

WORK INTEGRATION SOCIAL ENTERPRISES: A TESTBED FOR CHALLENGE-BASED LEARNING?

Marco Bertoni

Department of Mechanical Engineering, Blekinge Institute of Technology

ABSTRACT

Work Integration Social Enterprises (WISE) are a particular enterprise form permeated by a so-called 'double business idea'. Besides the commercial imperative of providing product and services, WISE offer employment and training opportunities for individuals considered less able to compete in mainstream labour markets. The paper argues that this multiple goal structure makes WISE an ideal testbed for Challenge-Based Learning (CBL). The latter deepens both problem-based learning and CDIO, by featuring open-ended problems that stress an entrepreneurial, value-driven and sustainable approach to problem formulation and decision-making. The aim of this paper is to describe how real-life design projects conducted in collaboration with WISE take CBL a step forward compared with those involving more 'traditional' enterprise forms. Evidence is gathered along 4 main lines of thought, which are: 1) iterative problem formulating and designing; 2) entrepreneurial mindset and of value-driven learning; 3) social sustainability-aware designing; and 4) social-constructed learning. The findings indicate that WISE-based design experiences bring forward additional characteristics compared with more 'traditional' engineering ones. Students are able to expand the scope and depth of their problem identification and formulation activities, due to the continuous dialogue with a broad range of stakeholders, enthusiasts, and volunteers. They become more aware of the multifaceted meaning of the word 'value' in engineering, realizing the existence of competing value systems for the design problem. Eventually, their decision-making activities emphasize the pursuit of different goals and objectives (e.g., technical feasibility, business viability, and sustainable development) in the design process.

KEYWORDS

Challenge-based learning, project-based learning, Work Integration Social Enterprise, entrepreneurial mindset, global engineer, Standards: 5,7,8.

INTRODUCTION AND OBJECTIVES

Engineering systems today are characterized by increasingly complex and multifaceted values, and engineers must become aware not only of the economic and technical aspects of a design but shall also be able to grasp 'softer' and more intangible value dimensions in their work (Huntzinger et al., 2007). The tension between these growing needs in contemporary undergraduate engineering education is a major driving factor in the development of the

Conceive-Design-Implement-Operate (CDIO) framework (Crawley et al., 2013), as well as in the definition of learning outcomes that are more holistic and closer to the professional role of the contemporary engineer (Splitt, 2003).

In recent years, the original CDIO concept has evolved to highlight the need for engineering graduates to use design as 'learning through' rather than 'learning to' experiences (Malmqvist et al., 2015). Challenge-based learning (CBL) (Kohn Rådberg et al., 2018) is then proposed as an evolution of CDIO and more traditional problem-based learning approaches. CBL is inspired by the idea of 'grand challenges', which are described as issues that critically need to be addressed to ensure a sustainable future for the generations to come (Al-Atabi, 2013). Grand challenges are a cornerstone of national research and innovation agendas (see: European Commission, 2014) and inspire the design of learning experiences that foster the identification, analysis, and design of a solution to a socio-technical problem.

Sustainability is a critical dimension to be leveraged when designing CBL experiences. Nevertheless, while the introduction of social sustainability aspects in engineering education is of foremost importance for the creation of a 'Global engineer' (Bourn and Neal, 2008), sustainability is often confined to environmental aspects and suffers from the underdevelopment of the social dimension (Missimer et al., 2017).

The main aim of this paper is to provide evidence of how innovation projects with Work Integration Social Enterprises (WISE) represent a step forward in leveraging a social sustainability dimension in engineering education and CBL. WISE are a particular enterprise form that, besides the commercial imperative of providing product and services (e.g., cafés, laundries, recycling centres, and others), offers employment and training opportunities for individuals considered less able to compete in mainstream labour markets, such as the physically and developmentally disabled (Cooney, 2016). While obeying the commercial logic of efficiency, profitability and competitive rivalry, WISE also serve a social welfare logic, maximizing a program of supportive intervention to produce results for its beneficiaries.

Intuitively, WISE are of great interest when it comes to foster competing 'value systems' and objectives in problem-based learning experiences. Hence, this paper argues that their multiple goal structure makes them an ideal testbed for CBL. Yet, in spite of their intriguing mix of business and social values, little is known about the pedagogical benefits of choosing WISE as case study providers in engineering education.

Emerging from 9 innovation projects conducted within the Value Innovation course at Blekinge Institute of Technology (BTH) between 2016 and 2018, the objective of this paper is to describe how real-life design projects with WISE have the potential to take CBL a step forward compared with projects involving more 'traditional' enterprise forms. The evidence is gathered along 4 main lines of thought, as presented in the following sections, which are: 1) iterative problem formulating and designing; 2) entrepreneurial mindset and of value-driven learning; 3) social sustainability-aware designing; and 4) social-constructed learning.

ENGAGING WISE IN CBL EXPERIENCES: A LITERATURE REVIEW

The main driving factor for selecting WISE as case study providers are to ensure a quality design-implement (D-I) experience for students. Advanced D-I experience (Crawley et al., 2011) are key features of CDIO programmes. These are characterized by tasks of increased complexity and authenticity that allow students to design, build and assess an actual product, process or system in a way that the object created is operationally testable. CBL experiences are further described as learning situations that expand and deepen both problem-based learning and CDIO (Kohn Rådberg et al., 2018) (Figure 1). In problem-based learning, students are posed with a design, research or diagnostic 'problem', and the learning takes place through the process of working out the solution (Hmelo-Silver, 2004). CBL finds the starting point in

large open-ended problems and stresses a value-driven approach to problem formulation and decision-making (Malmqvist et al., 2015) while addressing societal concerns and fostering an entrepreneurial mindset and working method.

In CBL, products are still developed through a process of conception, design, implementation, and operation. However, a stronger focus is put on problem identification and formulation, on establishing a dialogue with core stakeholders, on the business model components of engineering solutions, and the societal context and impact of a product rather than just the corporate benefits (Kohn Rådberg et al., 2018). These experiences also expand on the meaning of 'values' and 'ethics' in addition to customer needs in decision-making.

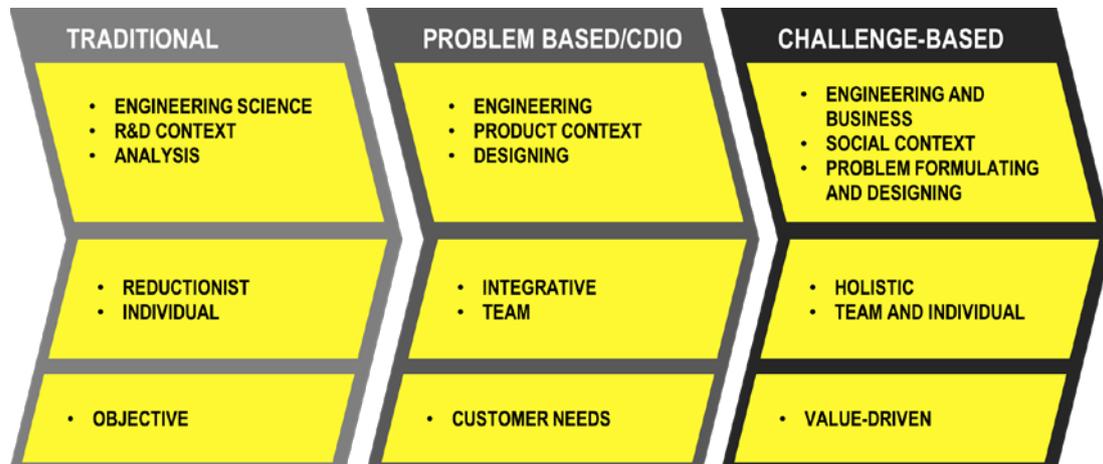


Figure 1: Evolution from traditional to problem-based to challenge-based education (adapted from Malmqvist et al. 2015).

The opportunity to exploit principles of Design Thinking (DT, a key component of CBL according to Kohn Rådberg et al. 2018) has long been debated (Melles et al. 2012), mainly as a way to move beyond today's conventional problem solving in social enterprises (Brown and Wyatt 2010) and to generate ideas with superior social sustainability content (Vezzoli et al. 2017). The literature proposes several DT application examples in the domain of social innovation and social entrepreneurship, such as those documented by Selloni and Corubolo (2017), Chou (2018) and Mosely et al. (2018). Nowadays, Design Thinking is also part of the innovation toolbox for the development of social enterprises incubated at the National University of Singapore (Prakash and Tan 2014).

Pirson and Bloom (2011) are among the firsts to highlight the critical role of DT in curriculum design from the perspective of educating social entrepreneurs. The application of DT in social enterprise-based projects is shown to stimulate the generation of more creative solutions to solve existing problems (Kickul et al. 2018) and to facilitate learning as students create and incubate social ventures (Coakley et al. 2014). Yet, literature does not analyse in detail the pedagogical impact of engaging social enterprises in engineering education, and little information is provided about the additional characteristics brought forward by these projects compared with more 'traditional' engineering experiences.

DEVELOPMENT OF THE 'VALUE INNOVATION' COURSE AT BTH

Recent literature has highlighted the benefit of value creation projects for engineering education (Bosman and Fernhaber, 2018). These projects connect the traditional scientific method and the engineering design process to business and marketing, through a focus on

'goals' rather than on 'problems'. This iterative process promotes a method of solution-focused thinking, which encourages engineering students to think outside the box and to apply active learning and creative thinking to theoretical concepts. Furthermore, value creation projects increase motivation for learning by allowing students to see the value by connecting real-world applications to the class topic (Bosman and Fernhaber, 2018).

Value Innovation is a 7,5 ECTS Master Programme course at Blekinge Institute of Technology. The expression 'value innovation' originates from innovation management literature. It refers to the creation of new and uncontested market space through the development of solutions that generate a leap of value for customers and users, while reducing cost and negative impact on our planet and society. The main objective of the course is to raise students' understanding of how to develop innovative products and services with a focus on value creation, going from the analysis of customer and stakeholders need, to the generation of innovative concepts, to the creation and verification of value-adding prototypes. The course introduces students to the Design Thinking (DT) methodology framework (Leavy, 2010). This represents a paradigm shift from the traditional linear problem-solving approaches and fits well with design situations dominated by ambiguity and lack of knowledge (wicked problems).

The course features lectures on design and innovation, which include a mix of short theory reviews and active work in different group constellations. These are complemented by workshops and class exercises that give participants a first-hand experience of the most relevant tools in the DT toolbox. Importantly, course participants are given the opportunity to apply the acquired theoretical base in a 'real-life' development project conducted in collaboration with selected company partners. In line with the CDIO framework, the course is designed with an overreaching project work that kicks-off just after the course introduction and stretches along the entire period of the study (8 weeks). Each project is conducted by small cross-functional design teams (4 to 6 participants), which mix students from the Master Programmes of the industrial economy (year 4), mechanical engineering (year 5) and sustainability innovation (year 4).

Experience and lessons learned from the project work are shared during presentation events in the classroom, while peer evaluation and group coaching (feed forward) are used to stimulate critical reflection regarding the process and the results. Results are gathered in a written report, which constitutes the basis for grading. Individual self-reflections aim at further stimulating students in learning about methods and tools for value innovation.

Redesigning Value Innovation: leveraging WISE collaborations to foster CBL

An important aspect of designing value innovation projects concerns the Operating stage of the CDIO model, which is acknowledged to be the most difficult phase in an academic setting. As discussed by Biggs and Tang (2011), students need to expect success when engaging in the learning task because nobody wants to do something they see as worthless.

At the end of the 2015 edition of Value Innovation, there was a general feeling of "pointlessness" with regards to the design challenges featured in the course. Students expressed their dissatisfaction with the idea of conducting "bold projects" with large Original Equipment Manufacturers (OEM), mainly due to the intrinsic difficulties in measuring the value added of their work when embedded in the larger processes of a multinational enterprise. Furthermore, the analysis of the students' self-reflection reports at the end of the course highlighted a widespread will to apply their knowledge for the good of society.

Several participants later approached the author (in the role of course coordinator) to ask for advice on how to exploit the 'value innovation toolbox' for the good of no-profit organizations they were volunteering in, such as the Red Cross and community centres. These inputs suggested the author, in its role of course coordinator, to make the course being part of the

European project “Social including och Tillväx i Blekinge” (in English: “Social Inclusion and Growth in Blekinge”), with the aim of involving WISE as case study providers in the course.

Working Integration Social Enterprises

The WISE phenomenon emerged during the 1990s, awakening interest across Europe due to its unique business orientation. WISE combine rehabilitation and work training as a way for long-term unemployed to return to the labour market by creating jobs that are adjusted for them. Sweden counts today about 340 WISE that employ approximately 10200 people. The main goods and services being offered are hotel and restaurants services (25%), public services (17%), education (16%), services to enterprises (15%), services to the public administration (15%), and processing industry (9%) (Hulgård and Bisballe 2004).

Due to their unique combination of business and social values, WISE are often described as permeated by a so-called ‘double business idea’ (Peverada, 2016). While traditional entrepreneurship targets the creation of financial returns to its owners, WISE see economic gains most as a means of achieving other (social) goals (Tynelius, 2011), which is supporting people in their journey to employment and self-sufficiency. Importantly, the social dimension is not detached from the business one: at the end of the day, it is the ability to generate (even marginal) monetary returns that allows reaching the social goal (Peverada, 2016).

Design challenges and projects with WISE

Between 2016 and 2018, 9 student projects (involving a total of 8 companies and 42 students) were conducted in collaboration with WISE in the Blekinge region. Table 1 details the challenge addressed the students’ background and the extent to which CDIO was covered in each project. The main aim of all projects was for students to apply the acquired theoretical base in a ‘real-life’ setting, deepening their reflections on the application of different tools thanks to the frequent interaction with selected company partners.

Students were initially asked to describe target groups and customer types in relation to each design challenge. They later analysed the customer experience with regards to existing products/services by using needfinding methods and tools. The analysis of societal and technological trends helped in the development of innovative product-service concepts in the Ideation stage. In the Implementation stage, the students assessed the value of a new system by operating it, physically or virtually.

Table 1: Innovation projects with WISE (A: Problem formulation, B: Idea or model generation, C: Concept development, D: Testing/evaluation within an academic setting; E: Testing/evaluation by external stakeholders).

YEAR	PROJECT NAME	PARTICIPANTS	BACKGROUND	A	B	C	D	E
2016	The Sustainable agriculture experience challenge	5	Mechanical Engineering, Industrial Economy,	x	x	x	x	
	Product Service Systems innovation in caretaking	5	Mechanical Engineering, Industrial Economy	x	x	x		
	Theo-practical education for asylum seekers	4	Mechanical Engineering, Industrial Economy	x	x	x	x	x
	A new value proposition for the textile retail market in Blekinge	3	Mechanical Engineering, Industrial Economy, Sustainable Product Service Systems Innovation	x	x	x	x	x
2017	Kaffestugan: the ‘all-year-around opening’ challenge	6	Mechanical Engineering, Industrial Economy	x	x	x	x	x
	Redesigning the car washing experience challenge	6	Mechanical Engineering, Industrial Economy	x	x	x	x	

	Shoe-polishing Product Service System design	4	Mechanical Engineering, Industrial Economy	x	x	x	x
2018	The "socially responsible retail" design challenge	6	Mechanical Engineering, Industrial Economy	x	x	x	
	The "multipurpose service centre" design challenge	3	Mechanical Engineering, Industrial Economy	x	x	x	x

EVIDENCE OF CHALLENGE BASED LEARNING

In this paper, evidence of challenge-based learning is gathered mainly from the analysis of the project report and of the individual reflection papers submitted by the students at the end of the Value Innovation course. The analysis of the feedback received in course evaluation reports, together with the follow-up interviews with selected students and other stakeholders served as triangulation method.

A students' perspective on WISE attractiveness for engineering education

The underlying question when collaborating with WISE in engineering education concerns their 'attractiveness' for students in comparison to more 'traditional' company types. As a way to measure this dimension, each student was individually asked at the beginning of the course to rank project proposals from the most to the least preferred. All proposals were presented together in the same format during a project showdown event, describing the challenge by means of a title, a description of the challenge, and a set of expected deliverables related to each phase of the DT process. In the following 72 hours, students were given the task to reflect on and communicate back their preference list to the course coordinator.

Overall, WISE was found to be slightly more attractive for students compared to more 'traditional' company types. In 2016, while 4 of 7 (57,1%) course project proposals featured WISE, 61,3% of the students in the course indicated one of these 4 projects as their first-hand preference. In 2017, WISE projects attracted 48,65% of first-hand preferences while representing only 42,8% of the sample (3 of 7). In 2018, only 28,5% of the proposals (2 of 7) featured WISE, gathering 21,8% of first-hand preferences. WISE was also observed to attract a more mixed student population when looking at gender distribution. Among those who indicated WISE as their first-hand choice, about 70% were men and 30% women, which differs from projects in collaboration with more 'traditional' enterprises (85% man and 15% women).

Evidence of iterative problem formulating and designing

A recent study from Nespoli et al. (2018) shows that most design problems currently addressed by engineering students during their academic terms are still broadly-defined (as opposed to not-defined or ill-defined), only requiring the application of coded technical and scientific knowledge. However, the problems that are encountered when exercising the engineering profession "tend not to present themselves to practitioners as problems at all but as messy, indeterminate situations" (Schon, 1987, p. 4). While disciplinary knowledge prepares students to "solve the problem right", the integration of broader skills is necessary to teach them to "solve the right problem". Hence, the problem formulation is a main distinguishing characteristic of CBL, as well as a critical capability to master when working on issues and challenges related to sustainability (Kohn Rådberg et al. 2018). Multiple stakeholder expectations, as well as multiple disciplines, need to be taken into account when framing and analysing a problem.

Table 2 shows the level to which the design challenge was iteratively formulated from the description provided at the beginning of the course (i.e., at project showdown event).

Noticeably, most of the initial formulations were iterated and significantly refined emerging from the findings of the Initiation and Inspiration stage of the DT process, as well as from the continued dialogue with the collaborating company partners.

Table 2: Extent of problem reformulation from the initial design brief

YEAR	PROJECT NAME	EXTENT OF REFORMULATION	INITIAL PROBLEM FORMULATION	ITERATED PROBLEM FORMULATION
2016	The Sustainable agriculture experience challenge	SIGNIFICANT	Development of a machine for recycling plastic to be used in an existing showroom.	Development of the showroom experience within the sustainable agriculture theme.
	Product Service Systems innovation in caretaking	MODERATE	Development of subscription packages for caretaking services.	Development of a servitized business offer (Product Service Solutions) for catering food.
	Theo-practical education for asylum seekers	MINIMAL	Development of education and training activities for asylum seekers.	Development of an educational experience including practical training for asylum seekers.
	A new value proposition for the textile retail market in Blekinge	MODERATE	Development of innovative textile product (one-sale model).	Development of servitized solution for the textile retail market including communication channels
2017	Kaffestugan: the 'all-year-around opening' challenge	MINIMAL	Development of a new business offer for a café.	Development of the café' experience to make it attractive during winter months.
	Redesigning the car washing experience challenge	MODERATE	Development of a car washing service for private customers.	Development of a car washing experience including layout and work scheduling support design.
	Shoe-polishing Product Service System design	SIGNIFICANT	Development of a shoe polishing service.	Development of a Product Service System solution to wash and recondition work clothes.
2018	The "socially responsible retail" design challenge	SIGNIFICANT	Development of a retail business idea for a centrally located facility.	Development of an adventure park based on the 'anger room' theme
	The "multipurpose service centre" design challenge	SIGNIFICANT	Development of a multi-purpose service center for a rural community	Development of an adventure park based on the 'Wipeout' theme including service facilities

WISE were observed to be successful, in most cases, in stimulating students in independently formulating the problem to be addressed. The analysis of the students' reflection reports shows further evidence that collaborating with WISE was beneficial to leverage the ability to deal with wicked problems. WISE were perceived to be more 'heterogeneous' than traditional enterprise forms due to the unique context in which these companies operate. Each problem was perceived to be novel and inimitable, and solutions needed to be carefully developed on that basis, reinforcing the wicked dimension. WISE students were also observed to be comparably more aware than their counterpart that no single design solution is either 'good' or 'bad', but that there are multiple different ways of addressing the problem that are not always compatible with each other. Also, they appeared more aware that a solution may be favourable at one point in time, but highly problematic at another, which is one of the driving characteristics of wicked problems with a sustainability orientation (Lönngren, 2014).

Evidence of an entrepreneurial mindset and of value-driven learning

Engineering graduates are often comfortable — and sometimes quite good at — focusing on the technical feasibility of a solution. Yet, CBL highlights the need to foster an entrepreneurial mindset in the engineering graduates, designing solutions with the value proposition and user needs in mind, and not simply based on technical and functional concepts (Bosman and Fernhaber, 2018). This is because there are many innovations that are technically feasible but

that do not make any business sense, failing from customer desirability and business viability point of view. Hence, challenge-based experiences, differently from traditional problem-based learning, shall be conceived to serve a broader purpose than just 'designing' hardware, so to contribute to added value for the society (Kohn Rådberg et al., 2018).

The analysis of the data gathered both from the final project reports and from the individual reflection papers aimed at verifying in what way do WISE promote an entrepreneurial mindset among students. One way to measure the ability to expand the traditional 'functional' and 'performance' view (typical of Basic level courses) to include softer aspects of value, was to scrutinize the type of criteria used to select innovative design concepts at the end on the project Ideation stage. Students collaborating with WISE were able to address, on average, a broader range of stakeholders when defining concept selection criteria, compared with other groups. Importantly, the customer satisfaction dimension account only for about half of the criteria used (on average) by each team to measure the 'goodness' (i.e., value creation) of a design concept. The other half of the criteria include aspects related to the provider organization, to the employees working environment and to other stakeholders (e.g., employment agencies, mentors, etc.). The same phenomenon is not observed with the same intensity among the more students collaborating with more 'traditional' enterprises.

Evidence of social sustainability-aware learning

Graduating engineers are expected to demonstrate insight into opportunities and limitations of technology, its role in society and people's responsibility for how it is used (Kohn Rådberg et al., 2018). CBL experiences must have then a strong focus on the social impact of design (see: Malmqvist et al., 2015), fostering awareness on and developing skills for socially-sustainable design. Hence, the project reports were further analysed from the point of view of how much the different projects include aspects related to social sustainability in designing and selecting solutions for the given design challenges. The 5 social sustainability principles described in the FSSD framework (Missimer et al., 2017) were used as a reference to verify whether students embedded a social perspective in their work. These principles are described as:

- *Health*: individuals shall not be exposed to social conditions that systematically undermine their possibilities to avoid injury and illness; physically, mentally or emotionally, e.g. dangerous working conditions or insufficient wages.
- *Influence*: individuals shall not systematically be hindered from participating in shaping the social systems they are part of, e.g. by suppression of free speech or neglect of opinions.
- *Competence*: individuals shall not systematically be hindered from learning and developing competence individually and together, e.g. by obstacles for education or insufficient possibilities for personal development.
- *Impartiality*: individuals shall not systematically be exposed to partial treatment, e.g. by discrimination or unfair selection to job positions.
- *Meaning-making*: individuals shall not systematically be hindered from creating individual meaning and co-creating common meaning, e.g. by suppression of cultural expression or obstacles to co-creation of purposeful conditions.

Table 3 shows that most of the project teams included social sustainability aspects in the definition and evaluation of ideas, showing good awareness on the use of 'social lenses' to measure the goodness of a proposed solution concept. Even though not all aspects of social sustainability are covered in the projects, these are found to be much less leveraged in projects conducted with more traditional enterprise forms, in particular with regards to the 'health and 'competence' dimensions.

Table 3: Social sustainability principles coverage (x: covered, p: partially covered) when defining criteria for design concept selection

Project name	HEALTH	INFLUENCE	COMPETENCE	IMPARTIALITY	MEANING-MAKING
The Sustainable agriculture experience challenge	x				x
Product Service Systems innovation in caretaking			p	x	
Theo-practical education for asylum seekers	x	x	x		
A new value proposition for the textile retail market in Blekinge			x		
Kaffestugan: the 'all-year-around opening' challenge					
Redesigning the car washing experience challenge	p	x	p	x	p
Shoe-polishing Product Service System design	p		p		
The "socially responsible retail" design challenge	p		p		
The "multipurpose service centre" design challenge	p		p		x

Evidence of social-constructed learning

The main reason for introducing WISE in the engineering curricula discussion is that several key issues and skills which define the global dimension of engineering have a social nature. Design work is often understood as a socio-technical business in "the debates about whether the design is 'done', if the specifications have been 'met' and if the result is 'good'" (Minneman, 1991, p.63). Due to the complexity of the target group (i.e., long-term unemployed individuals), WISE are usually started in the form of projects, involving regional and local development funds, mentors, care institutions, career supporters, unemployment agencies and other professionals (Peverada, 2016). This strong multi-stakeholder structure was found to facilitate the social construction of knowledge among the nine student teams. WISE were observed to foster the social construction of knowledge among the participating student groups, mainly because they forced them to interact with a wider range of stakeholders than in a more traditional project setting. They were also observed to positively stimulate mutual learning and peer feedback (Elmgren and Henriksson, 2010), mainly because they allowed students to connect not only with business people but also with a variety of enthusiasts and volunteers that were seen as models, to admire and identify with (Biggs and Tang 2011, p.36).

DISCUSSION AND CONCLUSIONS

WISE-based design experiences have shown to bring forward additional characteristics compared with more 'traditional' engineering experiences, fostering a process where students can couple theoretical and practical learning, developing skills in problem formulation and sustainable development. Students have been observed to expand the scope and depth of their problem identification and formulation activities, due to the continuous dialogue with a broad range of stakeholders, enthusiasts, and volunteers. They were also observed to be more aware of the multifaceted meaning of the word 'value' in engineering, emphasizing the pursuit of different goals and objectives and stressing the existence of competing value systems for the design problem. Eventually, WISE represented an eye-opening experience with regards to

recognizing that the value generation process is not merely a matter of building a solution (feasibility), but also of addressing how customer/stakeholders will react (desirability) and of ensuring that the solution is sound in a business sense (viability).

Future work will aim at consolidating the use of WISE as case study providers, strengthening the collaboration with all the different actors involved. The inclusion of the Value Innovation course as part of regional incubator for WISE in the Blekinge region (Coompanion, 2018) is considered a step forward in this perspective. Future work will also be dedicated to strengthening practices with regards to the supervision and tutoring of the project groups. One major factor affecting successful project work and learning process was the guidance provided by the course coordinator acting as a tutor. Active involvement and guidance were required, especially during the first weeks of the project. Most of the guidance took place in project work sessions, where noticeable differences were observable between the groups. These sessions shall ensure that students working with WISE can reach the required technical depth for design solutions to be implemented and operated. This means finding the right trade-off between the time spent on development work and the time spent to interact with the actors in the WISE network. It could also be observed that some groups are more innovative and get started with the project very fast, while others require more support. It requires professional skills from the teachers to see where and when additional guidance is required, yet still remaining purely as a tutor and not to influence the problem-solving process by providing solutions.

REFERENCES

- Al-Atabi, M. (2013). GRAND CHALLENGES FOR ENGINEERING AND DEVELOPMENT OF CDIO SKILLS. In Proceedings of the 9th International CDIO Conference, Massachusetts Institute of Technology and Harvard University School of Engineering and Applied Sciences, Cambridge, Massachusetts, June 9 – 13, 2013.
- Biggs, J. B., & Tang, C. S.-k. (2011). *Teaching for Quality Learning at University: What the Student Does*. Maidenhead: Society for Research into Higher Education & Open University Press.
- Bosman, L., & Fernhaber, S. (2018) *Teaching the Entrepreneurial Mindset to Engineers*. Springer.
- Bourn, D., & Neal, I. (2008) *The Global Engineer: Incorporating global skills within UK higher education of engineers*. Retrieved from Institute of Education University of London: <http://discovery.ucl.ac.uk/10000839/1/Bourn2008Engineers.pdf>
- Brown, T., & Wyatt, J. (2010). *Design thinking for social innovation*. Development Outreach, 12(1):29-43.
- Chou, D.C. (2018). *Applying design thinking method to social entrepreneurship project*. Computer Standards & Interfaces, 55:73-79.
- Coakley, L.A., Roberto, M.A., & Segovis, J.C. (2014). *Meeting the challenge of developing innovative problem-solving students using design thinking and organizational behavior concepts*. Business Education Innovation Journal, 6(2):34-43.
- Coompanion (2018) Modell över Blinkens stöd till ASF. Retrieved from Social Inkludering och Tillväx i Blekinge: <http://socialinkluderingblekinge.se/blinken-inkubator>.
- Cooney, K. (2016) *Work Integration Social Enterprises in the United States: Operating at the Nexus of Public Policy, Markets, and Community*. In Nonprofit Policy Forum, 7(4):435-460.
- Crawley, E.F., Malmqvist, J., Lucas, W.A. & Brodeur, D.R. (2011) THE CDIO SYLLABUS V2. 0. AN UPDATED STATEMENT OF GOALS FOR ENGINEERING EDUCATION. In Proceedings of 7th International CDIO Conference, Copenhagen, Denmark. June 20 – 23, 2011
- Crawley, E., Malmqvist, J., Östlund, S., Brodeur, D. & Edström, K. (2014) *Rethinking Engineering Education: The CDIO Approach*. 2nd ed. New York: Springer Verlag.
- Elmgren M & Henriksson A-S (2010) *Universitetspedagogik*, Norstedts.

- European Commission (2014) *Climate Action. DG for Communication*. Retrieved from the European Commission portal: <https://europa.eu/european-union/topics/>
- Hmelo-Silver, C.E. (2004) *Problem-based Learning: What and How do Students Learn?* Educational Psychology Review 16(3): 235–266.
- Hulgård, L., & Bisballe, T. (2004) *Work integration social enterprises in Denmark* (No. 04/08). Working papers series. Retrieved from the PERSE project: https://emes.net/content/uploads/publications/PERSE_WP_04-08_DK.pdf
- Huntzinger, D.N., Hutchkins, M.J., Gierke, J.S. & Sutherland, J.W. (2007) *Enabling Sustainable Thinking in Undergraduate Engineering Education*. International Journal of Engineering Education 23(2):218–230.
- Kickul, J., Gundry, L., Mitra, P. & Berçot, L. (2018). *Designing With Purpose: Advocating Innovation, Impact, Sustainability, and Scale in Social Entrepreneurship Education*. Entrepreneurship Education and Pedagogy, 1(2):205-221.
- Kohn Rådberg, K., Lundqvist, U., Malmqvist, J. & Hagvall Svensson, O. (2018) *From CDIO to challenge-based learning experiences—expanding student learning as well as societal impact?* European Journal of Engineering Education, pp. 1-16.
- Leavy, B. (2010) *Design thinking—a new mental model of value innovation*. Strategy and Leadership. 38(3):5-14.
- Lönngren, J. (2014) Engineering Students' Ways of Relating to Wicked Sustainability Problems. Licentiate Thesis, Chalmers University of Technology, Gothenburg, Sweden.
- Malmqvist, J., Rådberg, K.K. & Lundqvist, U. (2015) COMPARATIVE ANALYSIS OF CHALLENGE-BASED LEARNING EXPERIENCES. In Proceedings of the 11th International CDIO Conference, Chengdu University of Information Technology, Chengdu, Sichuan, PR China.
- Melles, G., Howard, Z., & Thompson-Whiteside, S. (2012). *Teaching design thinking: Expanding horizons in design education*. Procedia-Social and Behavioral Sciences, 31:162-166.
- Minneman, S.L. (1991) *The social construction of a technical reality: empirical studies of group engineering design practice*. Doctoral dissertation, Stanford University.
- Missimer, M., Robèrt, K.H. & Broman, G. (2017) *A strategic approach to social sustainability—Part 1: exploring the social system*. Journal of Cleaner Production, 140:32-41.
- Mosely, G., Wright, N. & Wrigley, C. (2018). *Facilitating design thinking: A comparison of design expertise*. Thinking Skills and Creativity, 27:177-189.
- Nespoli, O., Hurst, A. & Russell, J. (2018) FACILITATING NEED FINDING AND PROBLEM FORMULATION DURING COOPERATIVE WORK TERMS THROUGH VIRTUAL INSTRUCTION-PILOT IMPLEMENTATION RESULTS. In D. Marjanović, D.; M. Štorga, M.; S. Škec, N. Bojčetić, N. Pavković (Eds.) *Proceedings of the 15th International DESIGN Conference (DESIGN)*, May 21st-24th, Dubrovnik, HR.
- Peverada, E. (2016) Stödstruktur för ASF i Norrbotten: slutrapport. Retrieved from Coompanion Nord, https://nord.coompanion.se/wp-content/uploads/sites/30/2016/06/Slutrapport_Stödstruktur_juni2016.pdf
- Pirson, M. & Bloom, G. (2011). *Dancing with Wolves? Social Entrepreneurship Between Promise and Challenge for the Business School and the 21st Century University*. Fordham University Schools of Business Research Paper (2012-001).
- Prakash, R. & Tan, P. (2014). Landscape of social enterprises in Singapore. Asia Centre for Social Entrepreneurship & Philanthropy (ACSEP).
- Schon, D.A. (1987) *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Profession*, Jossey-Bass, San Francisco.
- Selloni, D. & Corubolo, M. (2017). *Design for Social Enterprises: How Design Thinking Can Support Social Innovation within Social Enterprises*. The Design Journal, 20(6):775-794.
- Splitt, F.G. (2003) *The Challenge to Change: On Realizing the New Paradigm for Engineering Education*. Journal of Engineering Education 92(2):181–187.

Tynelius, U. (2011) *Arbetsintegrerande sociala företag - användning och behov av statligt finansieringsstöd*. Retrieved from Sofisam:
<https://sofisam.se/download/18.3453fc5214836a9a47297c50/1472023483059/Tillväxtanalys,%20Arbetsintegrerande%20sociala%20företag,%20användning%20och%20behov%20av%20statliga%20finanser.pdf>

Vezzoli, C., Kohtala, C., Srinivasan, A., Xin, L., Fusakul, M., Sateesh, D., Diehl, J.C. (2017) *Product-service system design for sustainability*. Routledge, New York, NY, 2017.

BIOGRAPHICAL INFORMATION

Marco Bertoni is Associate Professor in Product Innovation and at Blekinge Institute of Technology, Karlskrona, Sweden. His research focuses on how knowledge from the later phases of a system's lifecycle (about how the product is manufactured, operated, maintained, upgraded, remanufactured or recycled) can be systematically captured in executable models to support decision-making activities during preliminary design. His teaching activity features involvement in several undergraduate and graduate courses in the topic on product development, systems engineering, Product-Service Systems design and engineering knowledge management.

Corresponding author

Associate Professor Marco Bertoni
Blekinge Institute of Technology
Department of Mechanical Engineering
SE-37179 Karlskrona, SWEDEN
+46-455-3670
marco.bertoni@bth.se



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).