FROM APPRENTICE TO MASTER OF SCIENCE IN ENGINEERING – AN EDUCATIONAL EXPERIMENT

Søren Wandahl\textsuperscript{1} and Lene Faber Ussing\textsuperscript{2}

\textsuperscript{1}Department of Engineering, Aarhus University, Aarhus School of Engineering, Denmark
\textsuperscript{2}Department of Mechanical and Manufacturing Engineering, Aalborg University, Denmark

ABSTRACT

As a consequence of the Bologna Process Danish higher educational system has fully adopted the 3+2 system. Access to Master of Science programmes is now granted to either Bachelor of Science or Professional Bachelor degree holders. The latter is known for admitting people with vocational qualifications. Hence, it is now possible for a person to go through apprenticeship, and later entering an Architectural Technology and Construction Management education, and finally, ending with a Master of science degree. Now in its fourth year of allowing MSc students with such background, it is possible to share some of the collected experience. So far it has been a success, but there have been hurdles. Students with vocational background combined with a professional bachelor degree are different from students with a Bachelor of Science background. This applies to the areas of among others: Mathematical skills and practical knowledge. The main success is that candidates have entered the job market with high success. Data has been collected through interviews and surveys with graduates, teachers and coordinators within the new master programme in construction management at Aalborg University in Denmark. This exercise has given insight what distinguishes traditional Master of sciences graduates and these new graduates.

Keywords: construction management, education, master degree, vocational training

INTRODUCTION

The construction industry is naturally interested in the educational system as customer to our candidates. This research limits focuses to only higher educations. On one hand, the industry often asks for well-educated candidates, especially with managerial skills. On the other hand, the industry asks for candidates with practical knowledge. Often these two requests are not to match in one education. Students with vocational training or an apprenticeship certificate is a seldom at our universities. This because these people often lack the requested admission requirements achieved in upper secondary educations. So if they were to enter the university they either have to restart their education and pass through upper secondary grades or take access course. People with vocational training can instead of a university degree obtain a professional bachelor degree. Until recently there existed no continuation of a professional

\textsuperscript{1} swa@iha.dk
\textsuperscript{2} lf@m-tech.aau.dk
bachelor degree. This could be seen as not fully implementation of the 3+2 system of the Bologna declaration, stating that a 3 year bachelor should grant access to a 2 year master.

This research reports on a Danish attempt to fully implement the Bologna declaration, and allowing students with a 3 year professional bachelor degree access to a 2 year master programme at Aalborg University. The programme is a Cand.Scien.Tech. programme in Construction Management, hereafter referred to as CST. The aim of this paper is to share knowledge of this process and to point out challenges in allowing submission to university from students with a professional bachelor degree and apprenticeship certificate.

The Bologna process
29 European countries signed the Bologna Declaration in year 1999 (EU 1999). Today the Bologna Process embraces 47 countries in the European Cultural Convention. The focus of this declaration is the higher educational system in Europe, vocational educations, and lifelong education. There are several aims of the Bologna process, where the most known is the development of the ECTS grade scale, comparable diplomas, mobility for students and a comparable grade structure. The main purpose could be shortened down to achieve comparable academic degrees in terms of quality and grading throughout Europe.

In this research the focus is on the comparable grade structure, known as the 3+2 system. The purpose is to grade the higher educational area in 3 year bachelor (both Bachelor of Science and Professional Bachelor), and a 2 year Master of Science (Dahlgren et al. 2009).

The current status is that the work is still in progress, and that the progression is different from country to country. The process has also had severe impact on the Danish higher education area. It is not within the scoop of this paper to describe the changes and impact thoroughly, instead a short “as is” description of the system is described in the following paragraph.

Short background on the educational framework
In general the educational level is high in Denmark (EACEA 2009). EHEA, a Bologna follow-up group secretariat, is leading the continuous change toward transparency in the higher education area. They also keep track on each country’s progress in the Bologna Scorecard. In the report from 2009 (Rauhvargers et al. 2009) Denmark is placed second, right after Scotland. Only implementation of the National Qualification Framework is not yet 100% in the Danish rating.

As mentioned, the implementation of the Bologna Process has created new ways of “moving around” in the Danish educational system, now allowing professional bachelor degree holders admission to Master of Science programs.

Brief introduction to the Cand.Scien.Tech. program
The students start at the the Cand.Scien.Tech. program at Aalborg University the 1st of February every year. The program is build-up of 4 semesters with four different topics. All 4 semesters are based on Problem-Based Learning principles, which implies: group work with real life construction cases, students identify and solve
problems in groups, teacher facilitates this process, interdisciplinary and practice based and students are active in class (Wandahl et al. 2008).

First semester has a 15 ECTS project where the topic is Project Design and design of construction sites. In addition 3 separate courses of 5 ECTS is mandatory. The courses are; Stressed concrete structures, Project management and economic, and Soil engineering. In addition students have to take a 2 week brush up course in applied mathematics.

Second semester has a project where the topic is Project management and production in the building sector and the three courses are: Building processes, Construction law and frameworks, and Development of quality and project management systems.

Third semester has a project where the topic is Management systems in construction companies and the three courses are; Development of advanced quality and project management systems, Strategy and performance measurements, and BIM.

The fourth and last semester has a 30 ECTS master thesis. Normally the students are working 2 or 3 students together on their thesis.

**METHODOLOGY**

With the purpose of evaluating the CST program, an electronic survey was conducted. The questionnaire was devised with outset in Forza’s (2002) designing theory. The samples in this survey were past and current CST students, and in total 75 respondents were invited. 43 Answered, which results in a response rate of 57% which according to Malhotra and Grover (1998) is acceptable. The questionnaire was composed of four sections. First section entailed basic data such as age, gender, last educational, practical experience, and apprentice diploma. Second section concerned the enrolment process and asked why respondents applied, if they had enough information available for taking the decision, and what worries they might had prior to enrolment. Third section focused on structural, pedagogical and academic challenges because universities are another scale in all aspects compared to university colleges. Questions in this section were all open end questions, providing room for respondents to elaborate. The final section was only a single question, where respondents on a Likert scale should rate how well the education matched their expectations. A single question in section one was also based on the Likert scale. Questions in section two, on basic data, was factual information. All other questions were open end questions.

Data analysis was conducted in correspondence with the question type. When possible, correlation test are carried out, in some cases by converting answers to binary variables. Open end questions were analyzed by spotting trends. The preferred method was clouding, i.e. grouping of post-it on whit boards. Some answers can be hard to interpret because they were a bit off topic, but no answers were rejected.

To increase validity by means of triangulation, unstructured interviews with teachers were carried out. In total 6 unstructured interviews were conducted.
FINDINGS

Findings are grouped in three sections relative to the first three section of the questionnaire. Result of the fourth section of the questionnaire is described in the conclusion.

Background before enrolment

CST students seem to have a different background compare to MSc Students. Their age at enrolment is normal distributed with an average of 25.6 years, compared to MSC students average enrolment age of 24. 85% of the CST students are male and 15% are female. This is very similar to all technical programmes at Aalborg University.

98% of the respondents have a professional bachelor degree in form of an Architectural Technology and Construction Management diploma. This is very positive, since the purpose of the program was to enable exact this target group to obtain a master degree. It is also possible to enter the CST programme with a scientific bachelor, and with a variety of more or less relevant professional bachelor degree.

26% of the students have had relevant work experience in between their professional bachelor and entering the master programme. The amount of work experience is limited, approximately ½ to 1½ year. Employees have mainly been architects and consulting engineers. Moreover, only 30% of the students have had vocational training, i.e. an apprenticeship certificate. The remaining 70% have had upper secondary education before entering the professional bachelor. This is a little surprise, but reflects general society very well, i.e. high focus on young people getting a proper education. These 70% could probably have entered directly at the university (if achieved right qualifications in mathematics and physics), but choose not to. There are three reasons for not entering university directly. Firstly, the requested level in mathematics and physics is a barrier. This barrier also embraces the lack of interest in mathematics and logical analysis. Secondly, some students cannot oversee 5 years of study. It is simply too long, and does not reflect their current view on life. Thirdly, the social heritage is hard to overcome (Munk & Thomsen 2011). The main part of this group is grown up in non-academic homes. Hence they should be the first in the family to enter a university.

On their background it can be concluded, that the variance is high in terms of knowledge, competences, and skills. It is a large challenge for the university to take this variance into account. The university has no tradition in carrying out differential learning. What the teachers experience is that the university model with group work is essential for the students. They help each other, and together they manage to solve a “bigger” case than they could as individuals. The first semester of the CST program is specifically designed very flexible to cope with this variety in skills. For example students begin with a brush up course in applied mathematics. This course has no specific curriculum. The teacher only know what students must be able to do when finishing this course, and the teacher then aims at lifting the students as individuals to the target level independent on their starting point.

Several teachers have indicated that they have observed the abovementioned challenges, but they also mentioned that they are impressed of the students’ practical knowledge in relation to construction. On teacher mentioned “I contrast to most of our MSc students these CST do in fact know how to build a house.”
Motivation for enrolment

When directly asked “Why did you enroll to the CST program?” the main answers are illustrated in table 1.

<table>
<thead>
<tr>
<th>Why did you enroll to the program?</th>
<th>n</th>
<th>in % of N= 43</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own ambition of a master degree</td>
<td>22</td>
<td>51%</td>
</tr>
<tr>
<td>Hard to find job in economic down times</td>
<td>19</td>
<td>44%</td>
</tr>
<tr>
<td>Obtain management competencies</td>
<td>14</td>
<td>33%</td>
</tr>
<tr>
<td>The education looks interesting</td>
<td>11</td>
<td>26%</td>
</tr>
<tr>
<td>Differentiation from other when applying for jobs</td>
<td>10</td>
<td>23%</td>
</tr>
</tbody>
</table>

Table 1: Authors’ interpretation of respondents’ answers. The sum of n is higher than N because each respondent put forward several arguments.

There are three key points to observe. Firstly, more than 50% stated that they had a general quest for continuing their education. This CST program is one of the first, direct and most visible opportunities for professional bachelors with a degree in Architectural Technology and Construction Management. Secondly, the financial crisis is still slowing construction activity down, and therefore, fewer jobs are available. Several of the respondents answered that their first choice was to get a job, and the second choice was to get a master degree. This is confirmed by observations from the teachers, where it is noticed that approximately 20% of newly enrolled students quit the program within the first semester. Many of them due to job opportunities. Thirdly, 33% of the students aimed specifically at increasing their management knowledge. This is very positive, partly because the program was designed to give students construction management competencies, and partly because the construction industry often request labor with enhanced managerial skills.

Students did have different worries before enrolling. 28% of students had concerns about the mathematical level. Students with vocational training often have a low mathematical level, hence a chi-square test on these two binary variables is performed to find the probability of correlation between vocational diploma and concerns of mathematics. The calculation of chi-square, $\chi^2$, is 2.437, which with a freedom of 1 give gives a probability, p, for correlation of 0.11. This is not significant. In general students are worried about the overall level of a master degree compared to a professional bachelor degree. 26% expressed exact this worry. Several of the students had to move to a new city. Several of these expressed their concerns in terms of finding a place to live, moving away from girlfriend, find new friends, etc. Hence the social impact of enrolling is quite high. Since this is a new education 14% of the respondents expressed thoughts on how well the education is known by industry when they graduate. University strategy for meeting these worries was threefold. A website and brochures was created to inform about both content and social impact of studying at the university. Contacts to tutors were offered, both physical meetings and email and phone conversations. Finally, two of the teachers from the program were on a road trip visiting all of the Danish professional bachelor schools, hosting information meetings. This effort seems valuable, since 81% of the students found that they had plenty of information available to base their choice of enrolment on. Several of the respondents however comment upon that they found that the program was over sold in terms of management learning and indicates that information regarding the technical and mathematical level was restrained in brochures and at information meetings.
Structural, pedagogical and scholarly challenges

Students were asked to respond to their perception of structural, pedagogical and scholarly challenges due to students' transition from professional bachelor to master program. Questions were developed as open end questions, which allowed respondents to elaborate their answers. In the data analysis, answers has been interpreted and grouped into observed tendencies. Most dominant is the students’ evaluation of structural aspects of now being a university student. Several of the students respond that they find the auditorium teaching challenging. They were used to have class based teaching with around 20 to 30 students, which they all were familiar to. A large amount of the university courses is conducted in large auditoriums because 50-100 students follow a course. More over there is students at different level from different programs following a single course. A key challenge for many of the students in such an environment is the lack of opportunity to raise questions and discussion technical matters. This one-way teaching with afterwards assignments needs habituation. It also challenges the way these CST students is used to prepare and do homework. Many of the teachers point out that the have a perception of CST students not preparing satisfactory. In some courses this is validated through a very biased exam score. For instance, the average fail rate in project management and economics is around 10%, but for CST students the rate has raised to around 50%. CST students are also astonished of the effort put into written work and assignments, and the need level for passing. This paramount focus on the writing abilities is new for the CST students. Finally, Aalborg University practices problem based group work, and many of these new students have trouble coping with group dynamics. It is new that they themselves have to found groups and also handle conflicts within a group. Some points out that this raises a kind of competition among groups, which is not the intention. Groups should foster mutual sharing of knowledge and resources which is found natural among other MSc students, but seems not to foster among the CST groups. It is also pointed out that several of the respondents find groups to be more isolating. They were used to have 20 to 30 “friends” in a class, now they only have 4 to 5 “friends” in their group.

Combining these three structural challenges several of the respondents rate the study environment as less attractive here at university than at their professional bachelor programs. This is a surprise for the university in general, because Aalborg University often promotes the great study environment (though comparable to other universities). Hence, there is room for easing transfer issues for these CST students, both regards to what the university can expect from prospect students and regards to how to better inform and prepare prospect students prior to enrolment. In general the transition process can be improved. Several helping guidelines were suggested by respondents. The information flow up to and during the beginning of the first semester should be more intense. Even though there is assigned a coordinator to each enrolment class, this seems to be insufficient. Some respondents write that they have a feeling of being misunderstood by “the university system” and that too little effort is put into knowing and understanding the basis that these students bring into the university. A few respondents describe situations among other students and teachers where they have felt condescending comments aimed at their workman background. This is inappropriate and unnecessary. A teacher stated that now after supervising more than 5 CST students during their final thesis he is convinced that these CST students is equal to traditional MSc engineering students, in terms of analytic and academic skills as well as in their ability to foresee new and improved construction management
solutions. In relation to the poor study environment the foundation for improving this lies in transition process.

Academic challenges in general are also commented upon, and a few general trends are observed. Teaching as well as project work is much more theoretical than the main part of the respondents is used to. Now students must know not only know how to do e.g. scheduling, but also why. This forces another challenges of homework. The workload is much higher than what they are used to. When textbook and sometimes classes is in English language some of these CST students find it very hard and time consuming.

Respondents were asked to point out what have been the most challenging in relation to their education. 36% pointed at the course in soil engineering on 1. semester. 20% thought the course in stressed concrete structures, also on 1. Semester, were the toughest. An obvious trend that the 1. Semester in general is the most challenging is evident. The remaining respondents pointed at a variety of courses, and only one respondent did not point out a course, but instead mentioned report writing as the most challenging of the program. As mentioned earlier, teachers have a perception that student entering through vocational training have more trouble with mathematics than their peers. Correlation between vocational training and pointing out mathematics as the most challenging is calculated with a chi-square test. The calculation of chi-square, $\chi^2$, is 8.66, which with a freedom of 1 give gives a probability, $p$, for correlation of 0.0035. This is significant.

Finally, the academic level was also assessed by the respondents. The assessment should cover all semesters and all courses. 22% answered low, 34% medium and 27% high, and finally 17% very high. This results in a slightly right skew normal distribution.

**FUTURE DEVELOPMENT**

Due to among others this research some changes has been implemented in the CST program. It is in general the 1. semester that have changed. The course in soil engineering has been eased and given a slightly different focus. Now this course is named Foundations and soil loads. The course in stressed concrete structures is deleted along with the brush up course in applied mathematics. Instead a new course in fundamental statistics and Problem-Based Learning is offered. In total this is lowering the request for mathematical skills and increases the focus on structural changes and conditions for now doing academic work at universities.

**CONCLUSION**

When concluding on the success of developing a master education that enables holders of apprenticeship certificate, two important elements surfaces. Firstly, only one third of enrolled students have in fact an apprenticeship certificate. Two third enters with an upper secondary education. Secondly, data analysis clearly show that the one third are slightly more satisfied with the education with an average score of 8,25 on a scale from 1 to 10 (best). The lowest score appointed is 7. The remaining two third has an average score of 7,3 ranging from 2 to 10. It is clear that some of these students are in fact disappointed with the education. Now to classes has entered the job market, and this in times where construction activity still is low. Nonetheless, 80% of the first class were in job after 6 months. This is a great success, but still a bit
below average seen over the last 10 years of MScs entering the job market. Hence, it seems that the construction industry not is ‘afraid’ of the new Cand.Scient.Techn. title.

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REFERENCES


