Towards an Information and Decision-Support System for the Building Industry

H G LESLIE and D G McKAY*

ABSTRACT

Although the building industry has passively accepted the computer industry's offerings for some time, it is now beginning to assess its own operational needs and how computers might best support them. Building Information Systems is working closely with industry groups in Australia and New Zealand towards a system for effective management and exchange of building-related information. Part of this impetus has resulted in *An Information and Decision-Support System for the Australian Building Industry* published by the National Committee on Rationalised Building as a document to promote discussion. It is widely supported and is now being redrafted as a strategy for establishing a framework within which a person or an organisation can solve specific local problems and, in doing so, contribute to a cohesive industry effort. The first parts of this strategy - the problems and the points to consider in their solution - are discussed.

Key Words

information management strategy; information systems; project-decision making; building procurement process

INTRODUCTION

Building is one of our more information-intensive industries. Despite this mass of information and the problems in communicating and coordinating project decisions, the industry has been slow to seek 'better' ways for its decision-makers to access and apply relevant knowledge. It seems, then, that the industry must develop a strategy by which information technology is effectively integrated with the building procurement process.

As the first part of proposing a strategy for implementing and maintaining an information and decision-support system across the building industry, this paper examines a number of the issues central to its communication and coordination problems and puts forward some key concepts intrinsic to the

* *Building Information Systems Project, CSIRO Division of Building Construction and Engineering (DBCD), Gate 2, 87 Delhi Road (PO Box 310), North Ryde, NSW 2113 Australia.*

assurance of quality and value in building projects.

Information Reference Sources

Whether the aim is to describe an object, decide a quality level or assess value, input to making a project decision will come from three major sources. These are: the personal knowledge and experience of the decision-maker or peer, reference sources (research, trade literature), and the current project description (the amalgamation of earlier project decisions). If these sources are to be well utilised for improving project performance, their nature needs to be understood.

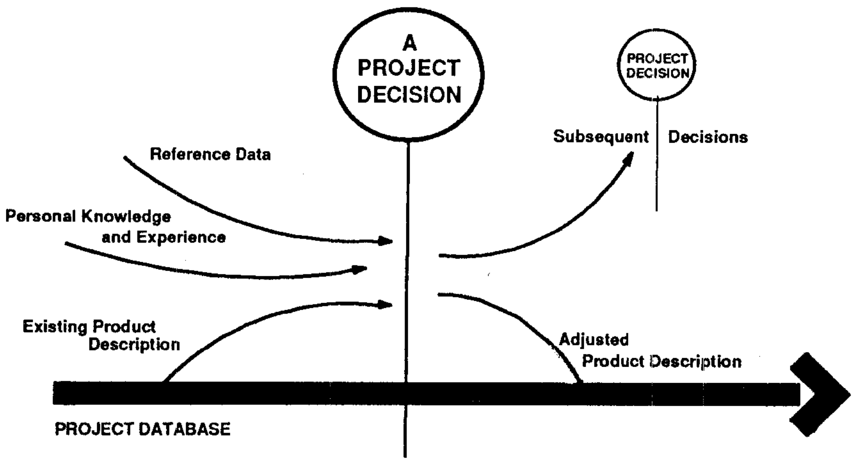

Figure 1. Information Transaction in a Project Decision

Personal Knowledge and Experience

There is a tendency for practitioners to rely on personal knowledge, their own or that of a peer, (Mackinder and Marvin, 1982). While such knowledge and the understanding it gives are essential components of decision-making, to rely on it primarily can be dangerous because it is difficult to keep up to date and it is difficult to assess another's understanding. The success, or otherwise, of a communication is usually only understood after the recipient acts. The person must also be there at the time of deciding, be attentive and have the necessary powers of recall.

Reference Data

What the practitioner should expect to obtain from this source is up-to-date information on such things as best practice, functional planning requirements, recommended construction details, product data, specification text and feedback on past performance.

Project procedures, contractual arrangements and even fee structures also discourage the practitioner from seeking new and possibly better solutions. Administrative issues are outside the scope of this proposal but an efficient and effective information system could significantly counteract their negative effects.

The strategy of the proposed information system seeks to ensure that relevant information would be:

- suitably indexed so that it is easily found,
- in a form that is appropriate and increases understanding,
- applicable to the decision at hand, and
- available within project constraints.

The need for this approach is evident in the aspects outlined below.

- *Data sources* - Under pressure to push the project out, a practitioner who is not sure of the need for extra information, whether it will be relevant, can be found in time, or will be digestible and applicable when it is obtained, is unlikely to invest a great deal of effort in open-ended searches. A quick and effective means of showing where particular information can be obtained will overcome this.
- *Data Indexing* - Research tends to be catalogued under subject/title/ author and product literature, commonly, under the name of the manufacturer/supplier or product. Using either effectively requires knowledge a practitioner may not have at hand. For example, the name of a manufacturer or product that offers the 'best' solution. These systems are even less helpful where all potential solutions need to be unearthed.
- *Presentation Form* - Access to information does not assure its application. Practitioners need to be able to quickly understand it and determine its relevance to the work at hand. Having to filter out inordinate amounts of background material in research papers to see whether results are relevant can be a barrier to all but the most ardent practitioner.
- *Phase Relatedness* - Another issue in presenting information is knowing when in the life-cycle certain data should be applied. For example, providing safe egress from a building requires planning the routes, ensuring 'exit widths', selecting, specifying and installing the appropriate doors and marking the route with exit signs. Each decision is made in a different project phase and is likely to involve different people.
- *Timing of Delivery* - Timing the delivery of information will depend on when the decision is to be taken. For each decision there is an optimum time in the project life-cycle. That is, after the decisions that lead up to it are made, but before those that rely on it as input. In deciding too early (before making lead-up decisions) there is a risk of work being completed incorrectly

and needing to be done again. If too late, project delay and other decisions being made prematurely could be the risks.

Existing Project Description

As the information components of this source are likely to be better understood conceptually after looking at some background on decision making, they are raised later in the paper.

Decision-making Strategy

Implicit in the foregoing is that efforts to assure quality and value of a project must be directed through the team responsible for developing it as a product. From this premise, the strategy proposed concentrates on the decisions necessary for such assurance and on the product itself. In doing so, it treats as an important element the information that supports these decisions and its exchange between the source and the user, and between user groups.

The first part of this strategy might require helping the project stakeholders to:

- define and communicate their goals for and concerns about the project,
- identify areas and levels of performance that are critical to these goals, and
- establish value frameworks against which to assess the solutions;

as well as helping the project team to efficiently and effectively:

- translate stakeholder requirements to terms that they can be more readily dealt with,
- raise and assess potential solutions in terms of their relative values, and
- communicate and coordinate the 'product' description during the project's life-cycle.

Developing ways and means to control the progress and quality of the project is yet another important area in which both groups might need assistance.

To attend to these observed needs it will be necessary to understand:

- what decisions will be taken and when,
- what information is needed and in what form,
- who should contribute to these decisions and
- who should communicate them to whom?

Evaluative Base of a Project Decision

As making a decision about a project is evaluative it can be regarded as 'an iterative process which brings together the **object** to be assessed and a **value framework,** such that its performance within that framework can be determined' (Rescher, 1969).

A project-decision maker has to consider a diverse set of unrelated documents, such as the brief, building codes and regulations, research findings and product literature. When brought together as a single, simple list of stakeholder-defined *objects* (building elements, systems, components and materials) and *value frameworks* (essential and desirable levels of performance) they become the decision makers' tools for determining the nature of the proposed facility.

Bases of Judgement

Quality - 'the totality of the attributes of a building which enable it to satisfy needs, including the way in which individual attributes are related, balanced and integrated in the whole building and its surroundings' (Burt, 1978).

By this definition 'quality' can be equated to 'fitness for purpose' which should be regarded as a project specific variable that must be negotiated by the stakeholders. That is to say, each project must answer a different set of needs and expectations for its stakeholders. Negotiations of these leads to a corporate view of the required areas and levels of performance from which the project team identifies and values potential solutions.

The concept of value - 'benefit/cost' - is the basis for distinguishing between competing solutions. Value is improved by obtaining a higher level of performance for a given cost or conversely, a given performance at a reduced cost. Levels of performance beyond those required (quality) normally represent a net loss of value.

To some extent quality can be determined in advance, through prototype briefs for example. Value, however, must be considered relative. It changes in response to variation in the site (location, orientation, access, geophysics), the stakeholders skills, values and priorities, and to wider factors like the economy. Its assessment must be the province of the project team whose members are the only ones to know the issues and understand their relative priority.

Performance-Based Decision Making

Performance

The performance concept of building procurement assumes that a building is designed, constructed and operated for identified purposes which might range from housing a particular activity, through presenting a corporate image to winning the designer professional recognition. The intention here is to make objective and explicit performance requirements (that otherwise tend to remain subjective and implied) and thereby provide a base for:

- improved information management at both an industry and project level;
- more efficient and effective project communication/coordination;
- increased opportunity for innovative solutions;
- assuring the quality and value of the building product and the procurement process - Total Quality Management.

Performance Domains

A number of organisations have put forward performance classifications (Figure 2). A synthesis of these suggests that overall 'project performance' might be divided into 'product (physical facility) performance' and 'process (management of its delivery) performance'.

The separation of the product from its procurement processes is a fundamental distinction in the proposed information and decision-support system. While it is possible to consider product quality in isolation, assessing value demands that product and process are considered together.

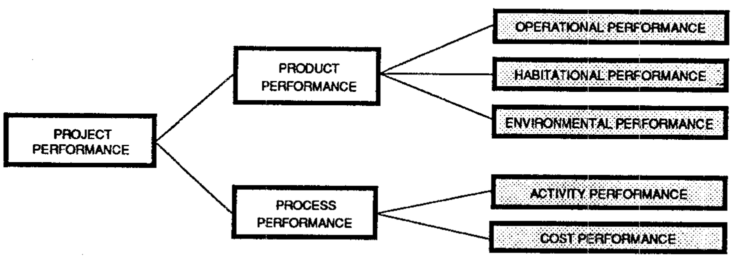

Figure 2. Project Performance

Buildings of a particular type will have many common performance goals but the stakeholders might, as suggested, place different priorities on each case to assure total quality and optimum value. Standard briefs, then (say for schools, hospitals, office building), should only be used as a 'performance mask' for developing a complete, project-specific brief. Regardless of whether a 'performance mask' or project specific brief is being prepared, the following defined performance domains should be considered in setting appropriate levels.

- *Operational performance* - the ability of the building or any of its facilities to meet the needs of the organisation(s) being accommodated and conversely, of the susceptibility of those facilities to that (those) organisation(s). The issues might range from need for image through to the impact of the facilities on recurring costs.)

- *Habitational performance* - the ability of the building or any of the facilities to meet the communal and individual needs of the building occupants and conversely of their impact on the accommodation. (Issues range from the overall atmosphere of a building or of its spaces, including consideration of the spatial, visual, aural and thermal environments (Manning, 1991) through to issues of occupant health and safety.)
- *Environmental performance* - the susceptibility (behaviour, durability, serviceability) of the physical components of the building and of its individual elements and materials to the environment and conversely, of the impact on it of them. (Issues include, for example, high wind and earthquake resistance, concrete cancer and UV radiation.)

Broadly, stakeholders would be able to express their interests and concerns in terms of the above domains but not, under present conditions, in a consistent form and terminology. The information would need to be coordinated and translated so that it could be efficiently and effectively used by the project team to set value frameworks.

Performance of Building Elements

Performance requirements might be presented randomly such as in discussing the project budget, the quality of the foyer and the colour scheme in the boardroom. The project team needs the means of filing this information so that it will be readily available to the relevant decision-makers. In this proposal, breaking down of the building into spatial, fabric and service systems and attaching attributes to each is seen as the logical approach to sorting and classifying the data (Figure 3). Not only are the basic units common to all practitioners dealing with projects, but they are also categories that cover every aspect of the building. Of course, the wider industry must agree on the types and names of elements and the typical performance attributes to be attached to them.

As well as sorting and classifying, this system would become a conceptual framework in which performance requirements (stakeholder needs) would be mapped to the building elements (space, fabric and services). To set the desired quality, stakeholders would have to nominate attributes and their performance levels as essential and merely desirable so providing the means for the project team to make value assessments. Moreover, with a target of Total Quality Management, the system would be utilised in a feedback loop to monitor performance and assure compliance (as discussed later).

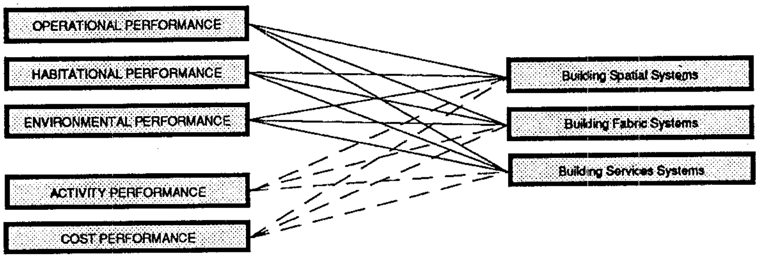

Figure 3. Performance of Building Elements

Interactions in Project-decision Making

Figure 4 models the interactions that should take place in making a project decision. The corporate view of stakeholder needs is introduced to the project team as the set of generic needs (1). These needs are translated into elements and their required performance attributes - *objects and value frameworks* (2). Armed with a definition of the problem, the project-decision maker then searches the elemental databases for potential solutions (3). From the known and unknown solutions presented, and adjusting the research criteria if need be, the searcher selects one or more applicable solutions (4). It is known from the search criteria that the selected solutions meet the requirements but each may have a different performance profile which project team evaluates against other project demands in making the final selection (5 and 6). The subject element is then embedded in the project description and tested for compliance with the original criteria at each occurrence (7).

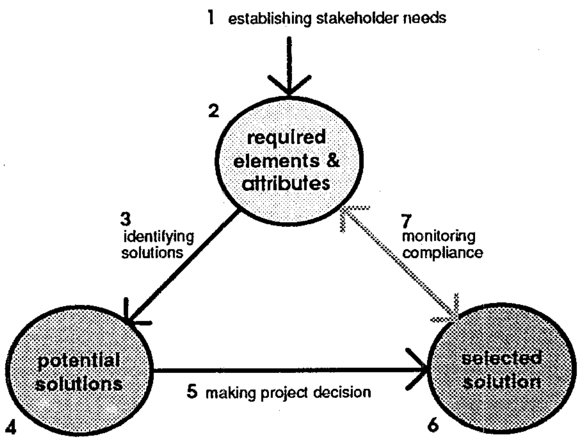

Figure 4. Project-decision Making

Commonly, the final selection would depend on another set of decisions. In such cases, it might be necessary to carry forward two or more potential answers. The project description, therefore would have to be able to manage multiple solutions yet drop the redundant ones after the final decision was made.

Describing Projects

Traditionally, the building delivery process has been managed as a series of discrete activities albeit with overall control from the project team (Figure 5). In paper-based documentation, phases of this process are described in functional layouts, sketch plans, contract documents, works as executed drawings and asset registers. The redrawing and double handling of information that are part and parcel of the procedure take time, threaten transcription error and make checking difficult. Even CAD systems, where they are used just to automate drafting, display similar shortcomings.

The key to solving these problems is to realise that all the documents noted above, no matter what discipline owns them, merely represent the same object in different stages of development. In other words, they are part of a description that becomes more finite as the project progresses. By utilising computer technology with this concept in mind, managing the description would be not only more efficient but would provide freedom to flexibly manipulate the input of information. In such a system the project description would be 'integrated', even more so if 'ownership' of descriptions by particular professions were discarded in favour of integrally describing the product itself (Figure 5).

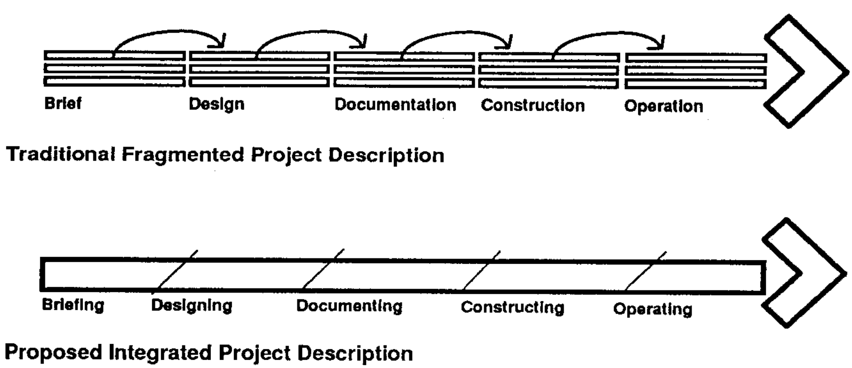

Figure 5. Project Descriptions

The obvious benefits from a computer-based description of a project as conceived above are savings of time and resources, helped by eliminating transcription errors. Less obvious is its capacity to assure quality and optimise value throughout the life cycle of the project by letting project team members (Figure 6):

- gain access to the stakeholder definitions of product quality and value,
- communicate performance requirements and flag subsequent action needed by others,
- coordinate with other team members in making decisions,
- monitor decisions and actions to ensure that interim conditions for meeting all the project's performance goals prevail,
- manage alternative solutions while related optimisation tasks are in progress, and
- check for and certify compliance with stated performance requirements.

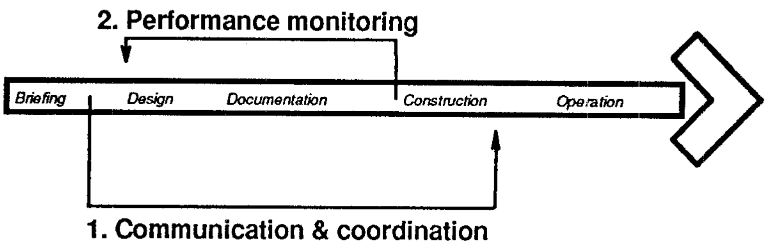

Figure 6. Typical Flagging and Auditing During Life-cycle

Strategy Development

As indicated in the introduction, the issues examined and the concepts put forward have provided the springboard for launching into the development of subsequent parts of the proposed strategy for implementing and maintaining the system in the paper's title. Apart from flushing out some of the matters raised here and explaining how they might work in practice, development is taking the line of proposing a base of standard terminology, classification, data exchange protocols and the industry structures to manage those elements.

It is evident from the last section that one matter needing further exposition is the idea of the integrated project description. What will be considered are both the manner of communicating and coordinating project decisions and of integrating the project itself with the information system as a decision-supporter. Discussion in this paper of sources, form, phase relatedeness and timing of the delivery of information touches these areas. A closely related matter for detailed examination is how information would be organised by and exchanged between experts and project team. The intention is to schematically develop a system of classifying that, as suggested earlier, supports performance-based decision making. To be defined are the appropriate inter-relationships of space, fabric and services with attributes grouped in the proposed performance domains. Practicalities of the role this system plays in exchanging information through an industry-wide network will also be discussed.

Standard terminology upon which classification is based is intended, depending on industry agreement, to be taken from the revised *Glossary of Australian Building Terms* shortly to be published by the National Committee on Rationalised Building, *Thesaurus of Australian Construction Terms* and *Australian Building and Construction Definitions* published by Standards Australia. These and other pertinent documents that come to light such as standardised exchange protocols and, naturally, a publication on the proposed classification are seen as the elements of a communication and coordination package, *ComCore.* The Australian Construction Industry Development Authority (CIDA), a federal agency has given tentative approval to the notion of *ComCore* and its being maintained by a committee of owners of the documents it contains. In electronic form, as an integral base in the information exchange network, it would be constantly under scrutiny of the users who, given the opportunity, would be able to feed back any corrections desired to the maintenance committee.

The acceptance that the information system idea has received, fuelled perhaps by some industry 'naval gazing' during this recessionary period, indicates strongly that it is something sorely needed that, over the long term will become part of normal life for the industry.

References

Burt, M E (1978), A Study of Quality and Value in Building. Building Research Establishment, Department of the Environment, Watford.

Mackinder, M and Marvin, H (1982), Design Decision-Making in Architectural Practice: The Roles of Information, Experience and Other Influences During the Design Process. Research Paper No. 19, Institute for Advanced Architectural Studies, University of York.

Manning, P (1991), Environmental Aesthetic Design. *Building and Environment*, Vol 26, No. 4, pp 331-340.

Rescher, N (1969), Introduction to Value Theory. Prentice Hall.

---

c. 1993, Management of Information Technology for Construction, K. Mathur et al (Eds), World Scientific Publishing Co., Singapore.