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(RE)DESIGNING THE DESIGN EDUCATION IN A KNOWLEDGE-BASED ECONOMY

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1. Introduction

Designing products nowadays faces new challenges. Increased global competition and the intensiveness of knowledge in the management of consumers and their needs are some of the more important factors influencing design processes in new product development (NPD).
More and more corporations are entering the global marketplace with new products, making the markets more complex and competitive. NPD is changing. What used to be a clearly defined process in which corporations develop knowledge and use it to create products to sell, is being replaced by complex webs of relationships that bind companies to competitors, industry to academia and bind business and scientific disciplines to one another. R&D teams are changing to global collaborative teams, central innovation to collaborative innovation and single-discipline work to multi-disciplinary work. Corporations have reviewed their product development processes and introduced new technologies, procedures and multi-disciplinary teams in order to increase innovativeness and progressiveness of their products and to shorten the time-to-market for new products [Yang et al. 2005].
At the same time today's economy and society have become increasingly knowledge-based. Intellectual capital is becoming as important as the financial capital for innovation and the future of economic growth. Human capabilities, leadership assets and experience, technology and information capital, collaborative relationships, intellectual property, information stocks and capabilities for shared learning and utilization that can be used to create wealth and foster economic growth have become the running force of the new economy. Knowledge acquisition and learning through experience, interaction, heterogeneity, and network exchange has grown in competitive importance relative to formally produced, discipline-based, scientific knowledge. The role of the university as the provider of knowledge for innovation has spread from providing theoretical knowledge to students towards resolving problems that arise from the practice [Crespo and Dridi 2007]. In doing so the cooperation with other institutions, such as the government and the society, is arising intensively. The academic interest has broadened from fundamental research towards providing the industry with the academic knowledge it needs to be competitive in the global knowledge-based economy. The way in which institutions manage knowledge, apply information technology and develop systems to enhance capability and competence has surfaced as a key factor in economic performance.
These trends have changed the traditional work of industrial design engineers, so that they must now be closely involved in the entire product development process, and interact and intensively communicate with other disciplines. Their competencies need to be adjusted and updated. This should start with the design education. As Buchanan [2000] states, the goal of design education is to form a designer that has adequate knowledge of design processes, but also possesses the wide perspective that

is needed in the complex environment of today and the future. However, it often happens that there is a gap between the knowledge that design students gain at universities and the knowledge needed for practice after graduation [Yang et al. 2005].
In this paper we make a proposal on how to reduce this gap in order to provide to companies graduates that have the needed skills and knowledge for future demands of global design. We observed that design education has developed more slowly over the last decades than the design practice and that many design engineering schools continue to teach students the traditional design skills, knowledge and processes. We also claim that the engineering design education has largely neglected the changing roles of institutions within the knowledge-based economy. We propose a model of redesigning design education, so that it will (1) fit with the changing economy relations, where special focus is done on university-industry-government-society interactions[Fain et al. 2007], and (2) enable students to gain practical knowledge and experience of global designing during the course of their study to enable a smooth transition from school to work. In this paper we present the findings on a case study of a design course implemented in 5 European Universities.
The rest of the paper is structured in three sections. First, we outline the changing relations in design practice. In section 2 we focus on the fourfold relations of university, industry, government and society [Fain et al. 2007] that are emerging in the knowledge-based economy and their effects on the changes in design practice. Then the new challenges for the design education are elaborated. In section 3 we propose a novel approach to structuring design education and present its application on a design course for Master students, called European Global Product Realization (EGPR). At the end, we discuss the findings and present our conclusions.

2. The changing relations in design practice

Industrial design in a knowledge-based economy should cover a wide range of expertise, including engineering, ergonomics, business and even social, environmental and cultural issues. Lewis and Bonollo [2002] claim that in addition to professional design skills and knowledge, a designer needs to have general competencies, team spirit, the personality to accept changes and interdisciplinary views.

2.1 Fourfold helix relations in a knowledge-based economy

Research on institutional relations within innovation processes [Etzkowitz 2003; Fain et al. 2007] has shown that there are four main institutions that need to cooperate in order to enable new product development success: university, industry, government and society. Their cooperation and the flux of boundaries between them enable effective design processes that result in competitive products that maximally satisfy the users' needs (figure 1).
The university has traditionally been seen as a structure that supports innovation and provides scientifically trained persons, research results and knowledge to industry [Etzkowitz 2003]. Recently, there has been a shift towards further integration of university and industry since the intellectual capital is becoming as important as the financial capital for innovation and the future of economic growth. Against increasingly competitive context universities in different parts of the globe have been under tremendous pressures from government and the general public to restructure or reinvent the way they are managed in order to adapt to the changing social, economic and political environments and maintain individual competitiveness [Mok 2005]. As a result the university is urged to provide differentiated training and research programs functionally required by the complex society and its power structures. As a result the entrepreneurial university is developing, implementing economic and social development in teaching and research. Academia is taking the lead in an increasingly knowledge-based society.
Companies increasingly consider universities, as well as other firms and government laboratories, to be a potential source of useful knowledge and technology. In a highly competitive global environment companies need external sources of knowledge and technology. Industries which have materials and know-how close to the chain of production, may still require the input of university experts to help them in solving certain problems beyond their capacities. The networks of academic and industrial researchers are 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 [Balconi and Laboranti 2006].

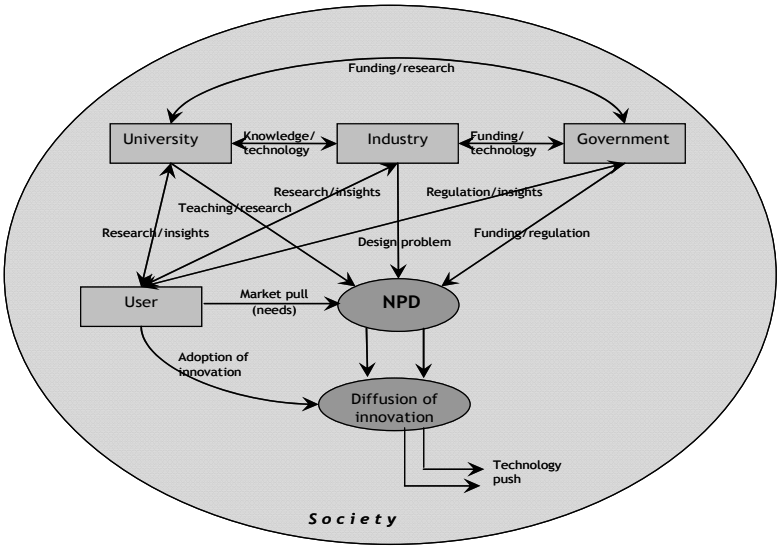

Figure 1. The institutional relations within the innovation process

In recent decades, federal, state and local governments have created a variety of mechanisms to encourage such knowledge-based economic development. These initiatives include the supply of bridging funds, grants and matching funds to support R&D and access to participation in joint projects with government laboratories. Governments have become a partner in the policy-making process.
The collaboration of industry, academia and government however is insufficient for the field of designing for humans in the changing environment, where the users' involvement in innovation is rising. The entrepreneurial university retains the traditional academic roles of social reproduction and extension of certified knowledge, but places them in a broader context as part of its new role in promoting innovation [Etzkowitz 2003]. Industry on the other hand, supports university research by extending it beyond technical innovation. Scientific research is increasingly becoming more relevant for socio-economic development. And consequently, governmental policies affecting the innovation process change their strategies in promoting R&D and other entrepreneurial activities to fulfill the "society-centred" forms of governance, which presume the involvement of sectors other than state (such as markets, the society and other non-state actors) in governing the public domain [Mok 2005]. What matters is not only the development of technical innovations, which can be well done by implementing the mentioned interactions among institutions. Especially the organizational devices created to tie these innovations to social and economic purposes have become the significant factors.
In its broadest sense innovation is about creating the climate or culture which promotes implementation of productive change in order to improve the wealth creating capacity of society [Duggan 1996]. And if innovation is about social and cultural change then it follows that changes, and the circumstances leading to the adoption and ultimate success of those changes will take place within unique systems and cultures – the society. As Rogers and Shoemaker [1972] state, the adoption of innovation is a decision of the user to make full use of a new idea as the best course of action. This consequently means that the society, and more specifically, the users of products, will have the highest effect on the success of innovations. Their adoption rate – the speed with which an innovation is adopted by the members of a social system [Rogers and Shoemaker 1972] – will dictate (1) the diffusion of an innovation into the society and (2) its success rate.

2.2 Changes in design practice

These changes in the institutional relations within innovation processes have also led to changes in design practice. The current extent and content of designers' work 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 [Yang et al. 2005]. Five phases in the product development process were identified as the industrial design process: task clarification, concept generation, evaluation and refinement, detailed design of the preferred concept and communication of results [Lewis and Bonollo 2002]. But as the global market is becoming increasingly competitive, corporations are adapting the holistic design program, where designing includes the concept-to-market process and the designers participate also in decision-making for product planning and positioning.

At the design level, it is evident, that the traditional engineering design practice is not sufficient anymore, as it can not face and satisfy all the new design requirements within a reasonable design time frame. Collaborative design is emerging as a promising alternative to classical design approaches. It can be defined as a process where a product is defined through the collective and joint effort of more designers [Bufardi et al. 2005]. 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 are being formed to enable an in-depth view on design problems. Different institutions are participating in the concept-to-market design process, making it even more complex.

Yang et al. [2005] 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 and technical drawings; (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 concerns not only the specific functions for individual products, but also the system 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 transitions, designers not only need the individual cognitive skills and overall skill displayed in execution of design processes, but also require other skills, such as negotiation with clients, problem solving, acceptance of responsibility for outcomes, interpersonal skills and project management [Lewis and Bonollo 2002].

2.3 Challenges for design education

Rapid developments in design practice call for ongoing educational responses. Design education should enable students to get the necessary skills and knowledge needed to face the challenges yielded by the new trends in current real-world design problems [Bufardi et al. 2005]. Design students should be prepared to follow the emerging trend in industry that consists of forming multidisciplinary teams that work in a virtual environment where the boundaries of institutions participating in development processes are vague. Design education should cultivate students not only with the professional skills of problem solving, conceptualization, visualization and communication, but also with a solid base of understanding about arts, science, technology and humanities [Yang et al. 2005]. The development of multi-disciplinary knowledge, including analysis, synthesis, interpretation, creation, assessment and criticism 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 learn the emerging trends and gain their design knowledge and skills 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 in many design educational institutions the focus on

only industrial involvement leaves out two important institutions that also build the new product development practice today – the government and society.
Traditionally design education educated students in three competency categories: (1) generic attributes such as problem solving and communication skills; (2) specific industrial design skills and knowledge such as design methodologies, visualization skills and knowledge, design thinking and design processes; and (3) knowledge integration [Yang et al. 2005]. In global environments however, these competences are challenged by the changing trends and should be upgraded at least by several cognitive skills, such as criticism, creative and lateral thinking, motivation, research and discovery and discipline and ethics. Also the overall social and market context is gaining on importance, demanding changes in design education that enable new knowledge in fields like legislation, environmental issues, customer orientation, etc. as well. Restructuring the design education in the sense of broadening the boarders of design towards other disciplines is needed.

3. A new approach to design education

In order to be capable of successfully fulfilling design tasks at various stages of the new product development process, designer competences need to be developed in different fields. Following the global trends specified, the design education needs to focus more on providing to students the knowledge and skills of communicating through alternative channels of communications (i.e. video conferencing, internet communication, etc.), market analysis, marketing strategy, product planning, international and multidisciplinary views and an active attitude towards following the trends of continuous transformations of new technologies and product development processes. Also a more detailed approach towards the changing institutional relations in the knowledge-based economy needs to be integrated into the design education curriculum, because the emerging fourfold relations are significantly reshaping the role of the designers in the product development process. 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.
Following the emerging trends in design, a design course called European Global Product Realization (EGPR) has been brought to existence with the involvement of an industrial company and several European Universities. Its main objective is to provide a stimulating working environment for students, where they can conquer the design competences needed for their future professional practice. The main focus is put on multidisciplinary, multinational and multicultural teams, using virtual technological developments in solving a new product development (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 [Horvath 2006].
EGPR 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 [Bufardi et al. 2005]. 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 and on the other hand it poses the problem of handling the discrepancies not only in skills and expertise but also in view points about the same subjects [Bufardi et al. 2005]. One of the advantages of this course is that the students can engage in more risky activities than the present industries, because of their learning and developmental objectives. The course provides a combination of lectures on innovation topics and project team work 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 that have been produced by teams of students from the participating European universities.
EGPR has a specific organizational framework where cooperation and the flux of boundaries between different institutional spheres are enabled to provide the best possible innovation output. By doing so,

the course actually follows the trends of the changing institutional relations, as it combines learning and accumulation of knowledge within a real industrial environment.
The university provides theoretical and practical knowledge on innovation strategies, policies and the competitive environment, enabling students to design a product that is suitable for the involved company. The student teams are introduced to various facets of global product realization through selected lectures of experts from both academic and industry sectors. The lectures balance between practical and theoretical issues in order to provide the students with efficient tools to deal with global product development project in a structured way. From the educational point of view, design is mainly characterized by the need to combine theoretical knowledge and practical skills [Bufardi et al. 2005]. A strategy of paralleling theory and practice (students should learn about design and how to design), as proposed by the fourfold institutional relations, should so be adopted in teaching design. The EGPR course does that, since it (1) parallels academic lectures and strong theoretical knowledge with product development in EGPR project, and (2) involves the application of intensive practical skills.
The EGPR course is also regarded as an opportunity for closer cooperation between university and industry. The relation is seen primarily in providing students with a real life design problem that they can solve. Consequently, the solution provides an opportunity for the participating industry, as most of the activities necessary in NPD (from market analysis to prototyping) are executed by the participating students. In a constant search for new market opportunities and potential developments, the involved companies highly support the EGPR course. Both short term benefits and long term advantages for the future are expected. The industrial partners define product specifications for the products to be developed and provide the information and the data about the existing models in the comparable families of products. Their practice of product development allows the students to deepen their understanding of product development processes, to improve their professional skills and also to gain experience in multicultural, multinational and multidisciplinary cooperation. The students are the bridge between the academic knowledge and industrial application [Bufardi et al. 2005].

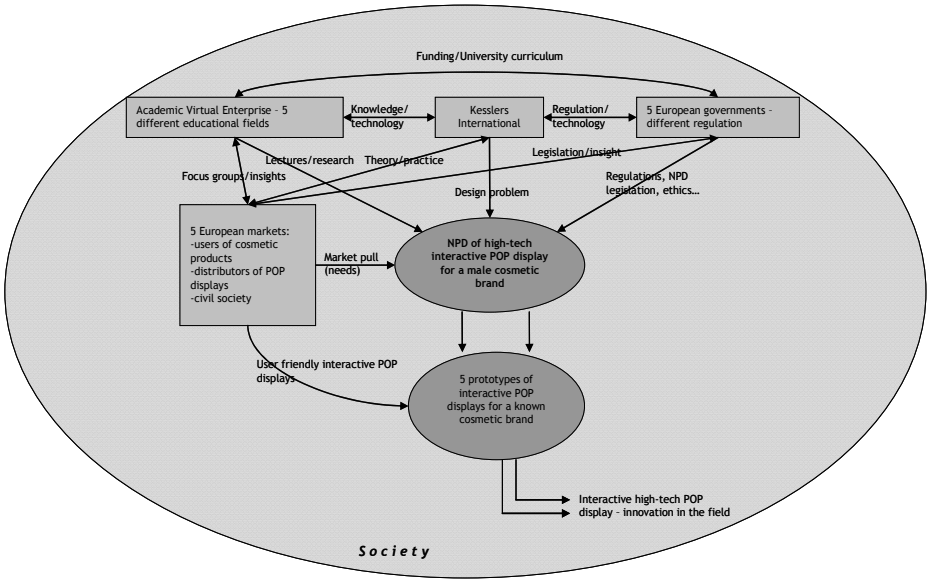

Figure 2. EGPR structure in 2007

In regard to the EGPR course the involvement of the government is subtle and indirect, but it is present. The government is responsible for providing the rules of the game and also for making new venture capital available [Etzkowitz 2003]. As EGPR is a part of the broader curriculum of the

participating universities, it is supported by governments of all participating countries and the involvement of the governmental institution is therefore not questionable.
The broader aspect of design is an important part of the course of EGPR. The user perspective is introduced at the start of student work with market research being done on regional, national and global scale. The design course is so not only technology-oriented, but also market-oriented. In 2007, for example, the project task was to develop a male grooming Point of Purchase display for a well known, global brand (figure 2). The students did research in all five participating countries, so that the results can be applied on a more general scale. They did extensive research to explore the market needs and the solutions already available on the market. With the user perspective analyzed they were able to see the user expectations and which other factors had to be involved in NPD to realize a result that is acceptable for the end user. In other words, further socio-economic and socio-political aspects of developing new products were well investigated during the course. For example, by testing the acceptability of proposed concepts by various standards and by taking into account the environmental aspects of the society, several indicators of how to keep a healthy society were taken into account.
With the implementation and collaboration of all the relevant institutions, the universities, participating in the realization of the EGPR course, have taken the new role and position that the knowledge-based economy has introduced for them. A design education framework has been formed that equips the students with the skills and knowledge needed for designing in knowledge-based environments and also gives practical experience during their course of study.

4. Discussion and Conclusions

Several emerging trends related to global design were addressed by implementing the EGPR course into the design education of the participating universities. The technological view and the market view on innovation processes were taken into account and all the relevant institutions were involved in the course. From the technological point of view the collaboration of university and industry might have been enough for presenting the phases of traditional design, as such cooperation may lead to generation of innovative new products, services, programs or technologies. However, from the market point of view, only considering these relations is not sufficient for successful NPD. The users do not necessary need or want the innovation, generated through these relations. The market, and more generally the society, influences organizational performance by accepting or rejecting new products or services. Therefore organizations should change either in response to actual changes in society or as a preamptive act in anticipation of changes in the market.
The students of EGPR were taught the principles of innovation diffusion and adoption, as well as the principles of market research, marketing strategy and market introduction, and they used this knowledge to solve a real life design problem for a real company from examining the main aspects of the involved stakeholders design problem to building a prototype. They acted as professional designers and cooperated in virtual teams in order to accomplish a concept-to-market solution. In this sense the EGPR course is a new approach towards the organization of design education within the knowledge-based economy, as it enables students a fluent passage from theory to practice.
There are however some limitations that still need to be resolved to fully integrate the new design trends into the proposed design education. First the time limitation of the course needs to be considered. The limited time for the realization of the EGPR course has pushed the students into doing their user (market) research in a limited amount of time. Although sufficient time was offered, they were not able to go into detailed analysis of the user/society perspective, so the quality of the results might be questionable. The main reason were the different levels of knowledge of the design process. Therefore their idea and concept generation phases were limited and so fewer conceptual solutions were presented. As EGPR is a one-semester course several new trends of designing were presented in general terms. We concluded that the knowledge of the students is insufficient and might need individual in-depth study. It might be suitable to consider expanding EGPR to two semesters or implementing several supporting courses to further deepen the knowledge of new design trends. Especially the fuzzy design phases in the forefront of the design processes might need further elaboration.

The next consideration is the involvement of several countries within the course. Although the trends in design are developing globally, different countries still have different approaches towards designing and design education. Some universities focus more on (mechanical) engineering design, others on industrial design (engineering). The subtle involvement of the government in the studied course is also an important factor that needs to be examined further. The differences in national governance might also play an important role in the development of relations among the four institutional spheres and the approaches towards design education. Even within the EU member countries differences were observed regarding the involvement of government in the fourfold relations and design education. An investigation of the perspectives of different countries in relation to the studied design and institutional relations might bring further insight into this topic. Further research is therefore needed to verify the proposed educational framework.

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