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The Role of the User and the Society in New Product Development

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Within the knowledge-based economy several institutions are involved in product innovation processes. Literature study has shown that the most researched and cited are the industry-university-government relations, presented in the Triple Helix model of institutional relations within new product development (NPD). Based on a case study of the Academic Virtual Enterprise, we have put the sole input of these institutions in NPD into question. We have tested and supported the claim that the user and the society are equal partners in the product innovation process. We have put forward the Fourfold Helix model that features a new formation of institutional relations where special focus is placed on the involvement of the user and the society in NPD.

Keywords: triple helix, user, society, market pull, technology push, fourfold helix, European Global Product Realization course

1 INTRODUCTION

Strong competition, the market of customers and increased complexity of products and processes are the characteristics of today's competition. Fast product and process development, combined with timely participation of customers and suppliers together with entering the market at the right time, seem to be the decisive criteria for the market success of a product [1]. In today's competitive environment, every company wants to achieve shorter product-development times, lower costs, higher quality of the product, and, consequently, the satisfaction of its customers. In order to achieve the set goals, the company has to take into account the customers wants and needs during the new-product development process [2]. Due to these trends and everchanging business environment new product development (NPD) has been changed drastically during the past decades.

As NPD used to be in the domain of the industry, in today's global economy several other institutions (such as the university and the government) have become new partners of the innovation processes in NPD. One of the reasons for this shift is the emerging significance of knowledge. Nowadays industries do not depend solely on their production capital, but also on their intellectual capital. What matters is not so much the development of technical innovations. Organizational devices are created to tie these innovations to social and economic purposes [3]. Since the university is an institution providing intellectual capital, its involvement in NPD is increasing. With these increased relations between the university and industry in NPD, increased importance has also been put on science and technology policies. This means that university and industry relations are also shaped by the government, which is responsible for such policies.

Within knowledge-based economy the interactions between university, industry and government have become more complex and have been acknowledged and researched by several authors. One of the most extensive researches has been done by Leydesdorff and Etzkowitz [4, 5, 6]. They have proposed a model that describes the changing relations among institutions within the context of NPD. The so-called Triple Helix model presumes the involvement and flux of boundaries of several institutions participating in NPD. The relations of the institutions have been represented as a spiral process which emerges from reciprocal university-government-industry relations [4].

We have studied this model for its usability in the context of design education. We have found that it facilitates the setting up of useful relationships with regard to NPD. However, we have also found that it misses an important aspect of NPD, namely that NPD is usually done for artifacts that will be used by human beings and therefore, the processes and

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interactions within NPD need to be considered by the user. In industrial design engineering this has been manifested in the concept of Human Centered Design (HCD).

In this paper we will first elaborate on the Triple Helix relations as proposed by Leydesdorff and Etzkowitz [4, 5, 6]. We will show that this model does not sufficiently recognize (i) the role of the user and (ii) several important aspects of society. We will then present the research which explores the proposed reorganized model in the field of industrial design engineering education.

1.1 Triple Helix Relations in a Knowledge-Based Economy

The Triple Helix as a model of university-industry-government relations is proposed to be a key component of any future national or international innovation strategy [7]. It postulates that the interaction between university, industry and government is the key to improving the conditions for innovation in a knowledge-based society [8]. It is a spiral model of innovation that elaborates the reciprocal relationships of different institutions that are active in the innovation process. The three institutions are presented as three interacting helices that jointly perform NPD processes (Fig. 1). The spiraling form of the Triple Helix relations represents the interactions taking place among the three institutions in order to improve the local economy through NPD [8]. The industry acts as the centre of production, the government is the source of contractual relations that guarantee stable interactions between the three, and the university is a source of new knowledge and technology, the generative principle of knowledge-based economies [8]. The three institutional spheres (public, private and academic) are now more and more involved in a pattern of spiraling links that emerge in various steps in the process of innovation [9]. Their relations are relatively equal, but interdependent and they overlap as the institutions take the role of the other.

A Triple Helix regime (Fig. 1) typically begins when the university, the industry and the government enter reciprocal relationships, where each institution aims at enhancing the performance of the other [8]. Several important dimensions of institutional cooperation are outlined by the model.

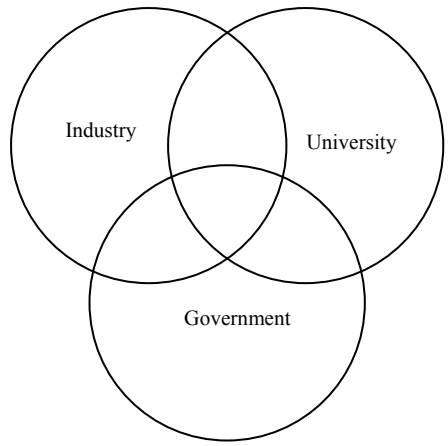


Fig. 1. *University-Industry-Government relations within the Triple Helix [8]*

The first dimension of the Triple Helix is the internal transformation in each of the helices/institutions, such as the development of lateral ties among companies through strategic alliances or an assumption of an economic development mission by universities [10]. The second dimension is the influence of one helix upon another. The Slovenian government has, for example, in recent years introduced several schemes for promoting technological development in industry. Industrial research in pre-competitive and near-market areas is subsidized, with special bonuses for co-operations between manufacturing firms, but also between industry and science [11]. The third dimension is the creation of a new overlay of trilateral networks and organizations from the interaction among the three helices, formed for the purpose of developing new ideas and formats for new product development [10]. Centers of Excellence are examples of these networks. Mostly funded by government resources, they are corporate entities, with a view to adequately manage their intellectual property and investing in the development of promising new research avenues.

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 [8]. Industry, on the other hand, supports university research by extending it beyond technical innovation. Scientific research is becoming increasingly relevant for socio-economic development.

Consequently, governmental policies affecting the innovation process change their strategies in promoting R&D and other entrepreneurial activities to fulfill the "society-centered" 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 [12].

Although Triple Helix interactions are usually a necessary condition for innovation, they are often not a sufficient condition [13]. As proposed above, the innovation processes are becoming more complex and the involvement of the user is both, necessary and natural in the innovation processes within the knowledge-based economy. At the same time all the participating institutions within the innovation process are part of the society that shapes them and reshapes their relationships.

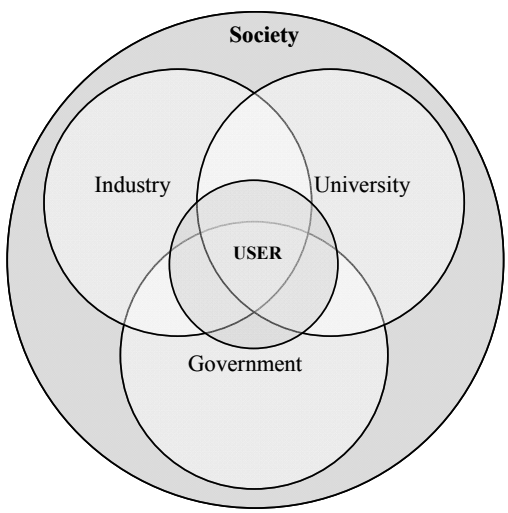


Fig. 2. *The Fourfold Helix relations within NPD process*

We propose a new framework (Fig. 2) of university – industry - government relations, where the user is put into the center of innovative relations among the studied institutions and where the society as a whole is the institution binding all of the actors together.

1.2 The Role of the User and Society in NPD

In its broadest sense, innovation is about creating a climate or culture which promotes implementation of productive change in order to improve the wealth creating capacity of society [14]. In this sense, it is an idea, practice, or object that is perceived as new by an individual or some other unit of adoption [15]. If we follow this definition and presume that innovation is about social and cultural change, then it follows that change, and the circumstances leading to the adoption and ultimate success of those changes will take place within unique systems and cultures – the society.

As stated in [16], 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 [16] – will dictate (1) the diffusion of an innovation into the society and (2) its success rate.

If, on the other hand, innovation is limited only to the diffusion into society, whereby the adoption of innovation is disregarded, only the Triple Helix relations are relevant. Diffusion is the process through which an innovation is communicated through certain channels (i.e. marketing, word of mouth, etc.) over time, among the members of the social system [17]. The three institutions of the Triple Helix are the communicators in the diffusion process. They push the innovation onto the market, whereas the acceptability and the speed of adoption of the innovation are not in their domain. The market point of view, where the user is the key player, is disregarded by the Triple Helix model. The importance of the involvement of the user and the society in the NPD is presented in Fig. 3.

Empirical research in a number of fields has shown that users are frequently the first to develop and use the prototype versions of what later become commercially significant new products and processes [18]. Although most of the users that innovate are "lead users", meaning they are at the leading edge of market trends, many of the novel products they develop for their own use will appeal to other users and could provide the basis for the products manufacturers might wish to commercialize [19]. As stated in [20], users (1) can be the source of incremental technical changes, (2) can develop unconventional design solutions or (3) can find and test new applications of a product. Since

products are always culturally evaluated, users in the widest sense always play a role in innovation. Their role is essential in the early development and diffusion phases of an innovation [21]. In many cases technical improvements are realized during the diffusion phase (the phase of product commercialization and adoption) by user feedback or by re-invention by the user.

User practices and the wider socio-economic environment are strongly related. Society may directly influence user-relevant characteristics of any technology [21].

According to [18] user innovation occurs when (1) a local community has unique needs and (2) when it is cheaper to invent anew than it is to search for and acquire a needed innovation that may exist elsewhere. To be able to use new technology successfully, many changes in user practices and the socio-economic environment may be required [13]. The social, the economic and the cultural aspects of the wider context are crucial for the innovation to be successful.

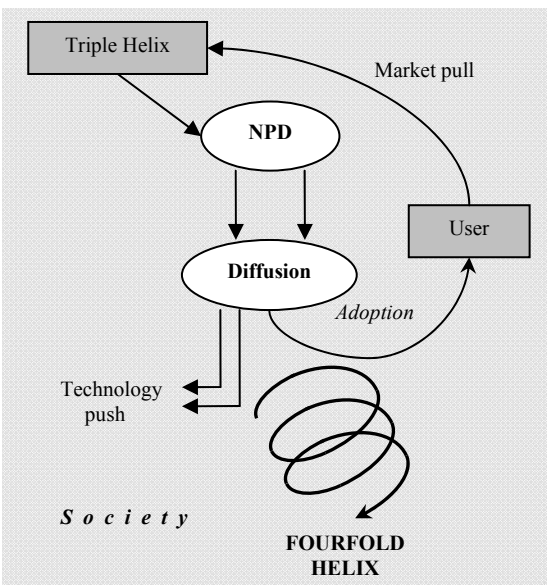


Fig. 3. *The importance of the user in NPD*

Therefore, the user is, on one hand the source of innovation and on the other, the evaluator of new products. Being a part of the wider society, neglecting this perspective might lead to NPD failure. According to [22], industry can only be successful if it is embedded in a healthy society. When a society is considered to be healthy, the following conditions are fulfilled: (1) education, health care, and equal opportunity are essential to a productive workforce; (2) safe products and working conditions attract customers; (3) efficient utilization of land, water, energy and other natural resources makes business more effective; (4) good government, the rule of law, and property rights are essential for efficiency and innovation; (5) strong regulatory standards protect both, customers and competitive companies from exploitation; and (6) a healthy society creates an expanding demand for business, as more human needs are met and aspirations grow [22]. A healthy society therefore, needs universities, industries, governments and users to properly function. There are two main aspects that we address in this research. First, we test the Triple Helix model on a practical case of NPD to research the institutional relations that are formed during that process. Secondly, we test the assumption that the user acts as an equal institution in these relations within NPD. In this way, we intend to investigate the proposal of extending the Triple Helix model into a Fourfold Helix of institutional relations in NPD. It is imperative that the institutions involved in innovation effectively capture unmet needs, continuously validate technology assumptions with customers and combine the technical and marketing functions in order to achieve NPD success.

The research questions are as follows:

1. Does the involvement of the user and the society reshape institutional relations in product innovation processes, proposed by the Triple Helix model? If so, how are these relations reshaped by the involvement of the user and the society?
2. Is the user an equal partner in the reshaped relations of NPD?
3. Should the user and the society be added to the Triple Helix model, thus forming a Fourfold Helix?

According to the constructs identified in the literature review presented, we will analyze how the institutional boundaries are being reshaped in product innovation processes on a case of an Academic Virtual Enterprise (AVE), embodied in the European Global Product Realization (EGPR) course. We will study all four institutions that are proposed to be a part of the innovation process within the selected course

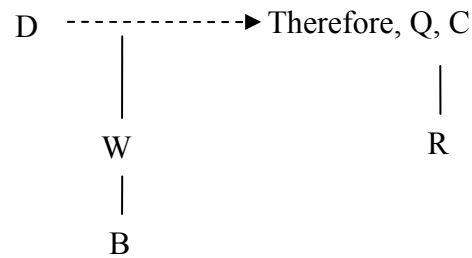
and their relations. Our objective is to present the role of the user and the society within these institutional relations. The theoretical focus is placed on the Triple Helix model and its enhancement with the society perspective, whereby the unit of analysis is the EGPR course implemented into design education of several European Universities.

There were several criteria taken into account when choosing a design course instead of a real-life NPD project for the case study. First of all, there was a need for a case study where the Triple Helix relations were present and the NPD process involved a common consumer product. Although the involvement of the university and the government in NPD is increasing and becoming more relevant, the majority of NPD projects is still strictly in the domain of the industry, whereby most of the innovative processes are done within business to business environment. The EGPR course presumes and supports the involvement of all the relevant stakeholders and its final result is a product intended for the consumer market. Second, the NPD processes within the EGPR course are conducted according to real-life design practice in order to enable the development of good designers. Finally, the rapid developments in design practice call for proactive educational responses. Design education should enable students to aquire the necessary competences that will allow them to face challenges yielded by new trends in current real-world design problems when they become professional designers. Experience shows that many graduates cannot cope with such NPD practice. According to this presumption, the EGPR course was formed as an application of AVE, with the notion to put the students into the real-life NPD environment. As such, it is presumed to be suitable to investigate the institutional relations arising from the NPD practice.

2 RESEARCH METHODOLOGY

To analyze the value of the Fourfold Helix framework, case study methodology was chosen. A case study maps real-world data onto an abstract, general framework, and expresses it in terms of a detailed substantive argument, which is in effect a theory [23]. The case study is suitable to answer questions like "how" and "why", whenever the empirical analysis focuses on real-life context [24]. Since the present work aims at identifying how the involvement of the society and the user in innovation processes reshapes the institutional relationships within the Triple Helix model, it will be necessary to conduct an explanatory study.

To increase the validity of the conclusions, the "quasi judicial" (QJ) method of case study will be used. It relies on assessing and weighing the evidence provided on a case-study for its causal arguments. In contrast to other case methods, it uses a systematic inductive procedure to construct arguments about a specific case and tries to establish the causal connections referred to in the substantive arguments used to describe and analyze the case [23].



LEGEND:
C (claim): conclusion
D (data): relevant empirical data
Q (modal qualifier): subjectively determined probability that the claim is actually valid
W (inference warrant): presumptions, rules and theory that support the claim (C) on the basis of data (D)
B (background data): contextual information from background that supports the arguments (W)
R (rejection): conditions under which the arguments would fail

Fig. 4: *Representation of the QJ method [23] and [25]*discussed

In [25] the author helps codify the "quasi-judicial" method by setting forth eight formal steps for applying this method to clinical or social science research (see Fig. 4). These are the following: 1) the initial problems and issues of the case must be clearly stated, 2) background information should be collected to provide a context in which to understand the problems and issues of the case, 3) existing explanations of the case must be evaluated to determine whether they fit the evidence and to discern what they lack, 4) a new explanation should be set forth fixing the problems identified in previous explanations, 5)

the sources of evidence and the evidence itself used in the new explanation must be evaluated or "cross-examined," 6) the internal coherence and logic of the new explanation including itscompatibility with the evidence should be critically examined, 7) the conclusions of the new explanation regarding the case must be presented, and 8) the implications of the new explanation for comparable cases must be the elements presented in Fig. 4 the questions are as follows [23], [25].

These steps can be achieved by posing several questions, which are used to construct or dissect an argument. With regard to

- C: What are we trying to prove?
- D: What evidence do we have to go on?
- Q: How likely is it that our conclusions are correct?
- W: What entitles us to draw these conclusions from that evidence?
- B: What is the justification for our line of reasoning?
- R: What assumptions are we making?

The pattern of argument revealed by the QJ method may permit findings to be generalized to a class of similar cases and will be used in this paper on the case of the EGPR course, conducted within an AVE.

3 COMBINING THEORY AND PRACTICE

The concept of an academic virtual enterprise (AVE) was invented to establish a stimulating learning and working environment for students [27]. It is a project-oriented educational agreement, which is based on volatile alliance of industrial and academic partners for mutual advantages. As a result of a multi-year educational design, an international AVE was set up as a learning environment for an EGPR design course. Together with university educators and company experts, the students of several universities from different countries form the labor capacity of the AVE.

In 2007 five European universities (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 an AVE. The industrial partner provides a problem to be solved by the international teams of students. The AVE connects theoretical knowledge and practice (by combining academic and practical knowledge) to solve a real-life NPD problem. Its main characteristic is the formation of virtual teams of students that only know each other through the video-conferencing meetings. All the communication and work in such an enterprise is done with the help of IT technologies, as the participants are located in different parts of the world.

The goal of EGPR courses is to enable students to develop abilties that are needed to solve complex real-life NPD problems, to generate product ideas and forward them to the status of a working product prototype and to manage their knowledge inquiry and skill development for their future work as professional designers [27]. Through the EGPR course the students work in multicultural, multinational and multidisciplinary teams with the objective to solve a global product development problem using the knowledge acquired during the EGPR course, the knowledge learned during other courses at their universities and information provided by the industrial partner [28].

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 [28]. Teams are formed in such a manner that each team consists of several students from each of the participating universities. Therefore, students's profiles within a team are very different, which has the advantage of providing complementary knowledge and expertise that are needed for the development of a global product. On the other hand, it poses a problem of handling the discrepancies not only in skills and expertise but also in view points about the same subjects [28].

One of the advantages of this course is that the students can engage in more risky activities than the present industries, because of their supporting learning and developmental objectives. In doing so, they put the interactive Triple Helix in action. However, the course also actively considers the user and the wider society in the process of innovation, and in doing so it also implements the proposed fourth helix. As we argued earlier, the relations of the three helices are not enough for a successful innovation process. The user is the center of innovation, as he/she is present in every step of the NPD process

as an innovator or evaluator of the innovation and therefore, affects all three helices in innovation. The user is also part of the wider society, and in constant interaction and relation with the three institutions (government, university, industry). Together they form a society that can only be healthy and progressive when all the spheres are in creative and constructive relations. The students of the EGPR course take these relations into account and put them in to use to produce innovations that are creative, socially and environmentally acceptable and provide a competitive advantage for the company (Fig. 5).

The AVE 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. 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 by experts from both, academic and industry sectors. Lectures balance between practical and theoretical issues in order to provide the students with efficient tools to deal with global product development projects in a structured way [28].

From the educational point of view, design is mainly characterized by the need to combine theoretical knowledge and practical skills [26]. A strategy of paralleling theory and practice (students should learn about design and how to design), as proposed by the Triple Helix relations, should therefore, be adopted in teaching design. The EGPR course does that with (1) parallelling academic lectures and strong theoretical knowledge with product development in EGPR project, and (2) involving the application of intensive practical skills.

The EGPR course is also regarded as an opportunity for a closer cooperation between the university and industry [29]. The relation is seen primarily in providing students with a real life problem that they can solve with designing an appropriate product. Consequently, the solution provides an opportunity for the participating industry, as all 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 developmental potentials companies certainly support the EGPR course [29]. Both, short term benefits and long term advantages for the future are expected. The industrial partners present a real-life problem for the products to be developed and provide the information and data about the existing models in the comparable families of products. Their practice of product development allows the students to deepen their understanding of problem analysis, product development processes, to improve their professional skills and also to gain experience in multi cultural, multi national and multi disciplinary cooperation. The students are thebridge between the academic knowledge and industrial application [28].

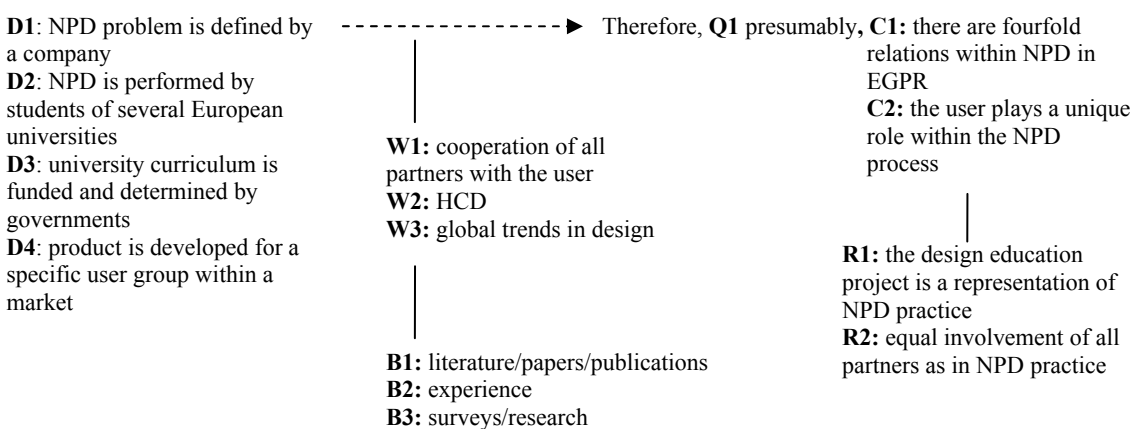


Fig. 5. *The Fourfold Helix relations within EGPR*

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 to help start new enterprises [8]. As EGPR is a part of a broader curriculum of the participating universities that is supported by governments of all participating countries, the involvement of the governmental institution is not questionable.

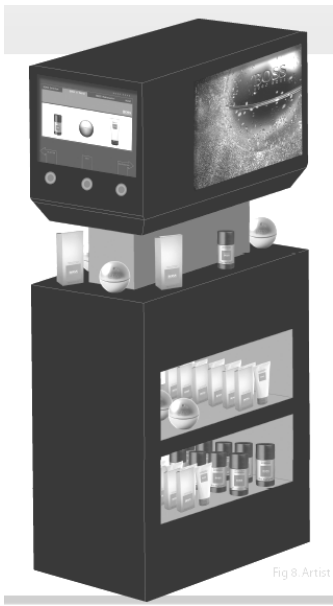


Fig. 6. *An example of the final prototype in EGPR 2007*

The role of the society within the EGPR course is, however, more obvious. The fourth helix is an important part of the course of EGPR from the very beginning. The user perspective is introduced from the beginning of student work with market research being done on regional, national and global scale. The design course is in this way not only technology-oriented, but also market-oriented. In 2007, for example, the project task was to develop a technologically and technically advanced Point of Purchase display, which would be used for displaying male grooming products produced by a brand at the premium range (Fig. 6). The display should have emphasized the brands' products and have them presented in such a way that the client understood and felt the brand advertised. In order to be ahead of their competition, the company wanted to offer its customer a display that managed to draw attention of male buyers by incorporating cutting edge technology and creating an interactive male grooming display. This should have helped the company's customers to increase the sales of their products.

Students' work was structured into several consecutive phases, whereby the user perspective was mostly investigated in the first phases – the so called fuzzy front end of the NPD process. During this phase the main concern of the teams was to get an insight into what the market needs regarding the specified product were, what the competition was like and what the trends within the given market were.

With such an analysis, the requirements, important for the next stages of product development, were found. As the assignment process had already been specified by the company involved, further insight into the market needs and company competition was done by a survey including a questionnaire and a focus group. Through the analysis of market trends and with the guidelines discovered from the survey, a list of requirements was put out as an introduction into the idea generation phase. The final result within the fuzzy front end phase were several ideas for the design of male grooming displays. They were further evaluated and developed in the next phases of the project. The main mission of the first stages of student work was therefore, getting to know the market and specifying the requirements that the male grooming display should satisfy to be successful within its target group.

The students did research in all five participating countries, so that the results could be applied on a more global 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 as well as which other factors had to be involved in NPD to obtain a result that was 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.

4 DISCUSSIONS AND CONCLUSION

In our study we have tested the validity of the Triple Helix model on an Academic Virtual Enterprise. With the QJ method we have found evidence to support our claim, that only university-industry-government relations within NPD processes are not enough for a successful product innovation process. Our proposed Fourfold Helix model that also involves the user and the role of the society in the NPD processes has been supported by empirical evidence. It has shown that technology-push and market-pull strategies need to be a part of NPD processes in order to make them successful. However, the presented case was a study of NPD within an educational area. Moreover, it is a single case study; therefore further research is needed to provide further support for our model.

The main differences between educational and real-life NPD practice that need to be taken into account in regard to our study are mostly related to the NPD processes. Professors at universities tend to teach the ideal case NPD process, meaning that the students go through all the phases of NPD process and consider all the institutions and actors involved in such processes. In practice, however, the environment of the firm and the NPD project needs to be taken into account and several risks need to be considered as well. The NPD process in real environments can go faster and must be cost efficient in order to bring success. Students can make mistakes in their processes that are reflected only in their marks. Furthermore, students can also take more risks and try satisfying user needs that are more complex and less feasible than in real NPD environments.

However, our study has efficiently proven that there are several more institutions than just the Triple Helix ones that significantly contribute to product innovation processes and consequently, provide successful NPD. Therefore, although in need of further confirmation, our Fourfold Helix model can be used as guidance in evolving institutional relations in NPD.

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