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INDUSTRIAL PARTNERSHIP IN DESIGN EDUCATION – EXPERIENCES FROM EGPR COURSE

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ABSTRACT

Partnership with industry is one of the main means to expose students to engineering practice. This paper presents experiences from the European Global Product Realization (EGPR) course jointly organised by six European universities. It attempts to extract desirable characteristics of a project and an industrial partner suitable for collaboration in practical design education. Particular attention is drawn to the learning outcomes which could suit this multidisciplinary and multicultural academic enterprise. Learned lessons will be applied to improve future EGPR courses.

Keywords: Industrial partnership, practical design education, development of global products

1 INTRODUCTION

European Global Product Realisation (EGPR) course is organized as an academic virtual enterprise of an industrial company and six European universities, namely TU Delft, The Netherlands - Faculty of Industrial Design, EPFL Lausanne, Switzerland, University of Ljubljana, Slovenia - Faculty of Mechanical Engineering, University of Zagreb, Croatia - Faculty of Mechanical Engineering, City University of London, United Kingdom - School of Engineering and Mathematical Sciences and Technical University of Budapest, Hungary - Department of Machine and Product Design. Not all of the mentioned universities have participated since early beginning initiated by TU Delft.

The ultimate goal of the course is to develop a concept and produce a physical product prototype within one academic semester. In order to expose students to a real life situation the prototype is being produced in tight collaboration with industrial partner. It must be a part of company current or future product portfolio. By this means this exercise is not a simulation of the project. Instead it is the actual, real life, industrial product development project itself. Such an approach, apart of the pure technical content offers students deep understanding of business and other social issues. University students and academics closely collaborate in the realization of this course. Student groups consist of 5 to 8 members, with at least one member from each university and if possible from different disciplines. Each year, one university is responsible to find a new industrial partner and to host the project for that year. That ensures diversity since a completely new project, different from any other year is offered to students and managed by academics.

Long term cooperation with various industrial partners has brought significant experience to the practitioners and participants in the course. In this paper we want to discuss technical and organizational issues of this industrial partnership that have significant influence on the outcomes of practical design education and have arisen from the 10 years of EGPR experience. A comparison and a short history of previous projects are given in order to define desirable characteristics of past projects and industrial partners in practical design education. Finding new industrial partner every year requires significant efforts to ensure suitable candidates are found to fulfil all requirements of the global product realization course. Although a participating company should fulfil requirements of the academic enterprise, they also need to have benefits from participation including potential commercial satisfaction [1]. The key factor for successful realisation of the course is the choice of industrial partner.

Course Outline

Due to size limits for this paper, only a short description of the course is given in this chapter. Broader description of EGPR course concept and its evolution can be found in [1], [2], [3] and [4]. Besides standard objectives of any course in engineering curriculum, EGPR has some specific objectives:

- to conduct product development in international teams by use of videoconferencing and other collaboration support technologies,
- to define and conceptualize new global products by applying state of the art knowledge and collaborative methods,
- to extend and apply students knowledge related to product technologies, product structuring and adaptability, use and recycling of materials, technologies for manufacturing, as well as economic, business and environmental aspects,
- to realize global product concepts in the form of virtual and physical models and prototypes, and
- to acquire communication skills by organizing presentations and by experiencing the teamwork.

Ideas and arguments have to be presented to other team members, academic staff and industrial partner representatives by use of available communication media (videoconference, e-mail, chat sessions, “blackboard” service, etc.). It has been shown that participation in project work through direct experience is the most important source of developing student competences [5, 6] cited in [4]. EGPR course exposes students to real life product development problem in international teams in order to find out their performance in situations when:

- students differ in culture, skills and domains of interests while they are expected to collaborate in a virtual environment,
- students have to assign responsibilities, share ideas, tasks and opinions on their meetings,
- work is coordinated and supported at each location by staff members and teachers.

Elements of EGPR course comprise:

- project definition – according to agreement with industrial partner,
- lectures composed and adapted to address current year project specific needs which are equally distributed to partner universities,
- project work is monitored by academics, with three distinctive phases and review points,
- and the final workshop that includes prototype manufacturing, assembly and testing, final presentation and exhibition.

The project work is distributed over three project reviews in which teams must produce written reports and make a presentation to other teams, teachers and industrial partner representatives. The issues to be addressed at review points are:

1. Identifying customer needs, clarifying requirements, company SWOT analysis, proposing and identifying products and business opportunities in the defined problem area.
2. Functional analysis, presenting and evaluating concepts, estimation of prototype costs, selecting the best concept in discussion with industrial partner.
3. Embodiment and detail design, presentation of final design, sending technical documentation to industrial partner, purchase of components that could not be manufactured at industrial partner.

EXPERIENCES COLLECTED THROUGHOUT HISTORY OF EGPR COURSE

In order to extract desirable characteristics of an industrial partner, this chapter gives an overview of the project definitions and specific learning outcomes in last 6 years. A table which summarizes EGPR history is given in [4].

Development of hand held blender for men and concealed toilet flushing system - 2010

Host University: University of Ljubljana, Slovenia

Partners: BSH Slovenia - hand held blender and LIV Postojna, Slovenia - toilet flushing system

Project description: Task for LIV Postojna was to develop an innovative toilet flushing system with special focus on innovative flushing plate. The user wanted to have a system that is efficient and satisfies its basic function through a long life span.

The BSH Company proposed project to design a hand held blender which would target modern urban men, who take an active role in the kitchen. Although this is a growing market segment, it is almost impossible to find small kitchen appliances which would fulfill men's needs for robustness and multi-functionality of the device. Of course, such device should be operated by women as successfully.

Requirements:

For LIV:

- Novel flushing plate with multiple functions.
- Upgrade of the flushing system without changing its basic purpose.

For BSH:

- Electrically/battery driven device, with energy charging system integrated into the device.
- Performances of the basic functions - blending and chopping of food - should be excellent
- Ease of cleaning, easy and intuitive handling of the device. Foldable handle.
- The device should fulfill all security standards (waterproof, electricity, ergonomics, etc)
- The fully functional tool must consist of maximum two parts and have sensor type switches.
- The storage box for the device should also have the function of the mixing pot.

Outcomes:

The student teams were faced with two very different project tasks, as well as with two very different company partners. One participated intensively in student work, whereby the other left the students to work independently on their tasks. This effected the motivation of student teams but in a surprising ways. The students teams working on the project in which partner was guiding them in their work produced prototypes that fitted company product portfolio but followed standard approach of a company. The student teams that had little support from the company presented complete novelty to the chosen market and gave breakthrough results that could be patented.

Development of an active rehabilitation support device - 2009

Host University: Technical University Delft, The Netherlands

Partners: University Medical Centre Utrecht, and companies Evalan and Protospace

Project description: Many real-life situations exist where humans should go through a physical rehabilitation therapy. In these cases, recommendations of the physicians should be strictly followed and executed, and the recovery condition and behaviour of the patient must be supervised and controlled. The project task was to develop a device and service which will help patients and physicians through the rehabilitation therapy.

Requirements:

- To monitor details of the patients behaviour and measure specific characteristics
- To assess this information with a view to the specification in the rehabilitation program and recognizes deviations and possible problems
- To inform the patient about what he/she can improve or may do differently
- To inform the physician about critical characteristics of the behaviour and facilitate communication with the patient

Outcomes: The task definition was wide open in scope which proved to be very challenging for students. They conducted comprehensive market research and have visited several medical institutions to become familiar with the area that was relatively unknown to them. Complex and highly innovative mechatronic products were required to be developed. Most of the teams struggled to understand the problem area and to focus to one specific rehabilitation problem due to difficulties in communicating with medical specialists. Once the problem was identified, it was still difficult to determine its clinical relevance. This required further multidisciplinary research which is normally not in the scope and the time frame of the EGPR course. However, such a challenging project definition gave the students very valuable insights and experience in design creativity and innovation. Most of them have for the first time faced the problem of defining the scope for a completely new product and finding its market niche. Project requirements included the development of specific software for data collection, analysis and transfer, but due to time constraints and lack of specific knowledge, most of the teams did not finalise this part of the project. The project was highly valued by the students and academics.

Development of a mobile ecological house - 2008

Host University: University of Zagreb, Croatia

Partner: TEHNIX d.o.o. Croatia

Project definition: The project task was to develop a mobile autonomous ecological house. Autonomy of house is defined in respect to energy which is to be provided from the available alternative sources. The student task was to research the efficiency of possible alternative sources, development of concepts for harvesting energy from these sources, detail design for chosen concepts and the design of the interior.

Requirements:

- project should be based on the standard product from company portfolio
- investigate possibilities for usage of solar panels, wind turbines, rain water storage and heating, and backup LPG generator
- develop control system and virtual prototypes

Outcomes: This project definition allowed analysis of collaboration between the students in various disciplines required in EGPR course. Industrial designers are expected to actively participate in market research phase and conceptual phase, but this project gave them the opportunity to fully express their potentials in house interior design. The design of control systems provided the focus area for micro engineering students. Mechanical engineers were mostly concerned with design of components for providing energy. Unfortunately, the project was too ambitious regarding the prototype manufacturing as the costs of building of several individual prototypes for each team were too high. Therefore only one prototype was built and the students were able to test only the configuration finally defined by the company. Tests included reliability, sustainability and energy consumption. Although the workshop was held at the company premises, the students did not have an opportunity to experience manufacturing of the final prototypes. Instead student teams built individual virtual models.

Development of a point of purchase (POP) display - 2007

Host University: City University London, United Kingdom

Partner: Kesslers International Ltd, UK

Project definition: The project task was to develop a technologically and technically advanced point-of-purchase (POP) display which will be used in sales of a male grooming products produced by a premium range brand.

Requirements:

- floor standing or counter display, generic retail display, interaction with the client,
- display and storage of a product, testing of product displayed, non invasive skin testing,
- movement for exchange of products or emphasis of a brand, adjustable shelves
- illumination, modern electrical equipment i.e. LCD Screens
- ROSH and CE compliant, stability, easy to assemble, must be lifted by two people

Outcomes: In the research phase students performed extensive market research, branding review and learned about manufacturing capabilities of the company. The company is the biggest European manufacturer of POP displays with only 2% share in the market which helped students to understand urgency in project timescales and the importance in applying structured product development. The final workshop was held at the University laboratory but all major parts for five prototypes were manufactured using the facilities of the partner company. The project execution was strongly influenced by marketing factors. Therefore the presence of marketing students aside of mechanical, electrical, micro engineering and industrial designers proved valuable for the project. In parallel with the final workshop, the seminar on competence development in EGPR course was organised by the academics to explore benefits for the students, Universities and the industrial partner.

Development of a transport device for multi-storey buildings- 2006

Host University: University of Ljubljana, Slovenia

Partner: NIKO, Železniki, Slovenia

Project definition: To develop a novel transport device system to be used for civil engineering, furniture moving, cleaning and other works performed in multi storey buildings.

Requirements:

- a device should transport 50-300 kg to a distance of 300 m
- should be operated by 1-2 (male or female) persons, should be able to climb the stairs
- short setup time, easy to manipulate and to manoeuvre
- load size: 1200x800x1200 mm, operational speed of 0.8-1.4 m/s
- target users: individuals and small companies, target production volume 1500-3000 units a year

Outcomes: The project focused on mechanical and electrical engineering with the emphasis on requirements definition and function specification. During the final workshop at the Industrial partner premises, the students built six working prototypes and obtained particularly useful and important experience on manufacturing. User testing proved to be important aspect of the project.

Development of a micro spraying equipment for the viticulture industry - 2005

Host University: EPFL Lausanne, Switzerland

Partner: Avidor S.A., Switzerland. **Project definition:** To develop a device for use in treatment of Swiss vineyards with the micro spraying technology.

Requirements:

- Micro spraying efficiency - spray droplets of the ideal size on both sides of each leaf,
- Environmental friendliness, user protection, global use
- Adaptability to external atmospheric conditions - the droplets size should be variable

Outcomes: Developed prototypes of spraying devices were mounted on basic company product – a small tractor specialized only for vineyards. Hydraulic and electrical connections of tractor were available as well as wide variety of device mounting possibilities.

LESSONS LEARNED

Variety of projects and industrial partners together with change of the host university every year provided some guidelines for selection of the industrial partner and project assignment.

Desirable project characteristics

Project definition should be balanced to give equal opportunity for engaging all students from various disciplines namely, industrial designers, mechanical engineers and micro engineers throughout the project realisation. If otherwise, project assignment could cause conflicts in teams and could be limiting factor for learning outcomes. Finding this balance is perhaps the most sensitive and most difficult task in the whole project. Some of the previous industrial partners failed to provide this diversity and thus were abandoned in the process of negotiations.

Usually, it is quite straight forward to define the project which will suit the needs of mechanical engineers. In some cases problems occurred in adapting projects to the needs of industrial designers. In past, if the nature of the problem did not require shaping of external surfaces or other artwork, the focus of the industrial designers activities were on project management and market research. From the experience, the best learning outcomes for the students were accomplished in realisation of mechatronic products that require intensive interactions with users. In all previous years the goal was to design the project assignment which will have significant degree of innovation and novelty and offer developing new products and ideas. At the same time, such products need to be part of the company portfolio or their future development programme. This always raises an issue of keeping the business secrets and it proved that many companies are not willing to allow students to go deep in their research & development plans.

On the other hand the project definition must be balanced between novelty and ability to be achieved in one academic semester by teams starting from scratch and having only "inexperienced designers". The scope of the project definition should be sufficiently open to give teams enough space for research. It should allow teams to formulate their own specific functionalities that will eventually

result in a slightly different variant of the project task. Degree of product complexity is very important issue. EGPR requires production of physical prototypes and therefore the project should be scaled to a component or subassembly in case the product appears to be too expensive and/or too complex.

Feasible industrial partners

With experiences gathered through EGPR course with various industrial partner and the new project each year it is now possible to propose guidelines for selection of suitable industrial partners. The following list outlines desired characteristics:

- To provide sufficiently open ended project assignment which will allow students of different disciplines to be involved in the project.
- To closely cooperate with academics in initiating and adapting the project definition to the needs of EGPR course.
- To be present in the global market with innovative global products.
- To allow insight in its internal infrastructures and external connections at least to the extents sufficient for students to formulate their problem and perform market research.
- To be open-minded for a wide scope of possible solutions and innovations and interested in academic approach of product development and innovation.
- To allow students sufficient freedom to explore and develop own ideas and concepts and to provide feedback that will eliminate developing of solutions that are useless for the company.
- To provide engineering help of their own experts in all project phases, especially at review points and in the final three weeks of project when the review is required of the detailed design, assembly and manufacturing procedure. This should include advices and feedback after testing.
- To provide manufacturing help at the final workshop. Ideally to accommodate students in the company premises and to provide all required tools, technologies and support of technicians.
- To participate in course expenses by financing prototype manufacturing and purchase of components as well as the final workshop.

CONCLUDING REMARKS

During the long history of EGPR course it was proved that the success of the project and the level of learning outcomes highly depend on the selection of the industrial partner and the project assignment. It is expected that the project assignment is aimed for the global product which is part of company's current or future products and is open enough to allow students to research widely and unrestrictedly develop novel ideas. The industrial partner needs to provide the full support to students throughout the duration of the project by providing information about internal and external features of the company, feedback on the presented results and manufacturing capabilities for achieving full experience. The learned lessons will be used in future to improve realisation of EGPR projects. We should aim to form a global network of academia and industrial partners for design education [7].

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