Computational & Methodological Studies for Interorganisational Design in Architecture, Building and Urban Development

RESEARCH PROGRAMME 1994 - 1998
Delft University of Technology
Faculty of Architecture, Housing and Urban Design
Section for Computer Aided Design and Building Informatics

1. THE GROUP

Research Coordination:
P.P.van Loon: Assistent Professor Building Informatics
Research Staff:
A.Tzonis: Professor Design Methods
A. Bridges: Professor CAD
A. Koutamanis: University Lecturer CAD
P. Barendse: University Lecturer CAD
M. Leusen: University Researcher Design Systems
R. Noordzij: Phd Student
A. Angulo: Phd Student

2. HISTORICAL BACKGROUND
The shift from hierarchic to decentralised design

One of the most radical changes which has taken place in the fields of architecture, building and urban development over the past few decades has undoubtedly been *the shift from hierarchic to decentralised design*. Some 25 years ago, the design process in these fields was almost always headed by one, or perhaps several, professional designers. While these were usually architects, they were sometimes building design engineers or, in the case of large-scale projects, urban and landscape designers.

Today, however, a comprehensive *design team* consisting of all the parties involved in the preparatory work is responsible for the design process. In other words, parties other than professional designers now also have a direct influence on the design.

In recent years the new participants have acquired their *own responsibility* for a particular aspect of the design:
- the structural engineer for stability;
- the building services engineer for the installation systems;
- the materials manufacturer for the building materials used;
- the costing expert for the prices;
- the traffic engineer for infrastructure;
- the urban planner for the allocation of land;
- the building contractor for the construction work;
- the investor for funding;
- official bodies for standards and technical specifications
- and the user for the functional requirements.

It is clear that professional designers have less influence than was formerly the case, the other participants often allowing them only to design the form and plan of the building and the site.

During a *cooperative process* within a design team, all parties put forward their ideas, alternatives and combinations of alternative solutions are discussed and evaluated and the best possible solution selected. Team design in architecture, building and urban development has come to be what is known in political and management science as a *'multi-actor' or 'multi-party' negotiation and decision-making process.*

3. METHODOLOGICAL FEATURES
- **Parallel positions of authority**
- **Individual design decision areas**
- **Design negotiation**

In this research programme we shall defend the view that in architecture, building, and urban development *the present methodological (computational) premise of design is unsuitable for the present general occurrence of decentralised project design* in these fields. We shall demonstrate that this premise is unfeasible as it does not include the following three essential characteristics of decentralised design:
- Decentralised design is based on *parallel positions* of authority. Parallel positions of authority are a special feature of decentralised design. Hierarchical design, however, is characterised by superior and subordinate positions of authority. In decentralised design the team members (both professionals and non-professionals) are equal partners, each with their own goals and means of achieving them.

- Decentralised design is based on *individual decision areas*. In decentralised design each member of the team is responsible for decision-making in his own particular area.
- Decentralised design is based on *negotiation*. Decentralised design involves a special form of negotiation. This in contrast to hierarchical design in which instructions are issued.

In this research programma we shall develop *a new methodological (computational) premise for design* which incorporates the three above features. In addition, we shall demonstrate that many of the existing design methods function effectively in design teams using this new premise.

4. COMPUTATIONAL FEATURES

Design innovations by means of systematic design

- **Interdisciplinary design**
- **Project design and**
- **Computer aided design**

A large number of *innovations in design methods* were introduced during the last 25 years. They began at the end of the 1960s with what was known at the time as *'systematic design'*. The design activity was divided into a logical step-by-step procedure, with each step being given rational consideration. The designer had to work only with the information which was 'known'. Separate systematic methods were developed for each step (Foque, 1975, p.118; Jones, 1970; Alexander, 1964).

This was directly followed by a second wave of new methods known as the *'interdisciplinary' approach*. In the interdisciplinary approach tasks were also split up, but now among those involved in the design. This took place under the pressure of growing specialisation in knowledge and skills. The split took place along the lines of the various disciplines cooperating in the design team. Even then, cooperation was an important precondition for tackling difficult and complex commissions. The new methods were directed at improving this interdisciplinary communication. (Foque, 1975, p.61; Jones, 1970).

Around 1975, a third wave of innovations occurred which related to '*project design*'. This wave was influenced by the new views on management and teamwork prevailing at the time, particularly those relating to ad hoc cooperation and non-hierarchic working relations among specialists. New design methods tailored to the unique nature of each design commission were developed. A new design team had to be brought together for each project and each team had to follow a design method for that specific project. (Mintzberg, 1979; Bennett, 1991; Wijnen et al. 1984).

The last innovations took place towards the end of the 1980s with the emergence of *Computer Aided Design (CAD)*. This fourth wave of innovations is still in full swing. The micro computer and the personal computer have made it possible to use two- and three dimensional drawing techniques for the purposes of cooperation and communication within a design team. CAD techniques still have a great deal of potential in the field of the methodical improvement of design, particularly as regards managing the complexity of design projects (Bijl, 1989; McCullough et al., 1990; Pipes et al., 1985).

These new methods regularly come in for *criticism* both from the professional designers and from the other participants in design teams, particularly the non-professionals such as users, principals and politicians. The main criticism was mainly of the *technocratic and rational design* that went with the new methods. Even those whose specific task it was to introduce the new design methods were critical; the new methods were too rigid and often *too complicated* to lend themselves to teamwork.

5. BASIC APPROACH

- **Design from the individual point of view**
- **Team design as an inter-individual proces**
- **Team design as an inter-organisational proces**

We shall deal in this research programme with the *computational design methods* for building, architecture and urban development *from the individual points of view of all the parties involved in the process*: principals, investors, owners, experts, officials, builders, users and residents. This is possible only if one assumes that the parties involved have their own standpoints in the form of a collection of definable goals, that they will endeavour to achieve those goals and that they will adjust their actions and decisions during the design process to serve those goals.

From the individual point of view the design process takes place between all the individuals involved and it can therefore be described as an *inter-individual process*. However, as individuals are usually part of an organisation (the body commissioning the project, the design firm, the structural engineering firm, the owners of a building, the users' organisation etc.) and as they usually participate in the design process in that capacity, it is more accurate to speak of an *interorganisational process*.

Assessment from an individual point of view is uncommon in the field of design methods. Design is usually assessed only from the point of view of the official principal. The question of how the design process is to be conducted and how the team is to achieve the principal's goals is examined. The underlying assumption is that the team is made up solely of experts, each of whom is capable of executing his particular part of the design process in harmony with the others. This assumed harmony is possible because consensus is expected on how the design commission is to be carried out. Furthermore, it is assumed that the design process will proceed according to a specified schedule and allocation of tasks which have been derived from the commission. The views of the user, as the third important party involved, will be considered only when the design is ready and has been approved by the principal. At that stage they can do no more than accept or reject the design.

This view of the design process reflects a *hierarchical 'linear' structure* with respect to the cooperation between principals, designers and users.

However, from the individual points of view, cooperation in a design process does not take place in a hierarchical structure but in a *flat 'matrix' structure*. This is based on the idea that it is not only the experts who are responsible for the design, but that all the parties involved contribute. Thus, principals, professional designers and users together form the design team, all pursuing different and often conflicting goals. Naturally, these individuals can operate in sub-groups within the process: e.g. users' interest groups, experts from a particular department, a consortium of investors etc. All this means is that a number of individuals have grouped their goals to form one set of common goals and that they will attempt to achieve these goals as a group.

6. **BASIC METHODOLOGY**
Methodological individualism

Discussion of the individual point of view will be based on *'methodological individualism'*, which is a concept in economics and, more specifically, in the economic theory of political decision-making (Van Den Doel, 1978). The view that a group of people working together form one independent entity is replaced by the view of the group as a *collection of individual* sub-groups producing something for another collection of individual sub-groups, who may or may not be working together.

In methodological individualism it is out of the question that the group which produces something together has its own responsibility for taking decisions for others, but rather individuals and sub-groups of individuals working together have special authority which enables them to take decisions for others and renders them accountable (Van Den Doel, 1978, p. 20-21).

Methodological individualism is becoming increasingly relevant to team design. The growing complexity of design commissions has made it impossible for professional designers to decide alone what is relevant to achieving the (individual) goals of all the parties involved.

We should say at this stage that the individual approach cannot be applied to all design teams. The view of the various conflicting interests is less relevant to *teams designing products for individual consumption* the use of which will have no effect on non-users and which therefore do not have to be taken into account in the design process. However, if *a team is designing a public utility* (with one or more user and affecting non-users too) then, as we wish to demonstrate in this research project, the idea of individual interests provides a great deal of insight into the design process in general and into the fields of architecture, building and urban development in particular.

7. **BASIC CONCEPT**
The interorganisational design system as a goal-oriented social system

In this research programme, *a model of the interorganisational design system* will be built up. The system will be portrayed as a limited set of interrelated elements. The three main elements are: the designers themselves, the channels through which they communicate and the design or plan on which they collectively work. The system is also regarded as a particular type of *'goal-oriented social system'*: a group of individuals striving for something and interacting with each other.

Examples include two chess players who both hope to win the game, a school board running a school or a design department working on a particular design.

Hanken and Reuver (1977) have devised a general model for a goal-oriented social system, based on the principles of the systems approach, and used this model to specify a number of special types. This section is based on their work.

A goal-oriented social system is a system which seeks to achieve a certain goal or goals and consists of at least two decision-makers. The fact that such a system contains decision-makers distinguishes it from empirical systems (systems in which processes are autonomous and spontaneous). In the literature, goal-oriented systems are often referred to as normative systems, since they strive to achieve a norm, or goal.

A goal-oriented system generally has n decision-makers: D1,...., Di,....., Dn. These decision-makers are interconnected, in the sense that they exercise a certain influence over each other. The systems approach assumes that this influence can be exercised in two ways: through *the primary system (PS)* or through *the communication system (CS)*. The primary system is the actual object with which the decision-makers are concerned. The communication system is formed by all the communication channels through which information is passed from one decision-maker to another (Hanken and Reuver, 1977, p. 60).

Let us take as an example a group of researchers testing a product. The product and the test equipment are their primary system. They use visual and oral communication to coordinate their individual activities. Another example is a school board, whose members issue policy memoranda and meet to consult on the appointment of new teachers, exchange information on the school's budget and discuss new curriculum proposals. They then take and implement decisions. This occurs within the primary system: the school, teachers, students, building, teaching material and budget. The school board 'operates' the primary system; it appoints teachers, accepts or rejects students, issues diplomas and ensures that the curriculum is taught so that the school can achieve its goals.

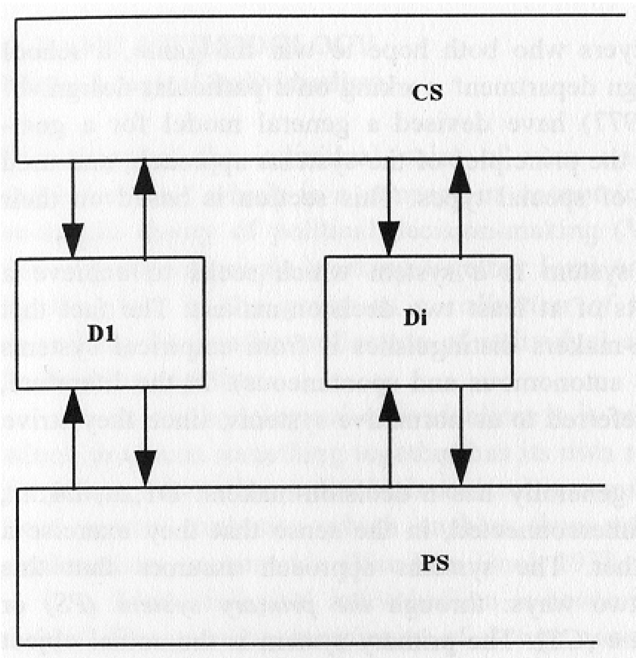

Figure 1: **Diagram representing a goal-oriented system**

In the first example mentioned above, the researchers communicate with each other while carrying out the test. Their decisions are implemented immediately using the test equipment. In the second example, the school board develops a plan on which it subsequently bases its decisions. When drawing up the plan it uses a model of the primary system, on which the board members base their negotiating position. A new budget or curriculum will first be examined in relation to that model and then evaluated before it is implemented. The process therefore has two stages (Hanken and Reuver 1977 p. 60):

- *the preparatory stage*: The decision-makers are 'off-line'. They act on the basis of their conception of reality and attempt to identify the best strategy on the basis of this image and what they wish to achieve.
- *the implementation stage*: Contact with reality is re-established. At this stage the decisions are implemented 'on-line', their effects are observed and decision-makers might alter their views in response to these observations.

These two stages can be illustrated in the goal-oriented system diagram by dividing the primary system (PS) into an image system (IS) within which preparations are made and an original system (OS), or object system, within which implementation takes place. Decision-makers, image system and communication system together comprise the preparatory system (PrS) (which is also known as the decision-making system).

Whenever decision-makers are able to consider alternatives, they will always use some model of reality in the form of an internal representation of the "real" (original) system. "Using this model, certain alternative strategies and their expected results can be considered. These results are evaluated by the decision-makers on the basis of their goals or values in order to determine the optimum, or at least a satisfactory, strategy" (Hanken and Reuver, 1977, p. 59). By implementing their chosen strategy, the decision-makers hope to achieve a new, better, or even ideal original system.

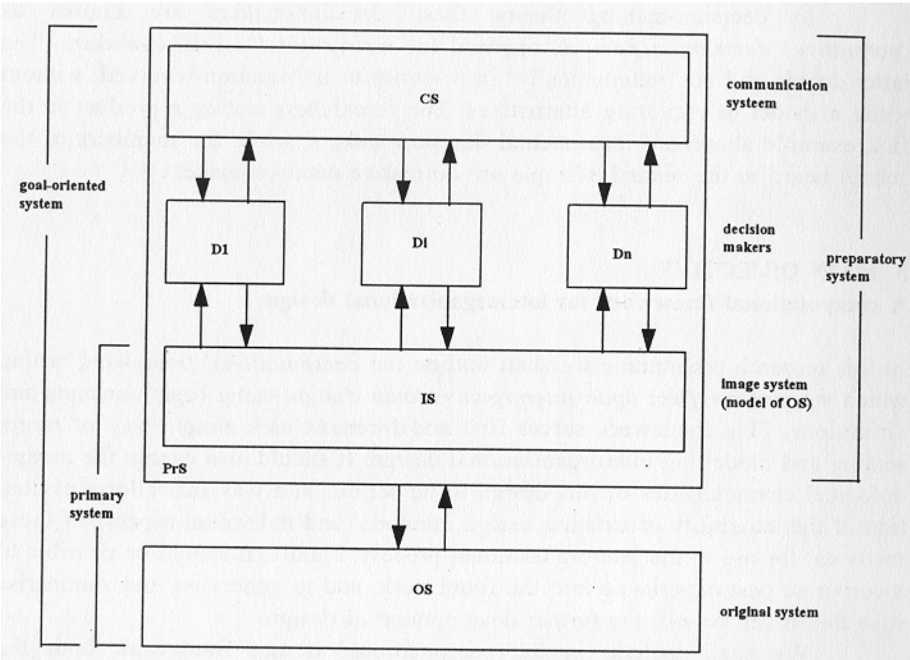

Figure 2: Diagram representing a goal-oriented system with image system and original system

In decision-making theory these decision-makers are known as *'normative' decision-makers*, as opposed to *'instrumental' decision-makers*. The latter decide and act 'automatically' in response to information received, without using a model or exploring alternatives. The researchers testing a product in the first example above are instrumental decision-makers, while the members of the school board in the second example are normative decision-makers.

8. MAIN OBJECTIVE
A computational framework for interorganisational design

In this research programme we shall outline the *computational framework* within which we are *to reflect upon interorganisational design*, using basic concepts and definitions. This framework serves first and foremost as a simple way of representing and modelling interorganisational design. It should also enable the methodological characteristics of this design to be set out in a way that allows evaluation of the suitability of existing design methods (and individual aspects of those methods) for use in the interorgaisational process. Finally, it should be possible to incorporate past experience into the framework, and to generalise and summarise it so that it can benefit the further development of design.

We shall include in the computational design framework both *the individual decision-making process and the group decision-making process*. Classic decision-making theory often assumes that both processes are structured in the same way. If one assumes that a group of decision-makers within an organisation is in fact a hierarchy of individuals, their decision-making process can be defined as a logical series of individual decisions. The decision made by each individual must always fit in with the decision of the individual who is above him in the hierarchy. Since each individual makes consistent decisions, the group also decides consistently, as if it were one fully informed, rational individual.

This classic theory takes little account of the processing of differences of opinion and conflicting goals, to power imbalances and lack of information and rationality. These issues certainly come into play in design processes involving several individuals and organisations. We shall therefore use decision-making models which incorporate differences of opinion and power imbalances, and which cope with insufficient information. These models occur mainly in political science (the study of, among other things, decision-making in representative bodies, such as parliament and local councils) and negotiation theory.