INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
8 & 9 SEPTEMBER 2011, CITY UNIVERSITY, LONDON, UK

STIMULATE STUDENT BUSINESS OUTCOME THROUGH NEEDFINDING-ORIENTED PROJECTS

Anders HÅKANSSON and Bengt HOLMQUIST
Department of Innovation and Design, Luleå University of Technology

ABSTRACT
At the department of Human Work Sciences at Luleå University of Technology, LTU, there is a long tradition of working in student driven product development projects in cooperation with companies in the industry. However, the tasks are relatively well defined and are more like consultant assignments where the students work directly with the companies' problems. The new ambition was to increase innovation and entrepreneurship and through that stimulate the ambition for starting new companies. To achieve this, needfinding methodology based on Patnaik and Becker was introduced. The projects were not defined more than as a few different scenarios. The outcome was a number of unique and innovative solutions. An additional aspect was introduced the third time the course was given. To spice the whole thing up, a company that committed themselves to buy and produce the winning solution was introduced. The outcomes of the projects were a great number of different solutions depending on which target group the students had chosen to focus on and which needs were identified. In the end, several solutions were chosen for production by the company. At least one additional solution was developed into a product and the students in that group started a company in order to realize the product. This approach turned out to greatly stimulate an entrepreneurial approach and develop the students' ability for innovative thinking. To focus towards entrepreneurship and innovation proved to stimulate start-up of new companies and it can also show the students that a self-employed future is realistic.

Keywords: Design, business, needfinding, innovation, prototyping

1 INTRODUCTION

At the department of Human Work Sciences at Luleå University of Technology, LTU, there is a long tradition of working in student driven product development projects in cooperation with companies in the industry. The main structure of these projects is that the university staff develops assignments together with the companies and let the students address these problems during the projects. This leads to stimulating and real tasks where the students are very committed. However, the tasks are relatively well defined and are more like consultant assignments where the students act like the consultants and work directly with the companies' problems. In order to increase the element of innovation and entrepreneurship in the new project, the assignments should be much more diffuse and loosely defined. Within Luleå University of Technology there is an ambition to stimulate innovation and entrepreneurship, e.g. LTU Innovation, which helps students who want to start their own business. On a national level, Sweden's innovation agency, VINNOVA, aims to promote sustainable growth by funding needs-driven research and the development of effective innovation systems [1]. Statistics from the Swedish Agency for Economical and Regional Growth [2] shows that small enterprises represent a major part of the employment in Sweden. Statistics from poll institutes also show the importance of small businesses when talking about economic growth in Sweden. Institutions of higher learning experience an increased demand for courses dealing with entrepreneurship and new venture creation [3]. A survey made by Vesper and McMullan shows that the number of courses dealing with entrepreneurship offered by universities in the United States increased from around half a dozen in 1967 to around 300 in 1988 [4]. Later studies show that this development is still ongoing [5, 6]. The layout of the project was changed to create a freer and more inspiring setting for the students. Instead of receiving a well defined task from a company, the students in this project received a scenario within which they were to identify needs and trying to fulfil those needs through an innovative solution. Carroll [7] introduces scenario descriptions as very useful when managing tradeoffs within usability

engineering. While being both concrete and flexible, scenarios deals with the contradiction of making quick progress and at the same time keeping the design space open. To focus on needs rather than solutions can be motivated by the fact that needs lasts longer than any specific solution [8]. Needfinding is considered as conveying an applied approach to identify, capture and communicate human needs into product development [8]. The project changed when a company was involved. The company is a growth company that designs, acquires and develops brands and products in the corporate promotion, gifts and home furnishings sectors. The company tries to achieve synergies by coordinating design, purchasing, marketing, warehousing and distribution of its product range. To ensure risk diversification, the company markets its products in the corporate promo market and the retail market. The main changes to the project were that, even though the students were free to investigate needs within different scenarios and markets, their solutions had to be more worked through and economically feasible. The fact that the company offered to buy and produce the winning product made the students very competitive and committed. This study describes the changes made to the project part of a third year course at the Industrial Design Engineering program at Luleå University of Technology and the outcomes from those changes.

2 IMPLEMENTATION

One key issue for the program "Industrial Design Engineering" at LTU is to put the theory into practice. To do that, project assignments of different kinds are used frequently during the education. The complexity of the projects increase throughout the education and at the end, the students carry out the projects more or less on their own with only minimum interference from the teaching staff. The project described in this paper is a product design project for the third year students.

2.1 First project layout

The intended learning outcomes, ILOs [9], of this course are to increase the student's knowledge about design methodology, especially methods for their own design activities, and to use physical design models for testing, visualization and decision making. The course consists of two parts. First, a theoretical part where the students get deeper understanding and knowledge of design methodology including needfinding [8, 10], design history, colour and form and the use of design prototypes, and second, a project oriented product development part where the students can put this and previous theory into practice. The time available for the project part is short, only 8 weeks. Initially the project part starts with forming project groups of approximately 3-4 students and presenting fictional scenarios [7]. The scenarios describe situations or contexts and are deliberately vaguely formulated. The tasks for the students are to further define the scenarios, identify needs and select one or more of these needs for which they should find solutions. In general, the students follow a systematic design methodology similar to the ones described by Ulrich & Eppinger [11] and Pahl & Beitz [12]. Initially, a project plan is established including a mission statement and a time schedule in the form of a Gantt chart. This is a working document and subject to change if so needed. To find the needs and to define a target group, needfinding methodology is used. Within needfinding, several sub methods, including observations, interviews, focus groups, personas, etc, are used to interpret the needs. When the needs are identified, ranked and selected according to the target group, a list of demands is created. Creative methods such as brainstorming, creative sketching, models and prototypes, QFD, problem reversal, synectics, lateral thinking, etc, are used to find solutions to the demands. These solutions are combined into concepts that are compared and evaluated according to the needs, the list of demands, benchmarking and the target group. Normally one concept is selected for further development. Usually the final result is a physical prototype or a graphical visualization as a part of the final presentation for the teachers in the course. The results from the projects showed a number of solutions with innovation potential but despite encouragement from the staff, the results stayed as concepts and were not developed further. This innovation potential should be possible to take better advantage of.

2.2 Second project layout

When assessing the outcomes from the projects from the first project layout, it was realized that the ideas and concepts presented by the students were worth developing further. Surveys made among the students in the projects show that the reason for not doing so is mainly because of partial lack of knowledge regarding the process of creating business from ideas. The students possess solid knowledge regarding the product design process in general including creating functional prototypes

but lack the final few steps for commercializing their ideas and concepts. Even though there are teachers in the course, acting as supervisors in the projects, that have own experience of starting and running their own business, the resources for supporting and coaching the students to do so are missing. The main reason for this is that teachers lack the time and possibility to find and create the network of surrounding resources that are needed to commercialize the students' ideas. There are central functions at the university that help the students with business start-up but there are still some steps missing before the product can be launched on the market. The solution to take these steps was to find an external resource that could fill this void. During the search for this external resource, a company that served several purposes in the project was found. Together with the course responsible from the university, they provided the assignment for the students, gave access to their network of subcontractors, offered their knowledge and experience within creating business from ideas and furthermore, they promised to buy and produce the best result from the different projects. Previous studies show approaches to stimulate innovation and entrepreneurship in different ways. The need for real world entrepreneurs taking part in the education is identified [13]. The approach used in the present study where the real world entrepreneur acts, not only as a mentor, but also as a client to the students, is one way of dealing with this fact. By introducing the element of competition and the possibility to make some money, the real world entrepreneur stimulates the students even more to reach a good result. The company provided the students with a number of different scenarios within which the students were to develop product concepts. Within the scenarios the students had to define a target group and identify its needs. The methodology was the same as in the earlier projects but the main difference was that the final result did not stay as concepts. To reach that far in the development of a product in that short time, the students have to be very efficient. One condition for being able to present more or less finalized products is the possibility to create prototypes during the development process. During the project the students were supported by the staff from the university. From the scenarios obtained, the student groups investigated the task further by developing personas and target groups within the scenarios. Recurrent status meetings were held throughout the project. In cooperation with the assigning company, the students developed their concepts into commercial products. The main difference to the earlier project layout where that the steps needed to take the solutions from ideas to commercial products were added. Finally, a presentation of the different products was held where the groups could promote their solution to representatives from the assigning company. Together with the project report, the presentation and the prototypes served as basis for decision when the assigning company chose the winning products.

2.3 Prototyping

Prototypes, either simple early ones or more complex final ones, are an important part of the design process. Simulating a design through prototyping can reduce design risk without committing to the time and cost of full production [14]. Throughout the course, the students have access to a tool work shop where they could build prototypes of different complexity. They also have access to two different Rapid Prototyping systems. Rapid Prototyping, or Additive Manufacturing, dates back to the mid 1980s with the method Stereolithography. The years that followed a large number of different methods were developed [15]. The common characteristic for the different methods are the additive manufacturing approach where a component is built by adding material to the part instead of subtracting material from a work piece. Traditionally there are three general methods to create a complex solid object [16].

1. Subtractive – Take simple stock material (bar, block, etc) and remove unwanted material as in machining.
2. Net-Shape – Take simple stock material (ingot, powder, melt, etc) and reshape the material in a complex die or mold as in forging, molding or casting.
3. Additive – Take relatively complex subunits and add material(s) selectively as in joining processes like welding to create a more complex object.

Rapid Prototyping technologies are capable of producing complex freeform solid objects directly from a computer model of an object without part-specific tooling or knowledge [Ibid.]. A condition for Rapid Prototyping is 3D CAD. The students in these projects possess extensive knowledge in computer based design methods, including CAD. This implies that the students have all qualifications needed for using Rapid Prototyping in their product development process. The CAD model is sent to the Rapid Prototyping machine where it is sliced into layers of 0.05-0.5 mm thickness. The layers are

then produced on top of each other to form the final part. Today, the outcome from a Rapid Prototyping process varies from early form and fit models in plaster or plastic to fully functional metal components. The possibility to directly produce a physical prototype of your concept allows for fast and easy iterative testing and improvement. At the division of Industrial Design at Luleå University of Technology there are two different Rapid Prototyping systems available to the students. During the project, several of the groups use these to create prototypes for testing and presentation of their results. The possibility to do this helps the students to finish their product development project in the short time available.

3 CASE STUDY

Even though the different project groups follow more or less the same methodology and use the same scenarios provided by the course responsible, many different results came out from the projects. Some of these results were implemented as products on the market. One of these projects is described here.

3.1 The project group

The group consisted of four male students. The thought of starting an own company varied within the group. Two of them had clear ambitions to do so after the education while the other two were less interested in doing so. Three of them had role models regarding being self employed, both within their own family and within well known successful businessmen and women. All of them had role models regarding being creative and innovative, mostly within their own family.

3.2 Scenario

Among the offered scenarios the group chose to work with corporate gifts. Together with the assigning company, three different personas were created to further refine the target group. Grudin and Pruitt describes personas as a method for communicating background information from interviews, observations and surveys by presenting them as a fictitious character [17]. They argue that by using personas, several shortcomings in traditional cooperative design techniques can be overcome by making the designers and users more engaged, reducing filtering-out of social and political aspects and aiding when identifying complexity of the problem. The personas in the student project were assigned personal attributes as e.g. areas of interest and marital status.

3.3 Needs

By using needfinding methodology [8, 10], three different basic needs that were common for all personas could be find. The needs where:

- Disorder among important papers
- Uncertainty if locking the front door
- Problems when washing socks

When scoring, interpreting and ranking the needs, the most significant one turned out to be keeping order among important papers. After analyzing the need and discussing it with the assigning company it was considered that most paper management is to be digitalized in the future. Therefore the second most significant need, problems when washing socks, was selected. This need was described as follows:

"Most people are familiar with, or have heard about, how a pair of socks becomes unmatched during washing. No one really knows where the socks go or what happens with them. Many also think that sorting and matching of socks are time consuming and boring. To solve this problem a product that can keep order of the socks during the whole laundry process, from putting them into the laundry basket to the sorting and putting them in the drawer, is needed. The product should save time and be easy to use. It is also of great importance that storing the product between uses is solved in a satisfactory way."

3.4 Development

When the main need was identified, an extensive list of demands and wishes were established. A benchmarking was performed and a number of different existing solutions to the problem were found. When comparing them to the list of demands, none of them fulfilled the demands completely. To achieve a solution that fulfilled all stipulated demands, different creative methods were used. The

ideas generated were then refined into more complex concepts. The concepts were compared and by weighting criteria and calculating merit numbers [11, 12] one was selected for further development.

3.5 Prototyping

To test and compare the concepts and to find weaknesses with them, functional prototypes were created. The choice of material was ABS plastic due to conditions like material qualities, resistibility against chemicals, recycling, etc. Since the choice of material was ABS plastic, the prototypes should also be of ABS plastic. Rapid Prototyping [15] was chosen as the method to produce the prototypes. To produce prototypes as close to the final version as possible, a Rapid Prototyping method that produces parts in ABS plastic was used. The prototypes were then used in a large number of laundry tests and the shape and function were refined several times and verified through further prototype testing.

3.6 Business outcome

The final result was presented to the assigning company and the course coordinator. The result contained, besides the prototype, also an economic overview, design drawings, manufacturing and packaging. The product was considered very promising but did not exactly fit within the profile of the assigning company. Instead of buying the product from the students, the assigning company helped them with contacts within their own network of subcontractors and the students decided to start up their own company to launch the product. As mentioned previously, the teachers in the course did not have resources to be of support in this process but the students used the central functions available within the university for that. Together with the support from the assigning company, this was enough to help the students to launch their own product within their own company. The future plans are to launch the product during the summer of 2011 and the second product is already under development. The students' ambitions are to run a fully operational product development company when graduating.

4 RESULTS AND CONCLUSIONS

There are several good outcomes from the second project layout. The projects had to be carried out in a more professional way than in the earlier layout. Project groups got the opportunity to practice their knowledge very close to reality acting in the role as professional consultants. This creates a more meaningful situation and builds student self-esteem. As fictional projects have shown a tendency to create grade hunting students, another outcome is the change of focus from grades to results. Adding a competition and a promise from the involved company to produce the best results spiced up student commitment to a new level. The concepts from the needfinding process led to model making, tests and prototypes of a quality more close to production ready products. The use of the rapid prototyping equipment and the use of the model making work shop was an important and natural part of the project. Also aspects of economy became of greater importance and the products were developed further. Students also took greater responsibility finding knowledge they felt lacked from previous courses. Questions about intellectual property became of great importance. These questions were handled professionally by support functions within the university. From a comp any point of view, working with students was a creative input to the everyday routine. More ideas than the company had expected were of a quality possible to produce and incorporate in the company collection. This had the outcome that the company is interested in continued cooperation with the university. The outcome for the teachers was more self going projects where students took greater responsibility for their studies than in the earlier project layout. Teachers checked the status of the work in the project groups according to the project plan, scheduled regular monitoring meetings and made sure the projects kept on track. Having 20% of the products developed in the projects implemented as commercial products on the market is a successful outcome. The students in the project groups also started own companies, compared to the first project layout where no companies were started. Some negative consequences were identified. One of these was distrust between the groups having the effect that students became unwilling to share even early results from the process to each other. While evaluating the course layout, it became clear that the feedback to the projects rejected by the client was insufficient. The feedback from the teachers should have been better to these groups because most of them also were of high quality. To finally sum this up, several good effects came out from the new layout. There is an obvious trinity taking benefit from this. Students are training skills in a close to reality project layout, companies having an exchange of knowledge and ideas with students, teachers and university getting

input and confirmation from the industry and this leads to a win-win-win situation [18]. As stated previously, small and medium sized enterprises are considered an important factor for the employment in Sweden. If well designed courses and projects at university level can stimulate start up of new companies it would be of significant importance to government and the society in general.

REFERENCES

[1] http://www.vinnova.se/en/About-VINNOVA/ (accessed 13.53, Feb 21st, 2011).

[2] http://www.tillvaxtverket.se (accessed 09.56, Feb 22nd, 2011).

[3] Clouse, V. G. H. A Controlled Experiment Related Entrepreneurial Education to Students' Start-Up Decisions, *Journal of Small Business Management,* Vol. 28, 1990.

[4] Vesper, K. and McMullan, W. E. Entrepreneurship: Today courses, tomorrow degrees?, *Entrepreneurship Theory and Practice,* 1988, 13(1), pp 7-13.

[5] Hills, G.E. and Morris, M.H. Entrepreneurship education: A conceptual model and review, In: *Educating entrepreneurs for wealth creation*, 1998, (Ashgate Publishing Ltd), pp. 38-58.

[6] Fiet, J.O. Education for entrepreneurial competency: A theory-based activity approach. In: *Entrepreneurship education: A global view*, 2001, (Ashgate Publishing Limited), pp. 78-93.

[7] Carroll, J. M. *Scenario-Based Design – Envisioning Work and Technology in System Development,* 1995 (John Wiley & Sons, Inc).

[8] Patnaik, D. and Becker, R. Needfinding: The Why and How of Uncovering People's needs. *Design Management Journal,* 1999, Spring, 37-43.

[9] Biggs, J. and Tang, C. *Teaching for Quality Learning at University: What the Student Does,* 3rd Edition, 2007 (Open University Press).

[10] Eriksson, Å. and Ståhlbröst, A. In Search of Innovation – Grasping the Concepts of Needs, *The International Journal of Technology, Knowledge and Society,* 2006, Volume 2.

[11] Ulrich, K. T. and Eppinger S. D. *Product Design and Development,* 4th Edition, 2008 (McGraw-Hill).

[12] Pahl, G. and Beitz, W. *Engineering Design – A Systematic Approach,* 2nd Edition, 1996, (Springer).

[13] Sullivan, J. F., Carlson, L. E., Carlson, D. W. Developing Aspiring Engineers into Budding Entrepreneurs: An Invention and Innovation Course, *Journal of Engineering Education,* 2001 Oct.

[14] Houde, S. and Hill, C. What Do Prototypes Prototype? In: *Handbook of Human-Computer Interaction,* 1997, pp 367-381 (Elsevier Science BV).

[15] Bourell, D., Leu, M., Rosen, D. Roadmap for Additive Manufacturing – Identifying the Future of Freeform Processing, *University of Texas at Austin, Laboratory for Freeform Fabrication,* 2009.

[16] J. J. Beaman, J. W. Barlow, D. L. Bourell, R. H. Crawford, H. L. Marcus, K. P. McAlea. *Solid Freeform Fabrication: A New Direction in Manufacturing*, 1997 (Kluwer Academic Publishing, Boston).

[17] Grudin, J. and Pruitt, J. Personas, Participatory Design and Product Development: An infrastructure for Engagement, In: *PDC 02 Proceedings of the Participatory Design Conference,* Malmö, Sweden, June 2002, pp 153-161 (CPSR, P.O. Box 717, Palo Alto, CA 94302).

[18] Håkansson, A. and Holmquist, B. University-Industry Cooperation and Student Driven Projects: A Model for Educating Design Engineers. In *The 12th International Conference on Engineering and Product Design Education, E&PDE 2010,* Trondheim, September 2010, pp. 414-419 (The Design Society, University of Strathclyde, Glasgow, United Kingdom and Institution of Engineering Designers, Wiltshire, United Kingdom).