231: Integral Sustainable Building Design Workshops in professional practice

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Abstract

To give a good collective answer to a variety of questions from society especially for a sustainable built environment an Integral Design approach is needed. This change can not introduced only by 'prescription' of new ways of working by methods, but needs working in the changing situation and adapting / reflecting / learning to this situation. The newly developed integral design methodology enables verification and reproduction of decisions made during designing. Morphological charts are used to exchange ideas and concepts. The workshops for multidisciplinary professional design-teams, throughout 2004-2008, showed that integral design provides a suitable methodological foundation for improvement of integrating the activities of a building design team as well as integration of sustainable comfort systems in the conceptual phase of design process. Workshops form part of the permanent professional educational program for BNA since 2006.

Keywords: workshop, sustainable building, integral design, permanent professional education

1. Introduction

Preservation of energy resources, occupant comfort and environmental impact limitation are the key issues of modern and sustainable architecture. A major portion of primary energy consumption, about 40 %, is due to create thermal comfort in buildings by heating, cooling, ventilating and lighting. During the last decades, the main focus of research in Building Services was on reduction of energy consumption of buildings. The strong focus on the energy reduction led to situations in which health and comfort are endangered. By using sustainable energy the negative effects of energy use become less important and the focus could be turned to health and comfort again.

The application of sustainable energy systems and components is too complex for integration in the early stages of building design. As a result, sustainable design options are added to the final stages of the design. This results in sub-optimal designs and rejection of the proposals.

In the world of designing, gaps between the different fields can be recognized [1,2 and 3]. Many research projects have aimed at bridging the gap between the world of building design and the world of building services (simulation), so far without overwhelming success [4]. In contemporary architecture an increasing emphasis on performance aspects like energy consumption leads to use of active and passive sustainable energy. The results indicate that the most effective sustainable energy building components are selected without proper underpinning in the phase of conceptual design. Getting a better understanding of the design team's role is essential for the investigation of the decision to request expert analysis interventions by building services consultants.

The HVAC (Heating Ventilation and Air Conditioning) -industry has identified a need to better integrate comfort and sustainable energy systems in buildings. In 2000, the Royal Institute of Netherlands Architects (BNA), the Dutch Society for Building Services (TVVL), and the Delft University of Technology (TUD) participated in a research project called Integral Design. The focus within integral design is on all that is essential to completeness, from all design disciplines nothing essential should be lacking. Since year 2001 'integral approach' has been propagated within Dutch building design practice, through continuously developing 'learning by doing' workshops by the BNA, the Dutch society of consulting engineers (ONRI) and the Technische Universiteit Eindhoven (TU/e). The workshops are a kind of practica or something very similar and are used to structure design actions from different design team members and to evaluate the proposed design method to improve sustainable design.

2. Methodology: Integral Design – Morphological Overviews

The frame for structuring actions of team members is found in 'Integral Design' model [5,6], a collection of design tools within a design process matrix. Integral Design is problem oriented and distinguishes, based on functional hierarchy, various abstractions and/or complexity levels during different stages and

design activities. This model is used because it allows design to be explicitly approached on different abstraction levels. This aspect is important because of the focus on sustainable comfort systems; changes on the level of sustainable comfort systems automatically have effects on the level of a building as a whole, and vice versa.

In order to confront respective knowledge and viewpoints of design team disciplines morphological overviews, a specific design tool and one of the features of integral design, are used. The main aim of use of morphological overviews [7] is to explore 'field of possibilities', leading to more thoroughly considered solution proposals [8]. This method uses a morphological chart where the main task is divided in functions and/or aspects, based on different abstraction levels. Following this initial interpretation of design task by design team, for each of these (sub) functions/aspects a variety of possible solutions can be generated.

By using the morphological overview all disciplines can look into the required completeness: if all necessary functions and aspects are listed. The construction of a morphological overview is like a kind of matrix. On the vertical axis of the matrix the required functions (or sub-functions) and main aspects are given. On the horizontal axis possible

solutions for these functions or aspects are given. The purpose of the vertical list is to try to establish those essential aspects that must be incorporated in the product, or essential functions that the design has to fulfill. They should cover all the necessary functions and the main aspects to consider for the product/building to be designed, see figure 1.

Fig 1. The morphological overview

The morphological overviews from the different disciplines involved in building design, such as architecture, structural engineering, building physics and building services, can combine their separate morphological overviews to one integral overview. This integral overview makes it possible to share in a transparent way all thoughts and ideas connected to the design problem, see figure 2.
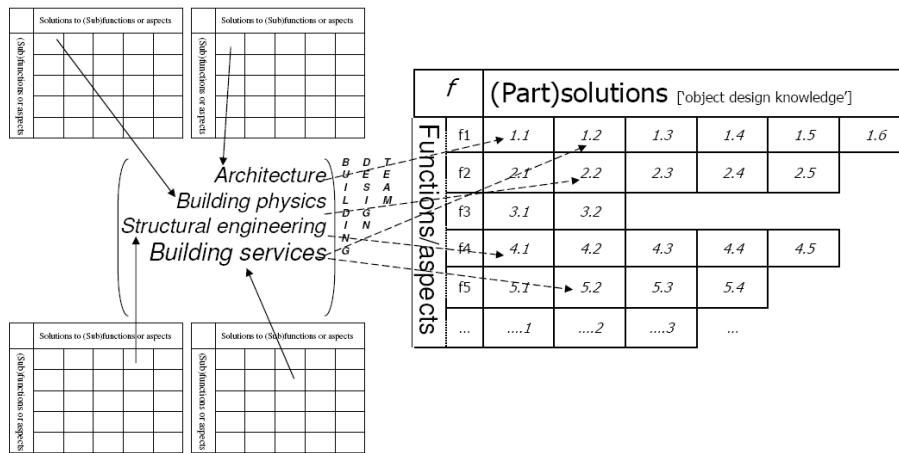

Fig 2. Combination of morphological overviews from the different disciplines to an integral overview

3. Experiments: Workshops in 'practice'

To test and analyse what kind of aspects are of influence on knowledge exchange during design processes different workshops series with professionals where initiated. The setting chosen is that of Reflective Practice [9]. To use human subjects in laboratory experiments to study design theory provide some insight. However, extending results from laboratory experiment to conclusions for the engineering practice is a risk. The effect of Macrocognition describes the differences in cognitive functions performed in natural – versus artificial,

laboratory – settings. The real-world setting requires activities in ways that artificial settings can rarely simulate. Schön [10] has proposed a practicum as a means to 'test' design(ing). Where a practicum is" a virtual world, relatively free of the pressures, distractions, and risks of the real one, to which, nevertheless, it refers [10, p.37]". In Schön's practicum a 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 [11]. 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 as during their education. As such a workshop provides a suitable environment for testing the approach. Besides full design team line-up there are a number of other advantages of workshops with regard to standard office situations, while at the same time retaining practice-like situation as much as possible. Workshops make it possible to gather a large number of professionals in a relatively short time, repetition of the same assignment and comparison of different design teams and their results. Never the less the workshops are a virtual world; "contexts for experiment within which practioners can suspend or control some of everyday impediments to rigorous reflection-in-action [9, p. 162]. Schön refers further to the dilemma of rigor and relevance in professional practice, there is a choice to stay on the high, hard ground ("A high, hard ground were practitioners can make effective use of research-based theory and technique") , or to descend to the swamp ("a swampy lowland where situations are confusing") and engage the most important and challenging problems [9, p. 42].

Together with the Dutch Royal society of architects (BNA) and the Dutch Association of Consulting Engineers (ONRI), since 2005 we organized 5 series of workshops with experienced professionals from both organisations voluntarily applying to participate. The participants of each discipline 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.

3.1 Workshop setting "Learning by doing"

Design team arrangement is the crucial element. To be able to compare different types of design processes, while at the same time excluding team development aspects [13], the same design teams are not observed during the two workshop days, instead the average results of each design setting of all participating teams are compared. For each setting the arrangement of design team members is changed (although all design teams are composed out of the same group of participating designers). The only rule is that no two designers can be in the same team twice. The focus is on the comparison of the same activities within different types of design processes. The sequence of used design settings is of utmost importance. Reverse order is not possible because learning effects would not allow for valid comparison of results [14], see figure 3 for the set up of the workshops.
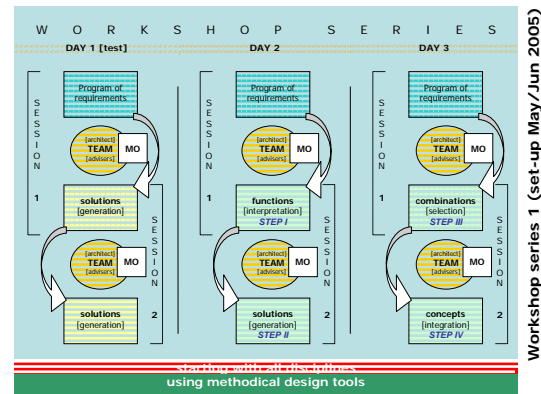

Fig 3. Set up of the workshops series 1 2005

On the first day the main focus was on the team interpretation of the design tasks. The formation of design teams were random, meaning that none of the participants worked together before, which is often also the case during the daily practice. The crucial aspect for learning in a team is the creation of the shared understanding. This is mostly a slow process that is often based on the social aspects of the interaction between the team members. To avoid these common practice situations where the purpose of the meetings is just to get better acquainted with each other, the teams were asked to directly proceed with the interpretation of the presented design task. The morphological overviews were used to structure this accelerated design process. The background information concerning methodical design and morphological overviews was beforehand sent to all participants. In addition, the lecture about the subject proceeded the actual design sessions. Because the basic principle of the workshop set-up was to avoid the 'laboratory situation', the teams were not forced to use the overviews. However, they were instructed how to use them, after which the presented design assignment had to be worked out in 90 minutes for a short presentation. The assignment was to design a small 'pavilion for sustainable architecture' on the building the workshops were taking place in. After the assignment presentation the design process was only observed and no further intervention took place. At the end of the day the teams had to give short presentations to each other about their conceptual ideas. The first day can be seen as a team building session, but at the same time also as a kind of training for the use of methodical design aspects.

Table 1. Design tasks

Day 1	Day 2	Day 3
A small pavilion	Zero-energy multifunctional office	

The second day the same design teams were given larger design assignment. The task was to design a zero-energy multifunctional office building on a standard location. This time the

focus was on the generation of the possibilities from different viewpoints, as anticipated by different disciplines. Before the generation of possibilities the design teams again had to first come to the mutual interpretation of the assignment. The expectation was that with the experience of the first day the design teams would need less time to effectively do this. For both interpretation and generation the morphological overviews were used. The TNO contributed to the search of the zero-energy solutions by giving an overview lecture on sustainable comfort systems before the start of actual design sessions. In contrast to the first day, at the end of the second day the teams did not have to present the provisional results. Instead they could use the whole 120-minutes design session for the generation of possibilities. During the last day the design teams had to integrate the proposed sub solutions into an integral office building design. But before making the final choice they had to report to the client what the status of the design was, which choices were made and why, and which were yet to be made based on which assumptions and/or design team proposals. In order to explain the transparency of the design process to the client the same morphological overviews were to be used. This way the use of the overviews for the external communication was also observed. The use of the same tool, in this case the morphological overviews, for both internal as external communication can show the applicability of the use of overviews in structuring and solving the various aspects of the design task.

The team's interpretation and generation are achieved through communication, but this aspect of the use of morphological overviews is only explicitly shown during the communication with someone that stands outside the design team itself.

One other aspect, the potential for archiving the solution steps, is emphasised at the same time. This is particularly helpful in relations with various external parties, new team members or for refreshment of memory in the case of long periods of project delays. The client role was 'played' by a representative from either the ONRI or the BNA organisation. After the feedback from the 'client' the design team had to propose the final integral design solution and present it to the other design teams. During short presentations, both on the first and on the final day, the participants rated each other. They did not, however, rated the results of their own design team. To summarise, each day was dedicated to a certain subject and on the 2nd and 3rd day the participants got the feedback from previous days. The main topics were: 'Methodical design' on the first day, 'Sustainable comfort systems' on the second and the importance of 'The role of the client for the quality of design' on the third and final day.

The total number of observed design teams was 9. Because 4-hour sessions were spread over three weeks, the teams' arrangements changed during that period. Only two out of nine teams had the entire time 4-discipline configuration, four teams were switching between 4-discipline to 3-discipline configurations, while three teams retained 3-discipline configuration during the whole workshop series. It was observed that (development of) design team communication was influenced by the number of design disciplines within a design team. The 3-discipline design teams developed some kind of mutual understanding and agreement faster than 4-discipline design teams. This was not directly related to the use of morphological overviews. On contrary, 4-discipline design teams, which internally communicated more on a 1-on-1 basis, used morphological overviews more frequently for communication purposes. Generally, from the observation results could still be concluded that morphological overviews were helpful in aiding communication / structuring object design knowledge of the design teams, especially in more complex situations (when more disciplines were involved).

Starting with a three day practice-like 'building team' concept, in which all disciplines are present within the design team from the start, the integral design method workshops have evolved to finally a two-day series.

The set up of the workshops , the different steps and the use of the morphological overviews with in the final two day program of the workshops is shown in figure 3. The development of the workshop setting was a learning-by-doing process. Instead of starting with a theoretically 'optimal' configuration, workshops were continuously adjusted and improved based on evaluations of participants and analysis of observation results, resulting in the final arrangement as shown in Figure 3. In the current configuration (Figure 3) stepwise changes to the traditional building design process type, in which the architects starts the process and the other designer join in later in the 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 the method (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) the integral 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 or her own [12].
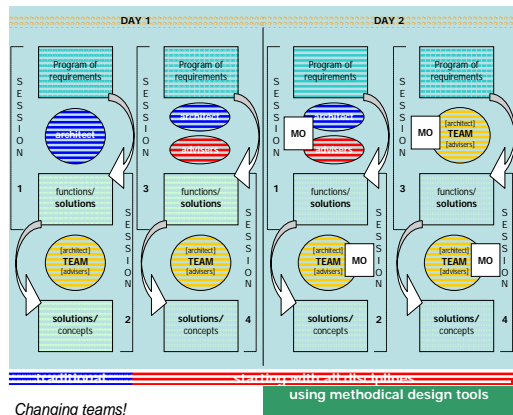

Changing teams!

Fig 3. Four different design settings during the final set-up of the two-day 'learning-by-doing" workshop.

4. Results Workshops

During all workshops, following the assignment presentation the design process was observed and no further intervention took place. Observations were conducted in two different ways: (1) noting design teams' activities using observation forms (by students) and the last 2 series the workshop sessions were registered by video cameras because the participants found the student something disturbing their concentration, (2) by taking photographs of design team's work (by researchers, in 10min intervals), (3) the acquired data was analysed

together with the material produced by the design teams.

The additional resources of information were the questionnaires that participants had to complete after each day session and another questionnaire after a period of approximately six months.

Over the past four years 5 series of workshops have been conducted, these typically include around twenty participants and lasted for two or three days. A total of 107 designers participated in the five workshop series, in which 74% of the designers were present during all days. The average age of the participants, all members of eider BNA or ONRI was 42 and they had on average 12 years of professional experience. Direct at the end of the workshop the participants were asked to fill in a questionnaire.

All designers of the series 1 to 4 were approached six months after their workshop participation in order to get their 'second opinion' on the proposed approach and also to assess effects that the 'ID-methodology' has had on their work in practice. Only reactions from designers who participated during all design sessions of a series were taken into account.
The participants were asked different questions and had to rate them on a scale from 1 till 5, the average results was then transformed to a percentage. The results of the most relevant questions related to the integral design method and morphological overviews are given below in table 1.
When we compared the results of the questionnaires after six month's with those directly after the workshops were held, there were some differences, see table 1.

Table 1: Comparison between ratings direct at the end of the workshops and after a working period of six month's

	average	*average*
	Direct after Series	After 6 months
Number participants	107	59
Percentage returned questionnaires	*94%*	63%
	rating (1-10)	Rating (1-10)
overall rating workshop	7,2	7,3
morphological overviews relevant for own discipline	7,4	6,4
stimulating the use of Morphological overviews is usefull	7,3	6,6
expect to use/ uses Morphological overviews in practice	6,5	4,1
workshop met expectations	6,7	7,0
workshop fit for professional education	8,3	8,4

Comparing the results of the questionnaires direct at the end of the workshop and after a period of 6 month's there is only one remarkable difference in rating, the use or expected use of morphological overviews, 6,5 compared to 4,1. When asked if they think the workshop approach is suited for the permanent educational program

the participants are after the period of 6 month's even a bit more positive as compared to direct after the workshops; 8,4 compared to 8,3. This clearly proves the added value of the approach to the practice of collaborative design management.

5. Discussion and Conclusions

The response provided important insights into practitioners' impressions of (mainly the usability of) the method. The results from the workshops indicated that the integral design method had been received positively by professionals in practice. However, they reported that the method was very difficult to implement during the design process in a traditional role setting of some of the disciplines, especially this was the case for the building services consultants. Because projects usually last far longer than six months, the majority of participants were not able to (try to) apply the approach during preliminary/conceptual design phases (because of being 'stuck' in ongoing projects).

Although the workshop experience of the participants is positive, they find it difficult to implement in practice. When participants were asked for the reason of the difficulties, they mention the already longer existing project setting in which they operate and in which they are the only ones with knowledge about this design tool. The workshops provide only a introduction and a few exercises to work with the design tool, most of the participants need more time to fully implement the basis into their own design process approach. Also the participants find it difficult after the short training sessions of the workshops to really change their traditional approach.

Most important recommendations and conclusions;

- working on inter-disciplinary knowledge exchange by profession organizations (BNA, ONRI) in collaboration with knowledge / research / education institutions (TU/e, TNO) has to be organized and developed; permanent professional education is a core activity for the future

- workshops are an effective tool to couple practice / research / education; the 'learning by doing'-principle is an effective aspect; the adaptive characteristics have to be developed more extensively; feed-back and evaluation are important tools to use experiences from the past; workshops should be part of the permanent professional education

- design methodology and design tools, for multi-disciplinary design teams, help to structure and develop each others knowledge and are thus a necessary perquisite to develop / effectuate sustainable integral designs

- the presented approach illustrates a 'path to success' model for implementing design methodology in the built environment and narrow the gap between design research and practice; workshops to take the professional design context into account

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