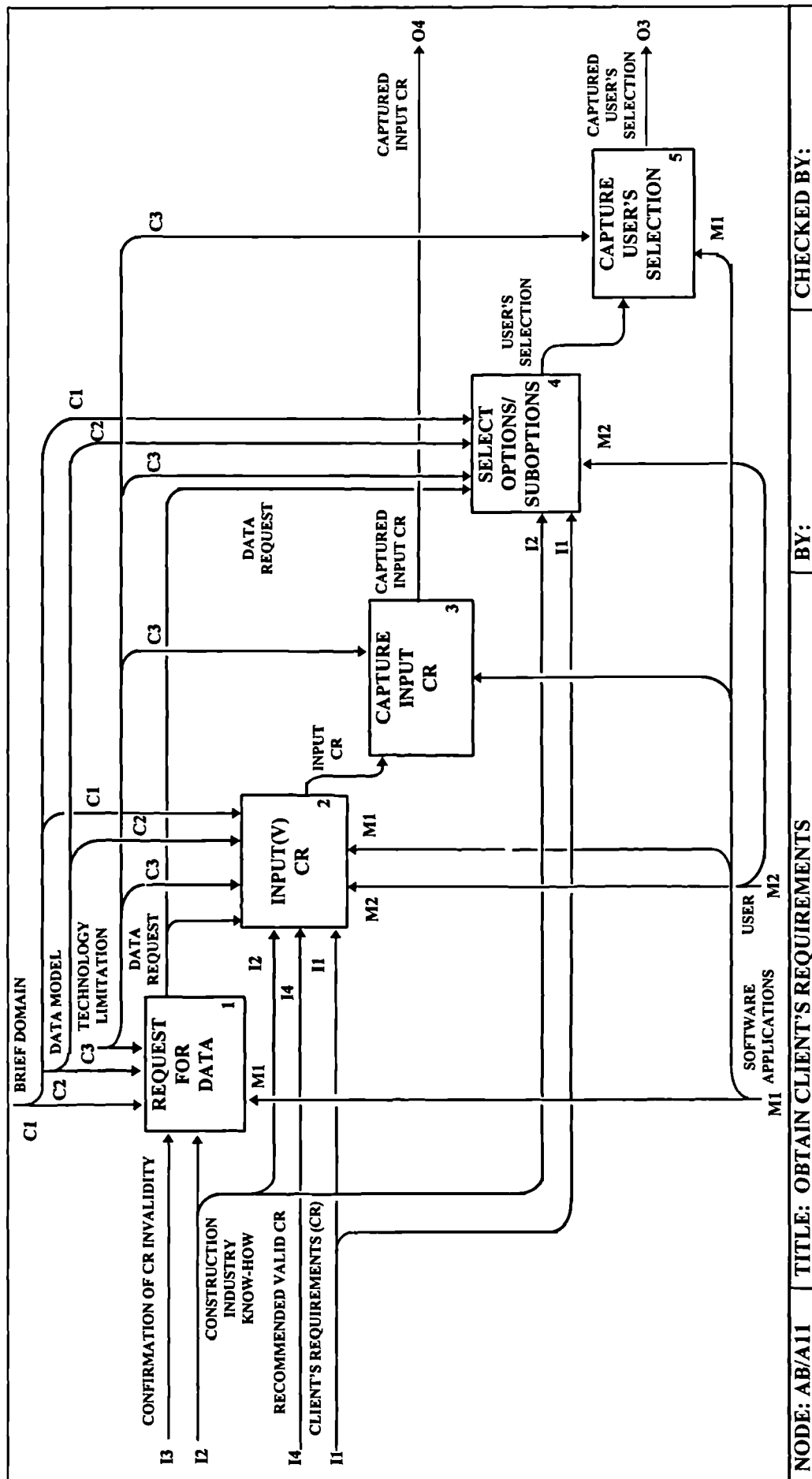


Figure C.10: Obtain Client's Requirements

(b) The “Validate Input Client’s Requirements” Process

This level 3 diagram is represented by the AB/A12 diagram shown in Figure C.11. It is decomposed into three sub-activities. Each activity utilises the “Software Applications” mechanism and the “Construction Industry Know-how” input, and are influenced by the three main controls for the “Develop Brief” context diagram. These activities are:

“Interpret and Verify Input CR”: This process interprets the input client’s requirements obtained from the user. It is analogous to the “Interpret and Verify CR” process of the A0 diagram (Figure 7.7; Figure C.6). This process interprets the user’s captured input, and verify it to see if it is suitable or appropriate for the development of the brief. The aim is to conduct a thorough examination of the input in order to identify the user’s actual requirements. The “Construction Industry Know-how” input assists the user to arrive at an appropriate decision. The outcome of the process are two outputs; “Valid CR” and “Confirmation of CR Invalidity”. “Valid CR” represents the information or client’s requirements that passes the verification process and is accepted by the system as a suitable client’s requirement, which can then be forwarded to the “Generate Brief” process. If, however, any of these requirements are found to be unsuitable, they are rejected by the process, and a message is displayed confirming such occurrence. This confirmation either leads the user back to the previous level 2 diagram, “Obtain Client’s Requirements”, or transformed into a control of the next process, “Recommend Valid CR”.

“Recommend Valid CR”: This process contains two additional controls. The “Confirmation of CR Invalidity” act as a control to trigger the system to make recommendations for an appropriate client’s requirements, with the rejected client’s requirements as a basis. The second control that affects the process is represented by “Conflicted Valid CR”. This is an output of the “Resolve Conflicts Between Valid CR” process. These two controls play an important role in ensuring that a suitable recommendation is made for a specific situation. The output of the process is therefore the “Recommended Suitable CR” output, which is conveyed back to the previous “Obtain CR” process.

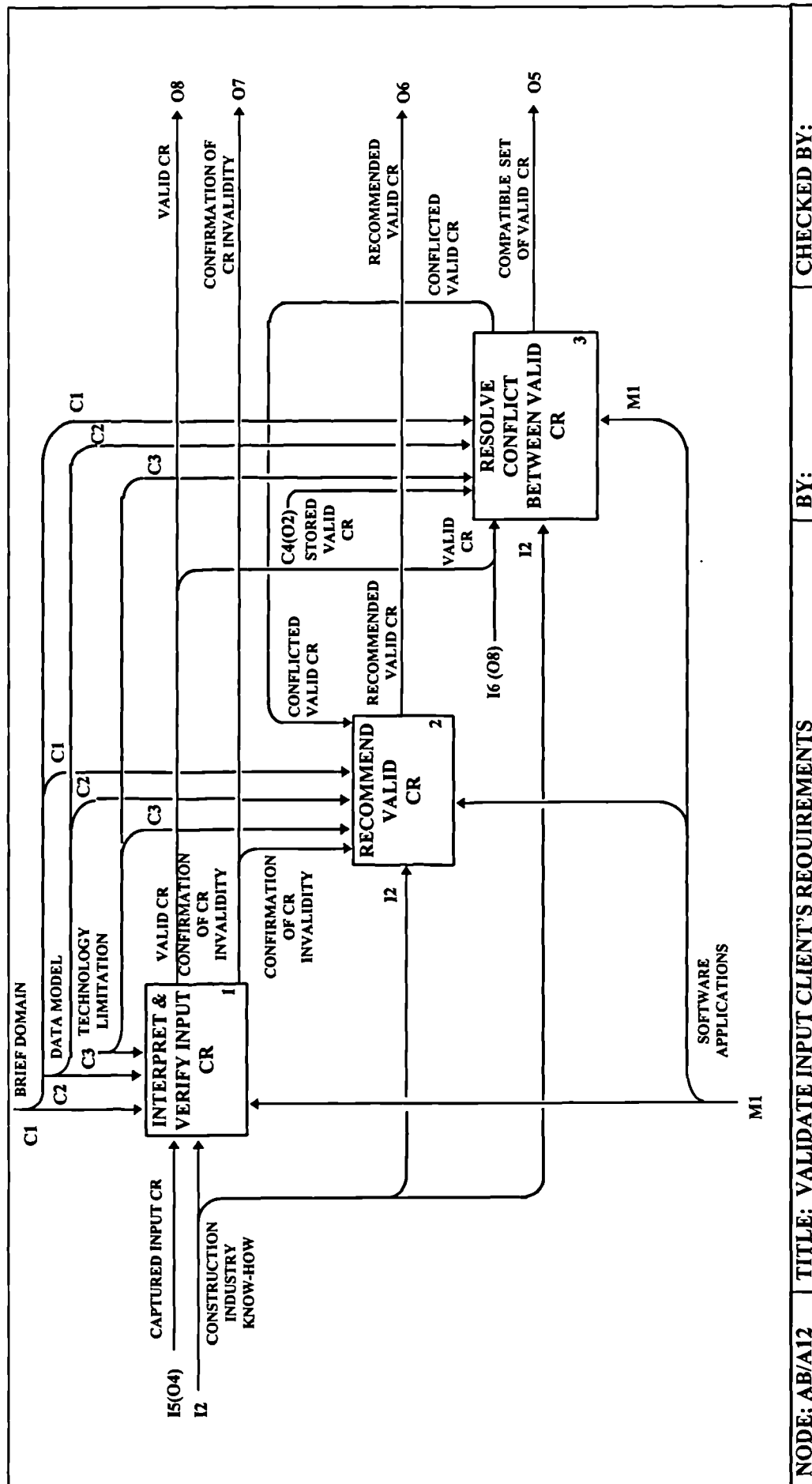


Figure C.11: Validate Input Client's Requirements

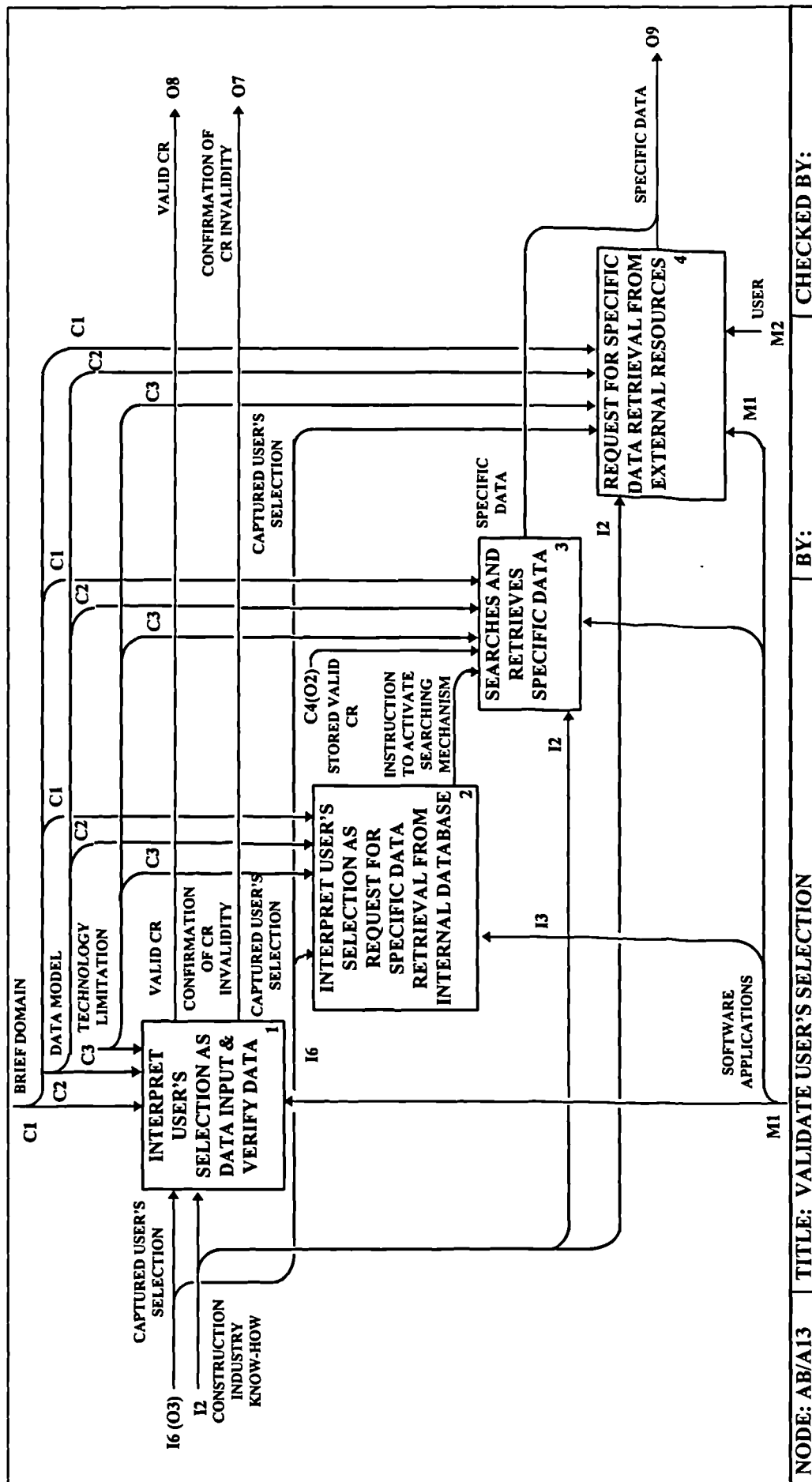
“Resolve Conflicts Between Valid CR”: This process aims to ensure compatibility between the various accepted client’s requirements. When a captured input or a selection is accepted as a “Valid CR”, it becomes the input into this process. This input is then checked against any related “Stored Valid CR”, the output of the level 2 diagram, “Store Valid CR”, which is converted into a control for this particular process. The aim of this process is to resolve any conflicting requirements of the client which have been accepted, and to ensure the compatibility of related requirements. The outcome of the process is represented by the “Compatible Set of Valid CR” output. Any conflicted requirements, represented by the “Conflicted CR” output, however, are sent back as a control to the “Recommend Valid CR” process.

(c) The “Validate User’s Selection” Process

The “Validate User’s Selection” process is a level 3 diagram represented by the AB/A13 node shown in Figure C.12. It is divided into four sub-activities. Each activity utilises the “Software Applications” mechanism, and are influenced by the three main controls for the “Develop Brief” context diagram. The “Construction Industry Know-how” represents the input into all the processes, with the exception of the second. An additional mechanism, the “User”, is utilised by the last process. These activities are described in more detail below:

“Interpret User’s Selection As Data Input & Verify Data”: This process interprets the captured user’s selection as data input, i.e. as client’s requirements for the generation of the brief. The client’s requirements which are found to be suitable for brief generation are transformed into the “Valid CR” output. Unsuitable requirements are rejected by sending out the “Confirmation of CR Invalidity” output.

“Interpret User’s Selection As Request For Specific Data Retrieval From Internal Database”: This process is triggered by “Captured User’s Selection” which enters the process as a control. It functions as a control in that the particular user’s selection is responsible for activating the corresponding “Instruction to Activate Searching Mechanism”, which forms the output of the process. As an example, if the captured user’s selection calls for the display of previous related inputs, then the instruction would be to activate the searching mechanism for these inputs.



“Searches And Retrieves Specific Data”: Based on the “Instruction to Activate Searching Mechanism” control, the corresponding specific data is searched and retrieved from the internal database. This process is also influenced by the “Stored Valid Data” in the data model. The output is therefore, the “Specific Data”.

“Request For Specific Data Retrieval From External Database”: This process serves the same function as the second process above. The only difference is the specific data is to be retrieved from an external resources. This process will be explained in more detail in the level 4 diagram.

C.2.5.2 Sub-Processes of the “Generate Brief” Process

All the sub-processes of the “Generate Brief Mode” require further analysis at this level 3 of abstraction.

(a) The “Obtain User’s Selection” Process

Figure C.13, which represents the AB/A21 node, depicts the “Obtain User’s Selection” process. This process is further decomposed into three sub-activities. The first two processes offer alternative modes for the display of the brief. The former, for the brief to be presented within the object oriented environment, and the latter, to be viewed either in Windows’ Notepad or Microsoft Word. The output of both processes are the user’s selection for the brief to be presented. These two outputs become the input for the “Capture User’s Selection” process, the output of which is the “Captured User’s Selection”.

(b) The “Compile Contents of the Brief” Process

This process is made up of four sub-processes as shown in Figure C.14, represented by the AB/A22 node. The three main controls for the “Generate Brief” process are maintained, together with the “Software Applications” mechanism. The first process is triggered by the “Captured User’s Selection” which act as one of the controls for this process. The relevant “Stored Valid CR” will be activated. The “Stored Valid CR” also acts as a control for this process because it controls which particular client’s requirements will be activated. The output of the process is the “Activated Valid CR”.

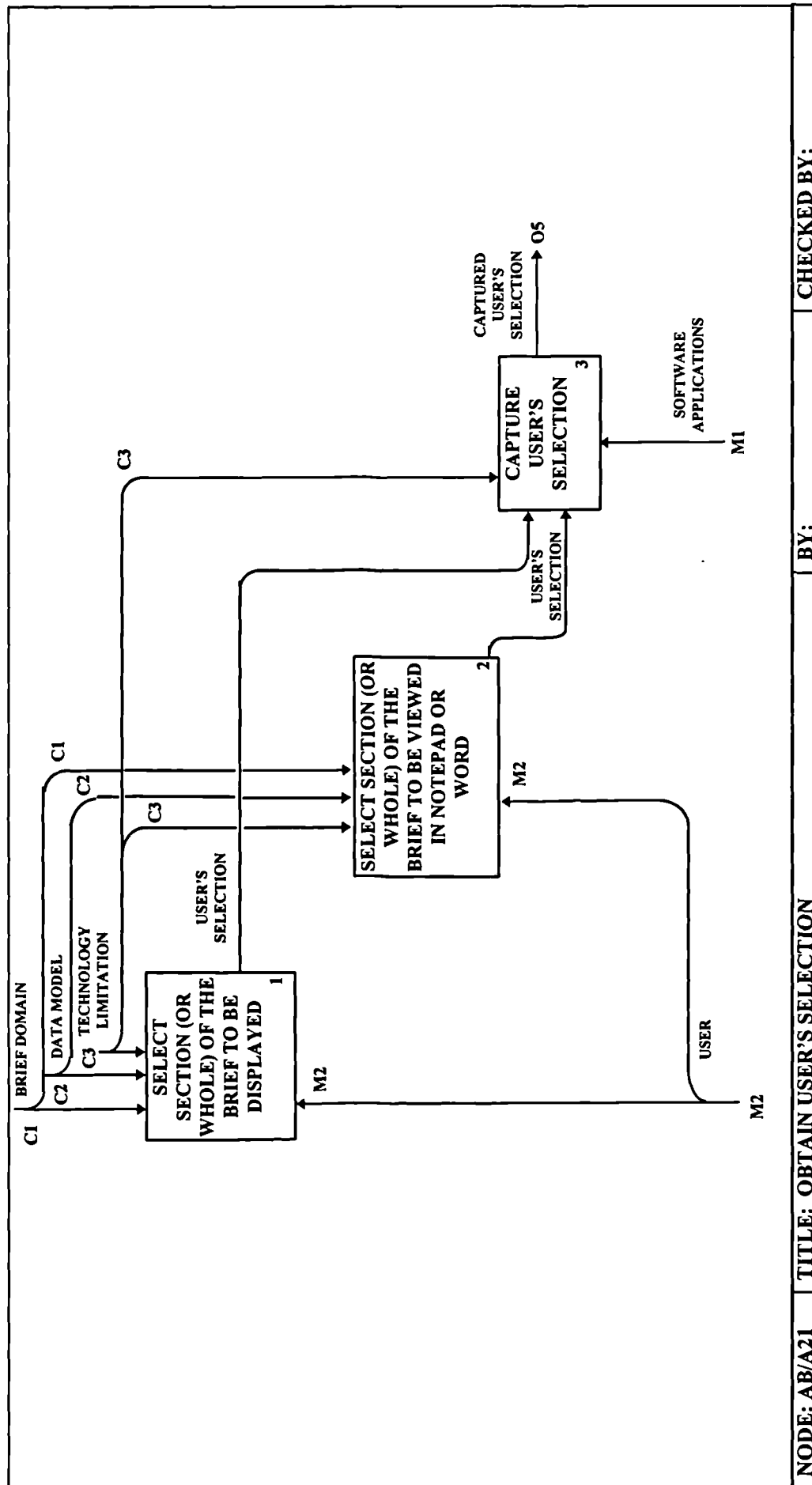


Figure C.13: Obtain User's Selection

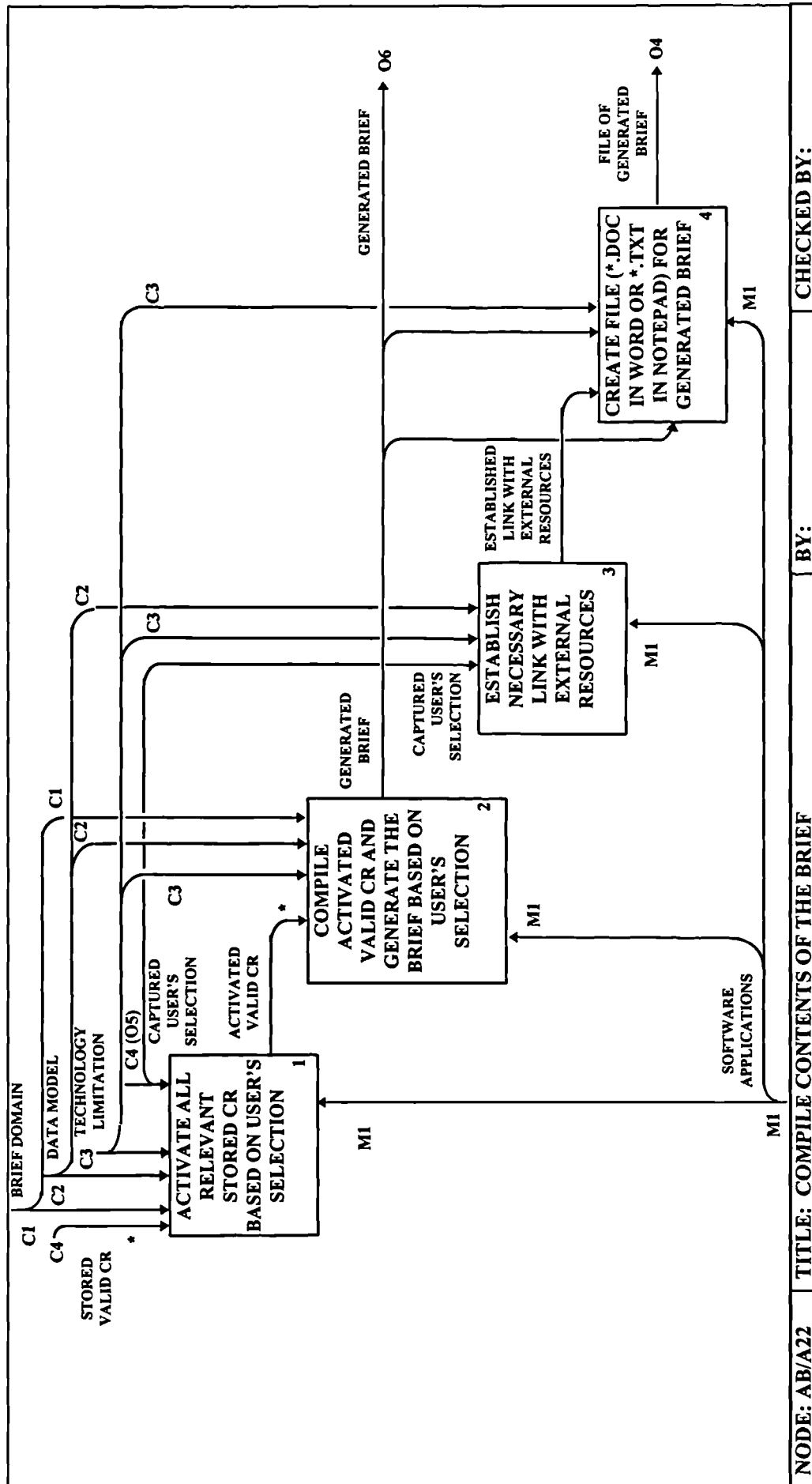


Figure C.14: Compile Contents of the Brief

The “Activated Valid CR” is then transformed into the control for the second process, **“Compile Activated Valid CR and Generate Brief Based on User’s Selection”**. This process generates the brief based on a fixed format. The result is a “Generated Brief” output which is consistent in its presentation.

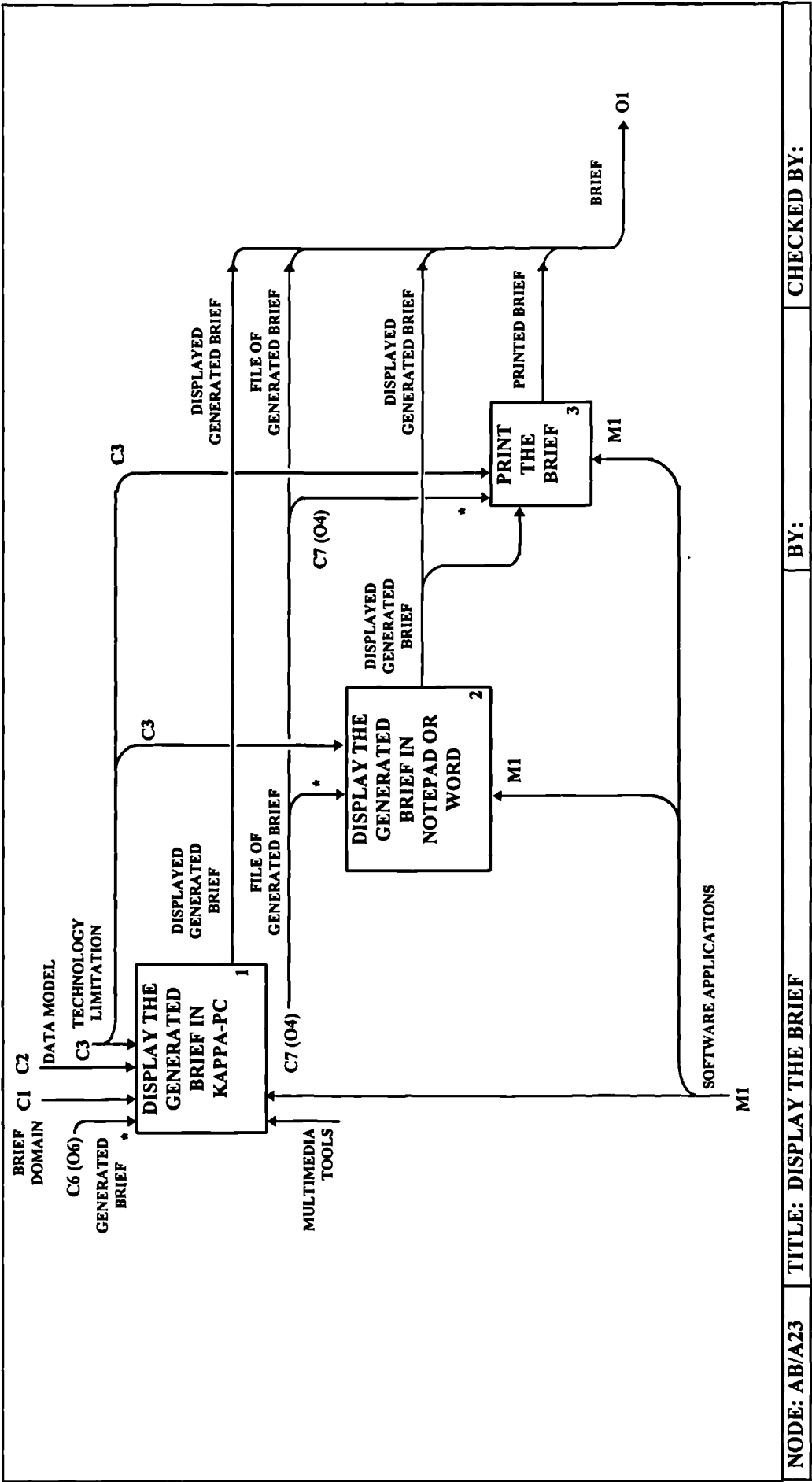
The third process, **“Establish Necessary Link with External Resources”**, makes the necessary link to the relevant external resources. This established link transforms into a control for the last process. The emphasis here is that the link needs to be established before the new file can be opened or created. The “Generated Brief” output of the second process then becomes the input of this last process, by representing the contents of the newly created file. The output is therefore, a “File of Generated Brief”.

(c) The “Display the Brief” Process

Figure C.15 shows this process, represented by the AB/A23 node. The process is decomposed into three sub-processes as described below:

“Display the Generated Brief in KAPPA-PC”: The process makes use of the “Generated Brief” as a control, along with the other three main controls, to display the generated brief in KAPPA-PC, which is selected the object oriented environment for the proposed prototype development. The mechanism utilised are “Multimedia Tools” and “Software Applications”. The output is the “Displayed Generated Brief”.

“Display the Generated Brief in Notepad or Word”: For this process, the “File of Generated Brief” controls the display of the brief, together with any technology limitations, if any. Again, the output is represented by the “Displayed Generated Brief”. Clearly, the form of presentation of the “Displayed Generated Brief” for this process differ from that of the previous process. Moreover, the previous one is static in that it can only be ‘read’ and not ‘write’. For this process, however, the “Displayed Generated Brief” can be considered as dynamic. The reason is with the use of an external software application, such as Microsoft Word, the displayed generated brief can be formatted to suit the user’s preference. This new format can then be saved separately as an electronic document, which does not form part of the prototype system.



CHECKED BY:

BY:

NODE: AB/A23 TITLE: DISPLAY THE BRIEF

Figure C.15: Display the Brief

“Print the Brief”: This process allows the user to print the “Displayed Generated Brief” and/or the “File of Generated Brief” which need to enter the process as a control. The output of the process, is therefore, the “Printed Brief”.

Overall, the “Display the Brief” process correspond to the last sub-process of the “Generate Brief” process. The main output of its parent activity, the “Brief” is represented in four forms. They include the two different forms of “Displayed Generated Brief”, “File of Generated Brief” and “Printed Brief”.

C.2.6 Level 4 Diagrams

The level 4 diagrams have been developed by decomposing a particular process that belongs to the level 3 diagrams. The only process affected at this level of abstraction is the “Request For Specific Data Retrieval From External Resources” process, which originate for the “Consultation Process” at the level 2 decomposition. The process is represented by the AB/A134 node depicted in Figure C.16. It is further decomposed into five sub-activities.

Each sub-activity utilises the “Software Applications” mechanism, except for the second, which is performed by the system’s “User”. “Construction Industry Know-how” enters as input into the second and last process. In the first instance, this is represented by a brief idea of what information can be selected by the second process. In the second instance, however, the “Construction Industry Know-how” input may represent the actual specific data that is to be retrieved by the last process, “Retrieve Specific data”. The three main controls are maintained for all the activities, with the third one being controlled by “Technology Limitation” only. The five processes will be described as follows:

“Interpret User’s Selection As Request For Specific Data Retrieval From External Database”: This process begins when “Captured User’s Selection” enters the process as a control. It functions as a control in that the particular user’s selection is responsible for activating the corresponding “Instruction to Establish Link with External Resources”, which forms the output of the process. As an example, if the captured user’s selection calls for the link to be made to the internet, then the instruction would be to

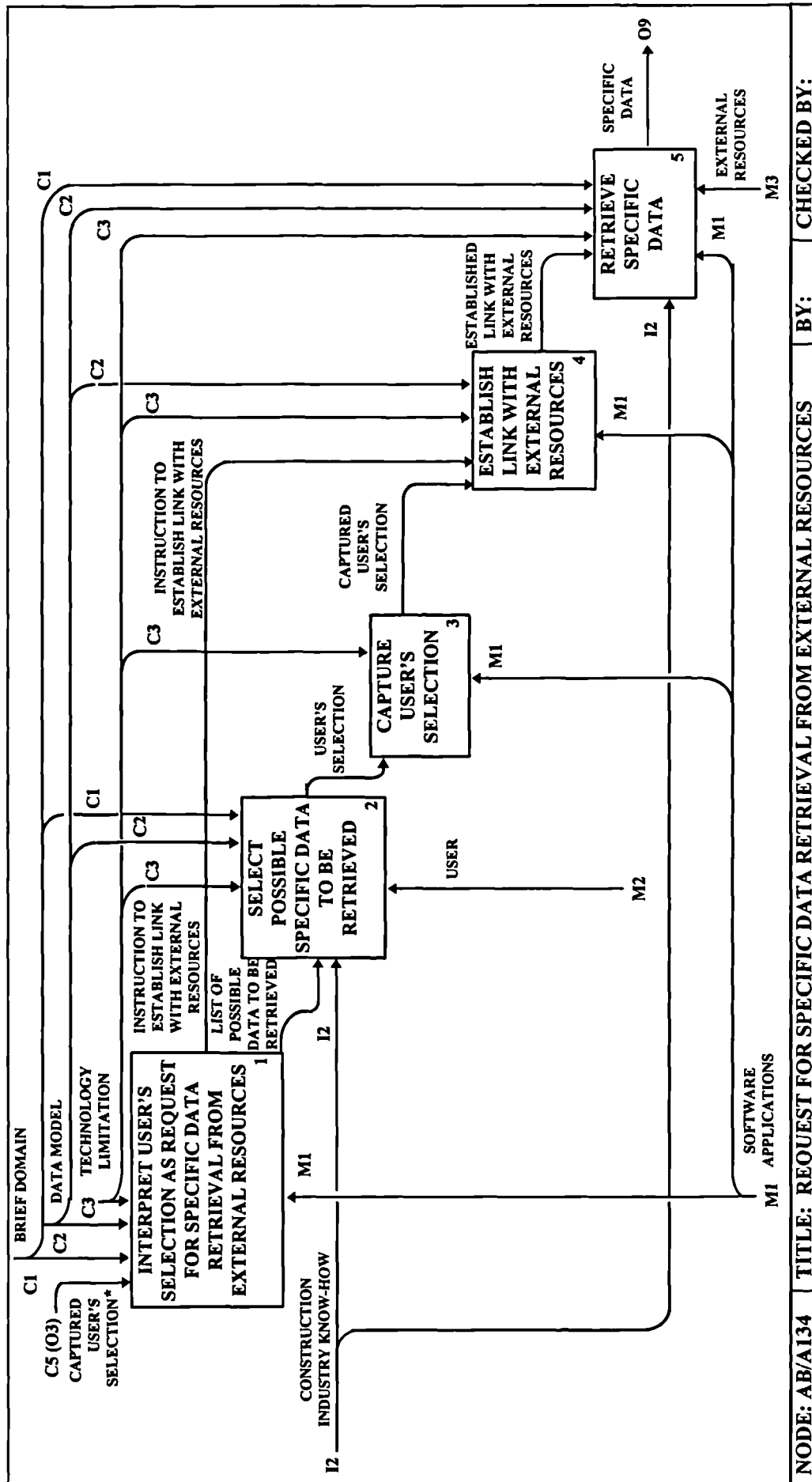


Figure C.16: Request for Specific Data Retrieval from External Resources

establish that link. Alternatively, if the process identifies more than one source of specific data, a “List of Possible Data to be Retrieved” is produced.

“Select Possible Specific Data to be Retrieved”: This process allows the user to select the data to be retrieved. The “User’s Selection” output is transformed into the input for the next process.

“Capture User’s Selection”: This process captures the user’s selection and produces the “Captured User’s Selection” output.

“Establish Link with External Resources”: The “Instruction to Establish Link with External Resources” and the “Captured User’s Selection” outputs of the first and third process respectively, is converted into the controls for this process. In other words, either of these controls will determine the actual link to be made to the relevant external resources, which can be in the form of the internet, an external software applications, etc. The result is the established link with the relevant external resources.

“Retrieve Specific Data”: This process is controlled by the link established by the previous process. This link is used to extract specific information from the “Construction Industry Know-how” input, in order to output the relevant “Specific Data”. “Specific Data” represents useful information that will be presented to the user during the “Display Specific Data” process of the level 2 diagram (Figure 7.9). For this process, the “Software Applications” mechanism includes external resources, e.g. the internet, external files, etc.

APPENDIX D

PROTOTYPE DEVELOPMENT

D.1 User Functions

USER FUNCTIONS:

FY_Begin
 FY_BeginConsultation
 FY_ContinueConsultation
 FY_DPRTemplate
 FY_DrawLines
 FY_Exit
 FY_GenerateBrief
 FY_GetActiveSA
 FY_GetActiveSpaces
 FY_GetBldgReg
 FY_GetBldgReg_WallCladding
 FY_GetInternet
 FY_GetSpatialActivities
 FY_PrintBrief
 FY_PrintPreview
 FY_ProjContextButton
 FY_RelBetSpActvt
 FY_RelBetSpatialSctvt
 FY_RemoveWindowMenu
 FY_ResetWindowMenu
 FY_RunApplication
 FY_SpatialRelship

Figure D.1: User Functions (Associated with Button Images)

D.2 Files created in the External Resources Component of the System Architecture

D.2.1 Notepad Files

The following tables list the text files created in Notepad and their contents. The files have been grouped according to the information that they are meant to deliver. Table D.2 itemises the files created for the presentation of specific information related to specific issues.

Text Files (*.txt)	Contents (Specific Information)
comfort.txt	Factors associated with comfort conditions in office buildings
flamspr1.txt	Methods of minimising the spread of flame
limitatn.txt	Describes the limitations of the prototype
objectiv.txt	Describes the objectives of the prototype
planshap.txt	Table: The perimeter efficiency of different plan shaped compared to a square (for buildings)
psv_fire.txt	Methods of passive fire protection
sa_sid1.txt	Table: Spatial Activities and Spaces Reference
soundred.txt	Assumed values of noise level
wc_panel.txt	Material associated to types of wall cladding panel
wc_vis1.txt	Explanation on picture sample

Table D.2: List of Text Files in Notepad (For Specific Information)

The contents of these files are obtained from relevant literature and are meant to assist the user in understanding specific terms used, or issues, leading to the identification of the client's requirements during the "consultation" mode. Also included in the list are the relevant files which describe the objectives and limitations of the prototype.

Text Files (*.txt)	Contents (Regulatory Issues on:)
ci_reg.txt	Health & Safety Regulations applicable to the construction industry
ci_reg1.txt	Health & Safety Regulations applicable to the safety in use
disabled.txt	Access and facilities for disabled people
fire_reg.txt	Fire Safety
firefigh.txt	Access and Facilities for the Fire Service
flamespr.txt	Spread of Flame
h&sreg.txt	Health & Safety Regulations applicable to office environment
planarea.txt	Table 12: Approved Document AD B3, Section 8
res_plan.txt	Plan Area of Storey
soundred.txt	Sound Insulation
strframe.txt	Structure Above Ground
strstblt.txt	Structural Stability
wc_fire.txt	Fire Safety of Wall Cladding
wc_glazg.txt	Safety Glazing
wc_hygro.txt	Hygrothermal Requirements of Wall Cladding
wc_life.txt	Materials and Workmanship of Wall Cladding
wc_pmv.txt	Materials and Workmanship of Wall Cladding
wc_sound.txt	Sound Insulation
wc_str.txt	Structural Stability of Wall Cladding
wc_tight.txt	Tightness Requirements
wc_vis.txt	Visual Requirements of Wall Cladding

Table D.3: List of Text Files in Notepad (Regulatory Issues)

Table D.3 above lists the files created for the presentation of information related to specific regulatory issues, such as the Building Regulations, Approved Document and British Standards. The contents of these files are obtained from relevant literature and are meant to increase the user's awareness and knowledge of the appropriate regulations related to the client's requirements. These files are displayed during the "consultation" mode.

Table D.4 represents the files that have been created in Notepad, ready to receive the client's requirements which make up the content of the brief (the generated brief) based on the user's input.

These files are updated every time it is accessed. The files are displayed during the “generate brief” mode.

Text Files (*.txt)	Contents (For the generation of the brief)
Allbrief.txt	Generated brief for all sections
Baaw.txt	Generated brief for “Building as a Whole” section of “Design and Performance Requirements” main section
Bldgfab.txt	Generated brief for “Building Fabric” section of “Design and Performance Requirements” main section
proj_aim.txt	Generated brief for “Project Aims” main section
proj_id.txt	Generated brief for “Project Identification” main section
proj_res.txt	Generated brief for “Project Resources” main section
sid.txt	Generated brief for “Spaces In Detail” section of “Design and Performance Requirements” main section
spcactvt.txt	Generated brief for “Spatial Activity” section of “Project Context” main section

Table D.4: List of Text Files in Notepad (for the Generated Brief)

D.2.2 Microsoft Word Files

Table D.5 shows the files produced for the tables, certain aspects of Building Regulations and for the description of the system architecture of AUTOBRIEF.

Files (*.doc)	Contents (Tables or Regulatory Issues)
fire_rst.doc	Table : Minimum periods of fire resistance
sysarch.doc	System Architecture of AUTOBRIEF
wc_sound.doc	Sound insulation of wall cladding
wc_str.doc	Structural stability of wall cladding

Table D.5: List of Files in Microsoft Word (Tables or Regulatory Issues)

Microsoft Word was also used to create the graphics for the structure of the brief contents. These graphics were created in Microsoft Word, copied and pasted onto Windows Paintbrush, after which they were edited and saved as a *.bmp files. The files that have been created for this purpose are tabulated below (Table D.6).

Files (*.doc)	Contents (Graphics)
briefstr.doc	To represent the structure of the brief contents, showing the brief at the centre with the main sections surrounding it
treestr.doc	Tree-like structures for the display
logo.doc	To represent the Logo for AUTOBRIEF
planshp2.doc	Table: The perimeter efficiency of different plan shaped compared to a square (for buildings)

Table D.6: List of Files in Microsoft Word (Graphics)

Files (*.doc)	Contents (For the Generation of the Brief)
Allbrief.doc	Generated brief for all sections
Baaw.doc	Generated brief for “Building as a Whole” section of “Design and Performance Requirements” main section
Bldgfab.doc	Generated brief for “Building Fabric” section of “Design and Performance Requirements” main section
proj_aim.doc	Generated brief for “Project Aims” main section
proj_id.doc	Generated brief for “Project Identification” main section
proj_res.doc	Generated brief for “Project Resources” main section
sid.doc	Generated brief for “Spaces In Detail” section of “Design and Performance Requirements” main section
spcactvt.doc	Generated brief for “Spatial Activity” section of “Project Context” main section

Table D.7: List of Files in Microsoft Word (for the Generated Brief)

As for Notepad, the main use of Microsoft Word is to produce the corresponding files for the generated brief. A file can be opened in Microsoft Word by utilising the “OpenWriteFile” function. Next, by using the “SaveTranscriptImage” function, the contents of the generated brief are saved into the opened file.

The file is then closed by the “CloseWriteFile” function. A *.doc file for the generated brief is thus produced in Microsoft Word. In this way these files are updated every time it is accessed. The files are displayed during the “generate brief” mode. These files are listed in Table D.7.

D.2.3 Bitmap Files

Table D.8 provide the list of files produced and their purposes, together with the corresponding bitmap image number as produced in the “Bitmap” image object structure in the object oriented environment.

Files(*.bmp)	Bitmap Image Number	Purpose
bf4.bmp	1	Tree-like structure for “Building Fabrics” section
brief2.bmp	2	Structure of the brief contents, showing the brief at the centre with the main sections surrounding it
baaw1.bmp	3	Tree-like structure for “Building as a Whole” section
brief3d.bmp	4	Tree-like structure for “Project Identity” main section
planshp1.bmp	5	Table: The perimeter efficiency of different plan shaped compared to a square (for buildings)
dpr2.bmp	6	Tree-like structure for “Design and Performance Requirements” main section
sal1.bmp	7	Tree-like structure for “SpatialActivity” section
sd1.bmp	8	Tree-like structure for “Spaces in Detail” section
sf1.bmp	9	Tree-like structure for “Safety Features” section of the “Building as a Whole” section
-	10	Blank background
pict1.bmp	11	Picture showing visual characteristics of cladding
	12	
proj_aim.bmp	13	Tree-like structure for “Project Aims” main section
projres.bmp	14	Tree-like structure for “Project Resources” main section
pcontext.bmp	15	Tree-like structure for “Project Context” main section
icc.bmp	16	Tree-like structure for “Indoor Climate Control” section of the “Building as a Whole” section
-	17	Blank background
	18	
-	19	Blank background
circle2.bmp	20,21,22	Icon to link the user to information resources.
logo.bmp	23	Logo of AUTOBRIEF
-	24	Blank background
-	25	Blank background
comfort.bmp	26	Tree-like structure for “Comfort Conditions” section of the “Project Aims” main section
concept5.bmp	27	System Architecture of AUTOBRIEF

Table D.8: List of Files in Windows Paintbrush

APPENDIX E

"AUTOBRIEF"

E.1 Samples of Screen Displays

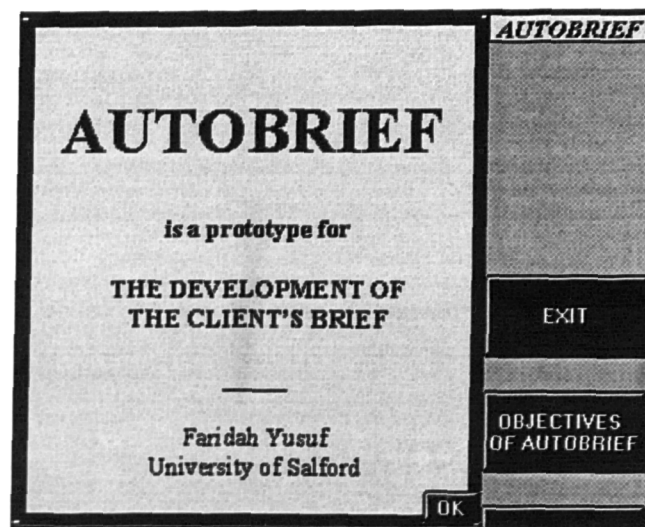


Figure E.1: Part of the Introductory Screen presenting the AUTOBRIEF logo

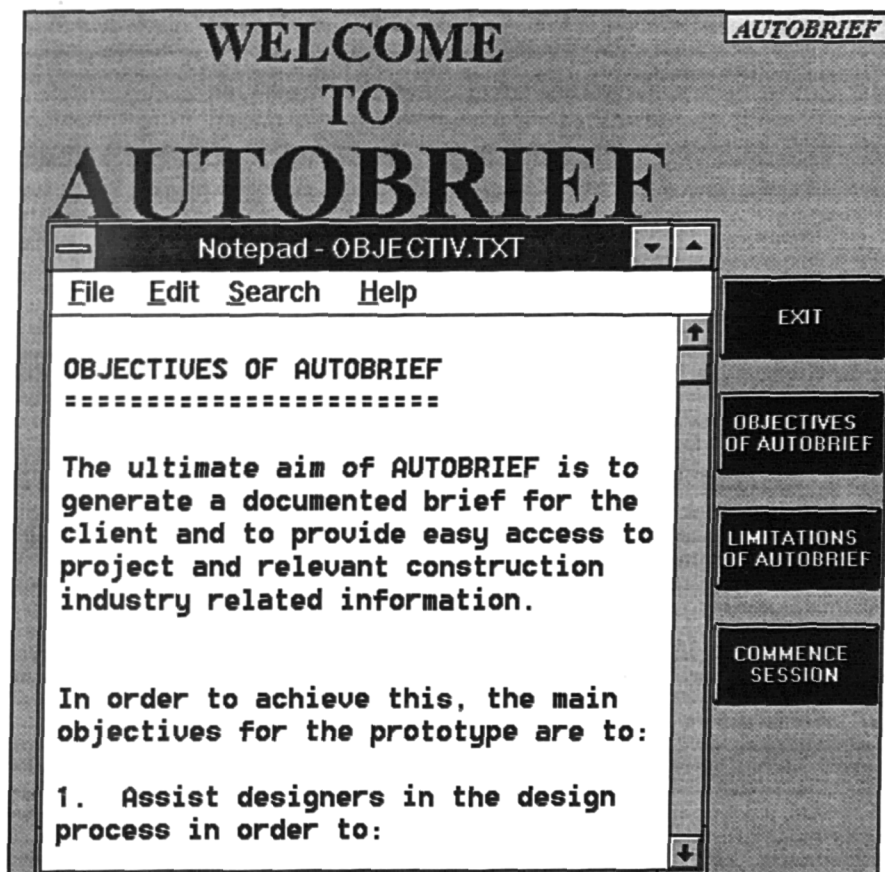


Figure E.2: Part of the Introductory Screen presenting the Objectives of AUTOBRIEF



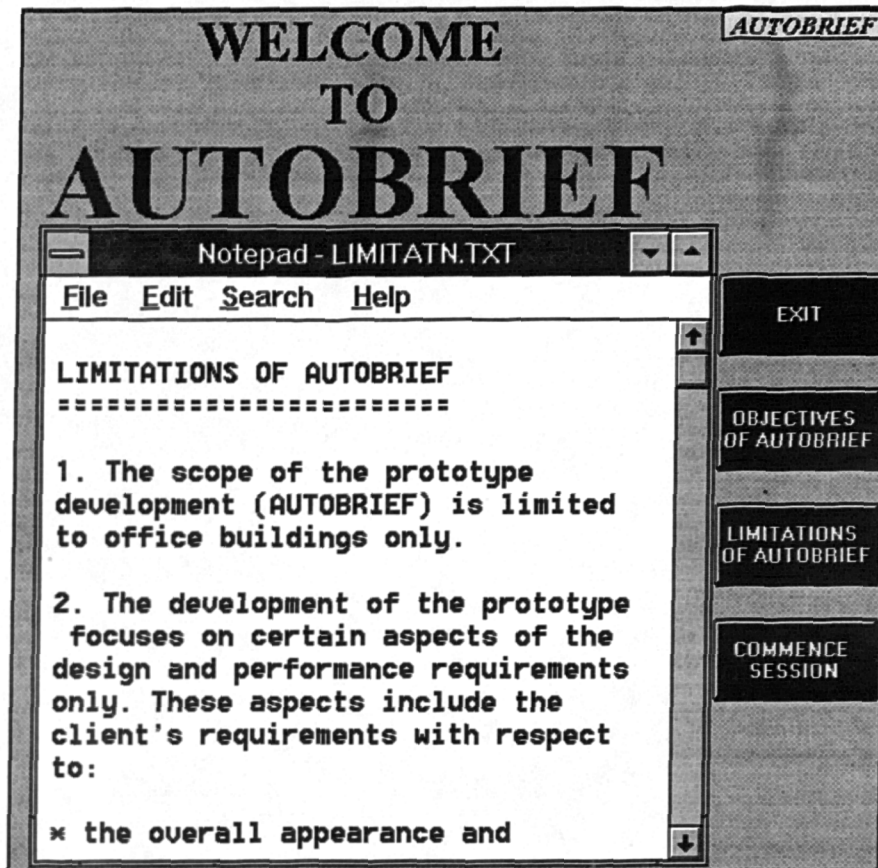


Figure E.4: Part of the Introductory Screen presenting the Limitations of AUTOBRIEF

E.2 A Sample of the Generated Brief (for all the Main Sections and Sub-sections incorporated in AUTOBRIEF)

14/02/97

PROJECT IDENTIFICATION

PROJECT IDENTITY

Project Title: Proposed four storey office building for MF Holdings

Project Reference: FY/100

Project Location:

Lot No./Ref: 1000

Road Name: Blackfriars Road

Town: Manchester

Postcode: M3

County: Lancashire

Building Type: Office Building

PROJECT PURPOSE

Project Main Aims:

Flexible_Work_Space

Building Life Expectancy: 60 years

Project Main Reasons: Expansion

PROJECT SCOPE

PROJECT SIZE

Total Gross Floor Area (GFA): 4500 m2

Net Lettable Floor Space (percentage of GFA): 10

Occupant capacity (no. of users): 450

QUALITY STANDARDS

Standard of Materials: High

Standard of Workmanship: High

Standard of Finishes: High

PROJECT FINANCIAL FRAME

Financial Frame: £ 2000000

PROJECT TIME FRAME

Design/Planning Time Frame: 6 months

Construction Time Frame: 18 months

Overall Time Frame: 24 months

FUTURE CHANGES

Future changes in terms of building use:
None

PROJECT RESOURCES**PROJECT FINANCE**

Financial Frame: £ 2000000

Items included in the Financial Frame:

Design_&_Planning
Construction
Site_Mgmt_Organisation
Costs_in_use
Contingencies

PROJECT TIME

Design/Planning Time Frame: 6 months

Construction Time Frame: 18 months

Overall Time Frame: 24 months

PROJECT AIMS**INTENDED EFFECTS OF THE PROJECT****EFFECTS ON USERS/THE PUBLIC****LEVELS OF BENEFICIAL EFFECTS:**

Comfort Conditions:

Temperature range (C): 22C +/- 2C

Rate of air change (litres/second/person: 10

Humidity Requirement: No

PROJECT CONTEXT

INTENDED OCCUPANCY IN DETAIL

SPATIAL ACTIVITY

Meeting

Frequency: Intermittent

Sensitivity to disruption: Yes

Type of user:

Group

Number of users: 15

Special Input type:

Power_Electricity

Lighting

Information_Technology

Telecommunications

Ventilation

Types of Byproducts :

Ventilation_Extract

General_Office_Works

Frequency: Continuous

Sensitivity to disruption: Yes

Type of user:

Organisation

Number of users: 450

Special Input type:

Ventilation

Power_Electricity

Lighting

Informatio_Technology

Telecommunications

Types of Byproducts :

Heat

Ventilation_Extract

Hygiene

Frequency: Intermittent

Sensitivity to disruption: Yes

Type of user:

Individual

Number of users: 5

Special Input type:

Lighting

Water

Ventilation

Types of Byproducts :

Heat

Wastes

Ventilation_Extract

Circulation

Frequency: Intermittent

Sensitivity to disruption: No

Type of user:

Organisation

Number of users: 20

Special Input type:

Lighting

Ventilation

Types of Byproducts :

Heat

Ventilation_Extract

RELATIONSHIP BETWEEN SPATIAL ACTIVITIES:

General_Office_Works and Meeting = Related_Activities

Hygiene and Meeting = Related_Activities

Hygiene and General_Office_Works = Related_Activities

Circulation and Meeting = Communication&Transport

Circulation and General_Office_Works = Communication&Transport

Circulation and Hygiene = Communication&Transport

DESIGN AND PERFORMANCE REQUIREMENTS

BUILDING AS A WHOLE

BUILDING APPEARANCE

Building Plan Shape (form): Rectangular

Building Symbolic Function: Medium

Building External Facade:

Sealed_External_Facade

BUILDING PHYSICAL CHARACTERISTICS

Building Size Characteristics:

Total Gross Floor Area (m2):4500

Total Net Floor Area (m2):NULL

Total Usable Floor Area (m2):NULL

Floor Area of any one storey(m2):NULL

Building Dimensions:

Length (m):NULL

Width (m):NULL

Height (m):14.4

Building Storeys:

No. of Storeys: 4

Storey height (under floor to under floor level) (m): 3.6

Provision for Adaptability/Flexibility: Add_vert_riser_capacity

BUILDING CIRCULATION AND ACCESS

Requirement of circulation and access for :

People_Disabled

People_Able

Goods

Method of circulation and access :

Mechanical

Non_Mechanical

Plane of circulation and access :

Vertical

Horizontal

Sloping

ARTWORKS

Type(s) of artworks :

Nil

SAFETY FEATURES

FIRE SAFETY

ACTIVE FIRE SAFETY:

Fire Alarms:

Bell

Means of Detection:

Heat

Manual

Smoke

Means of Extinguishing:

Sprinkler

Extinguisher

PASSIVE FIRE SAFETY:

Means of Escape

General Floor Layout:

Open_Space

Evacuation Procedure: Phased_Evacuation

Escape Routes Type:

Corridor
Stairways
Exits

Number of Protected Stairways: 2

Number of Exits: 2

Place of Safety: Car_Park

Fire Resistance:

Structural Elements (minutes):60

SAFETY IN USE

Safety Facilities:

Health Facilities:

Emergency Facilities:

INDOOR CLIMATE CONTROL

HYGROTHERMAL

Temperature range (C):22C +/- 2C

Air Change (in litres per second per person):10

Humidification Requirement:No

AIR PURITY

Air Pollution Level:High

Type of ventilation system:Mixed_Mode

ACOUSTICAL REQUIREMENTS

External Noise Level:Acceptable

Internal Noise Level:Acceptable

VISUAL REQUIREMENTS

Requirement of useful daylight:Yes

Type of lighting requirement:

Artificial

Natural

Visual continuity with external environment:Yes

Privacy from external environment:No

Visual continuity with internal environment:Yes

Privacy within internal environment:No

Possibility of darkness:No

TACTILE REQUIREMENTS

Internal surface texture:Smooth

Surface condition:

Dry

Non_Slippery

COMMUNICATION FEATURES

Telecommunication Facilities:
Telephone
Staff_Call
Information Retrieval Facilities:
Computer
Video
Clock Facilities:Yes

SECURITY FEATURES

Exclusion Device:
Security_Clock
Closed_Circuit_TV
Personal Security Features:
Authorised_Access

OPERATION FEATURES

Cleaning Facilities:
Vacuum_Points_System
Repair Facilities:
Platforms

Maintenance Facilities:
Access For Inspection:
Exterior Maintenance:
Powered_Cradles
Services Maintenance:
Zoning_of_Services

DESIGN AND PERFORMANCE REQUIREMENTS**BUILDING FABRIC****STRUCTURE****STRUCTURAL FRAME**

Material for structural frame:Concrete

EXTERNAL ENVELOPE**EXTERNAL WALL CLADDING**

Cladding type: CURTAIN WALL SYSTEM

CLADDING BACKGROUND

Cladding Background/Support: Framed_members

FRAMING MEMBERS

The framing material: Aluminium
 The span of frame (m): 6
 The view of framing members: Exposed
 The finish to framing members: Anodised

CLADDING PANEL

The cladding weight category: Lightweight
 The cladding panel visual size: Large
 The cladding panel material:
 Glass
 The cladding panel type: Flat_Sheet

GLAZING MATERIALS

The type of glazing unit (glass sheets):
 Toughened_glass
 The type of glazing unit (thermal properties): Double_Glazing

VISUAL APPEARANCE

The cladding panel form (shape):
 Flat
 The cladding surface finish (if applicable): Self_finish
 The cladding colours/coatings (if applicable): Manufacturers_specification

FIRE SAFETY

The minimum period of fire resistance for:

 The framing members : 60 minutes
 The glazing units: 60 minutes

TIGHTNESS REQUIREMENTS

The jointing principle for the glazing units: Pressure_equalised_drained

HYGROTHERMAL REQUIREMENTS

The thermal conductivity of the cladding system (W/mK): NULL
 The U-Value of the cladding system (W/m²K): 0.45

VISUAL REQUIREMENTS

Requirement of useful daylight : Yes
 The type of lighting requirement:
 Artificial
 Natural
 Visual continuity with external environment: Yes

TACTILE REQUIREMENTS

The cladding panel surface texture (externally): Smooth

The cladding panel surface texture (internally): Smooth

DURABILITY REQUIREMENTS

Lifespan of cladding (years): 20

ECONOMIC REQUIREMENTS

Capital Cost: Average

Running Cost: Average

Maintenance Cost: Average

SPACES IN DETAIL

Meeting_Room

Space Area (m2): 15

Length (m):NULL

Width (m):NULL

Height (m) :NULL

Space Volume (m3):NULL

Total Number of Spaces:4

General_Office

Space Area (m2): 2250

Length (m):NULL

Width (m):NULL

Height (m) :NULL

Space Volume (m3):NULL

Total Number of Spaces:NULL

Toilets

Space Area (m2): 5

Length (m):NULL

Width (m):NULL

Height (m) :NULL

Space Volume (m3):NULL

Total Number of Spaces:4

Corridor

Space Area (m2): 10

Length (m):NULL

Width (m):NULL

Height (m) :NULL

Space Volume (m3):NULL

Total Number of Spaces:4

RELATIONSHIP BETWEEN SPACES:

General_Office and Meeting_Room = For_Organisational_Purpose

Toilets and Meeting_Room = Association_Between_Spaces

Toilets and General_Office = Association_Between_Spaces

Corridor and Meeting_Room = Association_Between_Spaces

Corridor and General_Office = Association_Between_Spaces

Corridor and Toilets = Association_Between_Spaces

APPENDIX F

REFERENCES FROM THE INTERNET

Construction Information Gateway Demonstrator

Construct IT Study

The Department of the Environment (DOE) is committed to developing innovation within the construction industry. Effective use of information will be a vital component of an efficient and successful industry. Accordingly, the DOE has worked with BT to develop a strategy - Construct IT - for the use of IT to integrate the construction process.

This Construct IT strategy identifies current applications of IT in the industry and sets out the strategies for its future use. The primary recommendations arising from this study were:

- R1. Encourage the use of integrated project databases
- R2. Develop an industry wide knowledge base
- R3. Use IT to improve the efficiency of specific elements of the construction process

DOE has commissioned BRE to carry out two parallel studies with respect to the Construct IT recommendation R2. The Construction Information Gateway Demonstrator (CIG) project addresses this recommendation by creating a single point of entry to the Internet's construction related knowledge base. The other project, 'Scoping study for the construction industry knowledge base' will investigate the wider issues concerned with the Industry Knowledge Base, e.g. its contents, form and availability, commercial and legal considerations, and form of access and data security issues.

The CIG demonstrator will be shown at Interbuild on November 95 and in a number of roadshows to obtain feedback from the industry.

The project is funded by Construction Sponsorship Directorate of DOE and is carried out by BRE in collaboration with Engineering Technology and Newcastle University.

Continued...



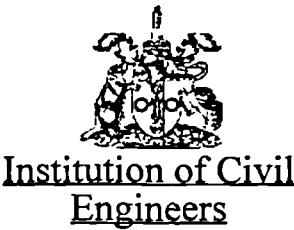
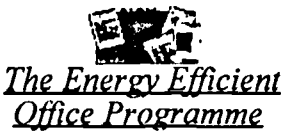
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Information Services



Other Web Sites

Manufacturer's Sites



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for

example architect scotland or flooring.....

concept or keywords:

To be included register with the biw.

reviews...

- ☐ coming soon the Web Review UK Institutes Oct 96
- ☐ VR Architecture in VRML review of buildings on the web
On-line Report/Catalogue
Construct IT 96 UK Construction Computer Show

aec directory resources ...

- Construction Computing
- Construction Professionals
- Contractors Contracting
- Materials Products
- News Stand
- Institutes & Associations
- Education & Research
- World Links

features...

- Javascript Calculator
Feasibility Developers Budget.
- ☐ Intranet J.Sainsbury Store presentation.
The Search page access to internet search engines including those for UK only sites.
Down Load biw for off-line use.

work shop..

- Web Design pages, images and on-line.
- VRML Construction Virtual Reality Modelling.
coming soon Java script programming for Construction.
- ☐ Intranet Web Server What, Where and How.

- ☐ reviews of web sites from institutes to trade associations to professionals to contractors.
- ☐ features covering the construction use of *information technology* with working presentations.
- ☐ resources of those in the construction industry who have email and or web sites. Our data entry provides searchable text from each index plus a full listing of the sites registered by our selves or by people registering a presence. The growing presence of Product manufacturers, suppliers and merchants on the web now means, more than ever, that you can obtain information and contact companies electronically via the internet and email .
- ☐ workshops designed to help you take advantage of the internet and intranet technology. From designing web pages for marketing presentation to presenting construction information and projects. The benefits of running an intranet and developing distributed information that is extendable customisable and transportable. How to a benefit form java and java script applications
- ☐ down loadable version of the warehouse that can be run off-line with valuable information from our data pages. Made available so that it can be run locally with a web browser or on an intranet. This will work on any machine capable of running a standard web browser.

- ☐ This service is being developed in association with ...
Newcastle University
Construction Industry Gateway at the BRE
-

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Shardlow Hall, London Road, Shardlow, Derbyshire, DE72 2GP, United Kingdom
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About the *biw*

The Department of the Environment sponsored the Construct I.T. initiative, which has the aim of using IT to reduce operating costs of the construction industry. A key aspect of that is to encourage construction professionals to use email on projects and on-line services to ensure the most current and appropriate knowledge is applied.

Although the level of investment to go on-line is small, the value to construction is limited by the distributed and fragmented location of relevant information. In particular, finding information on the INTERNET can be time consuming, often resulting in disappointment, thereby slowing growth of the medium.

To overcome some of these problems, the DoE has sponsored a research project to develop methods for applications software to seamlessly integrate with information sources on the INTERNET. The partners in this project are the Building Research Establishment, Newcastle University and Engineering Technology and the first demonstrators were shown at Interbuild '95.

To encourage the industry to publish information in a form which we can all access, Engineering Technology has established, with INTERNET service provider Pipex, a free access service using a high specification WEB server known as Building Information Warehouse which contains directories of Construction Professionals, Contractors, Product suppliers, Service suppliers, Education, Institutes, Research and Publications who have a presence on the WEB. This is intended to complement, not compete with, established information providers and value added services may be introduced on a collaborative basis in the future.

*Pages designed by the **biw***

[[Index](#)] [[Computing](#)] [[Professional](#)] [[Contracting](#)] [[Materials](#)] [[News Stand](#)] [[Institutes](#)] [[Edu & Research](#)] [[World Links](#)]

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Last updated time on 27:June:1996



Royal Institute of British Architects

The RIBA, in association with RIBA Companies and Newcastle University, are currently developing a fully operational internet service. Whilst the new site is constructed, this page will act as a link between the work done on behalf of the RIBA and RIBA Companies as part of the Construction Information Gateway project, and the new service.

We welcome your feedback on the developments and the services proposed and thank you for your patience.

For the CIG...



RIBAsite developments...



RIBAC Web

RIBA Information Services



CONTENTS

This page outlines the assistance provided by RIBA Information Services. Each service can play an important role in your overall marketing strategy

The creation of product awareness, within an acknowledged reference work utilised by the key specifiers at the point of internal product selection, is the next aim.

PRODUCT SELECTOR

plus

RIBA Product Selector is accepted as one of the leading publications referred to by many specifying professionals.

The ability to provide specifiers with comprehensive proprietary specifications, that enable them to marry products to specification clauses used in the compilation of the Bill of Quantities is paramount.

NBS Model Specifications are created by the industry standard specification system - National Building Specification (NBS) - for exclusive manufacturer use.

The initial aim of every manufacturer must be to ensure their literature is produced to an acceptable standard and is retained within a central reference source.

RIBA Office Library Service offers a selection of routes that achieve this aim.

Computers are becoming increasingly influential tools in the draughting and scheduling process. Product detailing coupled with annotation on British Standards and other key subjects on disk or CD-ROM are a consideration.

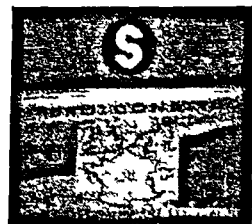
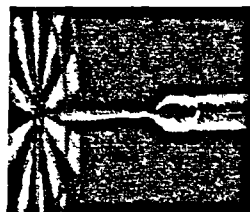
RIBACAD, a graphics library of pre-drawn product details, is unique to the marketplace.


Direct marketing, if targeted and precise, can achieve significant returns in the creation of product or service awareness.

RIBA Mail provides a database of specifying professionals, individually programmed to the needs of the manufacturer and delivered in list, label and disk formats.

Additional areas of marketing such as CD-ROM delivery of information, Product Cards, and export opportunities must also be considered.

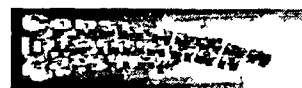
RIBA Information Services together with our European and American Associates can assist with these aims through such services as Sweet's Catalogue Files and the Euro Construction Cards



The information linked to these pages is also held in  form. A suitable viewer, Adobe Acrobat, is available from Adobe



to RIBA Companies Ltd



to the Construction Information Gateway

**Building Research Establishment**

About BRE

The Building Research Establishment is the principal organisation in the United Kingdom carrying out research into building and construction and the prevention and control of fire.

BRE is an Executive Agency of the UK Department of the Environment, and is based at Garston, near Watford in Hertfordshire. ([Location map](#))

BRE's main role is to advise and carry out research for Government, principally the Department of the Environment (DOE), on technical aspects of buildings and other forms of construction, all aspects of fire, and environmental issues related to buildings. It also manages information transfer for DOE's Energy Efficiency Best Practice programme. BRE has extensive links with research and technical organisations throughout the world. Since April 1990, BRE has been an Executive Agency of DOE.

BRE's research covers a broad range of issues, from studies of the basic properties of materials to investigations of the performance of complete buildings. BRE provides the technical basis for the Building Regulations and many British codes and standards, and communicates its findings widely to the industry and building owners through BRE publications and seminars. BRE also contributes to the development of European codes and standards, and supports Government departments and UK industry in the implementation of the Single European Market.

The Establishment's specialist skills and technical facilities are made available to the construction and fire prevention industries and to building users through BRE consultancy commissions.

BRE operates from three locations: its main site at Garston, near Watford, Hertfordshire (which also houses the Fire Research Station); its unique test facility at Cardington, Bedfordshire; and the BRE Scottish Laboratory at East Kilbride, Glasgow.

BRE e-mail address listing | Maps and directions to Garston and Cardington

Building Research Establishment

Garston, Watford. WD2 7JR, UK

Telephone: +44 (0)1923 894040 Fax: +44 (0)1923 664010



Peter White (whitep@bre.co.uk) 24 November 1995

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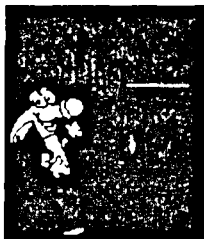
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Southern Pine
Council

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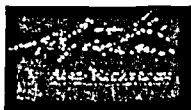
Tremont Nail

TrimJoist

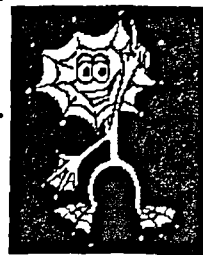
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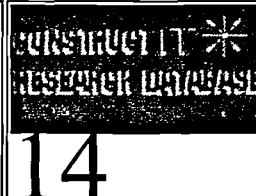
Dana Point, California

Phone: 714-496-6648 ~ FAX: 714-496-0036



Netscape Enhanced

A Client's Project Definition Tool



Aim

To give construction industry clients the benefit of using advanced IT visualisation devices, thereby allowing them to participate more fully in the design process; To offer process improvements that allow full use to be made of the benefits of this novel technology and to develop an outline training programme for senior personnel; To investigate the potential for developing a prediction score methodology of a design option.

Background

Advanced visualisation tools have an important role to play at the project design stage. They allow non-technical staff and building users to develop a more accurate impression of a potential building than is possible using traditional architectural drawings and perspective sketches. A wider body of knowledge, experience and opinion can therefore be incorporated at any stage in the design process. At the same time, it is important to ascertain what customers find pleasing and displeasing in a building design and to incorporate such customer-oriented concepts into the design at an early stage.

Programme of work

Encouraging the use of novel visualisation tools will involve developing an initial design solution, a design option at any stage or a detailed sub-design. Harnessing the benefits will involve identifying the key process improvements needed, offering solutions and developing an outline training programme for senior personnel that will alter ingrained attitudes and encourage new skills. Developing a prediction score methodology could involve predicting customer reaction to a particular layout or interior design and comparing this with actual reaction as the design evolves. It would also involve ascertaining what it is that customers find pleasing or displeasing about a building, and then incorporating customer-oriented concepts at the design stage. The results of this work will be exploited by the project participants.

Investigators

Professor Fisher N, The University of Reading, Dept of Construction Management & Engineering

University of Reading; British Airways plc; BAA plc; Intergraph Ltd; Colt VR Ltd; DEGW (Chartered Architects); Brandt Animation Ltd



Funding
Agent

Value

Duration

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Professor Fisher N

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Fax:

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E-mail:

kcsfinor@rdg.ac.uk

453



[Return to IT Database](#)

Construction Design Visualisation Through Virtual Reality/Virtual Environment



12

Aim

To develop a working prototype Virtual Construction Design Engineering (VCDE) design tool that can be used by clients and designers to visualise different design options; To test, evaluate and refine the prototype in collaboration with firms operating in the construction engineering field, and to provide guidance for future developers.

Background

The key feature of Virtual Reality (VR)/Virtual Environment (VE) technology is its potential to permit intuitive, real-time interaction with 3D graphical environments and databases. It is therefore perceived to be a valuable tool for productively exploring design solutions within the construction industry, a conclusion confirmed in recent interviews with construction designers. The British construction industry cannot afford to ignore VR/VE tools if it is to remain competitive. VR may soon become the standard method of design, planning, manufacture, selling and project management in the construction sector. However, there are, at present, few useful or usable construction VR design tools available to the profession.

Programme of work

The research element of the programme will have two major strands: * an examination of the underlying functional hierarchies of VCDE; * user interface design research that will attempt to make the system's operation almost 'invisible', thereby creating a design decision-making environment of 'pure relevant information'. The aim will be to provide systems primarily for use on low-cost PCs. Prototypes will be regularly tested in practical use at various stages in their development. They will then be upgraded appropriately. The research will be complemented by three Demonstrator packages. In the urban fit/misfit context, the development of a low cost, user-friendly PC-based design and planning tool should allow VCDE activities to be carried out by the standard in-house CAD draughtsmen of small and medium-scale enterprises. The second package is focusing on VR safety demonstrations, VR simulation being one of the few ways in which safety considerations can be demonstrated for an actual site. The third Demonstrator package will test the use of interactive VR for explaining to sub-contractors their role in the overall construction process and, hopefully, to maximise their contribution to the construction team. To ensure a fully usable design tool, the three packages will be integrated using a comprehensive database structure and user-sensitive interface.

Investigators


Professor Powell JA, Construction Virtual Environment Centre



Funding Agent

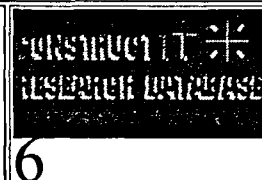
Value

Duration

Contact: Professor JA Powell	
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[Return to IT Database](#)

COMBINE - Computer Models for the Building Industry in Europe



Aim

To develop an operational computer-based Integrated Building Design System to specifications obtained through consultation with commercial architectural and engineering practices; To incorporate means and guidance for integrating drawing and other software tools through a common model of a building.

Background

There are several proprietary systems that link building design tools to CAD systems, but these use private databases and data models, making exchange between different systems either very difficult or impossible. This limits their use in a practical project with several different contractors. The first phase of the EU COMBINE project developed an integrated data model conforming to ISO STEP and providing an interface for six performance tools: heating and ventilation, internal space planning, thermal simulation, energy analysis, energy-economic design, geometric modelling, and the design of external building elements. This has made the exchange of data between diverse design tools technically possible. However, for this to work in practice, issues of ownership, control of revisions, the boundaries between traditional working domains etc need to be resolved. Interfaces with existing systems are needed.

Programme of work

An improved software environment is being produced to allow on-line data exchange between an extended range of practical application tools. These include Building Regulations evaluation, costing, component databases, daylighting and energy performance, EU Standards, and two commercial CAD drafting tools. This environment is being tailored for two specific applications: architects and building services engineers. Some limited testing will be undertaken to establish best practice, including: * establishing and generating models of existing working practices in Oscar Faber and Ove Arup; * developing appropriate mechanisms for data exchange and configuring each practice's design tools; * case studies in each practice using the integrated design system; * monitoring performance and establishing means for introducing appropriate QA systems; * organising seminars and workshops to present the results to other practitioners, ie to disseminate Best Practice guidance.

Investigators

Dr Parand F, Building Research Establishment


The project involves 15 organisations in eight European countries. Proposed Project. Three-Dimensional Object Libraries for Construction (3DOL)



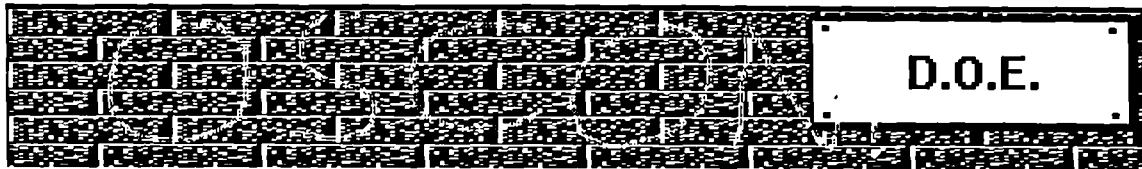
Funding Agent

Value

Duration

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Fax: 01923 664780	
E-mail:	

[Return to IT Database](#)



Open Systems for CONstruction

This is the work-in-progress page for the Open Systems for CONstruction (OSCON) project currently underway at the University of Salford (April 1995 to March 1997). The project is funded by the DOE and builds on the results of the preceding ICON project. Two research assistants are employed on a full time basis.

Aims

We aim to illustrate the benefits of using a centralised database as a means of integrating the information used by a number of participants within a construction project. The task domains we have chosen to integrate are; architectural design, design cost estimating and construction planning.

Methodology

To demonstrate how an integrated approach can benefit a construction project we are developing a suite of software which will actively share information via a central object oriented database. We are also addressing the problem of integrating legacy applications by providing 'wrappers'. The diagram below shows the system architecture.

The system revolves around a central object oriented information model. This model has two parts:

- The domain models which support integration of information within a specific domain e.g. Cost Estimating.
- The core model which captures knowledge on how information is transformed from one domain model to another.

All the models in the central database are completely independent of specific applications (although the domain models do provide support for general classes of application). In order to gather the knowledge required to design the models we have a steering group of industrialists. They supply case studies which we use to test the models and we have regular meetings to discuss progress.

Development Environment

The software is being developed using Microsoft Visual C++ v2.0 on the PC under Microsoft Windows 95. The database is implemented using the ObjectStore OODBMS in conjunction with the Object Engineering Workbench (OEW) modelling software.

Deliverables

The project has three deliverables:

- The Information Models - presented as a set of C++ classes plus a manual describing their use.
- The OSCON Software - consisting of a CAD Application using AutoCAD, a Cost Estimating application, and wrapper software for CA-SuperProject
- The OSCON Report - describing case studies and available in printed form and also via the

World Wide Web.

Team Members

Researchers

Terry Child

Alan T.Tracey

Management Committee

Dr. Ghassan Aouad (Chief Investigator)

Prof. Peter Brandon (Project Director)

Dr. Grahame Cooper

Mr John Kirkham (Project Manager)

Dr. Jim Yip

Dr. Martin Betts

Prof. Brian Lawson (Professor of Architecture. University of Sheffield)

Steering Committee

Prof. Noel McDonagh (Chair)

Mr John George, Barbour Index plc

Mr Andrew Hollway, Alfred McAlpine

Mr George Stevenson, Engineering Technology

Mr J T. Horsfield, AMEC Design and Management Ltd

Mr Barry Powley, AMEC Design and Management Ltd

Dr Richard Vidgen, University of Salford

Mr M. Crawford, Information Services Director, of NBS Services.

Mr F. Edwards of Elliott & Edwards, Architects.

Mr G. Hawkins, associate, of EC Harris, Quantity Surveyors.

Mr J. Chapman of R.James Chapman, Architects.

Mr J. Minnikin of Cruickshank & Seward.

Mr D. Elliot of Elliott & Edwards, Architects

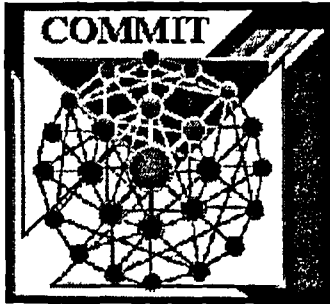
Mr G. Kelly, Head of Enterprise Unit, of The University of Central England.

Mr P. Tarris of The Royal Institute of Chartered Surveyors.

Dr G. Storer of Taywood Engineering Limited.

Mr D. Young of the Chartered Institute of Building.





COstruction Modelling and Methodologies for Intelligent information inTegration

- [Overview](#)
 - [Team Members](#)
 - [Publications](#)
 - [Deliverables](#)
 - [Development Environment](#)
 - [Contacts](#)
-

Overview

Projects in the construction industry are increasingly characterised by large numbers of actors working concurrently at different locations and using heterogeneous technologies. In order to support this kind of collaboration, project information needs to be conceptually modelled throughout its lifecycle, along with the events that impact upon it by causing state changes. The COMMIT project aims to address these issues by building on the work of previous projects, such as ICON, which proposed model-based solutions to the problems of computer integrated construction. The COMMIT Information Management Model (CIMM) has been proposed which addresses many of the problems surrounding this kind of collaborative work, such as versioning, notification, object rights and ownership. The model also facilitates the recording of the intent behind construction project decisions, thereby providing a complete project history. The project is ongoing; the CIMM is being currently being developed and refined and software prototypes demonstrating its use have been produced. The CIMM and CIMM prototype are intended to be generic in that they can, in principle, work with a range of object-oriented computer integrated construction environments.

COMMIT is a three year EPSRC funded project running from April 1995. The Salford COMMIT group is a well-established multi-disciplinary team involving the Department of Surveying and the Information Technology Institute. The Steering Group involves partners from various construction industry domains, including representatives from RIBA, RICS and CIOB.

Team Members

Principal Researchers

[Dr. Yacine Rezgui \(Team Leader\)](#)

[Mr. Alex Brown](#)

Mr Mike Jackson

Mr Paul Hayes

Mr Duncan Rose

Mr Alan Tracey

Management Committee

Prof. Peter Brandon (Project Director)

Dr. Grahame Cooper (Research Director)

Mr John Kirkham (Project Manager)

Dr. Jim Yip

Dr. Ghassan Aouad

Dr. Martin Betts

Prof. Brian Lawson (Professor of Architecture, University of Sheffield)

The project is also supported by a steering committee comprising regulation bodies, research institutions and industrials.

Publications

Refereed Journal Papers

- "An Integrated Framework for Evolving Construction Models", The International Journal of Construction Information Technology, (4)1, 47-60 (1996). Full text is available as WWW document (74K), PostScript print file (469K) and PKZipped PostScript print file (68K).
- "An Information Management Model for Concurrent Construction Engineering", accepted for publication in Automation in Construction.
- "Promoting Computer Integrated Construction Through the Use of Distribution Technology", The Electronic Journal of Information Technology in Construction, (1996). The full text is available as an Adobe PDF document (144K) or a WWW document (137K).
- "A Migration Path from the Current Document Centred Approach to Model Based Information Systems", submitted to the Journal of Computing in Civil Engineering.
- "An Object-Oriented Model-Based Approach for Evolving Information Representation", selected for publication in a special issue of Automation in Construction.
- "A Case-Based Approach for Concurrent Collaborative Construction Process Specification", to be submitted to Automation in Construction.

Conference Papers

- "Intelligent Information Versioning Support in the Context of Collaborative Construction Engineering", presented at the International Conference on Computing and Information Technology for AEC, Singapore, May 1996. The abstract of this paper is available as an HTML document.
- "The Architecture and Implementation of a Distributed Computer Integrated Construction Environment", presented at the CIB Workshop: Construction on the Information Highway, Bled, Slovenia, June 1996. The abstract of this paper is available as an HTML document. The full text is available as an Adobe PDF document (113K, pictures included) or a GZipped MS Word document (63K, pictures included).
- "An Object-Oriented Model-Based Approach for Evolving Information Representation",

presented at the [CIB-W65 conference](#), Glasgow, UK, September 1996. The abstract of this paper is available as an [HTML document](#).

Internal Papers

- ☐ "COMMIT Intermediate Report #1", internal report of the ITI, June 1995.
- ☐ "COMMIT Intermediate Report #2", internal report of the ITI, December 1995.
- ☐ "COMMIT Intermediate Report #3", internal report of the ITI, March 1996.

Other Papers

- ☐ "Intelligent Integration of Information in Construction (I3CON)", original project proposal. Full text is available as [HTML document](#) (15K, no pictures).
- ☐ "Information Futures: The COMMIT Project", Chartered Surveying Monthly, the official journal of the Royal Institute of Chartered Surveyors, August 1996.

Deliverables

Models supporting the intelligent management of information for construction have already been developed, and are described in several of the COMMIT publications. The first main deliverable is a comprehensive document which fully documents all these models. The second main deliverable is a software prototype which will implement the models, and demonstrate the concepts of intelligent information management in a integrated, concurrent and distributed construction environment. Development of the software is underway. A prototype was demonstrated at the second Steering Group meeting, the first fully working version is due to be delivered in December 1996.

Development Environment

The COMMIT project has chosen C++ for software development. It is both widely used and, importantly, has a robust [CORBA](#) binding. The [Object Engineering Workbench](#) is being used to model the CIMM and then generate C++ classes. OEW's reverse engineering facilities help to ensure a tighter integration of modelling and implementation. The C++ classes generated are augmented for use with the [ObjectStore](#) object-oriented database and [ORBIX](#) (a CORBA implementation which allows the distribution of objects in an ObjectStore database). The end result is a set of distributed objects which implement the CIMM and so provide CORBA compliant information management services for computer integrated construction environments. The combination of ObjectStore and ORBIX provides database and CORBA services which alleviate many of the implementation problems (which are not addressed by the model-based CIMM) associated with integrated construction environments. These services include transactions (which prevent concurrency anomalies and provide rollback) and efficient object retrieval services.

There is also a need to provide user interfaces which can allow a project's actors to flexibly browse and access managed information (rights, intent, actors, roles, versions, etc). This user interface software is being developed in [Visual C++ Version 4.00](#) for the Windows NT and Windows 95 platforms, again with OEW being used as a modelling tool.

Contacts

We are very interested in any comments or suggestions you may have regarding the COMMIT project. These can be entered in a [response form](#).

For more information about the COMMIT project either use the [form](#) or contact:





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<h1>Dynamic Building Archive</h1>			
<h2>45</h2>			
Aim			
<p>The purpose of this initiative is to develop a visualisation tool based on photographic images which can be used to familiarise students and professionals with particular construction environments and facilities.</p>			
Background			
<p>Providing site access often presents difficulties when introducing students to construction management or construction technology issues. However, visual information can greatly enrich the teaching process through experiential learning. The purpose of this project is to exploit multi-media technology to try and 'import' the site visit experience to the lecturing and tutorial situation.</p> <p>This is being undertaken using 'surrogate travel' technology, which is achieved by connecting a large collection of still frame images in such a way that a computer user can 'walkthrough' an environment.</p> <p>This approach provides greater flexibility than video sequences and <i>actual</i> as opposed to <i>virtual</i> imaging which is offered using conventional graphical simulations.</p>			
Deliverable			
<p>Surrogate travel player to be made available as an authoring tool to educational establishments in the UK, together with a number of building archives - via the internet.</p>			
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