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COLLABORATIVE INNOVATION: A STUDY OF CREATIVE TEAMWORK IN OFFSHORE INDUSTRY AND IN DESIGN EDUCATION

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ABSTRACT
Entrepreneurship is identified as a key activity to creating value to society as well as the successful adaption of the products and services to users' lives. This is why entrepreneurship as concept is finding it's way to the curriculum in higher education. To study how entrepreneurship is implemented through problem-based learning practice two case studies were conducted. The first case was from professional design practice including observation and cooperation process mapping in an offshore project. The key aspect of this project was commercialization of subsea seismic sensor technology. The second case was an example from product design education course module including observations of teamwork meeting, team member interviews and archival studies. The key aspect of this project was commercialization of a service. The concept of collaborative innovation, strategic entrepreneurship and problem framing was used to analyze and compare these two cases in order to study how entrepreneurship can be taught through problem-based learning and thus to identify relevant learning outcomes for project management in design education. While the first case study demonstrated how a company was establishing collaborative network to exchange expertise, the second case study showed how students were involved in idea and opportunity exploration process.

Keywords: *Strategic Entrepreneurship; Problem Framing; Opportunity and Advantage seeking*

1 INTRODUCTION: ENTREPRENEURSHIP IN EDUCATION

Entrepreneurship is important for national economies as it contributes to job creation, productivity and economic growth. [1] Innovation and entrepreneurship are rapidly finding the way into higher education curriculum across the fields and subjects. University college education that is practical and implemental is particularly expected to provide better understanding to their students of how innovation happens and how its being commercialized [2]. In response to this trend, the product design curriculum at a university college has been adjusted to incorporate entrepreneurship and direct cooperation with companies. This change is the basis for this case study which addresses the possible effects the role of entrepreneurship might have if included as a study module in a design-oriented bachelor program. One of the subjects on Institute for Product Design is especially dedicated to this goal, incorporating a course plan similar to start- up camp -'gründercamp' being organized by Norwegian organization Young Entrepreneurship -'Ungt entreprenørskap'. The course plan similarly to the start- up implements cooperation and coordination of a student group, real problem from a real client and a tight deadline of four weeks to final idea implementation and presentation.

1.1: Situated creativity in problem based learning

In this design education setting, students are using theoretical knowledge and skills to solve practical problems where the problems are vague and undefined [3]. Students have to be able to collaborate in order to learn fast, define and solve problems [4] throughout problem -based learning activity. This approach allows students to construct knowledge individually and co-construct through interaction with environment instead of getting knowledge transferred by a teacher. However, this interaction is limit by the participants in the learning process in this case students and teachers. As innovation occurs on many levels in product development, from ideation to execution, the perspective of involving students with external partners can be valuable for both problem –based learning and

collaboration skills. Although the value creation is the goal defined in this practice [5], it seems to be unclear what the gain is in this type of collaboration in school setting for both companies and students. There is a need to expand knowledge about this education practice, reflected in a pedagogical model that includes practice in collaborative design work. The research question therefore is: How can problem based learning be enhanced through establishing design network? This question will be discussed in relation to what extent the product designer can be situated in the creative process through a collaboration network.

2 METHOD: EMBEDDED CASE STUDY

2.1 Case study and participatory methods

Case study was chosen because there was a need to exemplify theory in the field [6] from a realistic professional context [7]. In order to understand how collaboration and innovation are managed in practice a relevant design project from the offshore industry was chosen for the case study. Participatory design approach [8] was used to gather the documentation from offshore field work in order to examine the organizational structure and dynamics of cooperation between participants in the process. Case study contains observation of a student group doing their project to gain direct information about their everyday practice and perspective concerning design process in school setting [9]. This project had a cooperative value, defined goal, but with an open ended result expectation, which was needed for this research in order to examine its opportunity seeking character. Archival studies of their project reports were used to analyze their reflection on accomplished project.

2.2 Cross case analysis

In order to study how design collaboration network can give value to problem based learning the concept of strategic entrepreneurship and collaborative innovation [6] are examined. Strategic entrepreneurship refers to firms' pursuit of superior performance via simultaneous opportunity-seeking and advantage-seeking activities. Collaborative innovation is the pursuit of innovations across firm boundaries through the sharing of ideas, knowledge, expertise, and opportunities. The interplay of these two concepts can define the value of external collaboration in higher design education in a strategic sense [10] because it examines how the innovation activities affect collaborative network. The other important aspect of the study is the pedagogical concept of context restructuring and problem framing through reflection in practice [11] that is crucial for knowledge construction in problem based learning and collaborative innovation.

3 RESULTS FROM PRACTICE AND DESIGN EDUCATION

3.1 A case study of collaborative innovation in subsea technology.

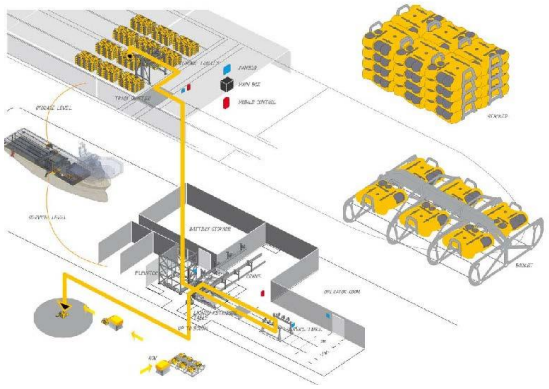

Figure 1. Seismic sensor technology logistics

In this case study the design undertaking was to commercialize seismic sensor technology (fig.1) and explore the possibility of higher scale sales. Technology gave a far richer 4D data that included the time aspect that enabled easy oil and gas detection. By compressing seismic sensor unit size and optimizing handling system, the number of sensor units per vessel was doubled and operating time of

a sensor unit planting reduced to one minute. Seabed, now SeaBird, is the owner of the technology and a seismic vessel was recruiting possible suppliers through series of pilot projects. These pilot projects were time consuming and on one hand, determined processes but on the other hand, opened arena for practitioners in the engineering team to gain new knowledge.

3.2 Strategic innovation: opportunity seeking and advantage seeking

Software and electronics were designed at a separate division in SeaBird that was the core of the new technology. Logistics and design were partly outsourced to a company that suggested including a product designer as a permanent member of the team. A company that was specialized in airport baggage belts for passenger self-service designed the onboard handling system including trolleys and elevators for automatic transport of the seismic sensor units. The system thus was based on engineering skills and knowledge about logistics. The company that specializes in remotely operated vehicle [ROV] navigation executed the subsea sensor unit handling (fig.1). This company was providing the whole subsea navigation service and they were a source of knowledge that enabled the core team to define design demands for the seismic sensor unit and the ROV tool. The sensor unit deployment system and ROV tool that was handling subsea load and placement of the sensor units was fully outsourced to the engineering company that handled high quality mechatronics to sustain active deep-water use. The construction of the sensor unit components were also outsourced to the series of companies. A metal frame and metal vessels were outsourced to a company specializing in metal processes and this knowledge transfer has influenced the frame design and handling procedures. The sensor unit shell was produced by the company specialized in rotational molding that allowed design of numerous multipurpose features of the sensor unit for both onboard, subsea handling, maintenance and human interfaces. The team leader stated that '*The crucial factor for innovation success was early, initial involvement of suppliers through pilot projects. This allowed the team not only to make strategic partnership decision but also learn new practices they were not familiar with'*. The Seabed team was constituted by two chief operators that were working both on development in the laboratory and offshore operating seismic procedures on the vessel. Others in this team were an engineer, a chief developer engineer and a product- designer that was outsourced from another company. The designers' role was to design systems and product features, but also to facilitate discussions through visualizations, animations and concept generation by exploring supplier's competencies. The product designer was working daily with chief operators on human aspects through participatory design. Daily decisions were made through discussions and operation mockups. This understanding enabled the designer to facilitate assembly and operating system procedures through manuals and user interfaces. The product designer was working intensely with an engineering team but also communicating on daily basis with suppliers about solutions and thus organizing relevant discussion topics. In practice it took a lot of testing of the sensor unit handling system. The tests demonstrated that the results were fair but also that the system needed improvement. The commercial goal was achieved when an average sensor unit planting operation took one minute. At that point it was not just technological improvement but provision of a relevant service. The process was generative and the participants were expanding their knowledge as well as making solutions. In this approach both people adjusted to the system and the system were adjusted to people. The design project got Honors Award for Design Excellence at the annual evaluation of Norwegian Design Council. It was also nominated for Best Design in British Design of the Year 2010. The concept was characterized as innovative and benefits were identified to especially contribute to functionality in terms of logistics and timing but also branding. It changed the perception of the clients of the data sales service.

3.3 A case study of collaborative innovation in design education.

The goal of the second case study was to exemplify a student project in context of educational setting similar to start -up camp as mentioned in the introduction. In this subject module problem -based learning was set to simulate a design office with young design entrepreneurs providing their services to their first client. Prior to this subject module, students were trained for two weeks in different skills: third year students in dynamic project leadership; second year students in branding, presentation and communication; and the first year students in mockup building and workshop equipment. The design students were then merged in several groups of up to twelve students across the three years of bachelor program. Each group was organized so that each class could exercise the theoretical knowledge they had gained in previous two weeks. The thought behind this subject module was that students were

encouraged to use design creativity to exercise innovative entrepreneurship [12] and to use design as tool for commercializing new technologies with focus on human factors. The pedagogical goal was to facilitate develop self- efficacy, motivation and independency as well as sense for responsibility and value creation [13]. A student group was observed during a 4 weeks period in November and December 2012, and interviewed after the concept generation phase and at the end of the project. They were told that observation and interviews were conducted as part of the subject evaluation.

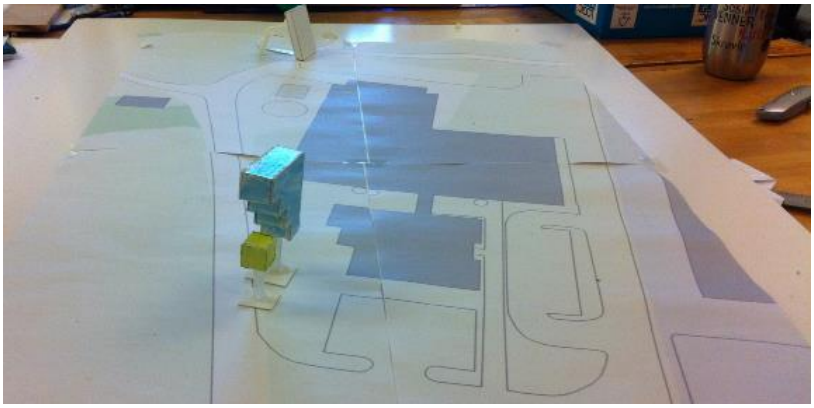

Figure 2. Akershus Energy information board

The project was carried out in cooperation with Akershus Energy, a local hydro energy plant company providing house heating. In order to stay competitive the plant has to implement new technologies and widen harvesting capacities to be able to reduce prices. The plant was therefore seeking the opportunity to expose itself to the local community, raise the awareness of its benefits to environment, create goodwill and raise satisfaction among the customers. The students gathered information about the energy plant and concentrated on the building surroundings. They examined what are the values their partner wants to communicate, what it means for the community. They have defined the framework of the project, in terms of system demands where the focus was on information delivery and education in terms of cognitive, sensory and values communication with the user. Students have used concept generation as a main tool to explore the problem, discover and discuss potential new product demands. The results for the concept generation period showed that the first group had not considered any other design aspects than those that were discussed with the client, that the client had pointed out or that they have discovered themselves through concept generation. Students had a weekly review with a client as well as email communication. The leader stated *'We have a tight cooperation with the client and he is providing us relevant information that we need to know'*. After the first round, students were encouraged to get a feedback from previously defined user groups. Conducted interviews with users within their target group influenced their choice of the concept for further development. However, the concepts were not tried by users, but rather further discussed with the client. The final concept was then presented as a 1:3 scaled functional prototype to the client and conclusions were drawn. The students claimed that they were not consulting literature since they had a practical task in a short period to complete, but they stated that they had used methods they already had learned from the previous two weeks training period. The final concept was generated around the idea that the series of attractions for the plant surroundings could provide the vivid experience, learning and motivation for visitors, especially families to come and build more connections with the client through time. The students had focused on creating a '*welcome installation'* for the visitors that would provide information as well as give identity to the area.

4 DISCUSSION: COLLABORATIVE INNOVATION IN DESIGN

4.1 Commercializing technology

In the first case, the company was already delivering seismic data to the offshore exploitation market when it started the project. The company had a goal to seek for advantage on the market by commercializing its incrementally innovated technology [10]. The goal was to enable streamlining of the data gathering process through mechanization and optimization of complex sensor handling logistics (fig.1). The company has established collaborative network by selecting supplier partners

over series of pilot projects for already framed problem. By initiating pilot projects with a number of suppliers the company had chance to examine and decide on knowledge and expertise network needed to solve series of small design problems through collaborative innovation [14].

4.2 Creating the information and knowledge network

In the second case, the company has established cooperation network with students in order to explore the means for the company to connect to its customers in an appropriate way. The goal of this cooperation was to explore opportunities and get ideas for potential further collaboration and problem framing. The goal of the project was decided but the problem needed framing and interpretation, as discussed by Schön [15]. Students then needed to create network by reaching the customers and potential suppliers to discuss realization of their ideas. As this was happening on ideation level, they never got to the point of generating final solutions. They also had to spread in smaller groups, gather the necessary knowledge fast and use it to examine potential concepts. As their resources were lesser and spread, they have not developed this network to the level where sufficient knowledge transfer would occur as a creative flow, as promoted by Csikszentmihalyi [16].

4.3 Strategic entrepreneurship through collaborative innovation

Both small and large firms face weaknesses while pursuing strategic entrepreneurship [14]. While small companies may have strong skills in opportunity-seeking, their limited knowledge resources and lack of market power prevent their ability to enact the competitive advantages necessary to appropriate value from opportunities the firms choose to pursue. In contrast, large firms are skilled at establishing competitive advantages, but their heavy emphasis on the efficiency of their existing businesses often undermines their ability to explore continuously for additional opportunities. In both of the cases, studied companies are managing the strategic entrepreneurship in their customer offering through establishing networks. In the first case the company has established collaboration and in the second case cooperation.

4.3.1 Creation of knowledge network

In the first case the company is managing to maintain its core business while being an owner and developer of the new technology through collaborative network. In the second case the core business is maintained while the new income concepts have been fully developed in collaborative network. The smaller partner companies in these two case studies are also managing their strategic entrepreneurship in a less successful fashion. While most of the suppliers in the first case study profit through knowledge transfer experience and developing a new fields for their consultancies for example, from airport baggage belts to offshore equipment, the new found student design consultancy company is struggling with the lack of knowledge and market power to gain competitive advantage [10] from their design skills.

4.3.2 Concept and knowledge exchange without boundaries

The concept of collaborative innovation emphasizes two aspects: knowledge or expertise and idea or opportunity exchange without boundaries [10]. Opportunity seeking still seems to be a key for small companies where the harm of initial trials and errors are limited by the very size of the company and scope of the project. According to Schön [15] opportunity seeking is explained as a continuously changing problem and context reframing process or idea exploration. This value emerges from discussing and interpreting a design problem. In the two case studies, collaborative network has been used differently. In the first case, the company owning the new technology has the framed problem and is using collaborative network for the knowledge and expertise exchange in order to realize the market potential. In the other case the company with the defined goal but undefined problem is using collaborative network to explore ideas and opportunities.

5. CONCLUSION: IMPLICATION FOR DESIGN EDUCATION

Problem-based learning is according to Bound [3] a co-construction of knowledge in interaction with environment where collaborative networks stimulate students to operate in idea and opportunity exploration area. Although this is of value for students with realistic feedback from the client, the network and collaboration setting is not sufficient for expertise and knowledge exchange. As innovations are happening on many levels [17], students might be missing on learning how to manage

expertise exchange in a project setting. The attempt to put them in the entrepreneurial situation did not fully reflect the real life outside the school.

5.1 Learning outcomes in dynamic project management

The results shown indicate that it is difficult and not likely for collaborative innovation to occur in education where project management is situated in various settings, as proposed for learning through reflective practice [15]. According to educational research strategies learning outcomes should be identified [18]. These relate to knowledge, skills and general competence. Relevant issues identified in the study was within the knowledge domain that students should be able to commercialize incrementally innovated technology. Further students should be able to exchange concepts and knowledge without boundaries. Within the skill domain, students should be able to create and use information and knowledge networks through collaboration not only cooperation. As a general competence, students should be able to manage strategic entrepreneurship through collaborative innovation. This is relevant in entrepreneurship education to be attuned to professional practice. Design educations can contribute to this by enabling interdisciplinary environments for problem based learning and teaching students to use time on development of necessary networks for knowledge sharing.

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