ENGINEERING AND PRODUCT DESIGN EDUCATION CONFERENCE
7-8 SEPTEMBER 2006, SALZBURG UNIVERSITY OF APPLIED SCIENCES, SALZBURG, AUSTRIA

A COLLABORATIVE SYSTEMS DESIGN PROJECT WITH THE NORWEGIAN POSTAL SERVICE

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ABSTRACT
With the globalisation of design, the creation of single entity products no longer meets the needs for solving complex problems in an environment where technologies become more advanced and complex, while user needs become more diverse.
This paper reports on the experiences of introducing systems thinking in early Industrial Design teaching based on a collaborative project with the Norwegian Postal Service (NPS). With reference to the metaphor *Mail Transporter*, holistic systems were analysed and proposed to improve the logistics of mail distribution.
The project, which was conducted in a year 2 Industrial Design studio environment, focused on the development of ergonomic work systems where students worked in groups of 4 to develop complete product-service arrangement prior to the actual design of its supporting sub-systems and products.
Subsequently, a wide variety of different products were conceptualised up to the level of design detailing. With the continuous support from the NPS selected designs were pursued for further refinement and materialisation beyond this studio, providing new aspirations for holistic systems development in collaborative design teaching.

Keywords: Systems Thinking, Ergonomic Work System, Norwegian Postal Service

1 INTRODUCTION

Within the context of systems design, there has been an increased interest in designing the ‘user experience’. The interest in designing experiences can be seen as an initiative to enlarge the design space, as well as a development of design discourse ‘beyond the object’, and a response to the shortcomings of existing models of how use and users are considered in the design process [1], [2], [3]. Design methodologies originating some 30 years ago systematised the generation of ideas and concepts through specific creative and problem solving techniques, such as Morphological Chart Method, Objective Tree Method, etc. [4]. However, most of these studies were approached from a product engineering viewpoint. For example, several design methods were introduced to develop quantified structural variations based on functional surfaces and form factors [5]. Case studies with a cost reduction and time saving perspective, showed that predictive and creative product architecture-based DFA techniques could be applied to accelerate the rate of product improvement as well as to enhance product flexibility, which is affected by physical parameters, modules and the way these modules are designed in the product. [6], [7].
From a market systems development perspective, literature related to product design and development addressed consumer behaviour and their needs rather than the difficulties encountered in the use of such products [8], [9], [10].

The introduction of product service system (PSS) shifted business focus from designing physical products to designing a system of products and services, which became increasingly recognised as an important innovation strategy [11]. This approach towards innovation was based on a new interpretation of the concept of *product*, underlining that the client does not really require the products or services, but requires what these products and services help the user to achieve [12]. The PSS model is also attractive from a business perspective, as it introduces new types of stakeholder relationships and/or partnerships, new constructions of mutual economic interests, and optimization of resources [13].

From a methodological angle, it may be useful to develop system models of the product design process from a human-centred perspective by involving potential users in the initial stages. The understanding of user's technological and cultural frames, and behaviour in relation to material and immaterial aspects of service are very closely related to design [14], [15]. This is in line with the objectives of Macro-ergonomics, which constitutes research, development and application of organization/machine interface technology [16]. This "third generation" of ergonomics, attempts to achieve major performance instead of the traditional incremental improvement within a fully harmonized work system at both the macro- and micro-ergonomic level, offering a complete systems thinking perspective through its own methods and tools. From a design perspective, this macro-ergonomic approach can be useful for establishing systems thinking in defining the overarching design problem and scenarios to achieve a significant value-add in the design solution [17].

When connecting PPS thinking and User Centred Design principles with the NPS project at a macro-ergonomic level, we found that a systems approach in Industrial Design can enlarge the design space, when approached from an ergonomic-logistic and market-strategic perspective.

2 SYSTEMS THINKING IN INDUSTRIAL DESIGN PROJECTS

The most inclusive definition of a *'System'*, is a set of interconnected entities, comprising people, processes and technologies, which are dynamic in their behaviour and have a purpose or reason for existence [18]. From a system level engineering design approach, complex systems include large products, such as automobiles and airplanes. which comprises of many interacting subsystems and components [19]. In this context of systems design, students need to approach the problem using an increasing number of parallel lines of thought [20]. Those who have an aptitude to process information and think holistically find it easier to structurally develop the system inclusive of its elements, boundaries and connections, compared to those who prefer to process information in parts independently and sequentially.

For the design studio a systems engineering perspective with the terms 'system' and 'structure' were introduced, whereby the system is a collection of elements and the structure is the underlying framework, which connects the relations between these elements [21]. In relation to the NPS project, the system is represented by sub-systems and products which make the mail distribution service, whereas the structure is the pre-determined logistic framework on which this mail distribution system is based. The term structure is diachronous in nature, which means that the relationships are time and sequence dependent.

To understand current and redesign new systems in the above context, involves observational studies, user-scenario development, story telling, etc. of a wide range of sequential and parallel activities. In the case of the NPS project, the above activities uncovered critical issues in systems thinking and task allocation to student group members concerning where to place the boundaries of the system. The closer in the

boundaries are placed to tasks and products, the lesser the number of parameters and variables have to be considered explicitly, but more crucial interactions will be omitted or simplified. This may lead to errors or an unrealistic understanding of the user's situation. On the other hand, the further out the boundaries are moved, the more complex are the set of variables and parameters to be considered, and the more work in systems thinking and management is required [22]. In this case 4th term, novice systems designers were observed. It was found that the students had trouble combining broad boundaries with concrete consequence analysis. In such a teaching situation a tutor needs to consider segmenting the system design process and allocating tasks.

3 IMPLICATIONS FOR TEACHING AND LEARNING

In the NPS studio case a metaphor 'Mail Transporter' was used to search for meaning and development of the overarching system [23]. However, the intention of this metaphor to develop the problem space was limited by the pre-determined logistics of mail distribution, which to a certain extent structured and limited the variety of viable systems. By applying a number of methods to the system analysis and design, students learned to reflect over and integrate methods and techniques within the framework of a systematic design process, as well as to understand an industrial setting. Methods include scenario and task analysis, conceptualisation, user testing and evaluation, concept refinement, materialisation and 3-D visualisation. From a systems development perspective, students had to describe, formulate, conceptualise and finally materialise a product or sub-system, subordinate to a cooperative system. The interaction between user functions, marketability and aesthetics were emphasized, whereas technological aspects were superficially considered.

In the first stage student teams iteratively generated and evaluated a wide range of system concepts using NPS as a fictive client. In the second stage, subsystems and products were individually further developed into two or three detailed design concepts. The selected design concept was subjected to iterative cycles of refinement, user testing and materialisation. The final stage was an extension of the studio, whereby selected designs were commissioned by NPS for further development and professional prototyping.

4 THE PROPOSED NPS SYSTEMS AND PRODUCTS

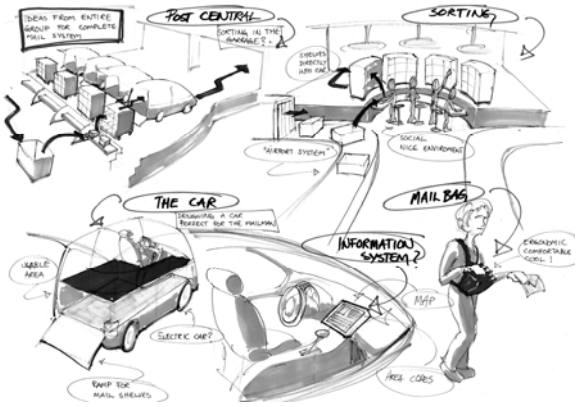

Figure 1. Example of a human-centered logistic approach in the development of a system proposal for mail production and distribution, considering market trends and technological developments

In accordance with the general systems definitions from part 2, the NPS System could be treated as a well delimited high level complex system. It was comprised of several subsystems and products, which were connected to each other according to a predetermined structure. This structure was visualised through a series of scenario and task analyses. In 3 of the 4 systems a user-interface device was introduced to manage the system structure. The above and following diagrams, illustrate the process of system's development from systems concept generation to product design and detailing. The materialization of the product leading up to the development of 4 selected working prototypes was extended beyond the educational framework of studio teaching.

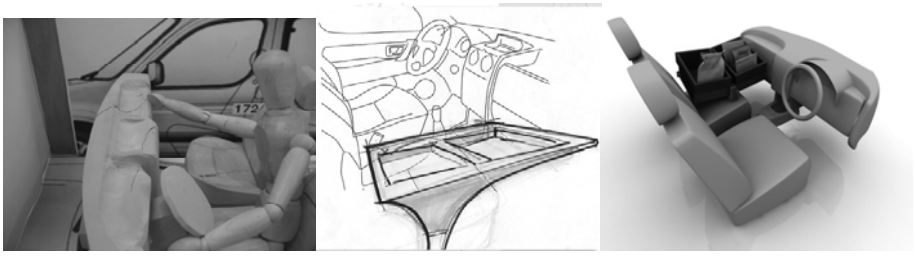

Figure 2A, 2B & 2C, Analysis and concept development of a front-seat mail sorter

Figure 3A, 3B & 3C. Examples of user testing and detailing and prototype development

5 RESULTS

The following results were observed in the teaching of systems design to novice Industrial Design students:

- A systems level approach proved to be an effective generator for a wide range of different design projects at product level while still interconnected. This provided students with real coordination and cooperation training while allowing individual practice in product design
- Selected concepts and design solutions were further developed from functional models to working prototypes after the studio project was completed. The continued collaboration was beneficial for the students, as they experienced for the first time a real-life design and engineering setting beyond the classroom.
- Fewer difficulties were experienced among students in defining the system's outer boundaries when the logistic structure of the human–centred system was partly determined by the metaphor and nature of the project, which was mail distribution and production.
- In the transition from group to individual work students encountered more difficulties in determining intermediate boundaries and connectivity within the system, concerning overlapping scenarios and products. Extra guidance in team and individual work, as well as project planning was needed:

- to understand at which level of systems thinking concepts had to be generated, suggesting the need for intermediate subsystem development prior to design concepts
- To determine whether the individual project needed to be centred around a product or activity, supported by overlapping products.

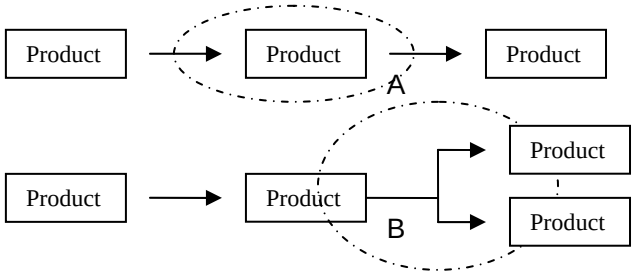

Figure 4, Situation A, clearly defined the design assignment within the system in the form of a product, whereas in situation B difficulties may occur, because the design assignment is based around an activity with overlapping products

- The natural introduction of an information hub within each system in the form of a PDA highlights a new challenge in design education, shifting understanding and teaching of systems design from a physical to an information level by incorporating elements of human computer interaction and information systems architecture.

6 CONCLUSION

In the NPS project, it was obvious that systems design exposed students to complex design thinking at an early stage of their education. It was a challenging task to be clear and detailed in the organisation and management of studio teaching, as well as the tutoring of students on how to plan and manage their projects.

Structuring metaphors, visions and value statements should be used at an overall systems level. Analysis should be concrete, user centred and focusing on information and experience. Real world requirements and guidance should be used to limit possible system structures. Subsystem definition and subsequent design should employ concrete modelling and drawing to aid communication and collaboration across subsystem and group boundaries.

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