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Enhancing Non-Technical Skills by a Multidisciplinary Engineering Summer School

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In general engineering studies focus on the technical skills in their own discipline. However, in their subsequent industrial careers a significant portion of their time needs to be devoted to non-technical skills. In addition, in an increasingly globalised world collaboration in teams across cultures and disciplines is paramount to the creation of new and innovative products. In order to enhance the non-technical skills for groups of engineering students a series of innovation courses has been arranged and delivered in close collaboration with an industrial company (Bang & Olufsen). These courses have been organised as summer schools called "Conceptual Design and Development of Innovative Products" (CD-DIP) and delivered outside the usual educational environment. In order to explore the impact of this single course we have conducted a study among the students participating from 2007 to 2013. This has been carried out both qualitatively using interviews with selected students as well as quantitatively using a survey. The results are outstanding in demonstrating that the non-technical skills obtained in this single course have been of high value for a large portion of the students' subsequent professional life.

1. Introduction

In an industrial setting developing products for consumers is all about solving problems which typically requires an ability to innovate across disciplinary boundaries. Different engineering disciplines are often included in such development teams, and an interesting question in this connection is how universities best can prepare their students to have the right skills to perform well in such a setting. This paper analyses the impact of a series of summer schools that has been delivered in close collaboration with an industrial company and presents an assessment of the impact this single course have been perceived by the students on their non-technical skills (Larsen et al. 2009; Bennedsen and Larsen 2010).

The importance of non-technical skills was known long ago where in 1944 King wrote "the unwritten laws of engineering" (King 1944); a three in a row article series describing the attitudes and competences needed to be an engineer. One of the things King wrote was

"About 99% of the emphasis in the training of engineers is placed upon purely technical or formal education. In recent years, however, there has been a rapidly growing appreciation of the importance of "human engineering," not only in respect to relations between management and employees but also as regards the personal effectiveness of the individual worker, technical or otherwise. It should be obvious enough that a highly trained technological expert with a good character and personality is necessarily a better engineer and a great deal more

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valuable to his or her company than a sociological freak or misfit with the same technical training."

Crawley (Crawley 2001) re-phrased King's attributes and competences by pointing out that an engineer of today needs

"skills such as those needed for good oral and written communications, planning, and working successfully in organisations. In addition, it calls for the honing of personal attributes, such as a propensity towards action, integrity, and self-reliance." (p. 2-3)

For very good reasons the curriculum of most engineering educations focus on providing the students with different technical competencies. Nevertheless it is our experience that only few engineering courses in practice are dedicated to enhance the non-technical skills for engineers.

Bang Olufsen (B&O) is a Danish manufacturer of exclusive audio systems, televisions, loudspeakers and digital media products. In order to assess the potential development of non-technical skills, a specific survey focusing on the topic was conducted. Email addresses from 183 students out of a total population of 261 participants was collected. In addition to the surveys a small series of interviews with selected students was carried out, in order to get a deeper understanding of the course's impact on student skills.

After the introduction the paper provides the motivation for the course in Section 2 and the learning objectives in Section 3. This is followed in Section 4 with an overview of how the course have evolved over the years in multiple dimensions. Afterwards Section 5 explains how the assessment of the course has evolved from assessing satisfaction to skills perceived in a survey used for students for all the years the course have been delivered. This section ends with the main research questions for this article that we would like an answer to from the survey. Finally we present the results of the study in Section 6 and provide discussions and concluding remarks in Section 7. In addition appendices are included where Appendix A contains a list of the questions from the survey we have used. Then Appendix B provides an overview of the answers for all the quantitative questions. Finally, Appendix C provides selected statements from the students for the qualitative questions.

2. Motivation for the Course

It is important that engineering students enhance their non-technical disciplinary skills compared to what is present in most engineering educations today. A holistic perspective on the education of engineers can be found in the "*Conceive – Design – Implement – Operate*" (CDIO) initiative (Crawley et al. 2014). This initiative was initiated in 2000 by MIT and three Swedish universities and a description of the early considerations can be found in (Crawley 2001). In this context what is important about CDIO is that it organises the collection of skills that an engineer needs in order to be able to work as a professional into four categories:

- Professional skills
- Technical skills
- Interpersonal skills
- Personal skills

Here the *professional skills* are related to see the entire product development cycle from idea into real operation and it is difficult to teach this in a pure academic setting so close collaboration with companies is important. That is the motivation for arranging this course directly on-site of a company and with strong influence with an industrial setting of the

challenges for the students. The *technical skills* have virtually not been in focus in this course, since we feel that these are traditionally well covered by the existing engineering curriculum. Instead this course have had focus both on the *interpersonal* as well as the *personal skills* in order to strengthen the students abilities in these areas that otherwise are getting less emphasis in more theoretical courses. In the planning of this course and its learning objectives the skills described in the sub-categories from CDIO have been used for inspiration (see Section 3). In the same way these have been used for the structuring of the survey that have been used to evaluate the impact of the course on the students (see Section 5).

From a historical perspective the idea for starting this series of summer schools came from a discussion back in 2006 between the company B&O and the Engineering College of Aarhus (now a part of Aarhus University). Collaboration between students with different cultural and disciplinary backgrounds on solving problems that becomes as “real-life” as possible was in focus right from the beginning, also because this was seen as one of the major challenges from an industrial perspective as well. The title chosen for the course was “Conceptual Design and Development of Innovative Products” (CD-DIP) since it always had a focus on how to uphold a holistic approach to the development of new innovative products in a professional setting using teams of students with different disciplinary skills. A teamwork that calls for new collaboration skills for the students.

3. Learning Objectives of the Course

In order to ensure that focus is on the non-technical disciplinary aspects this needs to be reflected in the learning objectives of the course. These are formulated such that the student after a successful attendance should be able to:

- (1) Co-operate in multidisciplinary/multicultural team activities;
- (2) Participate in a conceptual design process;
- (3) Demonstrate interpersonal skills during team development;
- (4) Propose and justify the value of new innovative technical solutions;
- (5) Conduct disciplinary analysis of a real-world industrial problem;
- (6) Present analysis to stakeholders with different backgrounds; and
- (7) Design disciplinary interfaces to other disciplinary products.

If one considers each of these learning objectives it is clear that the focus is on the non-technical aspects. The *professional skills* are covered in learning objectives (2), (4) and (5). The *inter-personel skills* are covered by learning objectives (1), (3) and (7). The *personel skills* are covered by learning objective (6). Finally, *technical skills* are also included in learning objectives (5) and (7). Assessment of the course was carried out with a basic pass/no-pass principle requiring an active participation in order for students to pass. In addition a collection of deliverables was required from each team. The students worked approximately 9-10 hours every day in a three weeks period, in total close to 150 hours more than the norm for a 5 ECTS course. Section 7 return to these learning objectives in relation to the results from our survey of the students who have followed this course.

4. Curriculum Development over Time

The “birth” of the CD-DIP course was a vision of providing engineers with a holistic approach to becoming engineers engaged in innovation and product development. Following this vision the organisers from 2007-2013 tested 6 different CD-DIP courses inside the B&O factory site in Struer, Denmark. As a strategic decision Aarhus University and B&O

Institution	2007 DK	2008 DK	2009 DK	2010 DK	2011 DK	2012 DK	2012 China	2013 China
Aarhus University	3ECE, 1ME	2ICT, 2ECE, 1ME	3ICT, 2ECE	3ICT, 2ME	3ECE, 2ME	2ICT, 2ME, 1ECE	7ME, 4ICT	6ICT, 1ECE, 1BIZ
Ostrava VSB	2ME, 3EE	3ECE, 2ME	3EE, 1ICT, 1COM	2ICT, 1AR, 1CS, 1O	3ICT, 1ECE, 1CS	3ICT, 1AR, 1CS		
Minho University		4IE, 1CS	3IE, 2ME	2ME, 1CS, 1ECE, 1MPE	3ECE, 2ME	2SE, 1MPE, 1ICT		2IE
Cracow Technical University		3AR, 2PME	2AR, 2PME, 1CS	3MPE, 1AR, 1O	3MPE, 2AR	2MPE, 2AR		3MPE, 1AR
Hansa Groningen		5HT	5HT	5HT	5HT	5HT		4HT
Zlin		2ID	5ID	5ID	5ID	5ID		
Newcastle University			2CS	3CS, 2ICT	3CS, 2ICT	4CS		
Struer Highschool				5O	6O	2O	6O	2O
Aalborg University							5PDP	3PDP, 2BIZ
Shanghai Jiao Tong University							6ECE, 6ID, 2IND	6IND, 5ECE, 2BIZ
Total (261)	9	28	32	40	41	37	36	38

Table 1. Overview of the recruited students for the summer school over the years

also tested the CD-DIP format in China. The Chinese market is extremely important to B&O. The Chinese educational system is likewise important to European universities and Chinese and European students are eager to learn how to overcome potential intercultural gaps among them. Table 1 provides an overview of the development of the course over the years and the institutions participating with different disciplinary profiles. The acronyms used for the different disciplinary profiles can be found in Table 2.

As a consequence a new CD-DIP course was hosted in 2012 and 2013 at the Shanghai Jiao Tong University. These two courses benefitted from the venue adding to it a strong focus on a market-driven product concept development. This led to the development of important new product concepts implemented inside B&O products today. However, it also turned out to be a very resource demanding process. In 2015 the course consequently returned to Denmark, now adding students from media, journalism, architecture and automotive design to the disciplinary matrix. A closer inspection of Table 1 actually displays a radical development of the CD-DIP course over time especially in regards to implementing a real multidisciplinary set-up.

During the entire period students across disciplines, B&O professionals and teachers¹ collaborated intensively to create a unique learning experience for everyone involved. Still the following five premises biased the course development over time:

- (1) Engineering should remain the core of the CD-DIP course.
- (2) More and more non-technical disciplines should be added for the students to work

¹We use this term to cover the academic facilitators for this course ranging from research-oriented professors over lecturers to stakeholders with a more entrepreneurial background.

Acronym	Explanation
AR	Automation and Robotics
BIZ	Business
COM	Communications Engineering
CS	Computer Science
ECE	Electronics and Computer Engineering
EE	Electrical Engineering
HT	Human Technology
ICT	Information Communication Technology
ID	Industrial Design
IE	Information Technology
IND	Industrial Engineering
ME	Mechanical Engineering
O	Others
PDP	Product Development Psychology
PME	Production Management Engineering

Table 2. Disciplinary acronyms (ordered alphabetically)

- holistically with their tasks during the course.
- (3) The course's intercultural and international dimensions should continuously be expanded to simulate global Research, Development & Innovation (R, D & I) environments.
 - (4) The work processes are based on "Design Thinking" Brown (2008) and engineering development approaches like "SCRUM" (Schwaber 2004).
 - (5) Focus on the gain of non-technical skills rather than technical skills.

The teachers engaging in the CD-DIP programme over years closely monitored the students' satisfaction levels and qualitative student statements also pointed towards interesting reflections on the students learning outcome.

5. Course Assessment over Time

Until 2012 the CD-DIP courses were assessed predominantly as satisfaction level assessments. The data showed a high degree of student satisfaction with the course. However, satisfaction levels tell nothing about gains in knowledge or changes in professional attitude. Thus, in 2012 and 2013 a new assessment method was tested. The focus was to monitor the students perceived gain of specific skills due to attending the CD-DIP course compared to any other course they had attended during their studies. The assessment was quantitative and qualitative including in-depth interviews of students. This data consistently showed that the engineering students in general had good knowledge about engineering as a discipline. However, it also showed that the same students had nothing but vague ideas of how to be and work as an engineer. Furthermore, data showed that the CD-DIP courses minimised this discrepancy quite efficiently. The students found that they acquired skills about concept development and innovation combined with skills to act professionally as engineers and to interact efficiently with other stakeholders. Based on these findings the organisers decided in 2015 to conduct a longitudinal study to investigate how the CD-DIP courses from 2007-2013 potentially had impacted the student's professional, interpersonal and personal skills. In a pre-study the organisers gathered data from the general CD-DIP assessments conducted over years.

Population & response rates	Total population	Total population found = Test Sample (TS)	TS responding to the survey	TS response rate	TS finalising the survey	Final response rate
	N = 261	N = 183	N = 141	77%	N = 117	64%
Engineers			N = 110	78%	N = 90	77%
Non engineers			N = 31	22%	N = 27	23%

Table 3. Population and response rates.

5.1. Questionnaire Methodology

The 2015 survey was pilot-tested and revised during spring 2015 and the final survey was submitted by early summer 2015. It consisted of a total of 29 selected questions designed to assess the students' perceived gain of skills on the three non-technical CDIO skill categories explained in Section 2 above²

5.2. Population and response rates

In total 261 students attended the CD-DIP summer school courses in the period 2007-2013. Mail addresses of a total of 183 students were retrieved and the survey was sent out to all of them. 141 of these started the survey and of these 117 students finalised it equaling a response rate of close to 64%. The response rate exceeded expectations and is acceptable given the fact that the student cohort finalised their course participation 2-7 years prior to receiving the survey. From the 24 students partially filling out the survey the qualitative responses are included in the interpretation. The final ratio of engineers finalising the survey is 77% and non-engineers 23% (see table 3). A concern could be a bias in the final sample and therefore the representativeness of the sample is low. Baruch and Holtom (2008) conducted a meta study on survey response rate levels and trends in organizational research and found that from 490 studies the average response rate was 52.7% – our response rate is more than 10% higher. We cannot be sure that the responses are representative but we have a strong belief in it.

5.3. Research Questions

Despite the disciplinary development over time the course has remained engineering focussed. However, by adding all the mentioned disciplines the course also has become fully multidisciplinary, intercultural and international. Given the course design development over time the organisers became increasingly curious about the course impact:

- Did the course impact specific competences relevant for the engineering profession globally?
- Did the course independently impact the students professional behaviour?
- And if so: Has this impact been stable over time?

²A full list of the survey questions is included in the appendix A.

6. Results of our Investigations

The results achieved must reflect that the fundament for the course is a problem based approach (Fink 2001), that the context for the course is an “out of the university and into the industry” venue and finally that the skills needed to be acquired by the students for analytical purposes are differentiated into professional, interpersonal and personal skills. Hence the presentation of the key results and the discussion and conclusion will be organised around these three main categories.

As noted in Section 5.1 the data are divided in two clusters of students; Engineers and a control group containing all other students. In general, data show only small variations in the results between the two clusters of students – meaning that the overall learning outcome is good for all students.

In the subsections below data about skills acquired is presented.

6.1. *Professional skills acquired*

Professional skills are often vaguely defined. In this survey we monitor these skills by questioning the students:

- Professional development in general (Q3, Q4),
- Ability to design concepts according to user needs (Q5),
- Ability to utilise sketching, drawing, graphical design etc. to design better product concepts (Q6) ,
- Acquisition of tools to create ideas and methods when developing product concepts (Q8),
- Ability to have global perspectives on product concept development (Q19),
- Ability to utilise leadership to improve their work processes (Q20, Q21, Q22),
- Ability to deliver product concepts according to user and market demands (Q23),
- Ability to balance between new and existing technologies when developing product concepts (Q26) and,
- Ability to finalise a product concept despite uncertain and incomplete information (Q27).

First of all, 37% of the students reflect in their comments that the main outcomes of the course are “transformative experiences” (Q2). Transformative experiences resemble that the students have gained new understandings of the way of working within their own discipline. In addition, quantitative data shows that the CD-DIP course has had a lasting effect on 96% of the students “professional development” (Q3). Within this result 41% of the engineering students state that effect of the course on their professional development was high. 39% of the control group students respond the same.

In the comments following Q4 82% of the qualitative statements show that a range of new relevant professional skills have been acquired. One student e.g. quoted:

“The camp gave me insight in areas I had never worked with before. The entire process from idea or need to prototype, is the hard work that is before us software engineers take over the project and start developing the products based on specifications etc. But these specifications all derive from the kind of work we did during the camp, so it was enlightening for me to take part in that process.”

Another student quoted:

“CDDIP have had significant impact in several ways. First of all, it introduced me to the business aspect of technology – a direction I’m pursuing today.”

Many quotes specifically deal with gaining a new understanding of the disciplinary field

– but as it is clear beneath the course also impact personal and interpersonal skills (see Appendix C).

Three other significant results stand out: The first being about concept development in a global perspective. Here 50% of the engineering students responds that the course severely impacted their global perspectives on product concept development (Q19). The second result goes along the same concept development line but with a specific focus on user and market demands. Here 47% of the engineering students learned a lot about how to deliver product concepts according to user and market demands (Q23).

Finally, the third result focuses on the effect of social learning from credible people around you. Here 42% of the engineering students claim that they learned a lot from the B&O industry experts involved (Q21) whereas 22% learned a lot from the involved teachers (Q22). Furthermore, 23% of the engineering students said they learned a lot from their fellow team leader making “peer learning” with a small margin exceed the learning from teachers. Nevertheless, both results are remarkably lower than the learning achieved from the day to day work with specialists from B&O.

For further data regarding professional skills, see Appendix B’s tables for Q5, Q6, Q8, Q20, Q26 and Q27.

6.2. *Interpersonal Skills*

Interpersonal skills is a broad category. In this survey we monitor these skills by questioning the students:

- Ability to work in cross-cultural teams (Q11),
- Ability to work in cross-disciplinary teams (Q12),
- Ability to handle potential disagreements or conflicts in teams (Q14),
- Ability to communicate with students from other disciplines and cultures (Q16), and
- Ability to ask for feedback and criticism from students from other disciplines and cultures (Q17).

Three key results stand out within the interpersonal skills’ dimension. First of all, the gains on the cross-cultural skills (Q11) and the cross-disciplinary skills (Q12) are exceptionally high. Regarding communication skills these rank high as well.

A stunning 82% of the engineering students experienced highly increased abilities to work in cross-cultural teams (Q11). 5% experienced a little impact – whereas 11% experienced an impact to some extent. Less than 2% have not gained or do not know if they have gained the skill.

Furthermore, 82% of the engineering students experienced highly increased abilities to work in cross-disciplinary teams (Q12). 5% experienced a little impact – whereas 12% responded they experienced some impact. Not a single student experienced no impact – whereas 2% responded that they are not sure whether the course had an impact or not.

Regarding communication abilities 65% of the engineering students responded that they highly increased their abilities to communicate across disciplines and cultures (Q16). 8% only gained a little in this area – whereas 26% gained to some extent their skills to communicate across disciplines and cultures. 1% had no gain – whereas zero students responded that they do not know.

For further data regarding interpersonal skills, see Appendix B’s tables for Q14 and Q17.

6.3. *Personal skills*

Also the “personal skills” category is broad. In this survey we monitor these skills by questioning the students:

- Personal ability to use the team and its creativity to solve one’s tasks (Q9),
- Personal ability to recognise and use other peoples better ideas (Q13),
- Personal ability to make other team members becoming more successful (Q15),
- Personal ability to balance different and important factors when designing and delivering a product concept (Q25) and,
- Personal ability to innovate (Q28).

One of the survey’s high scoring results is about the personal use of a teams creative resources to solve ones own tasks (Q9). This question reflects the fact that individuals may gain huge benefits when being in teams characterised by differentiation. Here 66% of the engineering students find that they have gained a high level of learning about how to utilise their teams creativity. An interesting result given that there were many different disciplines in the teams and that different disciplines focus at different parts of the concept development lifecycle.

Another great result is that 53% of the engineering students responds that they have become much better in innovating product concepts and that they understand the innovation process, from concept development to prototyping, testing, iteration and finalisation of the product (Q28). Several students respond that they now understand that in concept development one must balance a solution between user needs, technical feasibility and economically viability. One of the students commented on this aspect:

The camp allowed me to develop a number of my personal skills which have been invaluable for my professional development. I gained experience with dealing with a number of situations which have been applicable in interviews and day to day working life. The concepts we were introduced, such as user stories and design, have been fundamental in my career and provided me with basics I’ve been able to develop on.

Regarding the skill to utilise other peoples ideas, 49% of the engineering students claim that they have improved greatly in utilising other peoples ideas (Q13). This is considered a critical step when teams have to solve collective tasks fast.

Interestingly almost 80% of the engineering students do not think they have improved a lot in making other team-members better (Q15) which contrasts that a large proportion of the students gained a high degree of interpersonal skills. Exchanges of skills apparently happened.

For further data regarding personal skills, see Appendix B’s tables for Q25.

7. Concluding Remarks

The survey displays many key results pointing towards extraordinary course outcomes. Before going more into detail it is important to keep in mind that data were collected 2–7 years after the students actually participated in the course. This fact leave out recent experiences or influences on the data. Hence it seems fair to conclude that the course itself played a vital role in shaping the students’ professional development on a range of issues. Especially their abilities to work with innovation and concept development, from the formulation of early user needs, to concrete concept developments, to the finalisation of their concept solutions balancing user needs, economic viability and technical feasibility. Besides the innovation experiences and skills acquired a large number of engineering students also responds that they have acquired the work skills of engineers rather than

just having knowledge about the disciplines of engineering.

Secondly learning to work like engineers implies that students have to acquire a set of strong interpersonal skills too. Since engineering work involves complex problem solving, students must be able to work across disciplinary fields to solve such problems. Furthermore, solving problems on a global scale demand cross-cultural and communication skills. This result goes well with the fact, that the students found that they gained a global perspective on product concept development (Q19). Given these four results it seems clear that the course had a large effect on the students' interpersonal skills and that they support the overall conclusion about the students being able to work with innovation.

Thirdly the learning process for engineers in this case is speeded up by moving out the learning venue and enrolling industry experts directly as teachers, coaches, mentors, supervisors etc. It is a very interesting result, that the industry experts impact on the students learning is more than twice as high as the impact from teachers. The function of role models in the learning process is well described (Lave and Wenger 1991). The purpose of a role model is very much to help people form their professional identity which to a large extent seem to be experienced by the students.

At the personal level the students have improved a lot on two aspects. Firstly, they have improved quite dramatically in using team-members' creativity to solve their own tasks. Secondly, they improved their ability to utilise ideas better than their own. These two result connects well. It seems that the team construction and the teams' functions to a large extent made students capable of picking from a pool of knowledge and opportunities – much similar to notes about leadership and role models. These findings fall well within the conclusion of scholars like (Wenger 2000) arguing that learning basically is a social activity.

Finally, many students have referred to the learning experience as transformative. Transformative experiences basically mean that the course has impacted the professional development of the students. Many of them work in the industry today using the methods they learned at the course, which is meaningful and relevant since many industries use the same methods.

Looking back on the research questions it seems fair to conclude that the course has had a long, lasting, stable and independent impact on the all the students learning outcome – across disciplines. This is interesting given the fact that the course is “just a small 5 ECTS course”.

Then one could question whether the skills learned are sufficiently and adequately covering the skills needed to work in a global engineering context. Definitely not so! On the other hand, the organisers defined a range of skills to be important on the basis of the best available method to do this which is the CDIO curriculum version 2.0. In that case it seems fair to conclude that the skills actually acquired are important despite they are not exclusively representing all important skills needed in a global engineering work context. Engineers are hired for their technical skills – and maybe fired due to their behavioural skills. Albeit the technical skills are not being monitored in this survey – of course they are crucial for engineers and the customers. Nevertheless, the organisers argue that the professional, interpersonal and personal results, that the students have achieved still play a vital part in becoming a great engineer in todays globalised working environment.

In this study the point of analysis is structural and not on the individual level of learning. Future work using e.g. John Dewey's thoughts about learning (Dewey 1986) and/or David Kolb's thought on learning environment (Kolb 2014) to study the influences of individual learning and the learning design of the course are in the making.

The results of our survey demonstrate that a course like the one we have described can be very influential for engineering students. Unfortunately, only few universities have this kind of courses in their curriculum. We sincerely hope that others will get inspiration from

the work we have reported here and consider developing this kind of course for their own university. We definitely feel that we have been able to demonstrate that this kind of course can have lasting impact for the students following such a course. Different universities may have different limitations so you may not be able to follow the same journey we have taken, but we feel that the different incarnations of this course over time all will be able to give value to the students taking it. However, note that planning and executing a course such as this one requires a lot of effort, but it will be worth it.

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References

- Baruch, Yehuda, and Brooks C. Holtom. 2008. "Survey response rate levels and trends in organizational research." *Human Relations* 61 (8): 1139–1160. <http://hum.sagepub.com/content/61/8/1139.full.pdf+html>. <http://hum.sagepub.com/content/61/8/1139.abstract>.
- Bennedsen, Jens, and Peter Gorm Larsen. 2010. "An Innovative Summer School V2.0." In *Proceedings of the 6th International CDIO Conference*, Ecole Polytechnique, Montreal. June.
- Brown, Tim. 2008. "Design Thinking." *Harvard Business Review* 84–95.
- Crawley, E.F., J. Malmqvist, S. Östlund, D.R. Brodeur, and K. Edström. 2014. *Rethinking Engineering Education - The CDIO Approach*. Springer.
- Crawley, Edward F. 2001. *The CDIO Syllabus - A Statement of Goals for Undergraduate Engineering Education*. Tech. rep.. Massachusetts Institute of Technology.
- Dewey, John. 1986. "Experience and Education." *The Educational Forum* 50 (3): 241–252.
- Fink, Flemming. 2001. "Problem Based Learning in Engineering Education – a catalyst for Regional Industrial Development." *World Transactions on Engineering Technology Education* 1 (1).
- King, W.J. 1944. "The Unwritten Laws of Engineering." *Mechanical Engineering* May, June, July.
- Kolb, David A. 2014. *Experiential learning: Experience as the source of learning and development*. FT press.
- Larsen, Peter Gorm, Joao M. Fernandes, Jacek Habel, Hanne Lehrskov, Richard J.C. Vos, Oliver Wallington, and Jan Zidek. 2009. "A Multidisciplinary Engineering Summer School in an Industrial Setting." *European Journal of Engineering Education*.
- Lave, Jean, and Etienne Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press.
- Schwaber, Ken. 2004. *Agile Project Management with Scrum*. Prentice Hall. ISBN: 073561993X.
- Wenger, Etienne. 2000. "Communities of Practice and Social Learning Systems." *Organization* 7 (2): 225–246.

About the authors

Peter Gorm Larsen is professor in the Department of Engineering at Aarhus University, where he leads the software engineering research group. In addition he is the founder of a company called First Time Right Technologies. After receiving his M.Sc. in Electronic Engineering at the Technical University of Denmark in 1988, he worked in industry before returning to complete an industrial Ph.D. in 1995. In his industry career, as a development engineer and manager, he gave industrial courses all over the world, and saw the technology he developed be applied in areas as diverse as secure message processing and options trading. He returned to academia in 2005. His prime research goal now is to improve the development of complex mission-critical applications by implementing and applying well-founded technologies, in particular in the design of robust tools that help engineers to leverage models in early design stages to reduce overall product development risk in particular in the area of Cyber-Physical Systems. He is the author of more than 100 papers published in journals, books and conference proceedings, and several books and has an h-index at 26. He was the coordinator of the CD-DIP course in the years 2007 – 2009 taking place at B&O in Denmark.

Erik Lasse Kristiansen founded his company BRAINS in 2014. One of the main services delivered are University-Industry Innovation Camps. Another business focus are services to university management within topics of management in general and services about leadership, organisation, University-Industry partnership programs, curriculum improving activities, joint development projects etc. Furthermore, BRAINS deliver intensive innovation camps to public and private companies. Since 2012 Erik has operated 25+ international programs enrolling more than 1000 international students. Camp venues have been in Denmark, China and South Korea always with the involvement of relevant industrial companies. Prior to his current position he was Head of Center for Industrial Collaboration within engineering at Aarhus University. Furthermore, he has been Head of Quality Development and HR, and interim Head of the Bioprocess Technology group – both at Aarhus School of Engineering. In 2014 Erik Kristiansen received together with professor Peter Gorm Larsen Aarhus University's Award for best University-Industry Collaboration Project 2014 within Science and Technology. Erik holds a MSc in Political Science at Aarhus University and furthermore holds a range of courses from Denmark, Belgium and UK. He was the coordinator of the CD-DIP course in the years 2012 – 2013 taking place in China.

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Kim Bjerger is Associate Professor at Aarhus University School of Engineering. He has a master degree in technical information technology from Aarhus University (2013) and a bachelor degree in electronics engineering from the Aarhus School of Engineering (1989). He has 20 years of experience working as developer, consultant and manager in the industry covering different engineering areas like electronics, measurements, software and embedded

systems, automation control and professional audio equipment. All companies mastering multidisciplinary engineering skills with a high degree of International Corporation. Finally he worked as a senior consultant at the Danish Technological Institute before starting in the academia in 2010 lecturing in bachelor and master courses. He was the coordinator of the CD-DIP course in the years 2010 – 2012 taking place at B&O in Denmark. Today manager for the signal processing group and teaching in systems engineering, applied signal processing, digital system design and HW/SW Co-design.

Appendix A. The Questionnaire

- (1) Your educational background
- (2) What are your overall experiences from being a part of your B&O Camp?
- (3) Is it fair so say that the B&O Camp has been important for your professional development?
- (4) Could you motivate your answer?
- (5) The CD-DIP Camp improved your ability to design concepts according to user needs?
- (6) The CD-DIP Camp improved your ability to utilise sketching, drawing, graphical design etc. to design better product concepts?
- (7) If you have comments to your design process answers, please add them here.
- (8) The CD-DIP Camp gave you new tools to create ideas and methods when developing product concepts?
- (9) The CD-DIP Camp improved your ability to use your team and its creativity to solve your tasks?
- (10) If you have comments to your creativity answers, please add them here.
- (11) The CD-DIP Camp improved your ability to work in a cross-cultural team?
- (12) The CD-DIP Camp improved your ability to work in a cross-disciplinary team?
- (13) The CD-DIP Camp improved your ability to recognise and use ideas better than your own?
- (14) The CD-DIP Camp improved your ability to handle potential disagreements or conflicts in your team?
- (15) During the Camp you learned how to make other team-members become more successful?
- (16) The CD-DIP Camp increased your ability to communicate with students from other disciplines and cultures?
- (17) During the Camp you improved your ability to ask for feedback and criticism from students from other disciplines and cultures?
- (18) If you have comments to your team answers, please add them here.
- (19) During the Camp you gained a global perspective on product concept development?
- (20) Your CD-DIP Camp team-manager improved your team's ability to work faster & smarter during the camp?
- (21) The Bang & Olufsen experts improved your team's ability to work smarter and faster during the camp?
- (22) The university professors improved your team's ability to work faster and smarter during the camp?
- (23) The CD-DIP Camp improved your ability to deliver a product concept targeting the needs of the customers and the market?
- (24) If you have comments to your Business Understanding answers, please add them here
- (25) The CD-DIP Camp increased your ability to balance different and important factors when designing and delivering a product concept?
- (26) During the CD-DIP Camp you improved your ability to balance between new and existing technologies when developing product concepts?
- (27) The CD-DIP Camp increased your ability to finalise a product concept despite uncertain and incomplete information?
- (28) The CD-DIP Camp increased your ability to innovate?
- (29) If you have comments to your System Thinking answers, please add them here.

Appendix B. Responses from the Qualitative Questions in the Questionnaire

Q3: Is it fair so say that the B&O Camp has been important for your professional development?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	4	3.3%	4%
Yes – a little	15	12.5%	12%
Yes – to some extent	54	45.0%	43%
Yes – a lot	46	38.3%	41%
I don't know	1	0.8%	0%
Total	120	100.0%	100%

Q5: The CD-DIP Camp improved your ability to design concepts according to user needs?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	5	4.3%	4%
Yes – a little	19	16.2%	16%
Yes – to some extent	46	39.3%	41%
Yes – a lot	44	37.6%	36%
I don't know	3	2.6%	2%
Total	117	100.0%	100%

Q6: The CD-DIP Camp improved your ability to utilise sketching, drawing, graphical design etc. to design better product concepts?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	13	11.1%	11%
Yes – a little	38	32.5%	32%
Yes – to some extent	32	27.4%	28%
Yes – a lot	30	25.6%	26%
I don't know	4	3.4%	3%
Total	117	100.0%	100%

Q8: The CD-DIP Camp gave you new tools to create ideas and methods when developing product concepts?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	4	3.4%	3%
Yes – a little	23	19.8%	21%
Yes – to some extent	51	44%	44%
Yes – a lot	35	30.2%	30%
I don't know	3	2.6%	2%
Total	116	100.0%	100%

Q9: The CD-DIP Camp improved your ability to use your team and its creativity to solve your tasks?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	3	2.6%	2%
Yes – a little	10	8.6%	9%
Yes – to some extent	26	22.4%	22%
Yes – a lot	74	63.8%	66%
I don't know	3	2.6%	1%
Total	116	100.0%	100%

Q11: The CD-DIP Camp improved your ability to work in a cross-cultural team?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	1	0.9%	2%
Yes – a little	7	6%	5%
Yes – to some extent	17	12.1%	11%
Yes – a lot	93	80.2%	82%
I don't know	1	0.9%	0%
Total	116	100.0%	100%

Q12: The CD-DIP Camp improved your ability to work in a cross-disciplinary team?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	0	0%	0%
Yes – a little	6	5.2%	5%
Yes – to some extent	17	14.7%	12%
Yes – a lot	92	79.3%	82%
I don't know	1	0.9%	0%
Total	116	100.0%	100%

Q13: The CD-DIP Camp improved your ability to recognise and use ideas better than your own?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	2	1.7%	2%
Yes – a little	21	18.1%	18%
Yes – to some extent	38	32.8%	30%
Yes – a lot	54	46.6%	49%
I don't know	1	0.9%	1%
Total	116	100.0%	100%

Q14: The CD-DIP Camp improved your ability to handle potential disagreements or conflicts in your team?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	4	3.4%	4%
Yes – a little	19	16.4%	16%
Yes – to some extent	49	42.2%	35%
Yes – a lot	41	35.3%	42%
I don't know	3	2.6%	2%
Total	116	100.0%	100%

Q15: During the Camp you learned how to make other team-members become more successful?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	10	8.6%	11%
Yes – a little	18	24.1%	20%
Yes – to some extent	49	42.2%	43%
Yes – a lot	22	19%	20%
I don't know	7	6%	7%
Total	116	100.0%	100%

Q16: The CDDIP Camp increased your ability to communicate with students from other disciplines and cultures?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	1	0.9%	1%
Yes – a little	8	6.9%	8%
Yes – to some extent	33	28.4%	26%
Yes – a lot	74	63.8%	65%
I don't know	0	0%	0%
Total	116	100.0%	100%

Q17: During the Camp you improved your ability to ask for feedback and criticism from students from other disciplines and cultures?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	8	6.9%	9%
Yes – a little	22	19%	21%
Yes – to some extent	51	44%	40%
Yes – a lot	30	25.9%	27%
I don't know	5	4.3%	3%
Total	116	100.0%	100%

Q19: During the Camp you gained a global perspective on product concept development?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	3	2.6%	3%
Yes – a little	12	10.4%	10%
Yes – to some extent	41	35.7%	37%
Yes – a lot	59	51.3%	50%
I don't know	0	0%	0%
Total	115	100.0%	100%

Q20: Your CDDIP Camp team-manager improved your team's ability to work faster & smarter during the camp?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	3	2.6%	3%
Yes – a little	17	14.8%	14%
Yes – to some extent	55	47.8%	48%
Yes – a lot	29	25.2%	23%
I don't know	11	9.6%	11%
Total	115	100.0%	100%

Q21: The Bang & Olufsen experts improved your team's ability to work smarter and faster during the camp?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	2	1.8%	2%
Yes – a little	15	13%	12%
Yes – to some extent	41	35.7%	40%
Yes – a lot	53	46.1%	42%
I don't know	4	3.5%	4%
Total	115	100.0%	100%

Q22: The university professors improved your team's ability to work faster and smarter during the camp?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	4	3.5%	4%
Yes – a little	35	30.4%	32%
Yes – to some extent	42	36.5%	34%
Yes – a lot	26	22.6%	22%
I don't know	8	7%	7%
Total	115	100.0%	100%

Q23: The CD-DIP Camp improved your ability to deliver a product concept targeting the needs of the customers and the market?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	3	2.6%	3%
Yes – a little	19	16.5%	17%
Yes – to some extent	36	31.3%	32%
Yes – a lot	55	47.8%	47%
I don't know	2	1.7%	1%
Total	115	100.0%	100%

Q25: The CD-DIP Camp increased your ability to balance different and important factors when designing and delivering a product concept?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	2	1.8%	2%
Yes – a little	31	27.2%	28%
Yes – to some extent	39	34.2%	34%
Yes – a lot	38	33.3%	32%
I don't know	4	3.5%	3%
Total	114	100.0%	100%

Q26: During the CD-DIP Camp you improved your ability to balance between new and existing technologies when developing product concepts?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	11	9.6%	11%
Yes – a little	22	19.3%	18%
Yes – to some extent	37	32.5%	36%
Yes – a lot	43	37.7%	34%
I don't know	1	0.9%	1%
Total	114	100.0%	100%

Q27: The CD-DIP Camp increased your ability to finalise a product concept despite uncertain and incomplete information?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	3	2.6%	3%
Yes – a little	23	20%	19%
Yes – to some extent	42	36.5%	37%
Yes – a lot	44	38.3%	40%
I don't know	3	2.6%	1%
Total	115	100.0%	100%

Q28: The CD-DIP Camp increased your ability to innovate?

Possible answers	Respondents	Percent All	Percent Engineers
No – not at all	3	2.6%	3%
Yes – a little	13	11.3%	11%
Yes – to some extent	33	28.7%	30%
Yes – a lot	63	54.8%	53%
I don't know	3	2.6%	2%
Total	115	100.0%	100%

Appendix C. Selected Statements from the Students

C.1. *Q2: What are your overall experiences from being a part of your B&O Camp?*

- Learned a lot about working with people with other background than my own.
- Very positive. Work in a multinational team. Innovation approach for development of new products. Prototyping experience, visualisation and presentation of concepts. Design work.
- Excellent experience in the field of developing the product
- I was nice to experience teamwork in a multi-cultural group. It is good to know, that you are able to collaborate across borders.
- It was my very first contact with the business/work world. It hit me quite hard in the first week as I felt rather lost in the middle of so many things happening at the same time. Fortunately, the teachers and some of the students helped me and encouraged me. All in all, (and looking back at it after 7 years) it really contributed to my professional decisions.
- Fantastic opportunity to learn and work under time pressure in a multidisciplinary setting, great facilities and inspiring to work with B&O.
- Great experience! I learned a lot about my self, and how other people work in projects. What I really take with me, is the fact that, if you put talented people in the right setting, awesome ideas are bound to appear.
- Different approaches, Multi-disciplinary team work, Structured processes for Innovation
- Team work. The value of multidisciplinary backgrounds. Product development process.
- Loved it! Was a great learning experience, being multidisciplinary and multi-cultural.
- It was very good. A great setup, exciting subjects and beneficial learning. Furthermore it was useful side effect to gain multicultural understanding and networking
- Very positive. I went once as a student and a second time as teaching assistant. I had a great time in both occasions and met quality people
- The B&O Camp introduced to the area of product development and, since then, it has influenced my professional career. It was also a great opportunity to know different people from lots of different backgrounds and know a country and brand that I wasn't sure I'd meet otherwise
- Being part of a B&O Camp is having the experience working in one of the best and more innovative companies in the electronic industry
- I had an utterly fantastic experience at the B&O Summer Camp. It has remained one of my fondest memories and to this day something I would do again in a heartbeat.
- As a learning experience, working with students from other disciplines and cultures was a fascinating and enlightening time. I believe participating in the summer school led me to be a better employee, a better team player and an innovative thinker. I still believe it led to me getting my first job as a Software Developer.
- B&O camp gave me a very good opportunity to work on project based tasks with an array of students, each with different strengths and disciplines. We were able to interact with B&O specialists to inform our tasks/decisions and to experience, first hand, their design and development processes. All my key personal skills were developed from this process and has been invaluable for applications following the completion of my degree.
- I had a really great time during B&O Camp. Every time I had a job interview this was a great chance to talk about B&O Camp. Also I liked how was everything for us prepared so once again thank you B&O and other professors and experts.
- It was an excellent experience, with lots of camaraderie and an amazing opportunity to learn from people with different cultural backgrounds and disciplines. Visiting Bang & Olufsen was also an eye opener regarding technology and engaging with business

- Great opportunity. Put me on the right track for my professional career. Every single future potential employer was curious about this summer camp. Additionally, getting a proper background on innovations definitely helps a lot in the current economy, no matter where one finds himself employed.
- I really enjoyed it, specially working in a multi-disciplinary team. It gave us the opportunity to very quickly discuss, develop and implement our ideas, and achieve very good results in such a short time
- Great. It kickstartet my passion for product development
- I thought it was an amazing experience! It was really enjoyable. I learned a lot about the Danish culture, about B&O and I gained a lot of contacts across Europe. It was good to experience an international project with people of different backgrounds and expertise.
- Amazing experience! Learned a lot about product development within a company, which is so different than how you learn it in university
- It was an amazing camp, that gave me an amazing opportunity to grow in a professional (magical) setting. For every engineer is the B&O camp a must. I could improve my English skills and learn a lot about product development. But by far the best part was to meet all the interesting people with divergent cultures and backgrounds.
- I enjoyed the camp very much and were taken care of very good. This month it has been 3 years and i still think back with happy thoughts. The things that i liked were the ability to work in groups with different cultures and disciplines and get real genuine feedback. This made us feel like a group who really wanted to deliver a good prototype for Bang and Olufsen
- My overall experience was extremely positive. For me the most positive experience was to learn how to work and communicate in a multicultural and multidisciplinary team in a foreign environment
- It was insightful, I learnt about the process of ideation and innovation of new products. It was also inspiring to see some of the future ideas on sound technology on B&O's R&D. It was a fun experience and my team was awarded a patent which is amazing
- B&O Camp is a great opportunity for all students to work in x-functional groups in real work environment. I recommended it for everybody
- That was great experience, I can say that even one of the most important in my career
- Besides being an opportunity to explore the Chinese student- and work culture, the camp gave me insight in areas I had never worked with before. The entire process from idea or need to prototype, is the hard work that is before us software engineers take over the project and start developing the products based on specifications etc. But these specifications all derive from the kind of work we did during the camp, so it was enlightening for me to take part in that process
- It has been extremely interesting and enlightening to be a part of the B&O camp. The intercultural and multidisciplinary aspect was a very important part
- My overall experiences are that the camp was great. It was a really good experience to work multidisciplinary and multicultural and i have learned and benefitted a lot from this
- Especially working across fields in the product development process was hugely beneficial to me, as this gave insights into other professions, but also the strengths of ones' own profession
- Great experience to be part of the B&O camp. Personally I liked working together with other specialists and people from different cultures, with diverse backgrounds, skills and ideas. I learned a great deal from other people that were participating with me. What motivated me enormously is that we were creating something that was tangible and had real purpose

- multidisciplinary, multicultural. learning new languages and cultures, working together and use each other expertise. Going to places you have not a big chance to go (being a local and be part of the university, going to rich Chinese families and shops
- I experienced the program as intensive, whereby a wide spectrum of disciplines had to cover multiple assignments. The challenge was to work with a multi-disciplined team and get the best result of every individual
- Work in an international environment in order to reach a solid purpose. Development of group work capabilities. Learning and understanding product development from the idea until the mock-up. Learn about Chinese, Dutch and Danish cultures. Live 3 weeks in a foreign mega city.

Q3: Is it fair so say that the B&O Camp has been important for your professional development?

- I saw how things are working and at that time it gave me a lot of experiences
- It was great, that we were actually involved in real situation, so different comparing with school study.
- It helped to get permission to study abroad. It was a very good starting point for getting a job in a globally-ranged, multinational company. It helped to understand the innovation process and how an idea comes to product.
- You can see how it works when it works from inside. In one of the most prestigious and innovative companies in the history.
- It helped me to realise my weaknesses by comparing my skills with other young professionals
- Made me standout and understand my personal value to a team
- I realised working in a multicultural and multidisciplinary environment really makes my brain click. I am currently working in a European project with people from 7 different countries. And I left my home country 3 years ago, simply because I realised the work culture in central/north Europe is better than the one back home.
- It has been important not only for what I took from it, but it was a trigger for quitting my old job and moving to a new challenge after the Camp
- It showed me that I could compete in an international setting, and that I had the skill to achieve great results. The camp helped to identify and further develop these skills.
- After this experience, I was capable of applying some of the concepts learned in my professional as well as social life. I believe that part of my success today has in part to do with the experiences lived in this camp. And I still considered to be the best “professional” experience I had so far.
- Working in international environment and learning the danish way of working was a great experience. Together with huge amount of group work and working on real life projects can really bring students to another level.
- Having the summer camp on my CV got me both student jobs and admittance to other innovation camps. In extension it has affected the job I have today
- Business experience, multicultural understanding and network and tools for developing innovative products.
- During the second time as a teaching assistant I had the chance to talk with several engineers and define a master thesis proposal in collaboration with B&O. I got a 12 (Danish scale) in that thesis and received an award. That thesis would not have happened in case I would have not participated.
- The camp introduced me to the area of product development. Since then, all the projects and my overall career have been influenced by the camp experience. I’ve taken positions that are related to creating new products and services, introduce new methodologies

and manage innovation.

- Worldwide and well known company that use made the best product possible with the best professionals available.
- As a Software Developer it gave me my first real “insight” into how a project might develop, how to prototype software for a demonstration, how to work with other team members, to plan out the requirements. In general it gave me my first taste of professional software research, development and planning. I view it as my groundwork, my base and an example of how to work together with people.
- The camp allowed me to develop a number of my personal skills which have been invaluable for my professional development. I gained experience with dealing with a number of situations which have been applicable in interviews and day to day working life. The concepts we were introduced, such as user stories and design, have been fundamental in my career and provided me with basics I’ve been able to develop on.
- As a first experience regarding applying my knowledge into practical work in the business world, it broke some of my beliefs and also made me believe that all the hard work towards university hadn’t been in vain. The experience also clarified that engineering/programming was definitely what I wanted to do in my future.
- Since the innovation camp I have exclusively worked in R&D. If it wasn’t for that I am not sure if my professional career would have developed the same way. I have put extreme emphasis to work with state of the art technologies and innovations in general.
- It was a good switch from theoretical knowledge on university to practical work as a professional.
- It was very positive but of course it was only three weeks long. I would say it was the first time we worked together in a multidisciplinary team which was very useful for all of us.
- I have found a job thanks to the certificate from B&O
- I am currently a PhD student. In this area thinking of new ideas and bringing them to life is crucial. The B&O Camp has helped me develop the necessary skills to do so.
- I learned to work together with different people from different backgrounds. Furthermore, it is a nice project on my CV. HR people still ask me about this experience.
- Speaking English for 3 weeks and working in the amazing B&O tech-kitchen, surrounded by product/tech-minded people gives not only a lot of knowledge, it also gives a lot of motivation.
- It has given me better social skills and cultural understanding and helped in the process from becoming a student to being a professional. Since the camp I have attended various innovation events. The camp helped me seeing how my education could be used instead of the “normal” way.
- CD-DIP have had significant impact in several ways. First of all, it introduced me to the business aspect of technology - a direction I’m pursuing today. On the camp I also met incredibly capable and fascinating people with whom I have made friends. We motivate each other and try to stay in the work hard/play hard spirit of the camp. Ultimately the camp has been the gateway for my further adventures at an innovation camp in South Korea and a summer program at Stanford Graduate School of Business.
- The camp learns you to think further. What I mean is that when you have an assignment or school/work project the result is mostly determined and set. With the B&O camp we had to consider so much more and I felt that we were really creating something new, something that no one ever thought of. This experience is a real eye opener and very addicting. It motivated me to use this way of thinking in my future projects and work.
- I attended the camp just before my contract started a my current job where I work with a mix of different people, and whereby you have to manage yourself. The CD-DIP program helped me by the challenges we got in a short period of time with a multi-

disciplinary team, and whereby you had to discuss and convince with the team to come to a quick and creative solution. Next to the problem solving, the sales pitch of your creative solution was the key part. If this failed, so if you were not able to convince the audience your solution, you've worked the whole afternoon for nothing. My day-to-day work now as a broker looks quite the same. Also, my English wasn't perfect, so the 3 weeks English only, helped improving my vocabulary a lot.

- The cross-culture teamwork gives us an unique experience of understanding each other. It helps when I try to find a job in a foreign company, because I had already had such experience working together, they would prefer to choose me rather the others.

C.2. Q7: If you have comments to your design process answers, please add them here

- Was impressed at how good other disciplines are at this thing – the machine engineer did some great 3D drawings quite fast!
- The CD-DIP helped to understand that the design process is only a part of the innovation process and that a product has to reflect or create user needs.
- The Camp allowed to improve my product thinking flow and put brainstorming, concept and prototype skills on steroids.
- The fact that we had to work with such different people, meant that I had to make the most of my communication skills in order to understand the others point of views and make me be understood. That meant that almost all the time I had to express myself with drawings, sketches, graphics and flow charts. B&O, I mean the context where we were, also inspired me to excel in my drawing skills.
- Because of my study I could already interpret the user needs into requirements but seeing them being used to form a real physical prototype through a rough sketch made me and the group fill with pride.
- As an engineering psychologist it was not new to me. What was new was to use the methods in a group consisting of people with differences in cultural and educational backgrounds.
- The concept I have developed with my team, personally I consider very poor. I doubt if it really resulted from research we had done. Other team from my camp developed superb concept. It had nothing in common with the research. At first I thought it had been bad, I didn't get that. But then Lyle Clarke presented an excellent explanation to that concept. I understood how good it had been – new and path-breaking. I believe that designing a concept/innovation is about creating/discovering unknown needs and not only satisfying present existing needs.
- I think it was really great putting everything on the walls and setting really tight deadlines for coming up with ideas and then combine these with other peoples ideas.
- Before participating in the camp, a product was just a set of features that we thought to be “cool” while paying minimum attention to actual user needs. While I have certainly not become an expert on the subject, I still became aware of the discipline and it made me change my approach to product development.

C.3. Q10: If you have comments to your creativity answers, please add them here

- Some of the ways to bring forth ideas for concepts was new to me at the time. Being the team leader for my team I definitely improved my ability to act as a facilitator of creativity. The camp's strength in the form of the interdisciplinary teams really made the role interesting, as I learned to appreciate and utilise the diverse skills that everyone

brought to the table to come up with creative solutions that would never have been created among peers in the same field of study.

C.4. *Q18: If you have comments to your team answers, please add them here*

- feeling all the theory in the real world, helped my learning process speed up far more than all the classes about this subject together
- The biggest gain I got from the camp was dealing with communication/conflict as a result of multi-disciplined and cultural teams. It gave me an insight into what I was to expect as a project manager; having to deal with these issues is something I come across daily.
- I feel we all grew throughout the process, because it wasn't just a small assignment but a project for Bang and Olufsen. We all applied voluntarily during our summer and i saw everyone give it their best. Thats why we all made big steps and got better at all these points.
- It taught me that it is the 'Idea' or concept that is important, not who made it up or continue to develop on it. It taught me to put aside my own pride and how to encourage my teammates to go on developing on their ideas, when theirs where better.
- In my team I experienced a conflict grounded in cultural differences. The conflict escalated to the point where I as the team leader had to bring everything to a halt and change the environment so we could solve the conflict. We managed to identify the cause and solve the conflict which enabled us to continue the work in a significantly more productive manner. I have since then become more aware of the potential challenges that intercultural work are very likely to cause. The situation has in educational context been used to illustrate the cultural differences between western and eastern culture.

C.5. *Q24: If you have comments to your Business Understanding answers, please add them here*

- During the program we got feedback from different disciplines. This made us feel Bang and Olufsen was really committed too. It made us feel we were not only learning but could also give something back to Bang and Olufsen. It was almost like a clockwork where we got better every iteration thanks to the team-manager, experts and professors as well. This gave us a real life example of the product development lifecycle.
- I loved the setting of this camp, and the product that we had to create. Being in China when you are making a product for China really creates a next dimension on product development

C.6. *Q29: If you have comments to your System Thinking answers, please add them here*

- Never before have I experienced going into an enormous city such as Shanghai together with a local student to find and buy a secondhand car door to visualise our concept. The camp lures you into thinking "out of the box" and to sometimes look over problems and lack of information to still create and present something extraordinary.
- It was very useful to see that the B&O team was creative and able to think out of the box, but still very good on thinking one step ahead and reflect that to us. In other words, they recognised useful innovative ideas/thoughts and useless ideas in a very soon stage. Therefore, they could guide us so we were not working on useless ideas.