UNIVERSITY-INDUSTRY EXPERIENCES. CASE OF A UNIVERSITY-INDUSTRY-ADMINISTRATION AGREEMENT

Joaquim LLOVERAS
Universitat Politècnica de Catalunya (UPC)

ABSTRACT
This article describes the author's experience in R&D projects developed in collaboration with industrial companies or the state administration ─agreements─ and their relation with university education. In the last sixteen years he has been the head researcher in nineteen agreements: sixteen with companies, one with the state administration and a medical institution, one with the administration and a company, and one with the administration. As can be seen, the author's collaborative preference lies with companies, usually in the form of small agreements with local SMEs which put an emphasis on the conceptual design of product engineering. The results of these collaborations are product designs and patents. These agreements are legal contracts between the company managers and the Rector of University. This article presents three examples of agreements. More specifically described is a University-Industry-Administration project, or "triple helix", to redesign Barcelona's rubbish containers for adaptation to wheelchair users.
From the educational point of view, the results of these projects led to an increase in participants' knowledge and practice, including the lecturer, who directly or indirectly transferred the knowledge gained to the classroom.

Keywords: University research, triple helix, education.

1 INTRODUCTION

The main tasks of a university lecturer are teaching and research. Teaching and research feed off each other and allow knowledge to be transferred and university faculty to keep abreast of developments in their fields. In order to apply research to engineering design, it is important to establish relationships with local production sectors. Hence, university teams work hand in hand with companies to make technological developments and obtain economic benefits in a win-win relationship, but without university's loss of independence. Faculty are assessed on the basis of their curriculum vitae, which outlines the three main areas of work, i.e. teaching experience; scientific and technological experience in R&D projects promoted by the administration or companies; and scientific and technological activities, especially scientific publications or works.
R&D project agreements are not only a way to improve university education, but also a source of income for the university and researchers. These agreements often involve the participation of final year or PhD students and/or, occasionally, technical staff.
Although the author is primarily involved with undergraduate education, he also teaches postgraduate and PhD courses and makes their management. Additionally, he has conducted research, especially in conceptual design, and participated in agreements with local companies.
This paper presents data, results and experiences gained from agreements between companies and academia, with a special mention to a University-Industry-Administration project.

2 DESCRIPTION OF AGREEMENTS

This section gives three examples of the above agreements: a project in collaboration with a medical institution approved by the state administration, several agreements with companies, and a University-Industry-Administration agreement.

2.1 Agreement with the state administration and a medical institution

A rowing bicycle for paraplegic users (figure 1) was designed within the framework a program of the state government [1]. A scholarship was obtained and collaboration with a medical institution for disabled people [2], some of whom took part in the project, was essential to conduct tests.

Figure 1. Prototype of rowing bicycle for disabled users. Source: National Geographic Spain (April 1999)

The project involved much bureaucracy, and although the prototype was commended by government representatives, a second scholarship requested to improve the prototype was denied. Nonetheless, a patent was made [3].

2.2 Agreements with companies

These agreements (twelve), were mostly small collaborations with local SMEs. They consisted in technical assessment and conceptual design. In one particular case, some parts of a cooking robot, including the casing, which was redesigned by a student of architecture (figure 2). The result was the improvement of the appearance of the device.

Figure 2. Left: Design of a casing (by Albert Lloveras). Right: Cooking robot (source: Pujadas Group)

2.3 Case of a University-Industry-Administration agreement

A University-Industry-Administration agreement consists in the collaboration between two institutions and a company to develop a project. This union, described by Etzkowitz [4], Etzkowitz and Leydesdorff [5] as "triple helix", has advantages in some types of projects. The project here presented was aimed at making city garbage containers accessible for wheelchairs users. The management of these containers is the responsibility of Barcelona's cleaning services whereas their supply is managed by private companies, as well as transport of urban waste to its final destination.

Each container is identified by a colour, i.e., brown for organic waste, blue for paper and cardboard, green for glass, yellow for plastic and metal packaging, and grey for general waste. Citizens carry these fractions in bags from their homes to nearby garbage containers. There are about 25,000 in the city.

Figure 3 shows some old containers in 2004. Grey containers (figure 3, left) were not accessible to wheelchairs users and, in general, to people who could not press the pedal to lift the lid of the container and put the rubbish bag inside. Moreover, the lid was heavy and closed too rapidly upon release of the pedal. The opening in blue and yellow containers (figure 3, right) was too high to be accessible to wheelchair users. Since at that time organic waste was not collected, there were no brown containers.

Figure 3. Left: Old container for general waste (grey) (own source). Right: Old containers for paper (blue), glass (green) and packaging (yellow) [6]

The initiative of this agreement came from the city's cleaning services. They contacted a design team from the Universitat Politècnica de Catalunya and a garbage container manufacturer who was willing to participate in the project [7]. This company gave scholarships to two students who were preparing their final project, followed up on the project and built and tested the prototypes. The university team coordinated the project. For seven months, several design solutions were proposed at monthly meetings with the representative/s of the cleaning services and engineer/s of the company. The requirements of the project were that the new containers should have the same capacity and lateral size as existing containers to avoid the need for changing the collection trucks.

The pros and cons of all solutions were analyzed, and opinions about the designs were given by the engineer/s and representative/s of the cleaning service, as well as by disability organizations. Two alternative designs for the general waste (grey) container (figure 4) and two for the paper (blue) and packaging (yellow) containers (figure 5) were presented. Figure 4 shows the solutions for the general waste (grey) container, i.e. the lid of the container is raised by a lateral handlebar with an internal mechanism (left), or by a handle directly attached to the pedal (middle and right).

Figure 5 shows two designs of paper and packaging containers, i.e. one with two holes in the front of the container (left), and one with a mailbox-type opening at a height suitable for wheelchair users (middle and right).

Two of these initial designs were selected for prototype development. The container with the handlebar attached to the pedal (figure 4, middle and right) was chosen for general waste collection whereas the container with the mailbox-type opening (figure 5, middle and right) was chosen for paper and packaging collection.

The company protected the chosen solutions with two patents and made several prototypes that were placed in some streets for several months with satisfactory results.

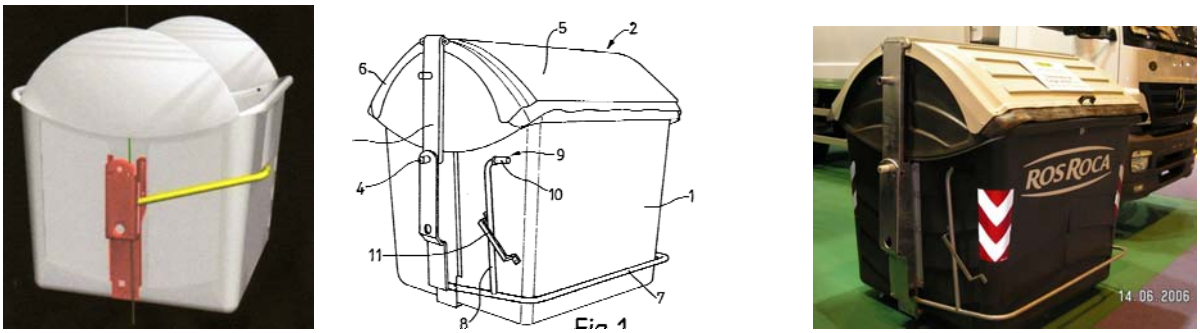

Figure 4: Grey container solutions and prototype. Left: Drawing with lateral handlebar (source: Bayod - Carreras). Middle: Alternative solution with lateral handlebar attached to pedal (drawing: Ros Roca). Right: Prototype in a trade fair (own source)

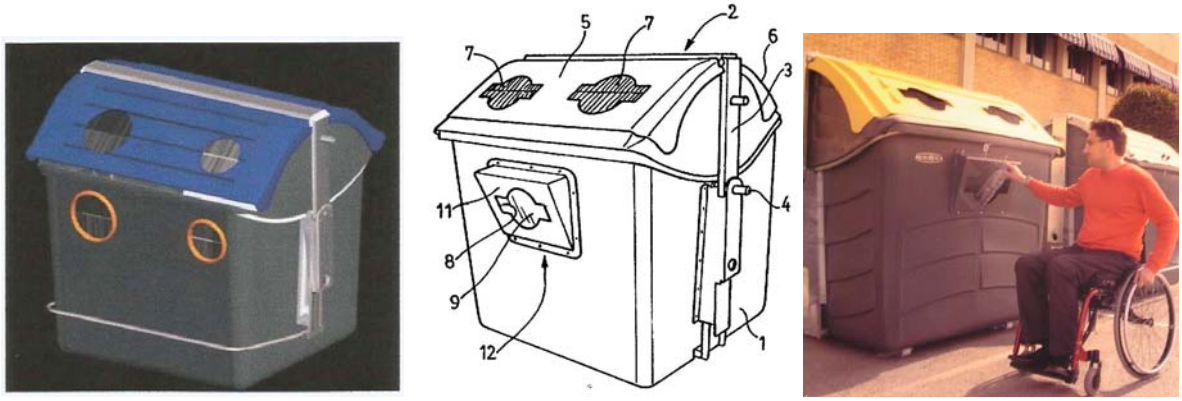

Figure 5: Blue and yellow container solutions and prototype. Left: Blue container with two extra openings in frontal panel (source: Bayod - Carreras). Middle: Alternative solution with "mailbox-type" opening (drawing: Ros Roca). Right: Prototype in a trade fair (own source)

Discussions about the design continued after the agreement had come to an end and some prototypes had been tested. Finally, the company decided to choose the other designs for industrial production (figure 6). The container with a lateral handlebar was selected for general waste collection (figure 4, left) whereas the container with lateral holes was chosen for paper, glass and packaging collection (figure 5, left).

Figure 6. New containers, from left to right: blue (paper), green (glass), yellow (packaging), two greys (general waste), and brown (organic). Diagonal Av. Barcelona (own source)

The maximum height of containers regarding wheelchair users allowed in ergonomics manuals is 1.4 m tall, which was left by openings or holes in the containers. The top holes were eliminated in the new design, which had new holes accessible to everybody. The new containers had symbols in relief for the blind and were placed throughout the city keeping the same order of colours. Subsequently, the company launched a final design of the external shape of containers (figure 6) [8], with engineering

and ergonomics based on the university team's design. In the meantime, organic waste collection was initiated. The organic waste (brown) container was designed just as the waste (grey) container, but smaller in size.

3 RESULTS

The aim of the nineteen agreements was mainly to design or redesign products or part of products (twelve of them), sometimes only reaching the stage of conceptual design of product engineering and others the stage of detailed designs. Six were technical studies and one was a training course.

Among these agreements, sixteen were made with eleven different companies; three companies collaborated in two agreements and one in three. Most of the companies were local SMEs. In addition, one agreement was made with a design institution and another one with a state institution.

The sources of the agreements were diverse: One was expressly requested to a state institution, but the rest were welcome to be developed. Two companies came in touch with the Centre of Technological Transfer (CTT) of the Universitat Politècnica de Catalunya, who connected them with the university participants. Five agreements were made with them. An executive of a consulting company who was also with the teaching department proposed two agreements. Another agreement was signed through a university professor. Another one was born as a result of winning an award. Two published university patents also led to the signing of agreements with two companies. In one, a training program for a new R+D department in the company was developed from a postgraduate course [9], which consisted in the learning and practice of creativity techniques and innovation procedures. Two from a head of a company, and finally, four agreements were from students that were granted a scholarship and needed a research tutor.

These nineteen agreements lasted 122 months in total, with an average of 6.4 months per agreement and 1.2 agreements per year. Some periods were quite intensive but two periods of nearly 3 years went without agreements. The amount of time devoted by the author for each agreement is different: Twelve agreements required much dedication, two some dedication and five little dedication.

The direct participants in these 19 agreements were 44 (an average of 2.3 per agreement), although there were also occasional collaborators. They participated in agreements: 23 undergraduates, 8 PhD students, and 7 technical staff and others.

One of the most important agreements was the University-Industry-Administration project to redesign Barcelona's rubbish containers.

4 DISCUSSION AND CONCLUSIONS

One early experience of the author as the head of research was the university-medical institution-administration agreement (rowing bicycle). However, it involved much bureaucracy and financial aid was cut off after the building of the first functional prototype.

His preference was for agreements with industrial SMCs to develop conceptual engineering designs of products, so he ruled out organising projects within state programs. The advantages of this option are more agile relationships, less bureaucracy, close contact with the company's technical staff, and view of current business problems and world context. The disadvantages are that the projects are small and have low budgets.

Some specific technical needs of companies can be solved by academia. Therefore, it seems appropriate to jointly develop conceptual designs from SMCs, and in this context, the knowledge of faculty members and good students is often required.

Experience shows the possibility of closer collaboration between the engineering school and industrial companies. However, more must be known about the culture and needs of the two parties to row in the same direction in a win-win collaboration. Companies need to understand professors' curriculum vitae needs and be aware that granted students must be promptly paid.

The number of students that collaborated in these university-company agreements is very low. Students and lecturers come in contact with the company's reality and finest commercial criteria. They also gain interest in the final product and feel the pressure of time. These points of view are hard to find in the university and are complementary to student training. The above agreements led to an increase in participants' knowledge and practice and also provided lecturers with a point of reality, an experience which was directly or indirectly transferred to the classroom. In this context, all undergraduate students must undertake a traineeship in a company.

The University can help companies, especially SMEs, in the initial phase of an innovation, because at university time to think can be taken whereas in companies decisions often have to be made on the spot. Moreover, students are trained in technical skills and creativity techniques, know patent databases and design processes, have a fresh vision of the current product, etc. However, R&D activities are both a risk and the future of companies. University-company agreements are generally an investment for the future that keeps the industrial network.
The joint efforts of government-university-company (triple helix) were very useful as the views of all parties involved in the project were considered to design the garbage containers. This resulted in increased safety of the designs. All aspects were checked step by step; otherwise, some would have been only speculations. At this respect, for example were consulted organisations of disabled in wheelchair or of blind persons for to check the new design. It was a very interesting project. Moreover, in each course a class was devoted to a description of and discussion about the process followed to complete the project, including the key points of the design, how it came to the proposed designs and a whole analysis. Students showed much interest and asked several questions.

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