TO RESCUE THE DESIGNER FROM EPISTEMIC FREEDOM AND OTHER CHALLENGES

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ABSTRACT
In the 1960s, Horst Rittel asked to what extent design could be made explicit. This question was based on the premise that only explicit processes could be scrutinized, and better understood and taught. Rittel's approach served as the foundation for our proposed methodology for teaching design.
While rejecting the idea that the design process can be systematized, we believe that certain tasks are integral to it. Our teaching methodology emphasizes the importance of understanding the own design process and suggests techniques to deal with the following issues: defining variables, generating alternative solutions, and engaging in decision-making.
The proposed methodology has been successfully tested in upper division and graduate level design studios in architecture.

Keywords: Design studio, design process, variables, alternative solutions, decision-making, design methods

1 THE DESIGN STUDIO

"Architects may find it extraordinarily difficult to give explicit, accurate, and useful accounts of understandings implicit in gradually learned competencies that have become intuitive." Donald Schön (1985:7)
Schön's statement captures the very problematic of learning to design and implies both the necessity for and the constraints of design studio teaching.
In the studio, students are engaged in a design problem setting while learning from and with one another. Schön (1985) identifies a paradox related to the designer's education. Students in the early stages of their design education feel confused, but they cannot be taught and explained whatever they do not understand. Understanding comes only through hands-on experience, by engaging in the design activity itself.
Even though design studios cannot present students with a systematic process of engaging in the design activity, they can and are expected to provide them with a thorough understanding of the nature of design and the difficulties it entails. Studio instructors can show the students how to set and explore the frame of a design problem in order to retrieve information pertinent to the particular design project.
Since the design process cannot be readily illustrated and taught, one has to take advantage of tools and techniques that can aid the designer's activity and are available to both studio instructors and students. The use of precedents, sketches, drawings, and models as means for understanding the implications of the design and communicating design ideas to others are integral parts of the studio teaching and learning.

2 DESIGN KNOWLEDGE

There are two kinds of knowledge involved in design. On one hand, there are tools like perspective drawings and plans, whose creation follows certain rules and conventions. Learning to construct and use these tools represents the explicit kind of knowledge. On the other hand, questions of how to approach a design task cannot be answered in such concrete ways. Much knowledge used by designers is acquired through experience. It is generally unverbalized and unspecifiable, and it is called "tacit knowledge" [8].

Schön (1983) sees tacit knowledge as playing an important role in the profession of architecture and understands design as involving the following cognitive processes: knowing-in-action, reflection-in-action, and reflection-on-action.

Tacit knowledge is knowledge-in-action. Designers make judgments without being able to state adequate criteria and display skills without being able to explain the rules and procedures underlying them [14]. Knowing-in-action helps designers frame a problem. It consists of the language and tools they use to describe the design situation and test their ideas, the value system they apply to appreciate the situation, the theories that help them understand different phenomena, and the frames within which they set their task.

Reflection-in-action is what designers do when they pause to reflect on how they have reached an understanding of the problem, and what to do next. It occurs most likely when what designers do instinctively brings about a pleasant or unpleasant surprise, or when knowing-in-action no longer works. Reflecting-in-action is criticizing and restructuring knowledge, so it can lead to new actions.

In reflection-on-action, designers try to understand how they approach problems and try to find out why certain actions seem to succeed and others do not. This constitutes an attempt to make the design process explicit.

3 THE ROLE OF DESIGN THEORIES AND METHODS

The field of Design Theories and Methods (DTM) studies the architects' works by exploring the cognitive aspects involved in designing, i.e., how the designers undertake their task, where they get their ideas from and how they develop them, how they choose among alternatives, how they deal with the context and the client, and so forth [9].

Horst Rittel, a design theorist with significant contributions to this field, founded his design theory on the characteristics of design problems. According to Rittel (1972), design problems are neither well- nor ill-structured. They are wicked, and as such, they have no exhaustive definition. Instead, "[t]he information needed to understand the problem depends upon one's idea for *solving* it. […] Problem understanding and problem resolution are concomitant to each other" (Rittel and Webber 1973:161).

Because of the subjective values involved in the search for solutions to wicked problems, the solutions cannot be classified as right or wrong, only as better or worse. Thus, a wicked problem can have an infinite number of correct solutions that depend on the values and judgments of the designer. The fact that there are no right or wrong answers implies the impossibility of having definite standards to test the solution to a wicked problem. Part of this difficulty lies in the fact that every wicked problem is unique, because no two such problems ever share all their properties.

A solution to a design problem cannot be tested in the real world prior to the implementation of the design plan. Since no trial and error is permissible, the designer has the responsibility to anticipate the consequences of his/her proposed solution.

Being concerned with DTM's contribution to design education, Rittel was interested to find out to what degree design processes could be made explicit and communicable to others, so they could be taught, and critically scrutinized and improved upon.

4 A MODEL OF DESIGN

The proposed model of design is based on Rittel's approach towards identifying and finding ways to deal with those aspects of the design process that can be made explicit.

While rejecting the idea that the design process can be represented in a systematic way, we believe that tasks like gathering information, starting off with a conceptual design, generating and discarding design solutions are integral to the design process. Even though our intention has been to make explicit as many of these aspects as possible, we have been primarily concentrating on three issues: (1) specifying variables, (2) generating alternative solutions, and (3) engaging in evaluation and decision-making.

4.1 Specifying variables

The specification of variables is one major challenge faced by designers, which Rittel called "epistemic freedom" (n.d.:5), understood as the freedom of choice. The underlying idea is that design encompasses a tremendous number of variables that belong to three categories: context, design, and performance. In the course of a design project, variables can switch between context and design, and the values of performance variables may change as new information enters the project. In order to be able to design, the designer needs to create a guide for the project by specifying some of the variables, thus getting an understanding of the nature of the expected design solution.

Design variables (D) are in the designer's control. The designer is free to choose the variable and its values, thus determining the form and shape of the designed entity.

Context variables (C) are variables that the designer has or chooses to have no control over, but that do influence the performance of the particular entity designed.

Performance variables (P) are the variables along which the designer decides to measure or evaluate how well the designed entity performs or meets the preset expectations.

The relation among the above variables is illustrated in Ashby's (1956) model of design: $P = f(D, C)$. This function, however, does not denote a mathematical relation. Neither do designers know exactly what the form of 'f' is.

At the beginning of the design process, there are many design variables, and towards the end, there are increasingly more context variables. What might be considered necessary are things out of the designer's control, which serve to reduce variety. Constraints or context variables are a matter of judgment associated with deontic knowledge, which allows the designer to determine how the desired design outcome ought to be. [1].

The specification of variables, however, does not fully determine form. Many solutions can satisfy the preset requirements and expectations. Therefore, the designer should explore different, and possibly very distinct design ideas before selecting the better one that is eventually developed to the final design solution.

4.2 Generating alternative solutions

According to Koestler (1964), the solution to a problem is reached when two separate trains of thought connect to give a flash of insight to the thinker. Koestler's bissociation theory of creativity postulates that discoveries, inventions, or creations come about when familiar, but usually unrelated frames of reference are brought together.

Fritz Zwicky's method of generating ideas represents a systematic exploration of Koestler's theory of creativity by bringing together familiar, but usually unrelated frames of reference in a "morphological box" (1996:123-141). In architecture, the frames are not necessarily unrelated, but the combinations of values may be novel.

A temporary shelter

Material	wood	metal	fiberglass	fabric	Combinations	Other
Grouping	yes	no	some grouping	Other		
Durability	very durable	for a few years	for a few months	Other		
Transportation	engine driven	on transporter	in the trunk	Combinations	Other	
Assembly	no assembly	quick assembly	elaborate assembly	Combinations	Other	

Figure 1. A morphological box with design variables and combinations of their values

Topological transformations are another method for generating alternative solutions. Topology is the branch of mathematics that deals exclusively with the positioning and interrelations of spaces and their boundaries independent of shape and size.

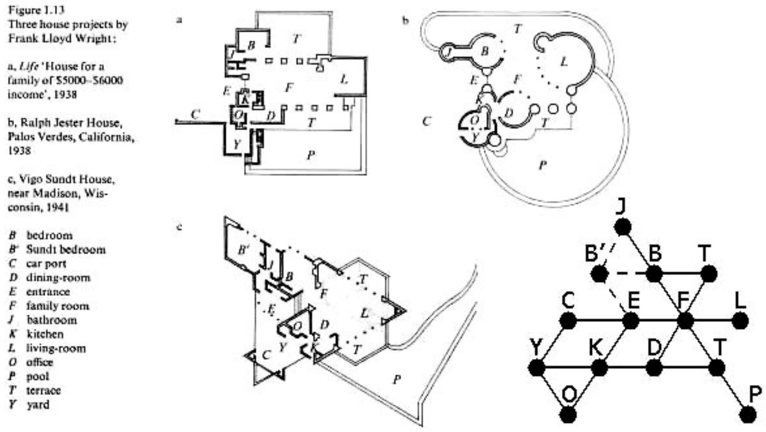

Figure 2. F. L. Wright housing projects as an example of topological transformations [5]

Of particular interest to designers is a branch of topology called "graph theory." A graph is an abstract construction indicating a finite set of entities together with a set of specified relationships between them. It can be used to study the spatial and access configurations of existing buildings and to establish the spatial/organizational requirements of a proposed building before developing a floor plan.

Selecting among alternative solutions is represented by the process of decision-making. How designers form their decisions is usually not very transparent. Frequently, ideas are dismissed because of 'gut feelings', without the designer being able to provide any reasoning. Such off-hand judgments can be avoided if the designer develops a technique for evaluating the performance aspects of the proposed design solutions.

4.3 Engaging in decision-making

Based on Rittel's theory, the designer is expected to be rational and think about the consequences of the design before the plan is implemented. Unlike the rationality promoted in the scientific approaches to design, which presumed the evaluation of all possible design alternatives and anticipation of all possible consequences for choosing a course of action, Rittel's rationality has rather the meaning of reasoning and reflection.

Rittel showed that even this weak form of rationality leads to inherent paradoxes (1972:391-392) that deny the designer the ability to proceed entirely rationally.

But, if design decisions cannot be based on rationality, on what are they based? Boulding (1956) argued that our choices are influenced by our knowledge of the world, or what he called 'the image' that is formed by our experiences, education, and culture. Our image is dynamic. Every new message we receive, every new experience we have potentially affects and modifies it. Whether and how messages and experiences affect our image depends on that part of our image that values or ranks things in the world.

To cope with fleeting knowledge and values, Rittel (1972) proposed that design decisions should emerge through a process of argumentation. Since knowledge is subjective and the design requirements are controversial, the process of argumentation helps the designer understand the given design situation, locate the sources of controversy, and select the appropriate course of action.

Solving design problems involves a lot of subjective judgments, which require that the designer be able to make his/her judgments explicit to other participants. Judgments can be overall or partial, i.e., they are about the 'whole' project or about one or more aspects of it, and they can be off-hand, i.e., 'off the cuff' or a gut reaction, or deliberated, when one thinks about and reflects upon the value of the object before making a judgment [9].

To deliberate is to find contributing aspects under which an object is to be judged. Each aspect may be deliberated into sub-aspects which may be broken down into sub-sub-aspects until reaching a point where further deliberation is no longer possible, either because you cannot deliberate an aspect any further, or because the number of aspects are sufficient to formulate a judgment [10], [9].

A procedure such as the Musso-Rittel Evaluation Procedure [7] can aid designers in forming decisions in a systematic way, and in justifying or explaining their decisions to others. Furthermore, this procedure reveals aspects that are in need of improvement, thus aiding the designer in making appropriate changes to the design plans.

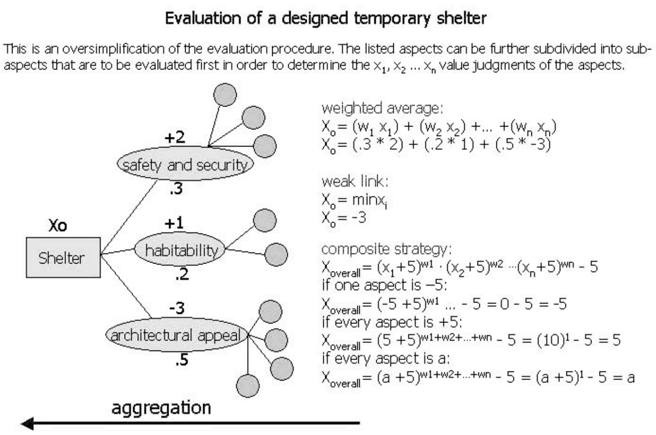

Figure 3. An example of the Musso-Rittel Evaluation Procedure

5 IMPLEMENTING THE MODEL INTO THE DESIGN STUDIO

Concentrating on and finding ways to cope with these major design issues should help design students get a firmer grasp on the design task, learn not to dismiss design ideas without prior deliberation, establish the desirable consistency between the design specifications and the design outcome, and make their decision-making process transparent to themselves and to others.

The design studio, however, is an abstraction of a real world design situation. The wickedness of design problems is limited so that dealing with them becomes a task manageable to students. So, for example, students do not need to worry about budget constraints, and there are no other participants to determine the fate of the design [3].

Our proposed teaching philosophy has been applied to design studios in architecture at the University of California, Berkeley. It emphasizes the design process as a way to teach students how to deal with wicked problems. Its major objective is to encourage the students to understand, analyze, and evaluate the own design process. Furthermore, it attempts to show how the use of suitable methods facilitates particular design tasks.

The studio is divided into three, five-week long segments. In the first segment, students are given an actual site and a theme, e.g., married student housing. They are asked to develop a program, find out the restrictions imposed by city ordinances and zoning laws, and set criteria for what they would consider an appropriate solution to the problem at hand. In other words, the students get involved in formulating the problem, or, in Schön's words, they "*name* the things [they] will attend and *frame* the context in which [they] will attend to them" (1983:40). In terms of the model of design discussed above, the students tentatively set out the context and performance variables they wish to consider. This exercise also intends to demonstrate the need for reducing epistemic freedom, i.e., lets the students experience how difficult it is to design if there are only choices and no constraints. With that accomplished, the students proceed to design a first resolution to the problem, i.e., they explore the design variables within their reach. It should be noted that explicitly stating the criteria for a good solution in advance of any design already gives the students some ideas about what they will design - an illustration of the fact that a design problem cannot be formulated without a solution in mind. At the end of the segment, the students present their work to a jury that is instructed to take each student's criteria into consideration when discussing the work.

For the second five weeks, the students are asked to design at least two other, distinct resolutions to the same problem. At this stage, the students, armed with their first experiences, may want and are encouraged to review and revise the chosen variables. With Ashby's model of design in mind ($P = f(D, C)$), students become aware of the interrelation and interdependence between variables. They realize that changing the value of one variable requires reevaluation of the appropriateness of the other variables. To facilitate the production of alternative solutions, students are introduced to some idea-generating techniques like morphological boxes, topological manipulation of floor plans, etc. A critique structured and organized like before concludes this segment.

The last segment is devoted to the design development of one of the proposals from the previous segments and ends with a critique similar to the one described above.

The students are asked to keep a log of their decision-making process and design moves. Of particular interest is noting the reasoning behind their design decisions to help them keep track of the design development. The log also allows them to reflect on their design actions, and thus evaluate and improve the own design process.

The process of decision-making is taking place continuously during the design activity and is intertwined with the process of argumentation. Since each student works alone, and the involvement of many voices with a say about the design outcome is missing, the process of argumentation could be best described as a process of self-reflection.

The decision-making process is concluded with the construction of a deliberation tree. The tree lists all the performance aspects of the design as defined at the beginning of the design process together with their level of importance.

As mentioned above, the critics are asked to comment on each student's design based on the performance criteria each of them has put together and used as the basis for their design decisions. This has proven to be a difficult undertaking. Most critics forget about the deliberation tree and criticize the designs based on their own biases as to which aspects are in need of consideration. The intended format of the critique is meant to give the students a measure of their progress within their own framework. Yet, when confronted with frameworks other than their own, students may experience to some degree the real-world condition of many voices having an impact on design outcomes.

6 CONCLUDING REMARKS

Based on the course evaluations, this particular design studio teaching has been highly appreciated for letting the students design the program, having them explore alternative solutions, emphasizing the awareness of the own design process, helping them develop their own ideas, and receiving from the instructor objective evaluation of their work.

The last two points are of enormous significance. A usual mishap in design studio teaching is that the instructor, consciously or not, tries to impose his/her design ideas instead of helping the students develop their own. Mirochnik (2000) illustrates that instructors bring their own biases into the design studio that can violate their teaching philosophies. The instructor may dismiss a project if the student's idea contradicts his/her own values, even if it is successfully implemented in a design plan. In this sense, the teacher has control over the students and may deprive them of their creativity.

Another kind of subjectivity frequently encountered in the design studio is related to the student's performance. Similarly to the critics who encounter difficulties in evaluating a design project based on the student's predefined criteria, many instructors also find it hard to take on the student's point of view when discussing and evaluating his/her work.

The proposed methodology has been successfully applied to design studios at the upper division and graduate levels. Because of the positive feedback it has received from the students, we believe that it represents a good starting point towards the attempt to limit the constraints set by the tacit knowledge in the design studio teaching and learning.

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