COLLABORATING WITH NORWEGIAN INDUSTRY IN AN ADVANCED STUDIO ENVIRONMENT

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ABSTRACT
In a globalised economy competitive advantage will be created through the development of innovative products, services and systems. From a design educational perspective much has been debated on how to direct post-graduate design teaching to create value-add beyond 'Core Industrial Design'. This value-add is to be established through focusing on specialized areas of design, such as strategy, innovation, interaction, transportation, etc.
At the Norwegian University of Science and Technology (NTNU) Department of Product Design, an educational framework for strategic design has been set up, where industrial design master degree students collaborate with companies as frequently and as interactively as possible.
The uniqueness of this program was that each student had been allocated a company, instead of a specific design brief. In this context, the problem space and solution had to be formulated by the student him-or herself, using complex analysis and design methods. From an educational perspective, this led to customized course preparation, mentoring and student evaluation.
In this paper the following aspects in connection to studio teaching will be discussed:

- The introduction of a step-by-step strategic design process to facilitate product planning and management among three types of industrial projects
- A teaching methodology to facilitate advanced design thinking and activity among year 4 Industrial Design students
- Level of innovation achieved by adopting Buijs' Product Planning and Management strategy.

Keywords: Strategic Design, Design Methodology, Design Thinking, Norwegian Industry

1 INTRODUCTION

Product development is an important factor for technology-based firms. Achievements determine the mid-, and long-term viability of companies and economies [1], [2]. The process is complex, because of the range of technical issues that must be considered, and variety of people and organizational structures that must be employed to realize the product development life-cycle[3], [4].
New Product Development (NPD) deals with entire process from market / company analysis and goal finding, through idea generation and conceptualization to the successful marketing of a new product. NPD, which may stem from 'needs pull' or 'discovery push', requires careful management and organizational commitment, particularly in the area of design [5].

In a previous study comprising two Scandinavian Companies, Stokke and Håg, a strategic approach, heavily reliant on ergonomic principles, was inaugurated in the design of both company's products [6].
A few years later, human-centred design was seen as an important aspect of Systems Engineering (SE) [7]. The SE "cradle-to-grave" structured and systematic approach is based upon the triumvirate of requirements engineering, compliance engineering, and reliability engineering. From a human-centred perspective, it was first applied to the micro-ergonomic range of hardware design/engineering, software development, human factors engineering, and seller/purchaser economics, but later extended to macro-ergonomic endeavors, when it was appropriate to effect organizational change [8], [9]. This was emphasized from a lifecycle perspective, where the determination and analysis of the organization's needs and wants put the consideration of ergonomic criteria as early as possible [10].
When discussing product management from a product service system (PSS) perspective, strategies refer to the extension of the service component around the product for business activities that are traditionally product-oriented or the introduction of a new service component, marketed as a product for business activities that are usually service-oriented [11], [12]. Within this context, the designer is required to synthesize solutions emerging from the comparison of different points of view, different needs and socio-cultural models, continuously shifting from the traditional design domain to the domain of design management [13]. For this studio, the problem was represented at a business, rather than a product level. This is in line with the student's progression from novice to expert user, whereby the latter demonstrated strong skills in managing goal-limited strategies rich and domain-specific knowledge [14]
Buijs' Product Planning and Management model was used to introduce strategic design among 'expert' students, as no specific step-by-step models were found in the area of Systems Engineering, Macro-ergonomics, PSS Design or Human Centered Design [15]. However, Buijs' model, which is based on a consultancy model for product planning for small companies, may not be applicable to the strategic and collaborative requirements of most companies today.

2 TEACHING AND LEARNING PRODUCT PLANNING & MANAGEMENT

The design studio in the first semester of the Product Design master's program was conducted in close collaboration with industry. It lasted for 19 weeks and was divided into lectures, seminars, and a major collaborative studio project.
The collaborative studio Project comprised of two phases: a Product Planning & Management (PPM), and a design phase. In this studio, marketability and systems design were emphasized, whereas user functions and technological aspects considered.
In the PPM stage a model for integrated Product Development, students were subjected to an innovation-step model, which guided them to determine their design brief through a systematic approach of product strategy development and goal finding [15], [16]. This activity of strategy development and Goal Finding lasted for +/- 6 out of the 19 weeks. The outcome, in the form of a design brief and problem definition, set the stage for design activity.

2.1 The Lectures and Seminars

The lectures addressed strategic and structured design processes and methods. Topics, which were presented, were information gathering, Product Strategy Development, Goal finding, Conceptualization, User Testing & Evaluation, Concept Refinement, Materialization and 3-D Visualization. These topics were further discussed and

elaborated in the seminars through presentations and critiques of related scientific publications. The project serves as a vehicle to systematically guide the student through the different stages of the strategic design and development processes.

2.2 The Collaborative Studio Project

From a collaborative perspective, 12 established Norwegian companies, such as, Stokke, Håg, Jordan, Helly Hansen, Tandberg, Lærdal Medical, Borealis, etc played the role of a 'real' client, discussion partner and to a certain extent an educator.

In the first part of the project, students analyzed internal capabilities of the organization as well as external market trends. Based on the matching of strength and opportunities, a short-, mid-, or long-term product strategy was formulated. Subsequently product ideas were generated and a design goal determined for further development.

The second part of the project comprised mainly of Systems and/or Product Design, where students iteratively analyzed and redefined the problem fields, as well as diverged and converged in the search of design solutions using a wide variety of analytical and generative methods.

2.3 Connecting Lectures, Seminars and the Collaborative Studio Project

Lectures and seminars served as a vehicle for students to learn and reflect over a variety of advanced research and design methods, as well as to apply them in a collaborative industrial setting. A positive correlation has been observed between the quality or effectiveness of a design and the degree to which the student follows a logical sequence of design processes [17]. This indicated that a 'novice' designer should be given explicit guidance on a systematic approach towards design, not to be presented as a rigid methodology. It should be an adaptable framework that facilitates self-awareness as the designer matures in time. Within the context of NTNU's Industrial Design Engineering programme, students, who are in their first 3 years of studies, are categorised as 'Novice Designers, whereas those who have moved on to the Master's programme are considered 'Expert Designers'. For these 'mature students', the introduction of selected scientific articles proved to be useful in providing them with new knowledge and insights to customize design activities and processes within the 'designing' stage of the collaborative project [18], [19].

3 RESULTS

The collaborative projects can be classified into three categories of strategic design projects. These categories are based on the following situation:

1. where SME's were strategically analysed to develop new design goals
2. where a specific business unit was subjected to strategic analysis
3. where a specific problem formed the basis for strategic analysis and design.

3.1 Where a SME's were strategically analyzed to develop new design goals

The first category of strategic projects involved companies, such as Øyo AS, Thor Bjorklund & Sonner AS, and Vestre AS. From the beginning, students were given the impression that these companies were open to a wide spectrum of process product ideas and design goals, as long as the process of exploration and decision-making is systematically well-argued, according to Buijs' Innovation Process [15].

This has led to the proposal of conservative as well as more revolutionary design goals. In the case of Vestre AS, an outdoor bench was proposed, which was very much in line with the companies activity in developing street furniture. From a more revolutionary angle, Thor Bjørklund & Sonner AS, a manufacturer of household cutlery who gained

recognition through the invention of a cheese slicer, supported the design of a cutlery organiser. Øyo AS encouraged the design of a contemporary oyster cutlery set, although they were into the manufacturing of traditional kniveware. If both companies, Thor Bjørklund & Sonner and Øyo, were to pursue the students' designs, changes need to be considered in their marketing and distribution policies, as well as production facilities.

3.2 Where a specific business unit was subjected to strategic analysis

Most of the participating companies fall in the second category, where students were given a business unit of the company to conduct their strategic analysis and goal finding upon. If, in all cases the students took on the entire company to analyse, the project would be too large and too complex to handle. The following companies fall in this category: Stokke Group, Håg, Helly Hansen, Norrøna Sport, Intra and Jordan AS.

For example, in the Stokke project, both students were guided into the children's collection from the beginning, which unconsciously led to a narrower exploration of search fields (see figure 1). As shown in table 1, similar trends were observed among the other industrial projects, where the proposed design goals were very much subjected to demands the commercial activities of the respective business units. Throughout the design process, these demands might have been explicitly communicated to the students, leaving not much space for strategic exploration from the beginning.

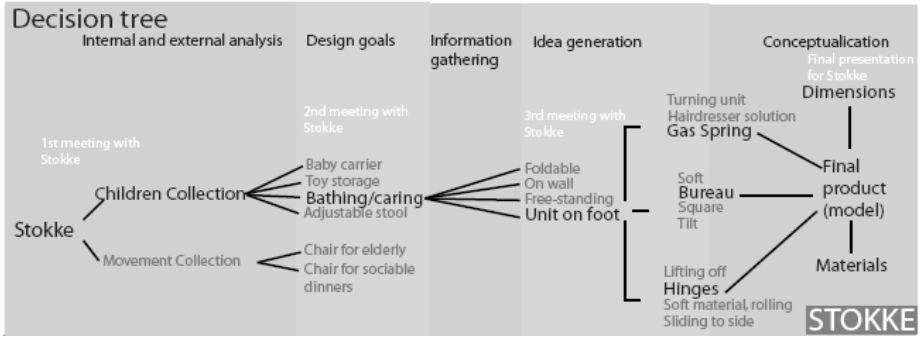

Figure 1. A strategic design approach within the context of a specific business unit was directed towards Stokke's children collection

Table 1. Relation between Companies Core Businesses and Design Briefs

Company	Core Business	Design Brief
Stokke Group	Furniture and Children Products	• Caring & Bathing Unit for Babies • Baby Carrier
Håg,	Office Furniture	• Flexible Office Chair
Helly Hansen,	Outdoor Sport and Rescue Wear	• Protective Wear for Fishing • Women's Bathing Suits
Norrøna Sport,	Outdoor Wear and Equipment	• Multi-purpose, midsize backpack
Intra AS	Bathroom Equipment	• Bathroom Sink with Integrated Mixer
Jordan AS	Personal Hygiene	• Personal Dental Care Device

3.3 Where a specific problem formed the basis for strategic analysis and design

The third category comprised of medium to large, specialized companies. These companies already had clearly defined design objectives formulated. 3 Out of the 4 students, who were attached to these companies, had been working with them in the summer period, prior to the commencement the studio.

The innovation process [15] was applied under narrow conditions, leading to a limited search for new opportunities within the problem field. In other words, the projects were more of a design rather than a strategic nature. The companies, which fitted in this category, were Lærdal Medical, Tandberg and Borealis.
In the case of Lærdal Medical and Tandberg, a design problem was narrowly formulated within the scope of interaction design with a strong graphical content. This has led to a limited exploration of the problem space resulting in a graphic user interface of respectively an existing remote control and an add-on indicator to monitor resuscitation activities. Borealis formulated the design objective around a specific production technique and plastic material, which was Borecene.

4 DISCUSSION

In today's context, it is difficult to find small companies, who adopt an open-mind towards the strategy and goal finding process, as well as its outcome. Usually, larger organizations already have set their minds on specific programs, where design and development activities are required to fit in, if support is required. Especially, when these larger organizations are more specialized in their core business activities, the strategic problem space may turn out to be rather narrow.
When assessing the innovation level of the collaborative projects according to Ansoff's Product-Market Expansion Grid, it can be observed that only 'Market Penetration' or 'Product Development' occurred among category 2 and 3 projects [20]. From a Technology –Market perspective, it can be observed that mainly 'Product Renovation' took place [21]. For example, in Lærdal's resuscitation device a technical improvement was added on in the form of a monitoring indicator.
The innovation process has proven only to be effective for year 4 studio teaching within category 1 collaboration. Although theories from the field of ergonomics, systems engineering, and PSS may be more relevant for today's strive for strategic advantage, no structured models were found in the above fields, which can be directly applied in the form of a step-by step teaching methodology in the PPM phase.
In terms of core design activities instructional lectures in combination with seminars enhanced the deeper understanding of design process and methodology, as well as stimulated design thinking among students. Students were able to customize their own design process, based on methodologies for iterative analysis and synthesis.

5 CONCLUSION

In today's collaborative studio projects, the relevancy of students being trained to act as consultants for Small and Medium Size Enterprises (SME's) should be reviewed within the context of innovation and product management. At the same time, alternative 'broader' user-centered processes should be reformatted in an easy to understand step-by-step methodology, which can be directly applied by students, who are for the first time exposed to PPM. Finally, a more 'integrated systems approach' in teaching strategic design, product planning and industrial design for master students should be explored in future studio teaching. To establish this integrated systems approach, new methods and processes should be developed first in the area of Macro-ergonomics and Product Service Systems

REFERENCES

[1] Ulrich, K T and Eppinger, S. D. *Product design and development.* McGraw–Hill, New York, 1995.
[2] Susman, G. I., *Integrating design and manufacturing for competitive advantage.* Oxford University Press, New York, 1992.

[3] Simon, H.A., *The sciences of the artificial*. MIT Press, Cambridge, 1981.
[4] Bucciarelli, L. L.**,** *Designing engineers.* MIT Press, Cambridge, 1994.
[5] Turner, B.T., *Managing design in the new product development process - methods for company executives.* Design Studies, Vol. 6, Issue 1, January 1985, pp. 51-56.
[6] Jevnaker, B.H., *Inaugurative learning: adapting a new design approach.* Design Studies , Volume 14, Issue 4 , October 1993, pp. 379-401.
[7] Chapanis, A., *Human factors in system engineering.* Wiley, New York, 1996.
[8] Hendrick, H.W., *Organizational design and macroergonomics.* In: G. Salvendy, Editor, *Handbook of human factors and ergonomics*, Wiley-Interscience, New York, 1997.
[9] Samaras, G.M. and Horst, R.L., *A systems engineering perspective on the human-centered design of health information systems.* Journal of Biomedical Informatics, Vol. 38, Issue 1 , February 2005, pp. 61-74.
[10] Carayon P., *Macroergonomics in Quality Care and Patient Safety, in Human Factors in Organizational Design and Management—VII*. Luzak H, Zink K.J., editors. Santa Monica, CA: IEA Press; 2003, pp. 21-34.
[11] Rocchi, S., *Towards a new product-services mix; corporations in the perspective of sustainability.* IIIEE, University of Lund, Lund, Sweden,1997.
[12] Mont, O., Product-service systems. *Shifting corporate focus from selling products to selling product-services: a new approach to sustainable development.* University of Lund, Lund, 2000.
[13] Morelli, N.,*Product-service systems, a perspective shift for designers: A case study: the design of a telecentre*. Volume 24, Issue 1 , January 2003, pp. 73-99
[14] Popovic, V., *Expertise development in product design—strategic and domain-specific knowledge connections.* Design Studies, Volume 25, Issue 5 , September 2004, pp. 527-545
[15] Buijs J.A., *Innovatie an Interventie*. Kluwer, Deventer, The Netherlands, 1987
[16] Buijs J.A. and Valkenburg A.C., *Integrale Produktontwikkeling.* LEMMA, Utrecht, The Netherlands, 1996
[17] Radcliffe, D.F. and Lee, T.Y., *Design methods used by undergraduate engineering students*. Design Studies Volume 10, Issue 4 , October 1989, pp. 199-207
[18] Bamford G., *From Analysis/Synthesis to Conjecture/Analysis: A Review of Karl Popper's Influence on Design Methodology in Architecture.* Design Studies, Vol. 23, No.3, 2002, pp.245-260.
[19] Van der Lugt R., *How sketching can affect the idea generation process in design group meetings.* Design Studies, Vol. 26, No.3, 2005, pp.101-122.
[20] Ansoff, H.I., *Corporate Strategy.* Penguin Books, Harmondsworth, 1968
[21] Kooy, B.J.G. van der, *Innovatie-strategieën. Management Methoden en Technieken,* Kluwer, Deventer, 1981

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