INTERNATIONAL CONFERENCE ON **ENGINEERING AND PRODUCT DESIGN EDUCATION**
4 & 5 SEPTEMBER 2008, UNIVERSITAT POLITECNICA DE CATALUNYA, BARCELONA, SPAIN

REFLECTIVE MORPHOLOGICAL OVERVIEWS AS PART OF CONTINOUS PROFESSIONAL DEVELOPMENT FOR INTEGRAL DESIGN

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ABSTRACT
Conceptual building design is becoming more and more complex. The aim is to support conceptual design activities within building design with a framework for structuring the design process: Integral Design. This method works with Morphological Overviews to support generation of conceptual ideas by structuring communication between design team members and stimulating multi-disciplinary knowledge exchange. Testing this theoretical idea in practice was done through workshops for professionals from the Royal Institute of Dutch Architects (BNA) and the Dutch Association of Consulting Engineers (ONRI). In the last 3 years more than 100 professionals have participated in these workshops.

Keywords: Integral Design, morphological overview, C-K theory, workshop

1 INTRODUCTION

Building design processes are complex and involve many experts from different disciplines. An additional complication is the different cultural background of designers/architects and engineers/consultants and their different approaches to design. Inadequate cooperation between the different disciplines in the design process results in gaps between design and construction, causing large failure costs; an estimation of the productivity loss in the Dutch building practice is about 8-10% of the total construction costs (€ 80 billion) per year [1]. Uniting various viewpoints from different design disciplines makes it possible to create integral design concepts. These integral design concepts stem from new object design knowledge created through the interaction of discipline-based explicit object design knowledge from the different participants within the design process. The focus of our research is on creating conditions in which different design disciplines within a design team will have the opportunity, first of all, to introduce their object design knowledge [2], and, subsequently to integrate it into design concepts. The emphasis on involvement of design disciplines forms the starting point for integral design process organization, contrary to design process organization.

2 METHODOLOGY

During the development of the design research field there has been a shift from prescriptive (rational, systematic and theoretical) to descriptive (based on empirical research) approaches to design(ing). Compared with a variety of prescriptive design models, the descriptive approaches are perhaps best represented by the reflective practice view of Donald Schön [3]. There appear to be good reasons for combining the

prescriptive and the descriptive; since a generalized model of the design process would integrate the strengths of both approaches, while (hopefully) avoiding their weaknesses [4]. An integral approach could result in synergy between rational problem solving and reflective practice.

2.1 Integral Design method

During the early 1970s a prescriptive design model was developed in the Netherlands to teach design to mechanical engineering students at the University of Twente: a Methodical Design model, based on the combination of the German (Kesselring, Hansen, Roth, Rodenacker , Pahl and Beitz) and the Anglo-American design schools (Asimov, Matousek, Krick) [5, 6, 7]. The approach by van den Kroonenberg is similar to the Integrated Product Development (IPD) by Andreasen [8], but has some special characteristics; " it is one of the few models that explicitly distinguishes between stages and activities, and the the only model that emphasises the recurrent execution of the process on every level of complexity [9]".

Starting with the extension of the original prescriptive Methodical Design an Integral Design model was developed. Distinctive features of the Integral Design Method are the four-step pattern of activities that occurs on each level of abstraction within the design process and the use of morphological overviews [10] for separate design activities, which makes it possible to use it as a descriptive reflective tool. Morphology provides a structure to give an overview of the considered functions and aspects and their solution alternatives. Using morphological overviews as a tool, others' contributions activate the individual interpretation of a designer, based on what he/she can make of the decision to also make an explicit contribution. By utilizing morphological overviews in this way, a reflective element is introduced within the design process, forcing reflection-on-action between individual designers and making actual reflection-in-action on a design team level possible. The reflection within the Integral Design Method represents potential for the creation of new object design knowledge through the integration of discipline-based explicit object design knowledge into integral design concepts, as seen in figure 1.

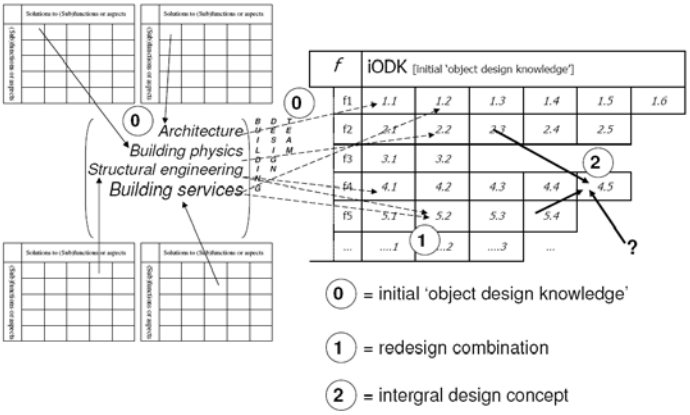

Figure 1 Morphological overviews show the initially available object design knowledge

2.2 Integral design concepts

The theoretical background on how design knowledge can be transformed into integral design concepts is found in "C-K theory" by Hatchuel and Weil [11]. C-K stands for concept-knowledge relation. The C-K theory defines design as the interplay between two interdependent spaces having different structures and logics, a process generating

co-expansion of two spaces, space of concepts C and space of knowledge K. Making object design knowledge explicit enables designers to use it for creation of design concepts. Integral concepts (IDC) and plain combinations (RE) are distinguished. It is important to stress that integration of initially presented discipline-based-design-object-knowledge is something different than the plain combination of (sub) solutions. Whereas combination can only lead to redesign (RE), concept integration involves transformation of design knowledge.
Special focus is on the possibility of expanding the concept space by integral design concepts (IDC, Figure 2), which represent potential for creation of new object design knowledge (nODK, Figure 2).

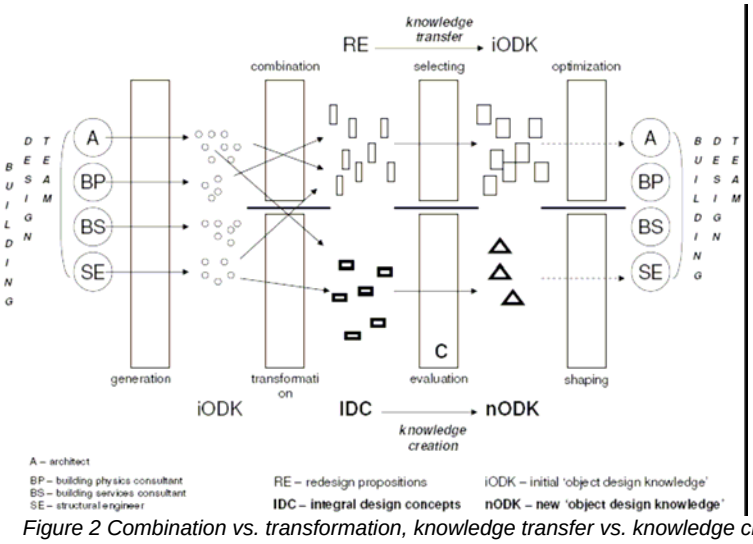

Figure 2 Combination vs. transformation, knowledge transfer vs. knowledge creation

3 WORKSHOPS, THE PRACTICUM BASED EXPERIMENTS

Communication between different members of a design team is generally a notoriously difficult problem, especially in the early stages of design process [12]. A workshop setting was used to test the theoretical model of the integral design model as a method to improve the design process. Other research shows that using human subjects in laboratory experiments as a study object can provide valuable insights. However, generalizing the results from experiments entails a certain risk. The real-world setting requires activities in ways that artificial settings can rarely simulate. Schön [13] has proposed a practicum as a means to 'test' design(ing). In Schön's practicum an actual person or a team of persons has to carry out the design. A practicum can asses a design method and the degree to which it fits human cognitive and psychological attributes [14].Crucial is the simulation of the 'typical' design situation. A workshop can be seen as a specific kind of practicum. It is a self-evident way of working for designers that occurs both in practice and during their education. As such, a workshop provides a suitable environment for testing our approach, while at the same time retaining a practice-like situation as much as possible. Workshops make it possible to gather a large number of professionals in a relatively short time, and allows repetition of the same assignment and comparison of different design teams and their results.

3.1 Workshops Integral Design Method

The first workshops were organized in 2001 and 2002 during the 'Integral Design' project that was conducted by the Dutch Society for Building Services (TVVL), the Royal Institute of Dutch Architects (BNA) and Delft University of Technology (TUD). During this period 9 workshops were held in which more than 160 designers participated. From 2004 the workshops were organized together with BNA and the Dutch Association of Consulting Engineers (ONRI), with experienced professionals from both organisations voluntarily applying to participate. They were randomly assigned to design teams, which ideally would consist of one architect, one building physics consultant, one building services consultant and one structural engineer. In the current configuration of the workshops (Figure 3) stepwise changes to the traditional building design process type, in which the architect starts the process and the other designers join in later in the process, are introduced.

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Figure 3 Workshop model: four different design settings used during two-day 'learning-by-doing'

In the current configuration (Figure 3) stepwise changes to the traditional building design process are introduced. Starting with the traditional sequential approach during the first two design sessions on day 1, which provide reference values for effectiveness of 'ID-methodology' (amount of integral design concepts), the perceived "integral approach" is reached through phased introduction of two major changes: (1) all disciplines start working simultaneously within a design team setting from the very beginning of the conceptual design phase, (2) methodical design model / morphological overviews are applied.
The second design setting allows simultaneous involvement of all design disciplines on a design task, aiming to influence the amount of considered design functions/aspects. Additional application of morphological overviews during the third setting demonstrates the effect of transparent structuring of design functions/aspects on the amount of generated (sub) solution proposals. Additionally, the third setting provides the possibility of one full learning cycle regarding the use of morphological overviews. It concerns an individual, rather than collective/team learning cycle, because in order to be able to effectively apply a new approach, one has to first understand it and make it his own.

3.1.1 Results workshops 2005 to 2008

Over the past four years the above described approach was tested in a series of 5 workshops. These typically include around twenty participants and lasted for two or three days. A total of 107 designers participated in a four workshop series, in which 74% of the designers were present during all days. The average age of the participants, all members of either BNA or ONRI was 42 and they had on average 12 years of professional experience. Directly at the end of the workshop the participants were asked to fill in a questionnaire and had to rate their answers. The average results were then transformed to a rating between 1 (very poor) to 10 (excellent), see table 1.The results clearly show that the participants of the workshops thought the use of morphological overviews of value within the conceptual design process to assist in communication and aid in the increase of relevant alternatives.

Table 1. Overview results questionnaires workshop series, average ratings participants

	series 1	*series 2*	*series 3*	*series 4*	*series 5*
Number participants	20	20	22	27	18
Percentage returned questionnaires	*88%*	*96%*	*98%*	*96%*	*97%*
MO increases relevant alternatives	6,2	7,3	5,7	7,8	7,9
MO improves insight other disciplines	7,4	7,4	5,6	7,7	8,5
MO relevant for own discipline	7,4	7,6	6,4	7,8	8,0
MO helpful for communication	e6,8	7,6	6,2	7,9	8,1
MO positive effect design process	7,0	7,4	4,7	7,7	7,7
MO positive effect final design	6,6	6,2	4,5	7,2	7,5
expect to use MO in daily practice	6,6	6,1	5,3	6,9	7,7

4 CONCLUSION

In building industry approaches are needed which look at conceptual designing as a knowledge development process. Starting from a prescriptive design model, an Integral Design Method is developed that integrates 'rational problem solving' with 'reflective practice'. This paper shows how morphological overviews could be used as a design support tool within the integral approach. Through visualization of (relations between) contributions within a design team, MO's can show how (integral) design concepts are emerging within design teams. Using a unified theory for design reasoning – the C-K theory [15] makes it possible to reflect in a clear and transparent way on the results of the design process steps. By structuring design (activities) and communication between design team members, MO's form the basis for reflection on the design results.

Workshops for building design professionals were organized to develop and test the theoretical concept. These workshops were also meant to transfer this 'ID-method' to the four main building design disciplines (architecture, building physics, building services and structural engineering), in a 'learning-by-doing' way. There is a similarity between our Integral design approach workshops and that of the KCP® workshops of Hatchuel and Weil, which they used successfully in several companies: Renault, Thalens etc [16]. The difference however is our approach: more strict in framing "pieces" of knowledge and a more structured approach to knowledge creation. As such it can be seen as a possible innovative approach within Concurrent Engineering practice. Since 2006 the Integral Design workshops have been incorporated into permanent professional development program of Dutch Royal Society of Architects (BNA) which shows the positive value of our approach to building design practice.

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