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CROSS-FERTILIZATION OF COURSES TO IMPROVE STUDENT LEARNING

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ABSTRACT
Teaching is an area that should be in a constant ongoing development or should at least be a process questioned and revised according to the fact that the society, the students and new knowledge about teaching methods are not static. Whether teaching needs to change in terms of how it can enhance student learning opportunities must always be subject to an ongoing process. This article describes this need and how changes are made to improve students learning in one of the courses in the Industrial Design engineering program. The set up in a program like this is a compromise between two different professions as in this case between mechanical engineers and industrial designers. This is a challenge that is tainted with some problems. One of these problems is to accommodate both professions in the same application. These compromises are never optimal solutions and this have the result that some subjects have to disappear or be minimized from each profession. Traditionally design training programs contains more of hands on education than machine engineering programs and students in industrial Design programs are also expected to have some basic knowledge already when applying when applying to their educational program. Some examples of hands on courses as Model making and sketching cannot be studied only as theory, skills in this case needs training and also time provided to allow the knowledge to mature. This article describes an attempt to improve this two profession trade-off and how to improve learning in both practical skills and theoretical skills by a new course design. The article also shows how this example could be of interest for other programs and other courses.

Keywords: Merging courses, theory-based courses, practice-based courses, teaching teams, Student learning, industrial design engineering.

1 INTRODUCTION

Education programs at universities can be of more or less theoretical and practical content. The vast majorities of programs are mainly theoretical and contains even no hands-on courses. When teaching at a program as Industrial Design Engineering and educating engineers, teachers have to deal with how to make theory and practice interact in the best way possible. This is one of the main challenges in these programs. It is not only a matter of two different program contents in one program, it is also two different kinds of teaching traditions and cultures. Both types of teachers, design teachers as well as engineering teachers have their background and tradition, and this must also be coordinated. Team-based work is widely used today, also within the teaching profession [1, 2, 3 and 4]. It brings many advantages but as Mohrman et al. [4] points out, there are difficulties to overcome. Often it means a new way of organizing your teaching and that might be uncomfortable and if the changes in teaching methods are proposed from management with little or no participation from the staff, it can meet rather heavy resistance. This implies that collaboration between participating staff throughout the implementation process of new teaching methods is very important. The student also experiences advantages and disadvantages with teaching teams. One advantage for the student can be an increased amount of feedback from instructors, but a disadvantage can be that the students experience different grading standards between the instructors/teachers [5]. Another benefit can be increased participation since the teachers may demonstrate different viewpoints amongst themselves and thereby encouraging expression of multiple perspectives on the subject [6]. Another aspect is that if several teachers from the education program are involved in a course, the constructive alignment in the program will benefit from this [7].

Interaction between theory and practice is not always as obvious to students as it should be. Programs are traditionally designed with separate courses for theory and practice. The idea behind this is that student's first study practice and then apply theory or use practice as a tool when studying theory. Because of this historical approach it might be difficult to make the connection between theoretical content and practical implications. This is also the case when educating industrial design engineers because the program is a mix of traditional industrial design and mechanical engineering. Mechanical engineering theory must be a part of the program as well as design theory. This is not a unique situation. Programs at universities not only as for example Luleå University of Technology (LTU), [8] but also at, Aalto University in Helsinki [9], Finland, and the D-School at Stanford University, USA [10], have courses mixing theory and practice as it lays in the nature of these programs.
CDIO is a worldwide initiative that started in 2001 and has as a vision to create an engineering education that stresses the fundamentals in the context of conceiving, designing, implementing, and operating systems and products. Their vision is, as stated on their website [11]:
"CDIO is based on a commonly shared premise that engineering graduates should be able to: Conceive – Design – Implement – Operate complex value-added engineering systems in a modern team-based engineering environment to create systems and products".
A central part is to create a curriculum with mutually supporting courses where the constructive alignment is clear [ibid.]. Other main objectives are to include many prototyping activities where the students can design, build and test their concepts as well as to train skills like communication and teamwork [ibid.]. The CDIO initiative addresses the issues stated above

2 CURRENT SITUATION

In the master program Industrial Design Engineering, (TD), at LTU, examples exist of this theory-practice course layout but have mainly been carried out in later parts of students programs and only on course level, not at program level as a whole. Today the course Sketching is a course containing basic level perspective drawing and design sketching. The main course objectives are to provide the students with a tool for visualization and communication during the product development process and to understand how this tool can and should be used. Assignments are designed only to fulfil the training in that specific subject. Therefore the application of these skills is not implicated in other courses until the course is finished and students examined. Students are supposed to understand that sketching is to be used in most of the following courses. The same applies to the course Model Making; the practical training is only applied to fictional assignments. The main course objectives are similar to the ones for Sketching 1 but applied to building physical models and prototypes to illustrate product concepts. The students will learn basic model making techniques and when to use them in the product development process. There is also a part dealing with presentation skills where the students use their models as visual aids when presenting a product concept orally. The courses Design Methods, Design Sketching, Design Theory and Model Making are like different islands in the program. Figure 1 shows the situation today of these four courses. If a more distinct link between the course contents could be created the connection between theory and practice would become clearer to the students.

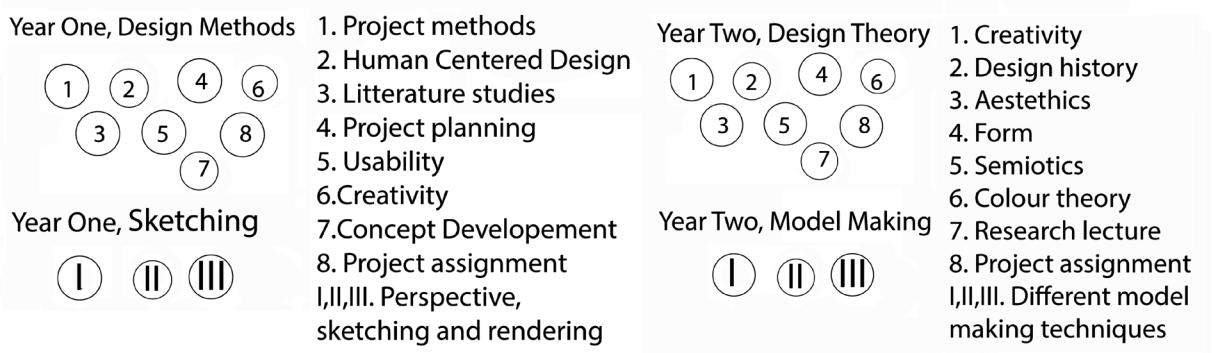

Figure 1. Current course disposition, 1-8 theoretical content and I, II, III practical content

3 FUTURE SITUATION

To improve learning and secure professional skills, the program TD will be redesigned according to the CDIO initiative [11, 12]. One of the actions is to integrate hands-on courses with theory courses. Practicing hands on skills to understand theory is a better way to understand theory and practice rather than studying this separate as it is done today [13, 14]. Program courses will be reviewed so that the input and output of the courses have a better progression throughout the program. This is to create a better constructive alignment throughout the program. With the new course design the learning-by-doing approach will be well implemented. Students will better understand how they are expected to use their knowledge and skill after graduation. These two new courses are more extensive and contain more subjects. A natural consequence is that more teachers will be involved. Teachers have to organize teaching in working teams. In the program there is a positive experience from working in teaching teams which means that extending this to more courses is the right way to go.

Hands-on skills like sketching and model making will be practiced as a method to understand theory and also to show why practical skills are necessary to know in a context and not as separate skills. To start with, four separate courses will turn into two. The new course design will create a more holistic view on courses. The course Design Methods will be integrated with the sketching course and the course Design Theory with the model making course. Design Methods is a basic course about design methods and development processes. The course Design Theory is a continuation of the course Design Methods where theory content is studied and analyzed. The new course design will be handled mainly as integration but also as separate parts in the course layout. This is because freshmen are not always prepared to start both practicing and study theory at the same time. There is a wide range of prerequisite talent levels when starting hands on courses. This requires a need for more intense practical training. Therefore, the two new courses, Design; Process and Method, and Design; Theory and Practice will start with boot camps to make sure that a basic level of skills in sketching and model making is reached to make it possible to implement it in the oncoming course content. Assignments in the new courses must be adapted to fit both the purpose to learn how to do things by hand and to use this to understand the theory. Teachers from more disciplines than in the earlier course layout have to cooperate according to the course content. This will secure the course objectives, the learning objectives and how this cooperates in the program as a whole. The main course objectives are to provide the students with an understanding of the field of industrial design engineering and the ability to use basic design methods and design techniques and also how these areas are connected. The course will give the students necessary knowledge and skills that are required in coming courses. The constructive alignment will be strengthened and progression improved when a wider range of teacher skills are implemented. The course year two is a continuation of the course year one and the first course, Design: process and method, will be planned to secure the input and progression for the course of year two, which in turn will be planned to necessary input to upcoming courses in the program. The course content is better connected and a more holistic approach is established where the practical content connects the theoretical content (See Figure 2).

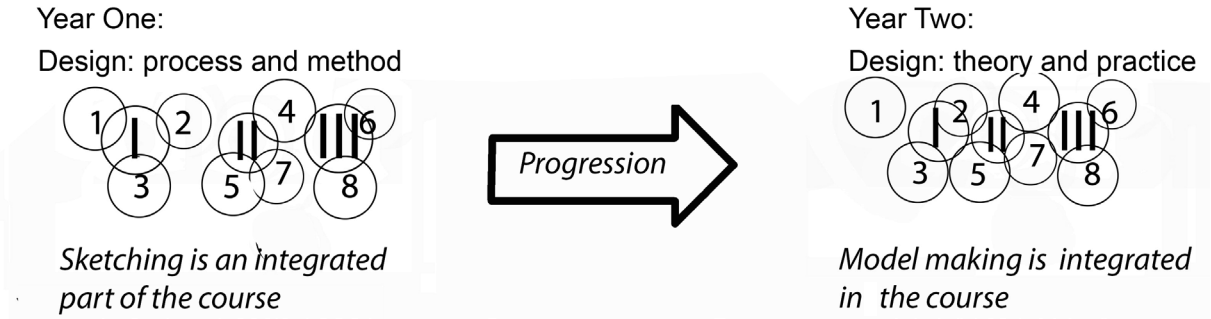

Figure 2. Practical content, I, II, and III, connects the theoretical content, 1-8

4 EXPECTED OUTCOMES

The re-designing of the program and the courses will create a more holistic approach. The student understanding for how different knowledge, both in hands-on and theoretical knowledge, sticks together will be improved. Design is thought to be a holistic way of thinking and this new layout will correspond better to that than the earlier course designs. Another outcome is that freshmen can have a wider range of knowledge from start in the program. Courses running in a longer period of time, as in this new course design, improve flexibility. When the course runs over a period twice as long compared with previous courses, opportunities increases to make a good schedule for both teachers and students. The access to facilities and equipment increases and the potential to change the planning is promoted. Smaller portions of knowledge can be presented early in the courses as illustrated in Figure 2. Adding smaller portions of knowledge in practical skills during a longer period of time and as progressive development in the course this will improve keeping up focus and interest. This will improve learning and encourage students to perform better. In a longer perspective all courses and the whole program will be redesigned in this way and the outcome of this will be the establishing of a natural path through the program from year one to graduation. By improving the program's courses so these courses better deal with how theory and practice are interconnected and integrated this becomes a way of improving the whole program [11, 12].

From a teacher perspective an important outcome is the need to involve more teachers in the courses because of the wider content. Establishing teaching teams will become a natural way of arranging teaching. Working in teaching teams has many good effects [7]. Team building will strengthen faculty members in their teaching mission. Different specialties from the teachers will improve the transfer of knowledge between the teachers. In this way teaching teams will improve skills as a whole and by time the improvement of knowledge grow. From student perspective teachers will be more available and feedback easier to get. Teaching teams are less vulnerable than single person teaching according to teachers being suddenly indisposed. The new course design will improve students learning and make teaching less lonely because teaching teams improves cooperation. In a program many teachers want their courses to be presented as early as possible. It is not possible to have everything in the first year but starting with this course design where more teachers than earlier are involved this will be improved. From a student perspective this also means that freshmen meet more of the teachers in the program early. This will found and establish a better sense of community between students and teachers.

5 DISCUSSION

This paper describes the process for developing a new integrated course and an obvious limitation is that the course is not yet in operation. The expected outcomes are what the course designers aim to achieve but there are no results to back them up yet. The course will be held for the first time in fall of 2016 and the course and outcomes will be analyzed and compared to the expected outcomes to ensure that the course meets program and course objectives. Any issues identified will be dealt with and necessary changes to the course design will be made to meet the objectives.

An optimal course design would be that students learn to use both sketching skills and model making skills in their first course to use them as a tool in their first and later design assignments. This could be done by turning this into just one course. That would be the best solution but is not technically possible in our context. This paper describes the merging of four courses into two. Theoretically it could be possible to merge the whole program to one giant course. There is probably a breaking point where a course becomes too large to handle and creates more problems than a smaller course. Teaching teams are not guaranteed to be problem free. Teams must be formed with teachers that can and will cooperate, otherwise teams could be dysfunctional. Much effort will be put into aligning the teachers' view of the course aims and how work will be divided and carried out to ensure the benefit from the merger between the courses. Also, it must be assured that the course objectives from the two underlying courses appear in the new course. When comparing the earlier course design with the new one, there are more good outcomes from the new course design than from the earlier one. The new design is more holistic and should therefore improve students learning. Courses are linked together to establish connections between course content, create progression and to achieve a better holistic course design, (see Figure 3). By illustrating theories with practical assignments, and vice versa, the understanding of how it all is connected will be made clearer to the students.

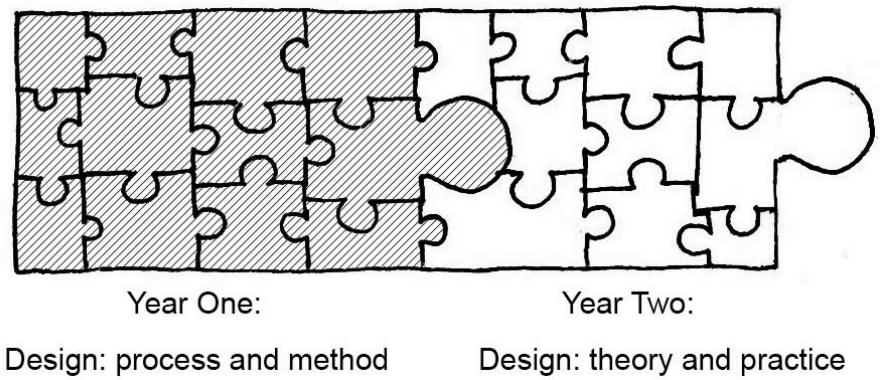

Figure 3. Linked courses

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