A NOVEL DESIGN EDUCATION APPROACH FOR PROFESSIONAL GLOBAL PRODUCT REALIZATION

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ABSTRACT
Emerging trends in design practice, such as collaborative design and multi-national, multi-cultural and multi-disciplinary (multi-x) teamwork, call for ongoing changes in design education. Educational institutions need to be proactive in adapting to such trends, in order to ensure an adequate development of the design competences of their students. The graduated design students must be able to effectively solve real-life new product development (NPD) problems in multi-x environments. In this paper we present a novel approach towards design education, where special focus is put on multi-x collaboration of design students in solving NPD tasks. We present the idea of an Academic Virtual Enterprise (AVE), a project oriented educational agreement, which is based on volatile alliance of industrial and academic partners for mutual advantages. A course, called Global Product Realization (GPR) is presented as an example of how to implement AVE into design education and provide a stimulating learning environment for students in several disciplines (i.e. mechanical engineering, programming, electronics, design, etc.), where they can get experience in multi-x collaboration in NPD and develop several aspects of design competences needed for their future professional practice.

Keywords: Trends in design practice, design education, Global Product realization (GPR)

1 INTRODUCTION

Nowadays, new product development (NPD) is occurring in an environment characterized by various factors such as expansion of global markets, multiplication of competitors, multiplication and rapid development of technologies, shorter life cycle of products, varying and more complex requirements of customers, increasing pressures of national and international norms about safety and environmental issues, changing institutional relations, etc. [1]. The current extent and content of designers' work therefore are different from those in the past.

In the past, most companies placed designers near the end of the product development sequence of activities, which significantly reduced designers' potential for contribution to corporate goals and strategies. The designers used to give a final ergonomics and aesthetics varnish. But as the global market is becoming increasingly competitive, corporations are adopting the holistic design program, where design includes the concept-to-market process and the designers participate in decision-making for product

planning and positioning [2]. Nowadays, a designer is one of the managers, who guide and control the complete development and management process in NPD.
The traditional design methodology is not sufficient anymore, as it can not face and satisfy all the new design requirements within a reasonable design timeframe [3]. Collaborative design is emerging as a promising alternative to classical design approaches [1]. Various disciplines such as decision theory, social science, operation management, computer science etc. have been used to deal with the emerging collaborative design. Teams that are multi-disciplinary, multi-national and multi-cultural (multi-x) are being formed to enable an in-depth view on design problems. Several institutions (university, industry, government, society) are participating in the concept-to-market design process, making it even more complex [4].
These rapid developments in design practice call for proactive educational responses. Design education should enable students to get the necessary competences that allow them, when they have become professional designers, to face the challenges yielded by the new trends in current real-world design problems [3]. They should be prepared to follow the emerging trend in industry that consists of forming multi-x teams that work in a virtual environment where the boundaries of institutions participating in development processes are vague. The development of multi-x competences should be taught to students for future design demands. Consequently, all of this knowledge should be implemented into the market by students through design projects during their education. In this manner they can get insight in the emerging trends and gain their design competences in the real world. Several universities have already reacted to this need, as cooperation with industry is increasingly becoming a part of design education. However, a systematic approach toward the integration of emerging design trends into design education is still underdeveloped. Design exercises are done in mono-disciplinary context, usually within one university only. In this way the students are not able to learn the multi-x aspects of designing and they rarely face a NPD task in a virtual environment. There needs to be a change in the design education processes, where such trends as globalization, virtualization, digitalization and the multi-x aspects of NPD processes are incorporated in the curriculum. This paper aims to explain a novel approach in design education, where most of these aspects are incorporated into the educational process.
The paper has two objectives: (1) to examine the emerging trends in design practice that challenge the traditional design education with a special focus on multi-x aspects of collaboration that need to be implemented in design education to ensure professional development of design students; and (2) to present a novel educational approach that evolved as a reaction to the emerging trends in designing.
In order to achieve these objectives, we will apply the concept of an Academic Virtual Enterprise (AVE) [2][3] that was formed in order to enable professional and effective collaboration of several institutions in NPD. A course called Global Product Realization (GPR) was formed to implement an AVE in educational environment. Its main idea is to provide a working environment for students, where they are stimulated to develop multi-x related aspects of design competences, needed for their future professional practice [2].
The paper is structured in three more sections. In section 2 we give an outline of the emerging trends in design practice that call for multi-x collaboration in NPD. In section 3 we outline the challenges design education is facing because of these emerging trends. Then we explain the concept of an AVE and the design course, where the focus is on

teaching and involving the students in the principles of multi-x collaboration in design teams. Conclusions and further research topics are presented in the final section.

2 CHANGES IN DESIGN PRACTICE

Due to increased global competition, environmental turbulence, rapid development of new technologies and involvement of several disciplines in NPD, designers are facing several changes in their practice. New trends in product development have appeared.

Yang et al [5] acknowledge five trends of the industrial design practice that emerge from the changing global trends, institutional relations and market needs: (1) emerging new technology increases the use of digital media, and has changed the presentation methods of sketching, rendering, model making, technical drawings and communication between designers; (2) the boundary between design disciplines is fuzzy, which makes it necessary for designers to understand other fields and interact more with other disciplines; (3) there is a need for multidisciplinary teamwork involving not only traditional issues of physiology, materials and technology related to product development, but also user research and lifestyle trends before the product development, and social, psychological and ideological issues; (4) the expanded definition of products demands development of systems composed of various products and the interfaces among the parts; (5) there is an increasing dependence on online resources, and the internet has become a tool to deliver teaching, learning, interaction and communication among the institutions involved in product development.

Because of such expansions of the design practice, designers not only need design specific skills, but also require other skills, such as negotiation with clients abroad, problem solving in multi-x context, interpersonal skills and project management [6]. Industrial design, as an integrated profession, therefore nowadays covers an extended range of disciplines, including engineering, ergonomics, business, and social, cultural and environmental issues [5]. To combine all these disciplines within successful NPD, design teams have to be formed beyond the boundaries of a single firm.

Industries which have materials and know-how close to the chain of production, often still require the input of external experts to help them in solving certain problems beyond their capacities. The networks of academic and industrial researchers are being formed as a fundamental instrument of collaboration between the institutions of university and industry and seem to be effective in enhancing productivity in terms of discoveries and inventions [7].

Further, as multi-x collaborative design and human centred design are evolving, the human/user is also considered to be an active and essential part of design process [8]. This requires on the one hand cooperation with and information from ergonomics, mechanical, psychological, rehabilitation, medical and social disciplines and with governments, and on the other hand the ability to do profound user and market research. As Ornetzeder and Rohracher [9] state, users can (1) be the source of incremental technical changes, (2) develop unconventional design solutions or (3) find and test new applications of a product. Contact with potential users increases empathy with the target group, which leads to more suitable designs and improved market acceptance [8].

All these changes cause the expansion of expertise and knowledge not only beyond the boundaries of the firm, but also beyond the boundaries of the industry and even the state. Geographically distributed teams are being formed as an answer to these emerging trends. Their structure is multi-x in order to be able to react to the turbulent and globalized NPD environment. Collaboration and communication is done by computer-

supported technology, mostly in virtual environments. Such developments call for adaptation of the design education.

3 CHALLENGES FOR DESIGN EDUCATION

In order to be capable of successfully fulfilling design tasks at various stages of the NPD process, design competences need to be developed in different fields. Following the global trends specified, the design education needs to focus more on providing the knowledge and skills of communicating through alternative channels of communications (i.e. video conferencing, internet communication, etc.), global market analysis, marketing strategy and product planning, forming an international and multidisciplinary vision and an active attitude towards following the trends of continuous transformations of new technologies and product development processes.

In the past, the main emphasis in design education was placed on the body of knowledge that a designer should posses and employ. Students have been equipped with competencies that helped them pass the exams, rather than solve real-life design problems with success [3]. However, over the past decades, design problem solving capacities have been given growing attention and various aspects of design competence have been investigated (for further details see [2] and [3]). The reductionist approach towards developing design competences is gradually being replaced by the holistic view. Students now gain practical knowledge, skills, experience and capabilities in NPD through real-life NPD projects that are carried out during their design education. However, working in virtual teams in a multi-x environment is often still neglected in design education. Students do work in teams to solve certain NPD tasks, but their working environment misses the multi-x aspects of design that are recognized to be an evolving trend in NPD. Thinking "outside the box" and cooperating in NPD tasks with design students of other nationalities and cultures, as well as other disciplines should therefore be systematically implemented in design education.

Also a more detailed approach towards the changing institutional relations in the knowledge-based economy needs to be integrated into the design education, because the emerging institutional relations (i.e. cooperation of university and industry) are significantly reshaping the role of the designers in the product development process [4]. Apart from the traditional competencies that the design education needs to provide to students, a more structured approach towards the integration of different fields of design conduct is needed. Students need to be taught the principles of multi-x collaboration in order to be able to properly function in such teams. Special focus needs to be placed on formation and work in virtual teams, where design processes are carried out without the team actually meeting face-to-face. Also the multi-disciplinary aspects of design (i.e. social sciences, computer sciences, operation management etc.) need to be implemented in the design education in order to provide to students the needed competences.

Several universities have already acknowledged such trends and have made steps towards providing a more collaborative design education program to their students.

4 MULTI-X COLLABORATION OF STUDENT DESIGN TEAMS

Following the emerging trends in design, a design course called (European) Global Product Realization (GPR) has been brought to existence with the involvement of an industrial company and several European Universities. It is a result of implementing AVE into design education (further details in [2],[3]). In 2007 University of Zagreb, Ecole Polytechnique Federale de Lausanne, University of Ljubljana, City University London and Delft University of Technology and an industrial partner participated in the

7th edition of a multi-x design course that offers to students the development of design competences needed for a smooth transition from education to professional practice.
The main focus of the GPR course is put on multi-x teams, using virtual technological developments in solving a NPD problem at a global level. The participating students only know each other through the video-conferencing meetings. All the communication and work is done with the help of IT technologies, as the participants are located in different parts of the world. Knowledge is built and exchanged by communication and collaboration of the various participants (students, company experts, instructors, lecturers, researchers, industrial partners, end users) via various forms of interaction and inquiry [2].
GPR is a one-semester course for Master of Science level students. It comprises several steps, such as market analysis, financial issues, product specifications, vision formation, concept generation, concept solution, materialization, prototyping and testing [1]. Teams are formed in such a manner that each team consists of several students from the participating universities. Therefore the profiles of students in a team are very different. On the one hand, this has the advantage of providing complementary knowledge and expertise that are needed for the development of a global product, but on the other hand it poses the problem of handling the discrepancies not only in skills and expertise but also in knowledge, design attitude etc., which often results in different view points about the same subjects [10]. The course provides a combination of lectures on innovation topics and project teamwork supported by selected companies. It concludes with a one-week workshop, where students build the prototypes. The final result of the workshop is a presentation of the functioning prototypes, produced by the multi-x teams of students. At this workshop the students meet face-to-face for the first time.
The students are the main actor of the GPR course, as they form the bridge between the academic knowledge and industrial application [1]. The practice of product development in a multi-x environment allows them to deepen their understanding of global product development processes, collaboration aspects and multi-x work in virtual environments. Although the main problems typical for virtual teamwork are discussed during lectures at the start of the project, students have to experience them before understanding the impact on their work. Students need the time and technology to be able to learn from their mistakes. Only then, they can master the skills and attitudes needed for multi-x collaboration. During the GPR course, the students are responsible for making team appointments, distributing the tasks and operating the communication systems. Since the course takes place for one semester, the students get sufficient time to experience and solve different kinds of problems and to get used to virtual team work. During the GPR course, all teams exist of a maximum of two students per university per team and 5 to 8 students per team. Therefore, all students gain experience with operating the video conferencing system. Besides that, all students have to present their teams' work and progress at some point in the process, allowing them to gain experience in presenting to a remote audience. Larger teams would have been a drawback to the personal developments of the students, while smaller teams would have simplified the multi-x teamwork and therefore would have been a drawback as well. Team sizes of 5 till 8 students, with maximum 2 students per university, therefore seem to be the most suitable.

5 DISCUSSION AND CONCLUSIONS

Although the GPR turned out to be a success in providing the students with important competences in multi-x teamwork in virtual environments, we have to acknowledge that

our research was in fact very limited in scope and many further investigations need to be done in order to have a validated theory of implementing multi-x collaboration into the design education in order to enhance the professional development of design students. In our study we were unable to compare the results of multi-x collaboration of virtual teams of students with actual multi-x collaboration in design practice. As a result of the multi-x collaboration of students working prototypes were presented that were not developed further from that point on. To prove the effectiveness of the final results of the course further development and research is therefore needed.

There are several new aspects that the GPR courses bring regarding multi-x collaboration in NPD. It is possible and valuable to let students experience multi-x teamwork in NPD. During the course, all students significantly developed their multi-x teamwork skills and attitudes. During the course, students were able to seek advice from their coach, both on the NPD level as on the subject of multi-x teamwork. In the professional design practice, this might not always be the case. Therefore, it is advisable to give students the opportunity to develop their multi-x teamwork skills and attitudes systematically during design education.

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