BUILDING DESIGN COORDINATION

Rusdi HA[1]

ABSTRAK

Artikel ini menyajikan hasil penelitian studi pustaka yang meneliti tentang proses dalam perancangan gedung. Penelitian ini mendiskusikan tiga aspek dari perancangan gedung: proses perancangan, koordinasi perancangan dan informasi rancangan. Bagian pertama menjelaskan bagaimana sebuah rancangan muncul dimulai dari client's requirements sampai menjadi rancangan lengkap. Pada bagian kedua menjelaskan bahwa bila perancangan melibatkan beberapa bidang yang berbeda maka diperlukan koordinasi perancangan. Bagian terakhir menjelaskan pertumbuhan dari informasi rancangan. Dari rancangan konsep hingga rancangan detil, informasi rancangan berubah dari lebih abstrak menjadi lebih konkrit, dari umum menjadi lebih rinci.

Kata kunci : *proses, koordinasi dan informasi perancangan gedung.*

INTRODUCTION

Humans are stimulated by their needs to do activities. In turn, these activities create things or services they need. However, frequently the things or services do not satisfy their needs. Ullman (1992) estimated that 85 per cent of the problems with new products are the result of a poor design process.

Designing previously is a creative process, which is difficult to analyse. Advance in computer technology provides tools that make designing easier. The use of computer in designing, however, is still limited. It is because the creative process is difficult to be implemented to computer systems. Until now, there is no computer system that can replace an architect or an engineer.

Many research projects are now addressed to designing and design process. One project analysed how a designer performs activities and produces a design. Then they tried to compose systematic steps and rules, which imitate the designer's activities. Another project dealt with a computer expert system i.e. the computer system, which can behave like a human expert. For example, Retik and Warszawski (1994) have developed a knowledge-based system for the detailed design of a prefabricated building. The input of the system is a preliminary architectural design of a building including layout and elevations of the building floors. The system then produces suggested structural patterns.

Balachandran (1993) defined design as the activity that is directed towards the goal of satisfying human needs. In the design process, first, the goal of satisfying human needs, called the design goal, must be established. The design goal may include functionality, performance, cost and user desires of the design. In order to get an optimum design, there are some limitations or constraints, which should be applied. The constraints might be either the area used by the design product, the time needed for performing a certain function or the cost needed for making the design.

[1] Dosen Fakultas Teknik Universitas Lambung Mangkurat

A design has several values that determine the design such as area, length, height, cost, capacity, performance, etc. These values are called design parameters. The design parameters, which are under control of the designer, are called design variables. The process of design is defined by Balachandran as the translation of information in the form of the design requirements, constraints and objectives into potential design solutions.

There are two approaches in the design process. These are iterative and optimisation approaches. In the iterative approach, the designers first choose an initial solution from potential design solutions. This solution is then tested with constraints. In order to satisfy the constraints, the designer may alter the design variables. This brings the designer to a number of new potential design solutions. The process is repeated until all design requirements are reached and all the constraints are satisfied.

In the optimisation approach, the design objectives are presented in objective functions. Then it is assumed that the objective functions and the constraints can be written mathematically as functions of design variables. The design solutions are obtained by carrying out the optimisation process of the objective functions and the constraints.

When design process involves designers from multiple-disciplinary areas, the design process also includes design coordination. Each designer may view the design from his/her perspective. An architect looks at a building from its overall appearance or the organisational spaces, while a structural engineer looks at the same building as a group of columns, beams and support walls.

It is often the case that designers should change the design due to availability of materials, site conditions, or a change in the design requirements. If one designer alters the design, he/she should confirm the alterations to other designers to avoid disagreements in the design. The confirmation may bring further design alterations in other designers' scopes. This process is called design coordination. In the conventional way, the coordination is done through meetings, memos, letters, etc. using drawings and written specifications.

BUILDING DESIGN PROCESS

Sequential Approach

The sequential approach means that each design stage for each discipline is done one after another. One design stage can be started when the previous design stages have finished or almost finished. This approach allows only small overlaps between stages (Figure 1). In a building design project, the design stages that are done sequentially might be preliminary, architectural, structural, detailed and services design stages.

The advantage of sequential approach is that there are clear and separate jobs for all designers. Therefore, each designer has a single and clear responsibility. However, there are also disadvantages of this approach. Firstly, the completion of design process is longer, because of small overlaps between stages. Secondly, when redesigning is needed in one stage, the design should be re-evaluated in the predecessor stages.

Figure 1. Sequential Approach

Concurrent Approach

Contrasted with the sequential approach, this approach allows larger overlaps between design stages (Figure 2). So that, it takes less time. However, this approach needs much effort to implement because good communication between designers should be established. It requires a similar data representation and data format for all designers. Research on concurrent building design is now becoming the current topic of building design research in industrial organisations and universities. The central aim of this design method is to integrate the main aspects of building design i.e.: architectural, structural, services and construction.

COORDINATION PROCESS

Conventional Approach

Coordination between designers is usually accomplished by transferring the project information such as drawings, specification documents, minutes of meetings, laboratory reports, engineering reports, formal letters, notes, etc. The content of the project information will increase along with the progress of design. In the earlier stages, designers perform more conceptual design and then in the later stages designers solve more technical design. The content of the project information initially is general information and then gradually builds up with more detailed information.

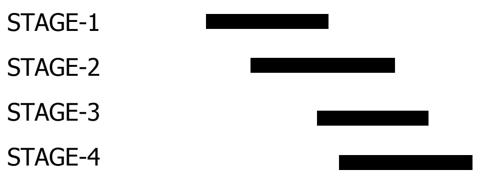

Figure 2. Concurrent Approach

If there are difficulties in the later design stages and these bring the need for changing in the design of the earlier stages, then the design process becomes prolonged. Moreover, it becomes complicated when each design stage is done by a different organisation. From this point of view it may be concluded that, a conventional coordination process a will run smoothly if the designers in the preceding stages have more experience.

Computerised Approach

A coordination process using a computerised approach can be used in the concurrent approach of design process. All design stages refer to the same knowledge rather than to the previous stages. They are more independent of each other, so all stages can be done with greater overlaps.

The system using computerised coordination approach consists of the design knowledge-base, design tools, user interface and inference engine. The knowledge-base can be created by a knowledge acquisition subsystem that performs the elicitation of design knowledge from expertise. The design tools are used by designers to create the design. The design tools may be application programs such as CAD systems and structural analysis programs or database management programs. A designer communicates with the system using the user interface. The interface may be a graphical user interface or a CAD system. The inference engine is a module in the system, which processes and controls all mechanisms in the system.

Each designer accomplishes the design process in his own environment using the user interface and the design tools. The system always refers to knowledge-base to confirm that the design is matched, so that all designers can perform their jobs almost simultaneously. Unfortunately, the complete knowledge-based system is not present yet.

Ahmed et al. (1992) introduced a process model for collaborative-engineering design in which design task hierarchies are mapped into a hierarchy of nested and grouped transactions, and the database is partitioned accordingly into private, local and global shared areas. This provides a mechanism to achieve greater concurrency and coordination in engineering design.

Virtual Technology Approach

Virtual technology has emerged from the advances in telecommunication technology. Virtual technology allows the creation of virtual environments such as virtual organisations, virtual teams, virtual offices, virtual shops, etc. Although a great number of communication tools are present, few standards are specifically created for building virtual environments.

Virtual organisations, to be more specific: virtual teams are defined by Guss (1996) as groups of working professionals, separated by geographical, psychological and temporal distance. Telecommuni-cations tools are used by these groups for professional and social communication to fulfil business requirements of jobs towards reaching common goals.

In the current construction industry, strategic project decisions are made through office and site meetings that gather all participants. These media are not always practical or efficient. The participants are not always successful in assisting teams achieve the required speed and coordination to manage schedules and resources. Virtual organisations offer new possibilities in the construction industry by replacing face-to-face meetings that are very expensive and time consuming for remote participants.

THE DESIGN INFORMATION

According to RIBA (1985), the design stages include outline proposal, scheme design and detailed design. In the case of building design, terminology names are *inception*, *concept design* and *design production* (MacLeod, 1997). Every design stage in the design process comprises sub-processes. There are six sub-processes i.e., *design input*, *design planning and control*, *cost management*, *safety management*, *design justification* and *design output*. Table 1 summarises all sub-processes and design stages.

Table 1. The Design Stages and the Sub-process

Sub-Process \ Stages	Inception	Concept Design	Design Production
Design Input	• Prepare the requirements statement	• Update the requirements statement	
Design Planning and Control	• Prepare design plan • Process documentation	• Develop the design plan • Process documentation • Concept design review	• Update design plan • Process documentation • Final design review
Cost Management	• Preliminary costing	• Cost studies	• Cost estimate
Safety Management	• Hazard identification	• Draft pre-tender safety plan	• Pre-tender stage • safety plan
Design Justification		• Concept design report	• Calculation, • Modelling
Design Output			• Drawings, Specifications • Construction methods

The *design input* sub-process establishes the requirements and other input information. At the inception stage, the sub-process prepares the design requirements statement from the client's requirements and constraints. At the conceptual design stage, the design requirements statement is updated. Similarly, other sub-processes evolve from the inception stage to the design production stage.

The design information that is used in every process will evolve from one stage to another. The design information as input information of one process will produce output information, which will become input information of the next process. This information flow model is illustrated in Figure 3.

The initial input information is the information for the first process i.e., the design input sub-process at the inception stage. This initial input is processed to produce the requirements statement of the design (see Table 1).

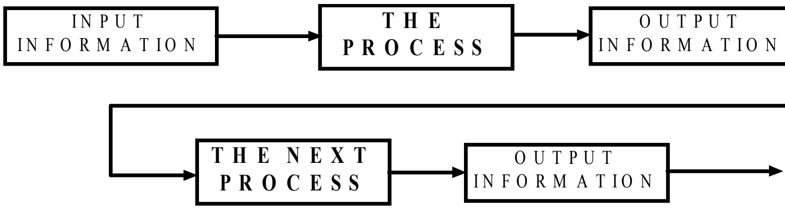

Figure 3. The Model of the Design Information Flow

The requirements statement can be established through the following procedures and principles. The basic procedures are:

- initiate the requirements statement using the client's requirements (*client brief*),
- append more items based on an early requirements analysis session that is accomplished by the design team,
- establish a classification system for requirements items,
- give a project specific identifier for each item,
- negotiate with the client additional items that are relevant to the client's requirements,
- add the new requirements as the project develops.

There are two basic principles for defining the requirements statement. The first is regarding the items in the requirements statement. The items, as far as possible, should not determine the form of the design solution. The requirements statement should describe the expected function of the design. The second principle concerns the updating of the requirements statement. For updating the requirements statement, protocols need to be determined (MacLeod, 1997).

The design can be presented in a *model requirements statement* (the common and the specific statement). The common statement, which gives requirements for a general category of the design, and the specific statement is the statement that has been used previously in a similar design. The initial design information is needed to establish the requirements statement. Other than the client brief the sources of the general information are:

- regulations,
- codes of practices,
- guidance documents: PBI, SNI, ACI-Code, Trade Associations, etc.,
- manufacturers catalogues,
- quality assurance documentation,
- libraries: books, journals, etc.

The sources of information, which is specific to the project, are the project itself and other similar projects. The information from these sources includes site information such as topography, soil conditions, geology, existing services, existing buildings, etc. It is very important to obtain this information before proceeding with the design work.

The design information develops from one process to another and from one stage to the next stages. The initial information is the client brief, general information and specific information. The final information is the complete documents of the design. This development can be illustrated as Figure 4.

From that figure, the progress of the design information can be described as follows:

- The design information starts with the client's need that is presented in the client brief. To complete the initial information, additional information is collected i.e., general information and specific information.
- The output information of the inception stage becomes the input for the conceptual stage. The process produces the new design information i.e., the updated requirements statement, the updated project documentation, design review, cost planning and design report.
- The process at the final design stage produces the final design plan, cost estimate and project documentation i.e.: drawings, specifications and construction methods.

CONCLUSIONS

The discussion about design process, design coordination and design information, may bring to the understanding in the designing mechanisms. It will open the ideas to new research topics by using a computer system not only as a designing tool, but also as a designer's partner.

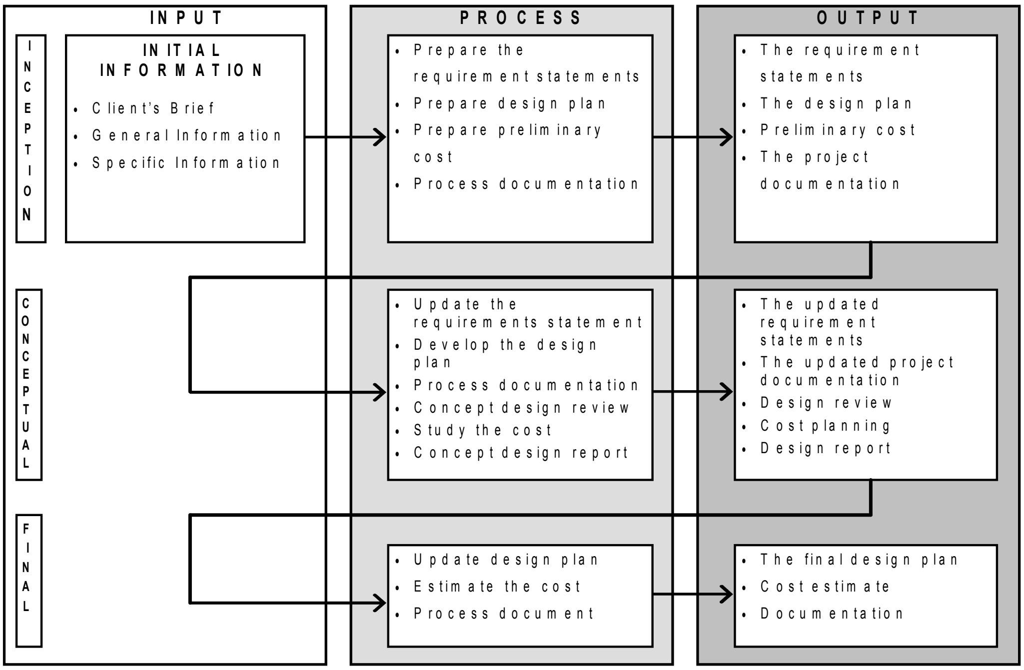

Figure 4. The Flow of Design Information (MacLeod, 1997)

REFERENCES

Ahmed, S., D. Sriram, and R. Logcher (1992), Transaction-Management Issues in Collaborative Engineering, *Journal of Computing in Civil Engineering*, Vol. 6, No. 1, January, ASCE, pp. 85-105.

Balachandran, M. (1993), *Knowledge - Based Optimum Design*, Computational Mechanics Publications, Southampton.

Guss, C. L. (1996),Virtual Teams, Project Management Processes and the Construction Industry, *Proceedings of CIB Workshop*, Bled, Slovenia, June 10^{th} - 12^{th}, 1996, pp. 253-264.

MacLeod, I. (1997), *Design Project Process: Guidance Documents Version 3.1*, Department of Civil Engineering, University of Strathclyde.

Retik, A., and A. Warszawski (1994), Automated Design of Prefabricated Building, *Building and Environment*, Vol. 29, No. 4, Elsevier Science Ltd., pp. 421-436.

Royal Institute of British Architects (1985), *Architect's Job Book*, RIBA Publications Limited, London.

Ullman, David G. (1992), *The Mechanical Design Process*, McGraw-Hill, Inc., New York.