# JOINT CONTEXT-SHARING INTRODUCTORY COURSE FOR FOUR DIFFERENT MASTER PROGRAMS

**Johan Karltun, Chris McIlroy, Lars Eriksson**

School of Engineering, Jönköping University, P.O. Box 1026, SE 551 11 Jönköping, Sweden

## ABSTRACT

The School of Engineering in Jönköping has made a thorough revision of all its programs, largely to improve the influence by the principles of CDIO. For the four master programs with about 100 students this meant that a new joint context-sharing introductory course for all master students should be set in operation. The aim with this paper is to present the basic rationale behind the course, how it was set in operation and the students' and teachers' experiences of the first trial as well as planned modifications for next year's course. The course should be appropriate as an introduction course for the four master programs, specializing in industrial design, product development, information engineering or production systems. The course should thus provide contextual understanding also for other stages in the product realization process that are related to but not included in the own education, both regarding the process, the leadership and the research methods used. Moreover, the course should support the development of a networking community of master students regardless of the master program they were following. The design of the course involved five teachers and the course was structured and taught by lectures, exercises, seminars and project work. Cross-functional projects groups were formed including at least one student from each program. The examinations were done by a poster and model exhibition regarding the content of the product realization process, an individual reflective assignment regarding the leadership and group development process during the project and an individual written exam regarding the research and inquiry methodology part. A plenary oral evaluation as well as a written questionnaire has been held where the students confirmed that some goals were reached and some were not. The experiences among the teacher group are multifaceted but largely positive and next year's course is looked forward to.

## KEYWORDS

Product realization process, student community, industrial design, product development, information engineering, production systems, standards: 1, 2, 3, 4, 5, 7, 8

## INTRODUCTION

The School of Engineering in Jönköping offered four master programs with in total about 100 students, relatively evenly distributed among the four programs 2013. The master programs were open for all Swedish as well as international students fulfilling the formal prerequisites and they were taught in English. The prerequisites however did not include such skills as group work or leadership courses taken but a bachelor degree in engineering in an appropriate field.

The school carried out extensive revisions of all of its programs during 2012/2013. One of the main reasons for the revisions was to improve and strengthen CDIO principles throughout all programs beginning at the start of the new curricula, fall semester 2013. For the master

programs this meant that a new joint introductory course for all master students was launched in concordance with the aim in CDIO to provide an introductory course (Malmqvist, Edstrom, Gunnarsson, & Ostlund, 2006). What distinguished the course under review here from previous courses was the focus on providing a contextual frame for each of the four participating programs. Most other introductory courses have been directed towards the specific area of the single program (Georgsson & Pettersson, 2011; Gustafsson, Newman, Stafström, & Wallin, 2002). There are, however, examples of courses trying to combine content from two different areas into a synthesizing course (Thomson, 2010) or programs developed to combine the strengths of different areas (de Vere, Melles, & Kapoor, 2009). Moreover, examples of introductory courses at master level are rare or lacking, usually introductory courses are provided for undergraduate students when they start their engineering education. In this case the introductory course should instead serve as a bridge between studies at undergraduate and graduate level.

The different realities of how highly successful companies actually work compared to the realities of how Universities train and teach students is usually left to the individual students to integrate themselves when they actually try and practice theory at work. The Universities' organization does not therefore mirror reality, furthermore it could be argued that we "train" students to focus only on their own specific area of expertise and to disregard other parts that are outside their own immediate knowledge domain. This in turn may lead to what could be called "silo – thinking", where different knowledge domains are kept separate rather than working from the premise that the constituent parts are interdependent upon each other and where changes made to one part influences the whole. One highly successful company, IDEO, works with projects involving different knowledge areas and has realized that the "normal" mix of professionals - engineers and designers – leads to silo thinking and the different professions become involved in competition concerning each other's differing perspectives and priorities. "Should it be form or function that is most important?" IDEO is a team orientated company with a mix of different professionals from different knowledge areas who work together. The mix of professionals always contains designers, engineers and also "human factors" specialists. These "human factors" specialists bring into focus customer problems and the team is focused on solving these problems by integrating the teams' knowledge and competence. The whole solution becomes much more than the separate parts from the different areas of expertise. Other highly successful companies work in much the same way and have, it could be argued, a systems perspective on ways of working and ways of thinking. For example IKEA uses knowledge about "Life at Home" as the starting point for each project where a product should solve an identified customer problem. The product has to be both functional and beautiful, the materials have to be environmentally friendly, and the production and distribution has to be as efficient as possible. For this whole process to work as efficiently as possible different professionals have to work from a systems perspective where there is a realization that one part influences the whole solution, not only from the specific perspective of one area of expertise. The decision to produce a joint introductory course was inspired by the examples illustrated above and based on the knowledge that in a professional working context different professions need to cooperate and interact by integrating and utilizing the different areas of expertise.

The aim with this paper is to present the basic rationale behind the joint introductory course, how it was set in operation and the students' and teachers' experiences of the first trial as well as planned modifications for next year's course.

**COURSE DESIGN**

The profile of research at the School of Engineering, Jönköping University is to advance knowledge concerning the product realization process in small- and medium sized manufacturing companies. The different master programs support this profile. There were two master programs within the department of mechanical engineering, industrial design and the program product development and materials engineering. Another master program was information engineering and management from the computer science department and the fourth master program was production development and management from the department of industrial engineering and management. The demands on the introductory course were that it should be included in each of these quite different programs and provide a significant contribution to each curricula. One of these main contributions was considered to be contextual understanding, by introducing the other fields of knowledge in the product realization process and the demands, limitations and difficulties involved in the processes in the respective field. The idea was that this knowledge should make the students more aware of and skilled in taking into consideration demands related to the other fields. Moreover, the course should support the development of a community of master students that knew each other regardless of the master program they were following in order to enlarge the opportunities for networking and bringing different experiences together. Two more demands were related to the introduction of the new education concept (Karltun, 2013) the school had introduced. One of these demand was to provide an introduction to research methodology other than mathematics used in engineering contexts and the last one was to provide leadership and group dynamic skills considered to be important for working with technical development and management. This can be summarized as contextualizing the Master programs in relation to each other regarding the process of product realization, leadership and the research methods used.

It was recognized that since this is an introductory course, basically no students could be expected to know their field of specialization but on the other hand, each student had a Bachelor's degree in engineering suitable for entering their Master's program. The course was designed by the four program managers together with a psychologist/lecturer from the field of leadership and group dynamics. The course was thus led and taught by a team of five teachers. To meet the expectations the basic design of the 9 credits course (out of 120 for a whole master program, corresponding to a total of 240 hours of student work, formal and informal activities included) was divided into three related but separate and parallel strands: The first strand consisting of a CDIO project involving the entire product realization process from idea generation to describing the operative demands regarding the production of the developed idea. The second strand included an introduction to research and inquiry methodology where the methods taught were related to the process in the project and needed as a compliment to mathematically based methods. The third strand included leadership and group development also related to the project and the group development process included in the work.

The project part of the course was designed as a CDIO project and the task given was to design a coffee machine for professional use. The project groups were formed cross-functionally with at least one student from each master program so that each program should be represented in each group. Moreover, the design of the coffee machine should include basic considerations that had to be made regarding the core content of each program. The result should thus include industrial design features like expression, form and function, product development issues like structural design and material used for main components, information engineering designs like basic functions and structure of control system and

customer interface as well as production issues like manufacturing strategies and configuration of the assembly system. The projects were examined in an exhibition where all the groups presented their solutions in terms of a simple white cardboard model and a poster describing the main elements regarding each topic. The teaching ran parallel to, and in the same order as the project proceeded, starting from industrial design and ending with production systems issues. To support the project, one lecture (2 h) and two seminars (2 x 2 h) regarding each topic was held, the seminars supported but highly dependent on students' own activities. In total 4 lectures and 8 seminars considered the project. The responsibility for these lectures and seminars laid on the teachers from each program responsible for the specific part of the design process.

In parallel to the project work teaching in research and inquiry methodology was carried out. It followed a similar pattern including the same amount of lectures and seminars but related to the research methodologies typically used in the different parts of the product realization process. In this part of the course a textbook was used as well as a written individual examination.

The third part of the course, leadership and group development, utilized students' own experiences as a member of a working group during their work on the project. Relevant theory was not only taught but used as a frame of reference that the individual student and groups of students could use in their reflections during the process of developing the group work abilities and their leadership skills. These reflections were also part of the examination.

The learning objectives for the course were divided into three categories according to the standard of the school and formulated as that after completing the course, students should be able to:
Knowledge and understanding
-	Demonstrate an understanding of the content, working methods and the context of different parts of the product realization process
-	Demonstrate knowledge of different fields of scientific theory
-	Demonstrate an understanding of research methods used in the product realization process and how these are linked
-	Demonstrate knowledge of key theories in the field of leadership.
-	Have knowledge of how leadership and membership can contribute to the development of a team and a business.
-	Demonstrate knowledge how to analyze the strengths and weaknesses of different forms of leadership - their own and others'.
-	Demonstrate knowledge how to identify and analyze leadership roles in relation to their study orientation and different contexts.
Skills and abilities
-	Demonstrate the ability to explain different methods of data collection and analysis, and its impact on the result
-	Demonstrate the ability to find published scientific works through appropriate search strategies, and to critically examine and evaluate the works
Judgment and approach
-	Demonstrate an insight in how different skills in the product realization process contributes to the entire process
-	Demonstrate an insight in how differences contribute to the outcome of development work

**EXPERIENCES**

The teachers involved in the course had, in general, largely positive experiences of the course and it was felt that many of the objectives with the course were reached to a large extent. There were however also experiences that need to be dealt with for next year's course in order to improve it. The description of the experiences are divided into two parts, process experiences from course development and giving the course and students' opinions.

*Process experiences*

The development of the course took place before it started as well as during the course. The main structure, the objectives and a thorough discussion of the content was done in advance as well as decisions on work packages for each professor. Five professors from different departments, each involved in different courses, research and other activities were however not easy to coordinate and it cannot be emphasized enough that such a course requires a lot of planning and information sharing to be viable. The main author of this paper was main responsible for the course and did quite an extensive job to make the course work in practice compared to what is needed for a course provided by the same department and involving only one or two teachers.

The control of what had been said and spoken about on the different lectures could be improved. None of the teachers had cooperated with each other in teaching and there was no practical possibility to listen to each other's lectures. We thus had to rely on the basic plan for the course and expect everybody to follow that plan more or less in detail.

The detailed development of the latter parts of the course had to be done during the course since the content of the previous parts were not known in detail in beforehand due to the need for a continual adaptation to the progress of the students. This affected the project work and the parts to be included in the tasks related to it. What had been accomplished by the project groups had to be considered before designing the details and demands related to latter parts of the project. This also led to a slight domination of the initial tasks in the project related to the design of the product.

The general ability of the students to attend, lead and perform in seminars was less than expected and have to be trained in order to reach the effects wanted of the seminars. Although these seminars were scheduled, announced as being compulsory and students were provided detailed information about them, a large portion of the students did not participate as anticipated.

19 project groups were formed with five or six students from the different programs in each group. Three or four project groups formed a seminar group, in all five seminar groups. The ability and motivation to perform in the project groups differed very much, some students seemed to totally lack experience and knowledge about working in groups, whilst other students had a good deal of working experience. To overcome this expected difficulty, several seminars were devoted to form the groups, discuss the demands on group members and making agreements on group norms and work discipline. Information was repeated several times that if any student in any group did not believe the group was functioning as expected, it was recommended to get in contact with course teachers and the group would be consulted in order to solve conflicts or problems. Two groups did that, one because of missing members (students who discontinued their studies) and one because of a lack of discipline among group members. All groups, however, did succeed in producing the expected results in terms of a model and a poster. In spite of this, the need for a more formal written contract between group members was obvious. Students coming late to the startup of

the semester also created problems for group work since the groups were already formed and had started working when new students had to be added.

Another difficulty observed was the complex character of the course. Although extensive information with detailed instructions and written schedules was provided as well as digital information on the web many students did find it difficult to understand the different parts of the course.

The examination of the project with an exhibition was a success and created large engagement among the students. The cardboard models together with the posters made the suggestions look professional and the students were obviously proud and satisfied with their achievements, see figure 1 and 2.



Figure 1.    Students visiting the exhibition and presenting their project results.

### Students' opinions

Two different evaluations were made. One being an open discussion including all students present during the last lecture. About 70 students participated. The comments from this assessment was sorted into different categories. A general comment was that the socializing between programs did take part and the students were pleased with this. The other dominating opinion was that the course required too much regarding industrial design tasks and too little from the other programs' topics. The structure was thought to be difficult but could be improved with better scheduling. The disciplinary content was not enough and analysis part should be improved. The research methodology part should be better integrated in the other parts of the course. The leadership part was considered good. The seminars need to always be teacher led, preferably with larger groups if resources are scarce.

In the written course assessment, being computerized and voluntary, only 18 % participated. The overall comments actually reflected these issues quite well. No further main issue of interest did come up. The opinions differ very much from students who do not like the course at all and suggest to devote the time to specialize even more in their own topic to students who really appreciated the high content of interaction between students from different disciplines and the context-shaping character of the course.



Figure 2.    Example of poster produced with the different processes illustrated


**PLANNED MODIFICATIONS**

Having both assessments available, the course teacher team had a development meeting in January. The results from this meeting were that the information to the students regarding the demands of the course and the expectations on the students could be even clearer. Moreover, the students should be trained in how to lead and actively participate in seminars. Another opportunity that was discussed was whether some type of assessment should be made regarding the introductory information to secure that all students had understood the requirements. Late coming students were to be avoided as much as possible and be put in separate groups not to disturb already formed groups and commenced development. The teaching should start with an introduction to the research method part, continue with the leadership and group development part and as a last step the project should be introduced so that all strands of the rest of the course are done in parallel. This start-up period can possibly be made during two weeks of the nine for the course as a whole. There is also a need to continuously improve the integration of the strands.

To summarize the decisions for modification for next year's course they are:
- The coordination of the course in terms of subjects taught can be improved and the teachers involved can improve their understanding and mutual consideration of each other's content.
- The research and inquiry methodology part needs to be better integrated into the different stages of the course and should also be introduced more properly in the startup.
- A more elaborated introduction into working in groups is needed, the ability regarding this aspect differed too much among the students.
- Training in seminar techniques is required, the seminars did not work as expected.
- Written contracts should be introduced in order to make all group members aware of what is expected in a project performed by a group.
- The content of the project work should be more balanced and the difficulties regarding the content can be increased except for industrial design parts.

## CONCLUSIONS

The joint context-sharing introductory course for four different master programs that this paper presents was in general considered to be a viable idea. A large portion of the program objectives with the course and the learning outcomes were found to be reached. The general structure of the course in three strands, covering the process, leadership and methods respectively can be viewed as a sustainable base. However, the course as such provided large challenges regarding organizing and coordinating both students and teachers.

It is believed that the shortcomings of the first year can be overcome and that the course next year will bring more of the benefits expected and that significant improvements are possible within the resources provided. Moreover, the experience of the teachers regarding how to cooperate in the course will make it easier next year. In general the involved teachers and program heads did view the course as a beneficial start for the master programs concerned.

## REFERENCES

de Vere, I., Melles, G., & Kapoor, A. (2009). Product design engineering – a global education trend in multidisciplinary training for creative product design. *European Journal of Engineering Education, 35*(1), 33-43. doi: 10.1080/03043790903312154

Georgsson, F., & Pettersson, J. (2011). *An introductory course for software engineers.* Paper presented at the 7th International CDIO Conference.

Gustafsson, G., Newman, D. J., Stafström, S., & Wallin, H. P. (2002). *First-year introductory courses as a means to develop conceive–design–implement–operate skills in engineering education programmes.*

Karltun, J. (2013). *Renewal of a local concept for engineering education including CDIO.* Paper presented at the 9th International CDIO Conference, Cambridge, Ma.

Malmqvist, J., Edstrom, K., Gunnarsson, S., & Ostlund, S. (2006). The application of CDIO Standards in the evaluation of Swedish engineering degree programmes. *World Transactions on Engineering and Technology Education, 5*(2), 361.

Thomson, G. (2010, June 15-18). *Engagement and learning in microcontroller systems projects among mixed engineering and product design cohorts.* Paper presented at the 6th International CDIO Conference, École Polytechnique, Montréal.

## BIOGRAPHICAL INFORMATION

***Johan Karltun*** is an assistant professor in Work Organization in the Department of Industrial Engineering and Management at School of Engineering, Jönköping University. He teaches production management and human factors engineering. His current research focuses on production activities and the interaction between humans, technology and organization at work and its consequences for productivity and health. He is also heading a master program in Production Development and Management.

***Chris McIlroy*** is a work psychologist and senior lecturer in leadership and group development in the Department of Industrial Engineering and Management at School of Engineering, Jönköping University. He has more than 25 years of qualified experience from working as a leadership consultant and process developer with many of the most prominent large Swedish companies.

***Lars Eriksson*** is professor in Industrial Design in the Department for Mechanical Engineering at School of Engineering, Jönköping University. He is heading the master program in Industrial Design and his current research focuses on functions of surfaces like appearance and impression.

### *Corresponding author*

Dr. Johan Karltun
School of Engineering, Jönköping University
P.O. Box 1026
SE-551 11 Jönköping, Sweden
+46 70 669 51 41
johan.karltun@jth.hj.se