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MULTIDISCIPLINARY TEACHING – MSc COURSE ON TEAMWORK AND OPARATION

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ABSTRACT

Industrialization and technical development led to a split of the traditional role of the master builder into two: the architect and the engineer. Additionally, new demands on functionality such as energy and cost efficiency led to an increasing need of functioning collaboration in large teams during the design phase; as well as a need of new work methods within the process. This calls for employees who are experienced in collaborating in interdisciplinary teams. To fulfill this demand a multidisciplinary course in “Advanced building design” has been developed at the Technical University of Denmark. The goal of the course is to provide training in teamwork at the final stage of the engineering education. The course has been carried out twice. It was held by a multidisciplinary team of professors in periods 2008/09, 2009/10 and 20010/2011. Teams of students were subject of a questionnaire investigation on collaboration and team work. The study has the following findings. The latest year there has been a special focus on team work and all members tested their role according to Belbin’s theory on teamwork. The work has the following findings: Collaboration was generally good. However the extra focus on teamwork did not lead to a improvement of the team work in contrary. The team-structure was generally flat and decisions were mostly made in consensus. It is worthwhile to offer a multidisciplinary course and give engineering students experience in collaboration methods.

KEYWORDS

Building design, collaboration, architect, engineer.

INTRODUCTION

Since the industrialisation of the construction industry and before the technical development the master builder [1]have been replaced with architechs and engineers [2]. Due to a massive technical development the role of the engineer has become increasingly more important.. Engineers have specialized into different domains and are today dealing with structural design, services, foundations, indoor climate, construction management, facilities management, IT and CAD specialists, are educated to fill the demand [3]. The traditional collaboration of the partners in a building process requires a minimum of team work [4], and lean principles and logistics are rarely applied to the process. The collaboration between architechs and engineers is descipted by Weingardt [5] as “difficult”, “turf battle” and being “warring cells”. There is a great risk of miscollaboration in the initial stages of a project which have been identified by McCluren [6]. A malfunction of the teams has been pointed out due to a lack of insight into other professions [6], [7]. Some engineers like Ove Arup and P Rice decided to work closely with architects with varying level of success while P L Nervi and Edurado Torroja decided to exclude the architects from their work [8]. The existing way of

collaboration have demonstrated its weaknesses in many projects and led to new way of organizing projects. One of them is partnering being an organization form turning into a collaboration method at a later stage of the process [9]. In some cases the method was cost saving [5] in others this type of alliances were negatively affected by competitive forces, overlap of the subprojects and lack of trust [8] [9][9]. Integrated Project Delivery (IPD) is a different approach that involving owner, architects, engineers, , and the contractors or builders as the core group to manage an integrated project delivery process [11]. Building Information Modeling (BIM) is used as a digital representation of a building to facilitate exchange and interoperability of information in digital format". BIM aims at improving the communication between parties.

At Technical University of Denmark a course for MSc. tries to both introduce the students to projects that can be compared with projects from the industry and introduced to the use of BIM. The students have to work within a given domain and development of collaboration has been studied for three years [14], [15]. The background for the course is based on the facts identified during seminar at the Technical University of Denmark with representatives from the industry [12][13]. The need for specialization but also collaboration abilities was expressed at the seminars in 2005 and 2007. In 2007 centre leader Simon Guy Marc from Manchester University expressed the "Need for creative workers trained in interdisciplinary and collaborative working". Besides professionalism and specialization the attendants of the DTU-avtagerseminar 2005 is was expressed that the engineer student's ability to" constructively collaborate in such as partnering and lean construction." have to be trained.

METHOD

The present statistical study is performed within a project oriented course. The task of the course is to plan a high rise office building in multidisciplinary teams. The students are expected to transform their knowledge into a building design by the group as a teamwork effort. It is the aim to enable the students a good start working in industry, by providing experiences about multidisciplinary design. The course is targets MSc. Architectural Engineering or Civil Engineering students, which already have a Bachelor degree. The professors were mostly trained as engineers. The course was given to the students for the first time in 08/09 and was mandatory for MSc. Architectural Engineering and Civil engineering students that year. The course was not mandatory the second and third time (09/10 and 10/11), but anyway difficult to avoid. Six different subjects were identified to represent different roles in a construction project. The six subjects were: Design (including fire strategy in 09/10), Structural (including structural fire safety), Building Services (energy), Soil and Water mechanics, Urban planning/ Construction Management/ Facility Management, and ICT Coordinator (and fire strategy in 10/11) . For each subject one or more professors were identified, and one or two students were given the role specified by the subject in each team. During the 13 week period autumn one morning weekly was reserved to the course. In total the workload for a 10 ECTS course at DTU is 280 hours. The students meet either in a subject group or together with the rest of the members of the team to a team session. The subject professors were present at groups meetings, while the team meetings were meant to be carried out without assistance from professors.

The goal of the present work is to study the change of collaboration over time and how collaboration is perceived in general as well as the structure of this type of teams. This is done developing a questionnaire which was answered in the years 08/09,, 09/10 and 10/11. The conditions for the course in the three periods are described below. **Conditions for period 08/09:** 67 students attended the course, and they were distributed into 9 teams. The course was led by a professor team with 15 members. 32 students (48%) and 7 (47%) of the professors took part in the questionnaire providing the results for the present study. **Conditions for period 09/10:** In periods 09/10 100 students registered the course. They were divided placed into 16 teams with 5 or 6 members. 67 students (67%) and 6 (60%) of the professors took part in the questionnaire. **Conditions for period 10/11:** In periods 10/11 allmost 100 students registered the course. They were divided placed into 13 teams with 5 or

6 members. 40 students (44%) took part in the questionnaire In the firstperiod the student and the professor teams have similar conditions, They were multidisciplinary, the participants did not explicitly choose to collaborate; no one could be excluded from the teams, there were tight deadlines and a high workload. All students were asked to answer the questionnaire. Students were given a standard- and course specific questionnaire including the possibility for making individual notes by the end of the course. In 10/11 the students were ask if they found a Belbin [16] self test useful. The current study is based on results originating from the three times the course has been conducted. Since the students are still studying at the university, it has not been possible to prove that the students have better qualifications in the given areas than students which have not followed the course. Hence, the outcome of the study can only give information on the short term development of a rather homogeneous group. Long term effects on collaboration of this teaching method could not be studied. However, such a course offers a base suitable for such an investigation since the students present a homogenous group of people, with similar background and age.

RESULTS AND DISCUSSION

The results discussed here deal with aspects of collaboration and team structure, based on the questionnaire and comments from the participating students of the three years.

The first two figures describe the collaboration. Figure 1 displays the answers to the question on how the collaboration the teams was experienced towards the end of the course. It can be seen that the collaboration was predominantly positive. However, in average 9% of the participants experienced a bad or very bad collaboration in their team. It can also be seen that the collaboration in year 2011 has a rather flat distribution compared to the previous years. Here the collaboration was experienced worst compared to the years 2009 and 2010. The question raises how this results is relates to the extra focus on collaboration and team work in year 2011, where lectures on Belbin's theory on teamwork [16], Johari window [17] and solving conflict by nonviolent communication [18] were introduced.

Figure 2 shows how the collaboration in this multidisciplinary course was experienced compared to other projects and courses. Here it can be seen that the collaboration in all years was not experienced to be easy compared to other courses/projects. It can also be seen that most students express that the collaboration was difficult in 2011 than the previous years.

The strategies for problem solving used in the teams were mostly consensus as shown in Figure 3. In all three years only few students experienced that the decision making process was steered from the top or by vote.

A majority of students in year 2011 thought that the use of Belbin profiles was useless, as displayed in Figure 4. This question was new for 2011, where the team work was extra stressed and Belbin roles were introduced and applied. None of the students found that the application of the Belbin profile was very useful.

In spite of the difficulties experienced by many students a majority of the students found that the course is a good introduction to designing a realistic multidisciplinary construction project, as shown in Figure 5.

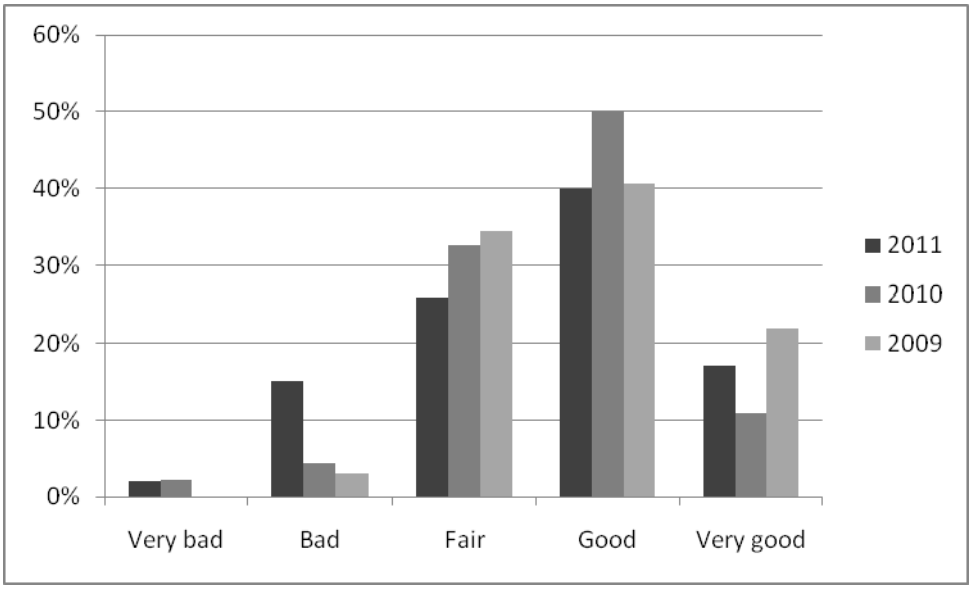

Figure 1: The collaboration of my team was:

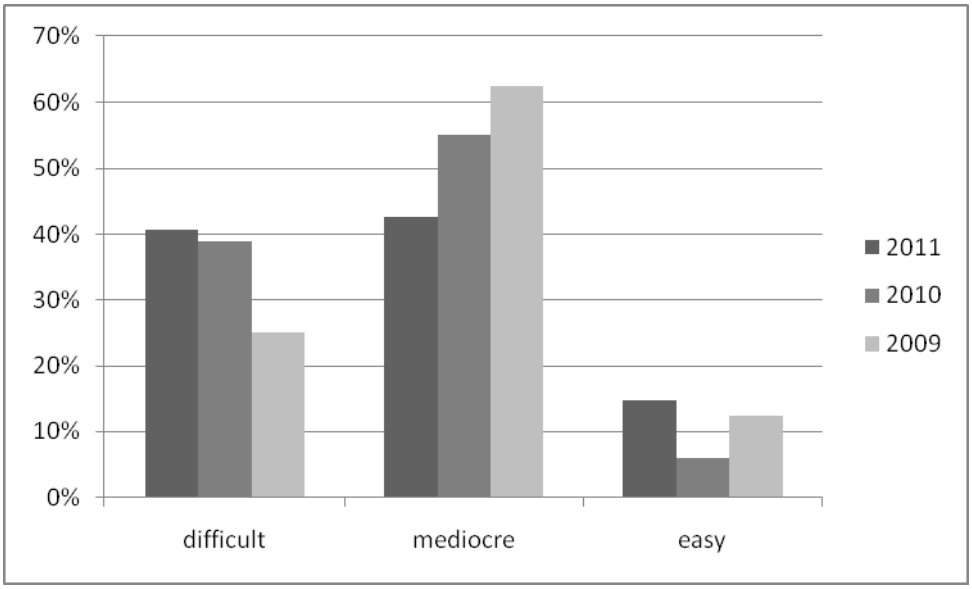

Figure 2: Compared with earlier courses/projects the collaboration was:

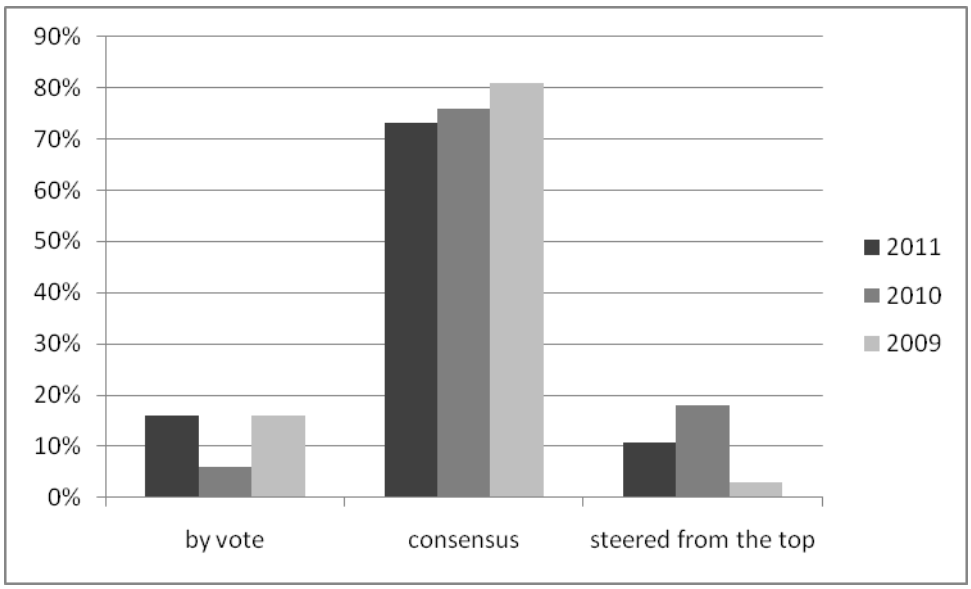

Figure 3: My team used one of the following strategies for problem solving:

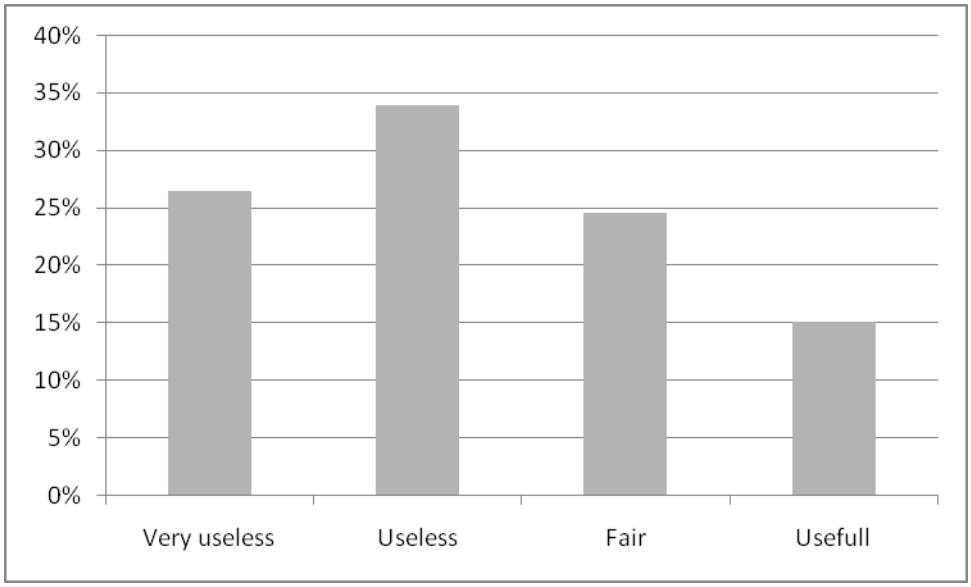

Figure 4: The use of Belbin profile analysis was:

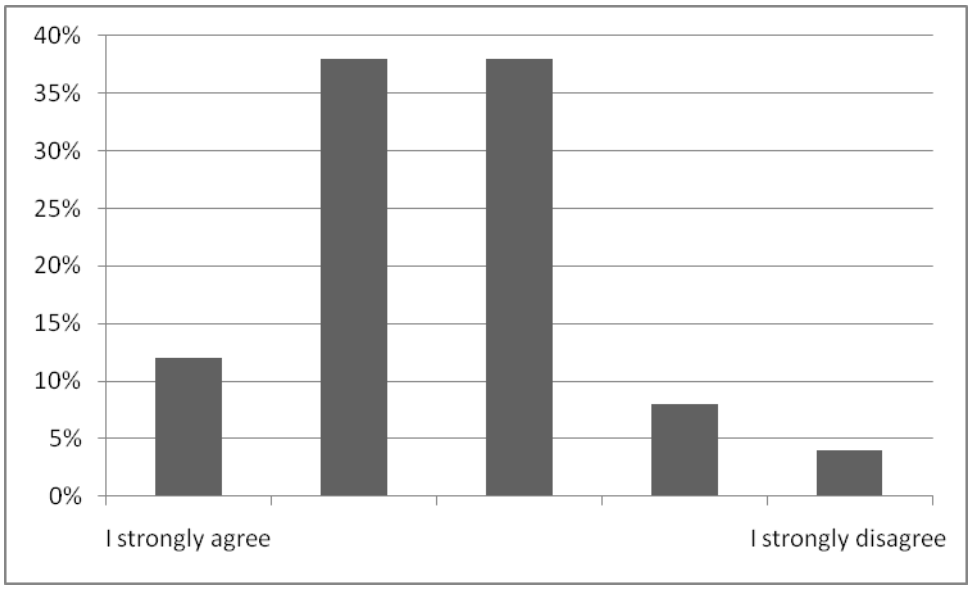

Figure 5: The course is a good introduction to designing a realistic multidisciplinary construction project

Based on the comments in the ordinary questionnaire all students receive it was clear that the teamwork aspect in the course had been a challenged. This led to the conclusion for some students that despite the challenge of making a fruitful teamwork, the course had been a good experience while others saw the course as something they rather would have been without. During spring 2010 a number of students were invited to be interview by the authors of this paper. Even though a limited number of students were interviewed and their view not may representative, it was clear that the atmospheres in their teams have had significant impact on the level of integration between the technical systems in the building. There may therefore be a direct relationship between teamwork in a team and the quality of the designed solution, this may not be a big surprise but nevertheless this can only encourage professors and managers to be aware of this aspect in order to make a good technical solution.
Based on experiences from the students it was decided to include lectures on teamwork for all students taking part in the course in 10/11 because implementing good teamwork in a team not can be dedicated to one member of a team.

CONCLUSION

The current work presents the results of a questionnaire study on collaboration and teamwork on the homogeneous population within a course run in 08/09 and 09/10 at the department of Civil Engineering at the Technical University of Denmark. Students and professors answered a questionnaire, which resulted in the following findings: collaboration was improved during the course in both periods. Initially collaboration was experienced more problematic than towards the end, confirming the statement by McCluren [7]. This statement is even strengthened by the result that collaboration was perceived better in retrospective. Furthermore the students and professors in both periods expressed that they learned on collaboration. During the first period the team leader in the student team was defined by the professors. The role of team leader was integrated in the role of the design manager and most teams followed this suggestion however a large fraction 17-18% picked the leader among the design students (which is the role traditionally taken). During the second period the students were free to choose their team leader. The leader came not from a specific subject, but was chosen according to other criteria not established in this investigation. The criteria may be individual characteristics. For both periods the team structure was generally flat and decisions were mostly made in consensus. For the next semester, the course is further developed, task descriptions are improved and the importance of team work and

collaboration methods will be stressed in the first weeks. A larger focus is placed on initial team building process.
Multidisciplinary teaching methods are essential any engineering education. Sustainable change in collaboration in the design process should be induced at Universities. In order to support such a change in industry students should be exposed to team work that differs from the traditional one.

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