Workshops as practicum’s to improve integration and knowledge exchange in collaborative design

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ABSTRACT

The cooperation between the various disciplines interacting in an architectural design process is often inadequate or lacking. This is due to the growing complexity of building design processes involving many experts from different disciplines, having a different knowledge background, view and approach to solutions for design and construction. This lack of collaboration is usually shown by the next aspects; a lack of integration in the team, knowledge gaps between design and construction, failing flows of information and communication and feedback between designers and practitioners. In order to increase the potential of creating better integral design concepts, practitioners tend to use support tools. A design management approach to support design teams integrally in order to improve collaboration and affecting communication needs to focus better on the process aspects of conceptual design. Such a design management approach should easily link all necessary information and knowledge of the involved disciplines (architects, engineers, contractors).

To that account in this paper, a support tool is presented that stimulates members of design teams to use collectively a specific method for collaborative design that incorporates the characteristics of an integrated product model. The aim of the management intervention is to support design activities by the use of a framework for the design process to structure information and knowledge exchange between and with commitment of all participants to optimize design solutions. This method, the so called Morphological Overviews, is based on Morphological Charts. The concept will be explained on its functioning and be discussed by the results and insights gained through a series of Workshops executed in the period 2005-2008 with practitioners from the Dutch Construction Industry. Also is discussed how partly, elements of this approach can be used in architectural design management. The paper finalizes with conclusions and recommendations for further research.

KEYWORDS
Workshops, integral approach, knowledge exchange, collaborative design teams

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1. INTRODUCTION

A lack of innovative designs in the Dutch Building industry can be observed in the designing of roofs. For the purpose of this research project a design is defined as a basic scheme or graphic representation that affects and controls function or development for a subject that has to be constructed or manufactured. Innovative designs can be defined as designs that show smart improvements in design solution by using experiences, and experiments or improvement actions for the design that affects its purpose and functioning greatly. Professional parties indicate that such a lack of innovation is caused by sub-optimal interaction between solutions and application in design practice of traditional roof design compared to innovative roofs [EURACTIVE ROOF-er 2005]. Cooperation between the various disciplines interacting in an architectural design team often is inadequate or lacking due to knowledge gaps between design and construction, failing communication and feedback between designers and practitioners and insufficient integration of such teams. This is due to the growing complexity of architectural designs, involving a growing number of experts from different disciplines, having a different knowledge background, view and approach to design and construction. During the design process, teams generate new knowledge by exchange and develop information about the design to be produced. Such a design process for the design of a (new) product might also be called a Collaborative Design [Bento et al. 2004]. Within such a setting, actors like architects and roofers, differ in cultural backgrounds, their way of working, and have a different motivation of collaboration and geographical conditions [Korbijn 1999]. Architect and Roofer collaborating on the roof design, acting as representatives of their discipline better can be described and defined by their competences that is expressed in their design activities as Dorst [1997] explains. Due to interdependency between the actors [Latour 1987] knowledge exchange and sharing is needed that is showed in their interpersonal communication using preferred communication tools [Emmitt et al. 2008].

An Integral Design management approach to support the designers in such design teams to improve their collaboration has to focus on the process of conceptual design in order to increase the potential of creating higher transparent Integral Designs (product level). Such a design approach should easily link all suitable information and knowledge of all the involved disciplines (architects, engineers, contractors). Due to the fact that the information and knowledge comes from various disciplines as described above, the information and knowledge collected, shows mostly several different characteristics, related to various levels of abstraction. Levels of abstraction means the decomposition of information into levels of increasing detail, where each level is used to define the entities in the level above. In the hierarchical way we can define the problem definition level, the working principle level, the detail design level and the realisation level. For each domain of industry the infill of these abstraction levels will be different [Kroonenberg 1986]. Representations, are methods which with different disciplines work, such as material systems, sketches and information technologies. External representations are the transformation of internal thought processes of people on cognitive level [Lawson 1994; Wiegeraad 1999; Reymen 2001] and expressed using some kind of interpersonal communication, together they are cognitive achievements by these people. Different disciplines use different kind of representations (concepts, terms, notations or language) [Brereton 1998]. An optimal support tool will affect optimum design proposals which can combine the different levels of abstraction with different kind of representations.
For these reasons this research focuses on the knowledge sharing and exchange on cognitive level of design team members. It is assumed that architectural design teams using a Design Method that incorporates the characteristics of the integrated product, easily might lead to better optimized and smart designs. The aim of introducing a specific Design Method is to support team members within this highly complex process (Collaborative Design) by means of a framework for the design activities to structure the information and knowledge exchange.

The Design Method presented to architectural design teams is the so-called, Morphological Overview. The method is derived from the Morphological Charts developed by Zwicky and Norris (1967). General morphological analysis was developed by Fritz Zwicky [Zwicky & Wilson 1967] as a method for identifying and investigating the total set of possible relationships or configurations contained in a given complex problem [Ritchey 2002]. Morphology provides a structure to give an overview of the considered functions and aspects and their solution alternatives. Transforming the client’s brief into characteristics for input and output (aspects) and formulation of the different relations between input and output (functions) to fulfill, leads to the construction of a Morphological Overview. The overview of possibilities from all disciplines involved in the team (such as Architects and Roofers) is based on interpretations of the design tasks and the representation of specific knowledge that different disciplines use through this interpretation, represented by the introduced functions, aspects and solutions. The ‘completeness of the design’ therefore can be viewed as an indication of how complete the different kinds of knowledge from each discipline is used and as an indication for the level of integration.

To be able to observe the disciplines involved in design in a relaxed, transparent and clear way without big brother effects [Orwell 1984], a practical setting is needed. In such a setting human subjects can be studied similar to a laboratory setting [Yin 2003; Frey et al. 2006]. However, generalizing the results from experiments need thorough care because the quasi-laboratory setting [Yin 2003] need to simulate all real-world characteristics. The practicum as proposed by Schön [Schön 1987] creates a setting as ‘a virtual world, relatively free of the pressures, distractions, and risks of the real one, to which, nevertheless, it refers.’ [Schön 1987, p 14]. In Schön’s practicum a person or a team of persons has to carry out the design. A practicum can assess a design method and the degree to which it fits human cognitive and psychological attributes [Frey et al. 2006]. The workshops used are designed as a specific kind of practicum. It is represented as a self-evident way of working for designers that occurs both in practice and during their education. Such workshops provides a suitable environment for collaborative design and doing observations. Besides full design team line-up workshops provides a number of advantages, regarding standard practice situations, and also retaining practice-like characteristics. Another advantage is the gathering of a large number of design professionals, the repetition of an assignment and the observation and comparison of the design process and the design that different design teams produce. By monitoring and comparing the knowledge exchange and knowledge development in various design situations between the Architect and the Roofer, that do or do not use the Morphological Overviews, the occurrence of knowledge gaps can be analyzed and what effects the use of morphological overviews have on the actors and the design produced. Earlier studies with a wider view in the UK [Latham 1995; Egan 1997, 2002] came to proposals for better organizing and training design and construction teams to accelerate the design process. Research on Integral Design in Dutch practice with professionals, both for development and evaluation, is ongoing from the year 2000 [Quanjel et al. 2003] The workshop as presented in this paper might contribute substantially to this research providing insight into collaborative design between specific disciplines (Architects and Roofers) on cognitive level, the effects on the design product and
the use of a specific design method, the Morphological Overview. In the next paragraphs the relation between the workshops and improvement of integration and knowledge- exchange and development between a designer and contractor.

2. WORKSHOPS RELATED TO KNOWLEDGE- AND DESIGN MANAGEMENT

By means of Collaborative Design meetings, team members are able to improve their own work, share knowledge and understand existing artefact or design state from collaborative point of view. Each session uses the individual and collective design knowledge that was generated as a resource to build an argument. During such a design process, a team collectively can easily transform tacit knowledge into an explicit form. Also aspects related to the specific design task are made transparent to each other. Structuring and questioning the explicit made knowledge by the team should result in building the much needed support for knowledge development and management of the design. Structuring the design is related to the rational problem solving-part of the design as Simon [1998] argues, and that questions the design as a part of the reflection in action-part [Schön 1987]. Both actions can be seen as part of the design activity of the design, the third part of describing the design [Dorst 1997]. However we are most interested in the design as ‘a basic scheme or graphic representation that affects and controls function or development for a subject that has to be constructed or manufactured’ that is represented by the explicit knowledge of each individual team member (Architect and Roofer). This knowledge is the result of transformation of the tacit knowledge of these team members derived by the use of Morphological Overviews in the setting of the workshop.

To identify the various types of knowledge of Architects and Roofers we take a closer look to the typology of knowledge as discriminated by van Aken [2005]. He discriminates between object- and realization-knowledge as part of the process-knowledge. This process knowledge through collaboration will link the needed requirements for innovative designs; the design- or object knowledge and the building- or realization knowledge [Aken, v. 2005]. The types of knowledge stated, are communicated between Architect and Roofer (both having another educational background and differ largely in competences and skills) through different kinds of representation [Brereton 1998]. Object knowledge can be defined as knowledge on the characteristics and properties of artefacts and their materials. Finally, the third type of knowledge, realization knowledge, can be identified as knowledge on the various physical processes to be used to realize designed artefacts [Aken, v. 2005]. By using the three types of explicit knowledge we need to find a way to extract practical information about each type related to the different disciplines. For that purpose we used the Competence-Profiles of the Architects and Roofers from the Professional Sector Organisations. Through these Competence Profiles we qualified the process-, design- and realization-knowledge of the different disciplines in the setting of Collaborative Design. Only the Architects and Roofers with these competence-profiles can give the information, in the specific setting, about how the knowledge exchange and development for innovative roof-designs, can evolve. All aspects related to the relation of the knowledge gap and designs for innovative roofs could be described in this way. The design situation of Collaborative Design in practice is described by the set-up of the Workshop. The design activities for Integral Design, as both rational and reflective, for structuring and develop the object- and realization-knowledge, are identified through the use and effects of the Morphological Overviews. Through a specific setting of the Workshop we can gather information about Knowledge Management (exchange and development) related to design task for innovative roofs and – in further perspective – use this Workshop-setting as a tool for Design
Management within the setting of Collaborative Design. An Integral Approach on the development of the Workshops was used; through different viewpoints on the setting and set-up of the Workshop we could define the optimal Workshop-setting. Two main aspects related to the Workshop-setting were insight into the design-process – exchange and develop specific knowledge related to the design task – and the influence of MO as a Design Method / support tool. In the next paragraph the development of the workshop-setting is demonstrated and related to Knowledge – and Design-Management.

3. DEVELOPMENT OF THE WORKSHOPS AND DESIGN MANAGEMENT

For the Workshop-development three different viewpoints were chosen. The first view (Figure 1.: WS 03) focuses on collaborative design-teams in an in-company-setting and the use on the support tool Morphological Overviews. The second view (Figure 1.: WS 04) shows the step to an ‘open setting with free-attending Architects and Roofers for collaborative design-teams, using two different support tools Morphological Overviews and a web-based Database. This set-up is compared with the third view; the setting with free-attending Architects and Roofers using only Morphological Overviews (Figure 1.: WS 05).

All participants had to have a specific Competence Profile in order to attend the Workshop to give an optimal contribution related to specific knowledge and skills as shown in the earlier paragraphs. This was the only selection criteria made, all participants submitted to the Workshop freely, all influencing effects the observers present might cause, were carefully avoided. The researchers organized and managed the workshops, although during the workshops the main role was only in the introduction. The researchers where assisted by post-doc students of Architectural Management for practical aspects as well as monitoring. One researcher was also the workshop leader. Three analyzing methods were used by the researchers for reflection on the workshop-setting; discussion between the workshop leader with the participants immediately after the workshop-session. A standard questionnaire that is
used for all workshops with questions about set-up and experience of the workshop and the use of the Morphological Overviews. The questionnaire had to be filled in immediately after the workshop. Six months after the workshop took place the participants were contacted and filled in the same questionnaire. The third method used was the evaluation from the researcher related to practical aspects for organizing the workshop and the optimal setting for monitoring and analyzing the results; the explicit knowledge exchange and knowledge development related to the use of Morphological Overviews. Practical aspects of organizing used are; the amount of time for the workshop per design-item as well as the amount of items itself, avoiding research influence on the workshop, promotion for submitting the workshop and efficient location. For monitoring and analyzing related to the workshop setting two aspects are of main importance; a) the comparison of design teams that used the Morphological Overviews in a ‘neutral way and the ones that did not, b) participants with the right Competence P and c) different ways of monitoring during the workshops. For all workshops video (sound and vision) are used, photographs of the group and group-results in a regular time-scheme. Trainees in Architectural Management functioned as observers of the sessions. They were introduced as working on one of their practicum-courses to make a critical analysis of design-teams. In the next part, shortly the development per workshop is described related to the described aspects. The monitoring of the Architectural Management Trainees was global on collaboration between the participants. They were used as general reflection on the setting and collaboration of the different workshop-settings, and part of the triangulation [Yin, 2003] Lessons learned from the different workshops are also given as well as the outcome of the questionnaires as filled in by the participants focussing on the reflection after six months.

The first view was the limited view from professionals working within an engineering / contractor company for the high-technology roofing-industry (Brakel & Atmos); the project situation inside a company is without the variables and influences of the multidisciplinary team in the projects outside. This specific view from the engineers / constructors was used to reflect on the project situation outside. Both individuals as internal teams were used to work traditionally and with the use of MO. The feedback used is that of the needs of knowledge with Roofers from Architects and visa versa, coupled on improvement of the workshop-setting with architects. In WS 03, 25 professionals were participating. Positive aspects of this setting were the guaranteed amount of participants as well as their Competence Profiles. Also publicity was no problem as well as the location because the company was positive about this initiative. This can also be seen as a negative point related to the probable influence on the research-results. Difficulty was also that there was only one big room available for the workshop; this made it problematic to let teams working simultaneously on a design task as well as parallel with and without Morphological Overviews without influencing each other. This made also the monitoring problematic. Other difficulty related to comparing the outcomes were that, beside of designers and contractors, also clients / users were part of the design-teams. Now knowledge-interaction between designer and contractor could not be observed and analyzed clearly. Time items were seen as problematic by the participants.

The second view was inside the project-context with Architects and Roofers. Output of workshop WS 03 showed clearly that focussing on Architect and Roofer, without other participants, was the best for monitoring purposes in the scientific context. In both WS 04 and WS 05 the BNA (Royal Dutch Organization of Architects) was involved and two Dutch Roofer-organizations: ‘Het Hellend Dak’ and ‘Vebidak’. This participation guaranteed that participants had the right Competence Profiles-check and that publicity was not connected to the researcher. Both workshops were divided in two parts; an individual part and a team work part, this provided the possibility to compare the knowledge of the individual discipline with
the situation of those disciplines in the collaborative team-setting. In WS 04, eighteen participants used the tools from the start, after an introduction, to determine which of the different design methods could be more effective during the workshop. The two different design methods used are the MO and a within the EURACTIVE ROOFer developed database (D). Beside of the positive aspects already mentioned also the location was more optimal than in WS 03; we used a beautiful congress-resort with separate rooms available, but still a bit too small for the group-setting. Negative lessons learned were the time-pressure due to the fact that the participants had too many sessions with two different design methods which were new to them. Focussing on just one new design method was therefore necessary for the follow up. Another negative aspect was caused by the set up only to work directly with the Morphological Overview and Database; due to this setting comparing situation with and without using the methods was not possible as well as that for the participants no reflection – second learning loop – was possible.

In the third workshop (WS 05) by means of parallel sessions of teams partly using the MO provided the opportunity to compare the design situations and comparing the knowledge sharing and development related to the use of Morphological Overviews. In this workshop 12 professional Architects and Roofers were participating, a rather small group (but sufficient for the scientific comparable amount needed). There was now also more time between the several design sessions. The chosen location was more central geographically and had more space for the different parallel sessions without influencing each other. One of the problems which could not be solved was research influence by the researcher; the organisation and publicity was done mainly by the researcher himself. The time-aspect in relationship to the second-loop-learning by reflection on the use of the Morphological Overviews could also not be fulfilled. Through this workshop and the lessons learned from the previous workshops we found the set up where we can compare the different knowledge-types and explicit knowledge used, exchanged and developed by roofers and architects. methods, individual and in teams.

Another indication for viewing the workshop-setting as proposed was the questionnaire-format (see Table 1.). To avoid influences on the participants by the researchers and observers present in the workshops only the response on the questionnaires after six months was evaluated. Overall the tendency of the ratings for the workshop as well as the use of the Morphological Overview was positive for all workshops, see Question Q4 in Table 1. Critical aspect of time related to the session (Table 1.; Question Q3) which were rated bad in the first two workshops where rated positive in the last workshop-setting WS 05; Architects 3,0 (4 out of 6) and Roofers 2,6 (4 out of 6). The ratings if it is useful to stimulate Morphological Overviews through Workshops and the future expectations seems more critical for Architects than for Roofers (see Q11 and Q12, Table 1.), but overall the ratings have a positive tendency. After evaluating the results of the former workshops with students and professionals, was to arrange the definitive workshop-setting (see figure 2; workshop WS D01). To give the participants, as part of the learning cycle, time to reflect on the use of the Morphological Overviews and the Workshop-setting the workshop is divided in two parts; there is one week between the first part (1 and 2) and second part (3, 4 and 5). For generalization of the results parallel to the setting the workshop-setting incorporates teams with Architect (figure 2: o1-oX) and Roofer (figure 4.; r1-rX), as well as Architect and Installer (figure 2.; u1-Ux). First part of the workshop has two steps; step one working individually without the support tool, this to get insight in the specific discipline knowledge related to the Competence Profiles and found functions, aspects and solutions (a-io1 – a-ioX, a-iu1 – a-iuX).
Table 1. Overview of average ratings questionnaire-format for all workshops WS 03, WS 04 and WS 05; average ratings for questionnaires after 6 months related to response are evaluated.

overview questionnaires WS 03-05

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<td><strong>R average 6 months</strong></td>
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<td><strong>R average after 6 months</strong></td>
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<td><strong>R average after 6 months</strong></td>
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The second step implied the working in teams (dt 2.1, dt 2.2) parallel with and without Morphological Overviews (MO). After one week the same participants come together. Now the teams are changed so that there is no influence on the group-learning process; team dt 3.2 formally working with Morphological Overviews (MO) is now working in a traditional setting were team dt 3.1 is now working for the first time with Morphological Overviews (MO). Results d-id-3.2 and d-id-3.1 can be compared as well within this step as with step 2 (b-id-2.1 and b-id-2.2).

setting WS D01

Figure 2: The Workshop set-up as developed to determine the influence of MO as Design Method (Knowledge Management) and Collaborative Design as process tool (Design Management).
Using the second-loop-learning effects method as Agrys [1999] described, finally the teams (dt 4.1 – dt 4.X) are working all for the second time with Morphological Overviews as a support tool and can reflect on this as well as on the workshop-setting itself. Due to the parallel design-sessions in separate rooms comparison of the monitoring situation is optimized. By experimenting with the monitoring tools the final setting could be fixed; video-recordings of each design-team-session, photographs in a regular time-schedule of the produced design-drawings and general assessments and evaluation by Architectural Design Management students. The organization of the Workshop by Professional Organizations a more research-neutral setting is possible as well as a better check on the Competence-Profiles of the participants. Also publicity and organization of a suitable location is optimized through the use of Professional Organization.

4. DISCUSSION AND CONCLUSION

The workshops executed in the past years in the setting as explained, are analyzed by the researchers and evaluated with the participants using structured Questionnaires. The comparison of the answers of the questionnaires showed that the workshops were effective to the opinion of the participants, also after six months. The outcomes of the questionnaires compared to the monitoring results show that this ‘tool’ is an effective setting that encourages designers and practitioners for active participating in Collaborative Design. The use of the M.O’s. were rated positive by the participants with a positive view on the usefulness of the workshops, as shown in Table 1.

The final workshop-setting (figure 3 WS-D01) developed is called the Collaborative Design Workshop. The tool proved to provide the right conditions for researching the effects of the use of Morphological Overviews to collaborative design. Throughout 2009-2010 three workshop sessions for Architects, Installers and Roofers will be organized, with approximately 75 professionals within the Permanent Professional Education Program. The organizing of these workshops is a first step in stimulating Design and Knowledge Management within a multidisciplinary, integrated setting, All effects will be evaluated to optimize the workshop setting and the use of Morphological Overviews. The outcomes of the final workshops executed during 2009-2010 will be compared on its functioning and expectations: improving the design output and stimulating collaborative working between the concerned designers. The results will also be compared with the results out of earlier workshops on similarities and differences. The observations, design output and opinions of the participants will be used to develop conclusions for the research project and the use of this workshop model as an effective tool for implementing a new approach in collaboration leading to effective exchange of design knowledge and information. To the opinion of the researches further research is needed to Collaborative Design on the other abstract level: user-client is necessary to optimize Collaborative Design and the role of the contractor in a Design Team (Architect, Structural Engineer, Building Physics Adviser and Building Services Adviser). The addition of last aspect is related to another PhD-research executed by Savanović (2007).

5. ACKNOWLEDGMENTS

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6. LITERATURE


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