

# WORKSHOP AT A COMPANY WITH STUDENTS FROM TWO DIFFERENT DISCIPLINES

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## ABSTRACT

Teachers from two different disciplines, Materials and manufacturing and Industrial design, are brought together to give a course on masters level. Also the students come from different disciplines. They study two different master programs in Product development, Product development and materials engineering and Industrial design. The course is called Materials and design, and it covers both disciplines. Apart from lectures, computer labs and home assignments, a workshop was arranged where the students during one day solved a task related to product development. The students were divided into groups in such a way that a mixture of students from the two programs was obtained. The workshop was held at a company in order to make the work more realistic. Before they started to solve the task, they were given an introduction to the products made by the company and their applications. The main task was then to investigate the products and come up with ideas about what applications there might be in the future. The result was at the end of the day presented to the company. In this paper, the workshop is described, and comments and reflections from the students and the company are summarized. Finally the teachers involved give their opinion about the result and the pedagogic benefits from such a workshop, and also what to think about for the next time. It appeared that the workshop was an eye-opener to the company at the same time as the students had a fair chance to work in a realistic situation and practice how to use their knowledge. Also for the teachers it was a good experience, not only from a pedagogic viewpoint but also on how to arrange this kind of workshops in the future.

## KEYWORDS

Problem-based learning, reflective learning, industrial relevance, T-shaped engineering, CDIO Standards: 7, 8.

## INTRODUCTION

The background to the workshop described in this paper is that the School of Engineering at Jönköping University in their new concept for engineering education, see Karlton (2013), focus on the collaboration between faculty and industry. Among the different activities is e.g. a new course, "*Off campus integrating theory and practice with progression*" (Eckert et al.,

2013). In that course the students spend the major part of the time at a company. However, this is only one part of the increased involvement of the industry in the teaching. Other activities that will increase are e.g. company visits and personnel coming from the industry giving guest lectures. Also different kinds of projects with the industry will increase in the courses. The workshop described in this paper is another example of this increased collaboration, and is the result of discussions between two teachers from the university and a group manager from a company. Both teachers and company involved have long experience from working with collaboration between academy and industry. In this case, it took approximately one year from the first discussions until the workshop was performed.

The teachers, who are from two different disciplines, Materials and manufacturing and Industrial design, are brought together to give a course on masters level. This is itself quite unique, as it bridges the gap normally existing between engineers and industrial designers. It is not only the teachers that come from different disciplines but also the students, who come from two different master programs in Product development, specializations Product development and materials engineering and Industrial design. The course described here is called Materials and design, and is about material selection and how to optimize this selection from the two perspectives, materials engineering and industrial design. This course is not new, but it has never before been given by these two teachers together. However, it is not the first course given jointly by these teachers. The last three years they have been teaching together in another course, on bachelor level. Also that course is about product development from the two perspectives, materials engineering and industrial design. The reason behind this mixture of disciplines is to increase communication and interdisciplinary understanding between different student groups and increase their ability to collaborate in their future profession. Earlier, it has been discussed that there is a need for more T-shaped engineers capable of communicating across disciplines improving the product development process, see e.g. Heinemann (2009) and Elmquist et al (2011). With an increased understanding between these roles in the product development process, better results are obtained faster, leading to a more competitive situation for the company. One can say that the course Materials and design aims to foster a more T-shaped thinking in the product development process. The course content is described in the following way in the course syllabus:

*“An important part of the product development process is about selecting a suitable material. A large part of the course is therefore intended to give deeper skills in materials selection and knowledge about the methods needed to choose the most optimal material for a specific product or component. To do this, a thorough understanding about the demands a product and its application is imposing on the materials properties is needed. In the course, not only mechanical and physical material properties are treated but also tactile and visual properties. Product design and how the product will be manufactured also influence the materials selection, and therefore design tools are introduced. The course also includes discussions on how the choice of materials affect the environment from a sustainability perspective.”*

The course is based on lectures covering topics related to both disciplines. Apart from the lectures, the course also includes computer labs and home assignments. The computer labs are about material selection and how this selection can be optimized using software. The home assignments are related to methodologies used to select a material for a certain application. The students from the master programs have already had a common introductory course about product realization where tools and methods used in industrial design were introduced. As the course Materials and design is given in English, also exchange students can join it. So, actually there three different groups following the course,

with students coming from thirteen different countries. Besides, they are not only coming from different cultures, they also have different backgrounds and experiences.

In addition to the course activities described above, a workshop was arranged where the students during one day solved a task related to product development. The students were divided into groups based on their background in such a way that a mixture was created with students from the two master programs and exchange students. The students were “locked” into a room for the whole workshop and solved the task using methodologies taught in the course. The workshop was held at a company in order to make the work more reality-based. Before they started their work, the students were given an introduction to the products and their present applications. The main task was then to investigate the products made by the company and come up with ideas about what applications there might be in the future. The result was presented at the end of the day to the company management.

The company develop, manufacture and market KALLER gas springs and hydraulic systems for stamping dies, and KALLER hydro pneumatic suspension systems for heavy ATVs. The gas spring technology has been developed and refined since 1983, but the company has been around since 1876. For years, the company have led the world market with 95 % export (customers seen below). Today KALLER have nine companies worldwide and is an independent part of Barnes Group, located in the U.S. Today we have "in-house" - manufacture and assembly in both Sweden (10,000 m<sup>2</sup>) and North America (3500 m<sup>2</sup>). In 136 years, we have kept to the small town of Tranås, Sweden. The premises in Tranås, we have state of the art CNC technology, high automation. In addition, we also build a test track for our Hydropserie (hydropneumatic suspension systems for heavy off-highway vehicle). Currently we have approximately 380 employees with an annual turnover of 1000 million and a strong profit. New acquisition, new technology, exciting projects and very good and exciting new clients, we are now looking for new creative staff. The company is located approximately one hour by car from the university.

In this paper the workshop is described as well as the comments and reflections from both the students and company. Finally the teachers involved give their opinion about the result and the pedagogic benefits from such a workshop, and also what to think about for the next time. As the workshop is a new method of teaching and learning, it was developed with CDIO Standards 7 and 8 in mind. Involvement of industrial partners in the design of learning experience, as well as problem solving activities and evaluation of ideas are some examples.

## **THE WORKSHOP/IMPLEMENTATION**

The workshop was a one-day activity, and the program was divided in two parts, separated by the lunch. The first part started by welcoming all participants followed by an introduction to the background and purpose with the workshop. This also included the agenda for the whole workshop. There are many reasons to arrange a workshop like this, see e.g. Dunn and Rawlins (2010). From the pedagogic viewpoint the teachers had the following purposes:

- Practice your knowledge on real questions
- Learn and reflect about methods
- How to work in project teams

In the product design process it is important to learn about methods and methodologies, and also reflect on how they influence on the outcome. Working with a real case is a good

opportunity to practice these skills. For the company the workshop is an opportunity to show what they are doing and also to show that there are international and successful industries also located on the countryside. In other words, an opportunity to attract skilled students, normally difficult to reach. It is also an opportunity to be involved in and contribute to the engineering education. After this introduction some “ice breaking” activities were carried out, and for example, when the participants shortly introduced themselves they were also asked to describe their best Christmas gift ever (the workshop took place just before Christmas). Some general rules for the workshop were then introduced, see Figure 1. The purpose with these rules was to enhance the creativity and improve the outcome.



Figure 1. Workshop rules

The next step was to identify and define the main task for the day. This included a discussion about the meaning of the different words. As the workshop was in English and most of the students have English as second language, this part is important for the rest of the day. The task they had to work with was:

*“What other products/services can be developed from KALLER’s standard range”*

After a short break, a suggested methodology was presented to give the students a common starting point. As they did not get much time to solve the problem this part was very important. Without it they might lose time from the task itself. The methodology presented is called Design Doing, and is strongly connected to Design Thinking. Most people associate design with the physical attributes of a product that makes it more attractive and salable at a market. But design is also an activity that is associated with action research. The purpose of the activity is to develop solutions to problems and create things that are not there yet. Creativity is an ability to create something new. Therefore, design is rather an action than as an attribute and is aligned with innovation. Design Doing is about a reframing of the collective mindset. Design thinking contains valuable methods too quickly and innovative produce many different solutions to a problem. The method is described in the process image shown in Figure 2. In the first step, it is about understanding the problem and application. Then all of the six open questions are to be brought up. In step 2, it is about defining the problem without coming up with concrete proposals for solutions. These 2 steps were conducted in the start up session described above. In step 3, the work is exploratory with many different proposed solutions without criticizing and evaluate the ideas. This is to keep a flow of ideas and open up for a creative transcendentally synergy where each new idea leads to several new ideas. The method used is brainstorming with some supplemental activities in order to break up and give renewed energy. Simple explanatory sketches helps up to describe ideas, facilitates communication and enhances the synergy effect. In step 4, it

is about developing and testing some of the ideas on a deeper and more detailed level. In step 5, it is about communicate what jointly been concluded. The methodology is generally used for longer design projects but is also applicable in the form of short workshops like this. The open questions enables the use of different methods to generate answers in a creative way, depending on issue and application (Brown, 2009).

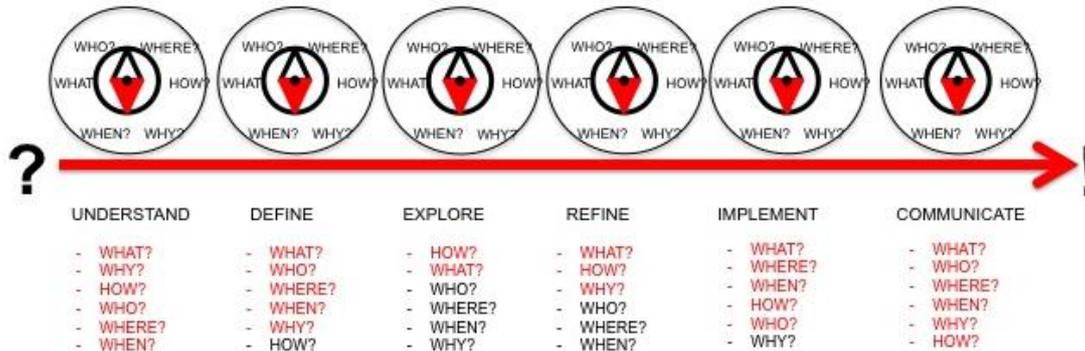


Figure 2. Describing the words associated with the methodology.

The last part before lunch was a presentation about the company, their products, and the end-users. This presentation also covered their main focus and business areas, and also possible markets in the future. Finally, a presentation was given about gas springs and how they works. During the day the students also visited the factory to see the production, and also the test track was visited.

After lunch, the second part of the workshop started, and the students were divided into seven groups. These groups were selected by the teachers to get a mixture of students coming from different backgrounds, and also with the intention of forcing people not knowing each other to work together. In total thirty-five students participated in the workshop and in five of the groups there were five students. However, in the other two groups, one was chosen to have six students and the other one only four students. The groups were located in three different rooms equipped with necessary material for the brainstorming. The teachers and also the supervisors from the company were walking around to assist and answer questions, and also listen to the group discussions. This was done without interfering too much in their work. During the workshop, the conditions were intentionally changed, the more important ones are summarized as:

- Group members were removed from a project and replaced
- Instructions were changed during the workshop
- Final deadline for presentation was postponed in last minute

From the beginning they got two hours to solve the task and after that be prepared to present two or three solutions. The students started to work and after one hour some of the students were exchanged. Group members selected by the teachers was told that they had been fired and had to leave the group immediately. A “fired” student was then introduced into another group with the instruction to criticize what the new group had done so far. In other words, come into the group with new eyes. This was done after one hour when the group members had become comfortable with each other and they all agreed upon the ideas they were working with. This was also done in order to create a real situation, where people for different

reasons are leaving or entering project groups. From the beginning they were told to come up with two or three ideas. With only 30 minutes left they were told that due to economic reasons they could only present one solution, which means that they had to select one of their ideas. Fifteen minutes before the deadline they were given information about the presentation, how it should be done and also that the Managing Director and the Sales & Marketing Director from the company was going to join the presentation. Five minutes before the deadline, they were told that the deadline was postponed and that they got thirty minutes more. All these things were done in order to force them to think in new ways, and hopefully by doing that, increase their creativity and generate even better outcome.

The result from their brainstorming was summarized in three different parts:

- Short presentation at the end of the workshop
- Seminar five days later at the university
- A short report with deadline two weeks later

During the workshop presentation, it was only their first prototype that was presented, and they only had five minutes to convince the decision-makers. They had to focus on what they had achieved and present the idea they had selected and the message they wanted to forward to the company management.

At the seminar at the university, they were supposed to give a more well-organized and professional presentation with better illustrations. For the seminar the following instruction was given:

- Maximum 10 minutes per group
- Maximum 5 PowerPoint slides
- Describe what you have done and how the result was obtained
- Focus on the process and not on the result

This presentation was more focused on the process, how they solved the problem, how the group was working together, what happened during the work, etc. As the seminar was a couple of days later, there had been time for reflection and possibilities to look back on the workshop from another perspective (Brockbank et al, 2002).

The workshop was also summarized in a short report. In this report the students were requested to discuss:

- The method they used
- How they solved the problem
- Alternative methods
- Result – good or bad solution
- What could have been done better
- Describe the process
- How did the group work

During the workshop they had different tools and materials available. Different kinds of notepads and post-it notes as well as large sheets of papers to put on the wall. Pens of different kinds and colors were also available, as well as parts from gas springs, as study objects. Based on the presentations and the report the workshop was graded as Passed or Failed. The whole course is graded based on the result on the final exam.

## RESULTS AND DISCUSSION

The results from the workshop are summarized in three different categories, Student Perspective, Company Perspective, and Teacher Perspective. First of all, everyone seems to agree upon the importance of a workshop like this. However, from all parts it is also agreed upon the need for improvements. Another more general conclusion is that the part in the introduction when the task was broken down into words which were discussed appeared to be very important. This is mainly because the students come from many different countries and for almost all of them English is second language. In the beginning, some of the students found this exercise irrelevant and unnecessary. However, after a short discussion they realized that the same word can have a very different meaning. Another more general comment is related to the presentations. At the workshop presentation there was not much time for discussions, only a few questions per group. However, at the seminar at the university there were much more discussions. This is mainly due to more time available, and show the need for this seminar.

### ***Student Perspective***

Student opinion was collected in two ways, first through I wish/I like statements written immediately after the presentation at the company. Their opinion was also discussed at the seminar, a couple of days later. Some of the positive comments are related to the importance of the workshop and also the company is mentioned as a positive experience. Several comments are related to the good atmosphere and work in the groups. The students noticed that something happened in the groups when people was exchanged. New discussions started and the group got new energy which was positive for the outcome. So, in general the new more critical group member had a positive effect. In general, they also experienced the other disturbing activities as positive, though frustrating. Some of the positive comments are shown below.

*“I like to work in an environment like this with a friendly atmosphere”*

*“I like that we got a real life task”*

*“I like the challenge to work with time pressure with something I didn’t know this morning”*

*“I like visit to a company that have a useful product and contact with a really production and manufacturing”*

From the negative side the more general comments are that the time was not enough and that a better understanding about the products and how they work was needed. Several students felt that their limited background knowledge was an obstacle. Another thing that they asked for was a more pronounced feedback from the Managing Director and the Sales & Marketing Director. They found it very positive that the Company management was interested in what they had done, and it made the work even more realistic and interesting. However, they experienced that they only had to answer questions during the presentation, but did not get any feedback. Some of the negative comments are shown below.

*“I wish we had a better understanding of gas springs before we came here”*

*“I wish more time to develop the final idea”*

*“I wish some feedback during session”*

*“I wish to see a real application using the gas spring”*

*“I wish possibly more constructive criticism from outside”*

Interesting to notice, at least for the company, is that some students explicitly expressed their interest in the company, and especially one student show it in the following way:

I wish: *“Get job here”*  
I like: *“Get job here too”*

### ***Company Perspective***

For the company it was very interesting to see the results obtained during the workshop. Some of the ideas was not possible to go further with, and this is mainly due to the limited background knowledge, while others were more interesting, though already in pipeline. For the company this is also an important possibility to attract future employees, maybe the most important outcome from this kind of workshop. Inviting the students to the company for this workshop also means that they had an opportunity to show the interesting products and applications they are working with, and also that their customers are worldwide, even though the company is located on the countryside. This can also lead to other activities such as thesis projects.

From the company perspective it was concluded that the workshop overall was a success. “It was interesting to see the students approach the task in such an enthusiastic way”. It was a good mixture of students in the groups. Creates different and interesting dynamics in the groups and discussions. A drawback is to get the students interested in the task during such a short time. An improvement could be to lengthen the course and let the company (and possibly also other companies) supervise a group of students in a project where they develop a product related to the company. This would give a better possibility to guide/teach how product development and project management etc. is done in reality. If the same concept is to be used next year, it would be an advantage if a lecture is given at the university by the company. This lecture should contain basic knowledge about gas springs and background knowledge regarding markets and relevant customers, etc.

### ***Teacher Perspective***

For the teachers the main result was related to how this workshop can be improved. A couple of days before the workshop, a lecture should be given about the products. The products and how they work was not fully clear to all the students and that resulted in some suggestions that were unrealistic. Also a more clear instruction to the whole workshop, including the work expected to be done afterwards, should be written and handed out. Apart from this, it was very interesting to walk around and listen and discuss with the students while working with their solutions. They took this work very serious, and did a very good job. It was also interesting to see how the work changed when exposed to the disturbances. In most cases this part was appreciated, though frustrating. Especially the part when they had to select one out of several suggestions when earlier told to come up with several solutions. However, the interruptions could have been more well-planned and organized.

This is a good opportunity for the students to use their knowledge in a reality-based task, which also affects their interest for the course and the topic. A more reality-based project puts the course content in a more reasonable and realistic context, making it more meaningful to the students. Realizing that they are working with something that might be interesting to a company is also very inspiring. In the forthcoming courses, this experience can contribute to their understanding and personal development. The course also deals with environmental impact and some of the lectures and labs are about with sustainability and Eco audit issues. It was therefore interesting to see how several groups actually focused on different environmental and energy saving solutions.

The workshop was a little limited from a material selection point of view. Not much was focused on material selection and optimization. There was simply not enough time during the workshop. This is something that must be addressed the next time this workshop is arranged, as material selection is the key word in all the intended learning outcomes. As it was now, more focus was on the industrial design perspective. However, by adding some additional tasks to the work after the workshop, also material selection could have been covered and in that way accomplished the learning outcomes in a more clear way.

It could also have been an advantage if people from the company were invited to the seminar at the university. Especially as there was more time for discussions, but also as the students have had time to reflect and might add more and improved ideas and solutions, interesting for the company to take part of. Besides, the students also had new questions better answered by people from the company.

It is also worth mentioning how important it is with a contact at the company that has a driving force for this kind of collaboration. Without this person it would not have been possible at all to run this workshop. This was the first time we arranged this workshop and of course, some things could have been done better. However, we decided to start somewhere and learn from the experience.

## **SUMMARY**

In this course the students get an increased understanding about the interrelationship between material selection and product design. They also get a more pronounced understanding for communication between different disciplines. Besides, their understanding for not only mechanical and physical properties but also properties that are more difficult to measure increase. In other words, the students become more T-shaped. This is further practiced in the workshop as they work together with people having different backgrounds. All agreed that the workshop was important and meaningful. However, it was also a general conclusion that improvements are needed. Among these improvements, some are more pronounced while others are less critical. When all comments are summarized there are three things that appear to be more important:

- Better background knowledge about gas springs. This can be solved by a guest lecture before the workshop.
- More and relevant feedback from the company during the workshop, but also afterwards. Partly solved by inviting the company to the seminar.
- A more detailed description about goals and expectations from the teachers. This can be solved by handing out a document where all necessary information is gathered.

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