# COOPERATION BETWEEN NOVICE DESIGNERS (STUDENTS) AND PROFESSIONAL IN BUILDING INDUSTRY

**Wim ZEILER**
TU Eindhoven, Eindhoven, Netherlands

**ABSTRACT**
Within the building industry, the clear need for more sustainable solutions. Building design is being transformed from a traditional mainly architect led process to a multi-disciplinary design team process capable of coping with the growing complexity of the design tasks. A supportive design method was developed in cooperation with the Dutch professional organizations of architects and consulting engineers. The design method is focused on the creation of proposals in the conceptual phase of building design. It helps in structuring communication between design team members as well as the provision an overview of the design task. After testing the method through workshops in the industry, the method was applied at the department of architecture by masters students' in their multi-disciplinary masters project Integral design. The participation and support from industry professionals led to the development of the design method. This cooperation between professionals and students is an example for a kind of educational bridge for engineering education. At the same time it allows us to research the differences between novice designers and professionals. At the latest version of the workshop, professional participation was introduced. In this article we focus on the use of morphological overviews in illustrating the difference in design projects between novice designers (master students) and professionals, as well as their influence and effectiveness.

*Keywords: Integral design, morphological overview, workshops, multidisciplinary design*

## 1 INTRODUCTION

A sustainable built environment is crucial for our future and therefore the European Directive 2002/91/EC requires practitioners to provide buildings with design proposals that comply with minimum energy performance requirements, while safeguarding thermal comfort [1]. Architecture has an important role in directing sustainable development [2]. Sustainable building designers need to provide proposals for sustainability issues such as the flexible use of renewable energy, and energy reduction measures while ensuring satisfactory comfort level of the users. However proper design tools and working methods are needed which could help architects in the design process [3]. Architects began modifying the usual design process(traditional design process) from projects designed(and built) at the start of the millennium (2000) by consulting engineers at a more earlier stage of the design process than normally done. In sustainable building projects designed in later years, many architects qualified their design process as an Integrated Design Process (IDP) as a result of the early engagement of engineers in the design process [3]. This early collaboration with engineers was found to be crucial for sustainable architecture like solar integrated architecture. However, this collaboration in the conceptual design phase was not always easy for architects because engineers 'spoke another language', were often 'too specialized', and 'not willing to compromise on certain issues'. In some cases, the consulting engineers representing all kind of different disciplines outnumbered the architects in a design meeting, which made architects uncomfortable [3]. So clearly, the building design process has become more heterogeneous, with several diverse actors involved such as architects, engineers, contractors and clients. The different viewpoints imply the need for cooperation: a collaborative approach to the design process. The constant and radical changes which characterizes the modern world makes it [4] as Dineen and Collins [5] observed, impossible: 'to base our future on the certainties of the past. Unable to define what we need to know, we have begun to focus on how we will need to know, on the flexibility and openness which characterizes creative thinking'. Creative collaborations that cross disciplinary boundaries are essential to innovation and the occurrence of boundary spanning, where ideas from one domain, discipline or functional area are imported into another, in a way that solves new problems or presents new proposals [6]. However, just putting people with diverse perspectives and from different disciplines in the same room is no guarantee that effective boundary-spanning collaboration will occur [6]. There is a clear need for a support tool to guide this process and try to reach for synergy between different disciplines to reach for optimal idea-finding and the design goals.

Although student studies play an important role in design research we in this experiment tried to develop a link between industrial and experimental contexts. The need for such an approach was identified by Cash et al. [7], as it enables comparison between the behaviour of students with that of professionals when designing [8]. The main focus of the research is on the stimulating effect of adding a professional to a multi-disciplinary student design team.

The main body of the paper starts (Section 2) with the development of the Integral Design (ID) method: a design method that helps to merge the different perspective of all designers and engineers involved in building design. The derived design method was developed in workshops for professionals (architects and engineers) in building design and as such was tested in practice and then implemented in the curriculum of the university [9]. The method was used in workshops with students as part of the master project Integral Design and  is described in section 3. In section 4 results are presented of the application of the ID-method with a specific intervention: the addition of a professional to the student design teams within the workshops. A discussion about the effect of this intervention of adding a professional to a student design team is presented in section 5. Finally in section 6 some conclusions are given about the added value of the presented approach for stimulation of the generation of new proposals for conceptual building design.

## 2 METHODOLOGY

In design one has to work with ill-defined problems where the wanted solution and the problem itself develops almost in parallel at the early stages of the design process. Also the amount of relationships and dynamic social interactions makes it increasingly complex. In the early sixties due to problems with the quality of products and projects people started to investigate new design methods as a way to improve the outcome of design processes.  Since then there was a period of expansion through the 1990s right up to date [10] with many models of designing existing [11]. In the Netherlands Methodical Design is the most widely used design method. Methodical Design is a synthesis of the Anglo-American and German design schools with a strong relation to the general system theory and has some exceptional characteristics.  This design method was extended into an integral design model by adding an evaluation step [12] and the intensified use of morphological charts to support design activities in the design process. The morphological charts are formed as each designer decomposes the main goals of the design task into functions, which are than listed on the first vertical column of the morphological chart, see Fig. 1. After this first step, in the second step the (with the mentioned functions related) proposals can be listed on the corresponding rows.  Each participant of a design team develops a Morphological Chart from their own specialist perspective to the design brief.

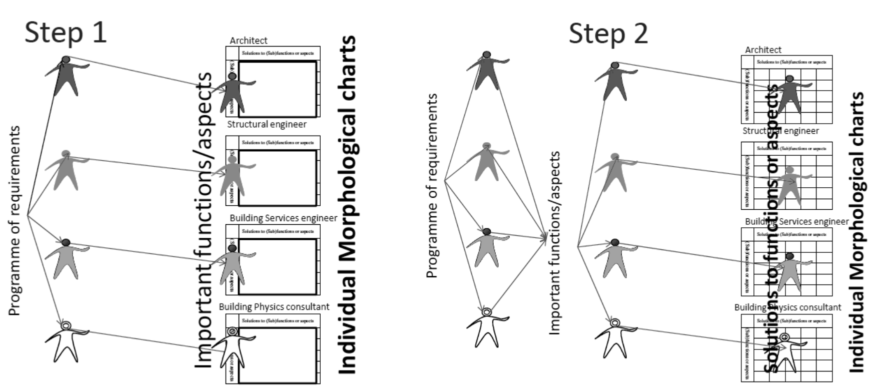


*Figure 1. First two steps using the morphological charts in the Integral design method*

These individual, discipline based Morphological Charts can be combined to one overall Morphological overview in two steps, see Fig. 2. In the first step, step 3 in the whole procedure, the design team discusses the different proposal for the functions in the first column of the morphological overview. In this discussion everyone brings in the notated functions from their morphological chart and possible misunderstandings can be cleared. After this the team has reached a shared understanding and interpretation of the design brief. In the next step, step 4, the design team can than add the different proposals in the rows connected to the specific functions.

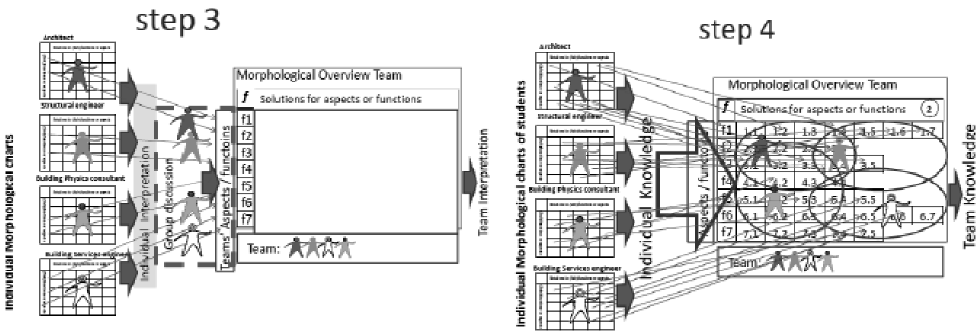


*Figure 2. Step 3 and 4 of the Integral Design method, the forming of the morphological overview from the individual morphological charts after the group's discussion*

The Integral Design method was tested with professionals from the Dutch Society of Architects, the Dutch Society of Consulting Engineers and the Dutch Society of Building Service Engineers [9]. After the testing the method was implemented in the educational program of the Faculty of the Built Environment of the University of Technology Eindhoven and formed the basis for the master project Integral Design. In this project, students from at least 4 different disciplines (architects, structural engineers, building physics, building services and building technology) formed a design team and had to design a net Zero Energy Building within one semester. At the start of the project workshops were organized to teach the students the basic principle of Integral design as well as hands-on experience working with morphological charts and overviews. In the last 7 years, more than 160 students have participated in this specific master project. Each year the project is evaluated and adjustments made as needed. Also new additions or interventions in the workshops were tested.

## 3 EXPERIMENTS: ADDING A PROFESSION TO A STUDENT'S DESIGN TEAM

To test the effect of the intervention of an experienced professional in a student's conceptual design session,in 2011 and 2012 the workshops were used as masters projects.The workshops started with two sessions in the afternoon followed by two other sessions the next morning.

The focus of the workshops was to teach the students the use of morphological charts and morphological overviews. This was done by starting with a lecture about the integral design method and its specific application of morphological charts and morphological overviews as design tools. The students were split up in design teams during sessions 1, 2 and 3 and all students worked only once with the same students. This was to avoid a learning effect in teams as they otherwise start to know each other better. In all design settings the teams were given the same or similar design tasks as used in the Integral design research by Savanovic [9]. In session 1, 2 and 3 the participants started individually, working on the different design task and making their own morphological chart, see Fig. 4 in step 1 and step 2. At the end of the first part of each session the teams made from the morphological charts morphological overviews. The individual part of the sessions 1, 2 and 3 took 20 minutes and the team parts lasted 40 minutes. In the first individual part of the sessions, communication between participants was discouraged when they had to make their individual morphological chart. In session 1, teams consisted of an architectural student and an engineering student. In session 2 the teams consisted of four students. In session 3, the students were again rearranged into teams of 4 students. The participants of the workshops were master students of the faculty of architecture, building and planning and had an average age of 22 and no working experience. In 2011, 29 students participanted in sessions 1 and 2, and 27 students particpated in session 3. In 2012, 22 students participated in sessions 1 and 2, and 40 in sessions 3 and 4. In addtion, in 2011 AND 2012 six professionals with an average of 50 years participated in sessions 3, one in each student team. This way, it was possible to observe and notice the effect of the intervention of an experienced professional to a team of inexperienced students.

## 4 RESULTS

As the first session of the design session was a learning session comprising only students, therefore the results are not included in this paper. The generated average amount of functions and proposals mentioned in the MC's and MO's of the session with teams of four students (sessions 2) with the participation of an experienced professional in session 3 are shown in Fig. 3.

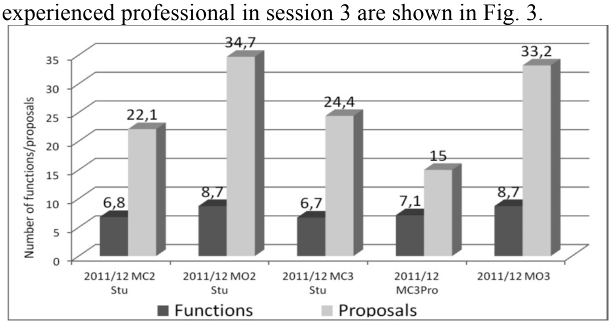


*Figure 3. Overview average number of mentioned functions and proposals in the workshops sessions 2 and 3*

In Fig. 4 the theoretical model of the intervention in the design process is represented, as well as an example of the real MC's combined to one MO. In the case of team 3 in session 3.

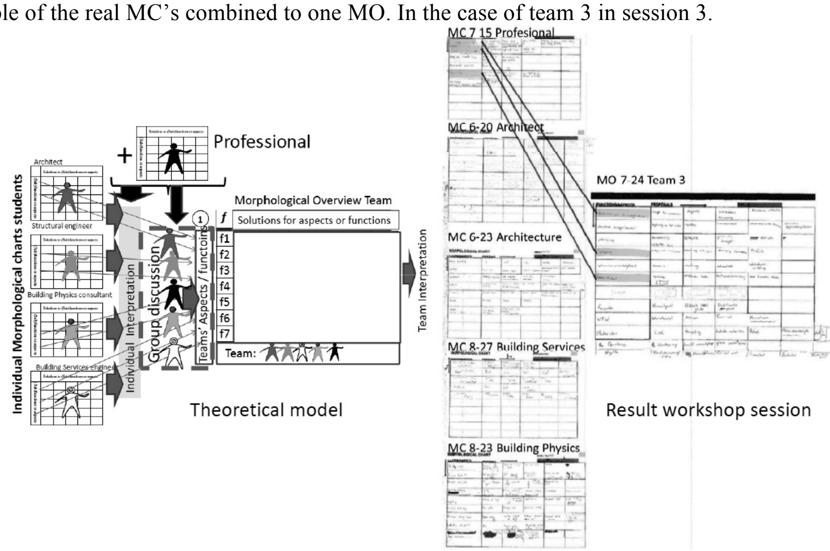


*Figure 4. The model of the intervention and an example from workshop session 3 team 3*

Besides the changes in the number of mentioned functions and proposals, we were interested in the influence of expereinced professionals on the outcome of the design process, in this case the morphological overview. Therefore we counted the number of functions mentioned by each professional in his morphological chart and checked how many of those we finally put into the design team's morphological overview, see drawn lines from MC to MO in Fig. 3. The same was done for the notated proposals, so for example in table 1 it shows that from professional 1, only 3 of 12 notated functions in the morphological overview were from the professional and only 3 out of 51 notated proposals. Based on these numbers the influence of the professionals were defined in a percentage:

number of functions/proposals as mentioned by the professional, divided by the total number of functions or proposals mentioned in the morphological overview, see Fig. 5.

*Table 1. The number of functions or proposals from the professional mentioned in the morphological overview compared to the total number mentioned in the morphological chart*

| Influence professionals in team: | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| functions | 3 of 12 | 3 of 6 | 2 of 7 | 6 of 10 | 4 of 14 | 1 of 8 |
| proposals | 3 of 51 | 3 of 21 | 3 of 24 | 7 of 41 | 4 of 48 | 4 of 33 |

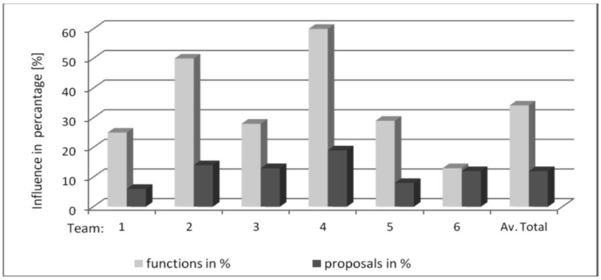


*Figure 5. Percentage influence of by a professional mentioned functions or proposals related to those mentioned in the morphological overview*

In the next step we looked at the effectiveness of the professionals in the design teams. We defined the effectiveness as the number of mentioned functions or proposals in the morphological chart of a professional, in relation to the number of functions or proposals that were notated in the morphological overview of the design team. So for example, of the 6 functions mentioned by the professional in his morphological chart, see Fig. 4, only 3 made it into the morphological overview. Of 15 mentioned proposals only 3 made it into the morphological overview, see table 2. Based on these numbers the effectiveness of the professionals were defined in a percentage based on the number of functions/proposals mentioned by the professional divided by the total number of functions or proposals mentioned in the morphological overview, see Fig. 6

*Table 2. Number of functions or proposals professional mentioned by professionals in the morphological chart compared to those in the morphological overview*

| Effectiveness professionals | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| functions | 6 to 3 | 10 to 6 | 7 to 2 | 8 to 6 | 8 to 4 | 4 to 1 |
| proposals | 15 to 3 | 22 to 3 | 15 to 3 | 7 to 7 | 12 to 4 | 13 to 4 |

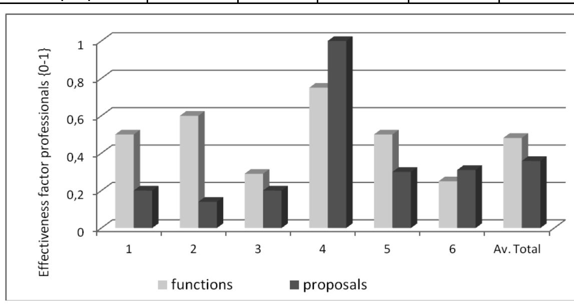


*Figure 6. Effectiveness of a professional (the number of mentioned functions or proposals in the morphological charts related to those in the morphological overview*

Next we looked at the average ‘effectiveness’ of the students within the design teams: the total number of functions or proposals mentioned in the different morphological charts by the individual students in relation to the mentioned functions or proposals mentioned in the morphological overview, but not mentioned by the professional, see table 3. This gives an indication of how effective the idea generation of the students were. Based on these numbers, the effectiveness of all the students as a group were defined in a percentage: number of functions/proposals mentioned by the students dividedby the total number of functions or proposals mentioned in the morphological overview, Fig. 7.

*Table 3. The average 'effectiveness' of by students mentioned functions or proposals*

| Average 'effectiveness' students | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| functions | 30 to 9 | 25 to 4 | 28 to 5 | 21 to 4 | 35 to 10 | 19 to 7 |
| proposals | 127 to 48 | 103 to 18 | 103 to 21 | 76 to 34 | 135 to 44 | 61 to 29 |

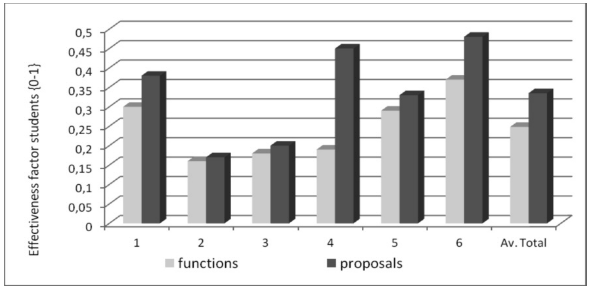


*Figure 7. Effectiveness students (the number of mentioned functions or proposals in the morphological charts related to those in the morphological overview)*

## 5 DISCUSSION AND CONCLUSIONS

Adding a professional to a student design team has no significant effect on the number of generated proposals and also on the amount of notated functions in the morphological overview. This indicates that the creativity of the student teams was not really increased by adding a professional. However the professionals had a major influence on the selected functions in the morphological overview, which might indicate that the relevance of the proposals might be increased. In contrast, the influence of the professionals in the total amount of mentioned proposal was much lower than that of the students. Given the relatively small number of design teams [12] the results have to be interpreted with caution and more experiment needed to verify the results. Analyzing the different design teams a rather big spread in results, indicates that the results of a design team depends heavily on the specific combination of and interaction between the different design team members.

## REFERENCES


[1] Mazzeo A., Giuffrè R., Ubelohde S., Lollini R., 2008, *Energy as a Kind of Architectural language: toward Design procedures for Building Energy Retrofit, Design Principles and practices* 2(1), 57-65.

[2] Taleghani M., Ansari H.R., Jennings P., 2010, *Renewable energy education for architects: lessons from developed and developing countries*, International Journal of Sustainable Energy 29(2), 105-115.

[3] Kanters J., Horvat M., Dubois M., 2012, *Tools and methods used by architects for solar design,* Energy Buildings http://dx.doi.org/10.1016/j.enbuild.2012.05.031.

[4] Williams A., Ostwald M., Askland H.H., 2010, *Assessing Creativity in the Context of Architectural Design Education*, Proceedings DRS2010, Montreal.

[5] Dineen R., Collins E., 2005, *Killing the goose: conflicts between pedagogy and politics in the delivery of a creative education*, International Journal of Art & Design Education, 24(1), 43-52.

[6] Joyce C.K., Jennings K.E., Hey J., Grossman J.C, Kalil T., 2010, *Creativity and Innovation Management* 19(1), 57-67.

[7] Cash P., Hicks B.J. Culley S.J., Salustri F., 2011, *Designer behaviour and activity: An industrial observation method*, Proceedings ICED11, Copenhagen.

[8] Cash P., Hicks B.J. Culley S.J., 2012, *A comparison of the behaviour of student engineers and professional engineers when designing*, Proceedings Design 2012, Dubrovnik.

[9] Savanović P., 2009, *Integral design method in the context of sustainable building design*, PhD thesis, Technische Universiteit Eindhoven.

[10] Cross N., 2007, *Editorial Forty years of design research*, Design Studies 28(1), 1-4.

[11] Gericke K., Blessing L., 2012, *An analysis of design process models across discipline*s, Proceedings Design 2012, Cavtat, Dubrovnik.

[12] Zeiler W., Savanović P., 2009, *General Systems Theory based Integral Design Method*, ICED'09, Stanford.