The Importance Of The Institutions For Transfer Of Science And Technology On Engineering Education - The Experience Of Instituto Pedro Nunes

M. Salete S.C.P. Leite and Maria da Graça Rasteiro
Faculty of Science and Technology of the University of Coimbra, Largo D. Dinis - 3000 Coimbra, Portugal
Instituto Pedro Nunes, Quinta da Nora - 3030 Coimbra

Abstract

The role of the Institutions for Transfer of Science and Technology (ITST) is briefly reviewed. The activity of Instituto Pedro Nunes, an ITST, is mentioned in the context of engineering education, from the training of students through participation in R&D projects in partnership with industries to the creation and incubation of based technology enterprises.

Introduction

The design of an effective course requires the identification of instructional goals. Today's students will be tomorrow's professionals and citizens; therefore education is a concern of the whole society. Of course, the fast and in some way unpredictable technological evolution makes specific knowledge quickly outdated and the central instructional goal includes helping students to acquire, together with a sound knowledge on fundamental science, other skills essential to survive and succeed in a rapidly changing society.

More than supplying knowledge and information, education should provide the development of critical thinking ability, curiosity, creativity, individual as well as group working capacities, intellectual skills for the various social roles the citizen is called upon to act.

The ever-growing importance and concern with education rests on the fact that investment in intelligence and human potential are decisive factors for the progress of society, and this places new challenges for education training.

What will be the role of engineers in the 21st century? What should be their background, qualifications and skills? What is the role of partnership between universities and employer organisations in integration into active life? These will be some of the points addressed in the present report.

The Employment Issue

Teaching and learning cannot be separated from the employment issue in a society that is evolving into a learning society. The employment market as we knew it is changing and to a large extent ceased to exist. The big units of intense manpower are obsolete and challenge now rests upon small and medium enterprises (SME's) with a large flexibility and dynamics. This allow them to adapt easily to permanent changes due to continuous technological evolution and new needs of the consumers. We live in an era of the product engineer: once the product is defined the project must be processed in a "made to measure way", with enough flexibility to adapt to the new needs the market will demand tomorrow.

Under these circumstances, human resources are, obviously, a critical factor of success of the enterprises. Adequate education and training of these resources has to be, and is indeed, a permanent concern of governments, educators and society in general.

In this context new professions play a crucial role, both in new areas of activity and in more classical fields, where new technologies made their way irreversibly.

So engineers, as the "engine" of technological societies should be prepared to be in a permanent attitude of training and learning to remain able and competitive to answer the new demands from consumers and society.

So we must educate for the future... What future? In a large way, an unknown future! We shall need tomorrow services and products that are simply unknown today.

It seems uncontroversial nowadays that curricula should be based upon a sound basic formation, complemented by specific technological knowledge to allow the fulfilment of a given profession.

But self employment is today a very important way out for engineering graduates. Micro and small enterprises, frequently technological ones, play a fundamental role on the job politics and economy. Therefore it is essential that engineering students are also helped to build an entrepreneurial spirit. Together with their intellectual skills and scientific and technological expertise, engineering students should be helped to develop other capabilities such as creativity, initiative, communication, critical reasoning, ethics in business.

The Role of ITST's

ITST's play a very important role as interfaces between universities and industry. Their main action rests upon transferring knowledge and technological innovation to industry, developing themselves R&D projects in partnership with the industry and having the university as a permanent support and source of top scientific and technological knowledge. They should be able to respond

fast and quickly to the industry demands, which is not, in general, compatible with nature and structure of the university. They have a privileged position in the application and transformation of fundamental knowledge in science and engineering into projects leading to new products, new services or technological improvement.

Of course the big enterprises may have laboratories for R&D of their own: however, most industries, and certainly almost every industry in countries like Portugal and many others in and out Europe cannot afford this situation. The investments needed are simply too expensive and unjustifiable.

So ITST's are planned to help large communities, at least on a national basis. They establish a kind of partnership between universities and industries and society in general in an easy, dynamic and flexible way.

The Institute Pedro Nunes (IPN)

IPN is an association for innovation and development in science and technology, created by the initiative of the University of Coimbra (UC) through the Faculty of Science and Technology (FCTUC) in 1991. It is a non-profitable private institution aiming at assisting economic agents in their efforts towards global competitiveness. Its objective is to develop R&D projects, as well as to make accessible to industry tests, measurements and other studies that require highly sophisticated apparatus and highly specialised know-how, having as a final goal to promote the innovation and competitiveness in the Portuguese industry.

This is carried out by promoting scientific culture and technological innovation, by providing technical and technological consultancy and specialised training, specially in the context of continuing education programs.

For these purposes IPN is internally equipped with a number of technological laboratories, which are complemented by marketing and project management departments, and with an incubator in order to promote and assist the start-up of technology-intensive firms, usually spin-offs of academic research.

As important as addressing its internal objectives, IPN plays a major role as an interface between industry and high education institutions, namely the University of Coimbra.

Among its associates are, besides the university, enterprise associations, enterprises, non profitable cultural foundations, local and national institutions for support of SME's, local government authorities, etc. IPN is installed in its own buildings in a university campus, close to many engineering departments.

IPN has a particular status among ISTT's: the University, particularly FCTUC, has a close connection to it. The Directors of the laboratories of IPN are University Professors, appointed by FCTUC and, under convention, the Faculty laboratories may be used to complement IPN's own labs when necessary. This, of course, enlarges the field of action of IPN upon the industry to every competence of FCTUC, thus having a high potential for research innovation and technology transfer which makes it a privileged agent upon the national industry. Of course IPN opens equally its labs and facilities to the university community. This allows a complementation of means and taking the best profit of investments, avoiding unnecessary duplications.

Under the statutes of IPN, the Direction Board of five members include two Professors from the FCTUC, one being the Chairman.

IPN Activities Relevant to Engineering Education

As an entity with a high potential for technological R&D, its action in engineering training lies mainly upon the following activities:

- Innovation and technological transfer in specific areas of excellence highly competitive;
- Training and actualisation of engineers and other highly qualified workers, for industries and other supporting services;
- Discussion of experiences and innovations in the field of science and technology through the organisation of conferences, seminars, workshops, short courses and other adequate forms of debate;
- Training of students, mostly engineering students, on their final year of undergraduate courses or as post-graduate students, either in experimental procedures and techniques or framing on specific projects relating to the technological areas of its laboratories;
- Involvement of graduate students on R&D projects in partnership with industry, sometimes under MSc or PhD programs;
- Incubation of enterprises through conditions being given for the creation of very small enterprises of technological basis.

The laboratories of IPN are the following:

- LIS - Laboratory of Information Systems;
- LAT - Laboratory of Automation and Telecommunications;
- LM - Laboratory of Materials;
- LED - Laboratory of Resistance Studies to Erosion and Wear;
- LABGRAN - Laboratory of Characterisation of Granular Materials;

The Experience of IPN on Engineering Training

Though founded in 1991, IPN's activity on its own building started only in 1994 and its activity on engineering training has been very relevant ever since. We stress three main areas of activity:

Training during and just after graduation

IPN has received in its laboratories more than one hundred engineering students either in their final year Project or Seminar work, or graduate students for practical training before getting a job in industry. IPN has also been lodge for many post-graduate students who developed there MSc or PhD work. They were mostly graduates or graduating in Mechanical Engineering, Chemical Engineering, Computer Science, Electronic and Electrical Engineering, Physical Engineering, Materials Engineering.

They were involved in R&D projects in partnership with industries in the areas of Ceramics, New Materials, Surface Coating, Ceramics Waste Recycling, Paper Quality,

Explosives, Wood Processing, Software, Multimedia, Energy Optimisation, New Products in Chemical Engineering, Electrical Systems, etc.

Incubator

The incubation of very small enterprises of technological basis (BTE's) is also a very important activity of IPN. Here, conditions for the creation and development of those companies are supplied.

The idea is to promote the production of high-tech products or services for small and restricted markets; the main added value of the product or service lies on its technological degree of innovation.

It is essentially an University based incubator, which consubstantiates the concept of "chain of technological creation":

University (pre-competitive investigation)	→	**IPN** (competitive investigation	→	**Incubator** (new enterprises)

This activity has been well succeeded. The incubator started with twelve sites and enterprises can stay up to three years. Presently eleven of its modules are occupied. Only two companies left before the three years of the contract: one moved to a different place and the other gave up after a few months. Those staying seem to be successful in a very high percentage. These enterprises are on the areas of Biotechnology, Health, Quality, Electronic Systems, Environment, Computer Systems, Surface Coating.

Four incubated enterprises are spin-offs from the University.

Their promoters include researchers from the university, scientists and engineers mostly graduated at UC. More than 90% of their workers are university graduates, 60% being engineers.

When enquired they all indicated the close relationship between the university and IPN as one of the reasons for choosing IPN Incubator. Several of the promoters had contacts or stayed at IPN before incubation.

Four companies were installed as a result of winning a prize in a contest of "Ideas for a Business", where IPN was also a promoter. The competing teams must necessarily include one student from FCTUC.

Continuing Education Programs

This is also a very important activity of IPN. To fulfil it, courses are designed "to measure", in order to suit demands from professionals wanting to update their knowledge or get acquainted with new techniques or technologies. Subjects relate to the scientific and technological areas of IPN, of FCTUC or of some other Faculties of UC.

Subjects such as Quality, Computer Science, Industrial Management, Information Systems, besides specific technology subjects, are just examples of demands brought to IPN by Associations of Enterprises, by Enterprises themselves, or by groups of individual engineers and which IPN is in a very favourable position so satisfy.

Conclusions

Of course, engineering students need some practical experience "on the field" before starting their professional activity. The traditional period of training in industry is still the main supplier of this experience.

However, there is a growing perception by the students themselves of the need to develop other skills required by a rapidly changing society, namely the need to develop an attitude of permanent training and learning, a critical thinking ability, a capacity to adapt to new technologies and new demands. The traditional training in an industry company does not fulfil completely this role. Therefore students are growingly motivated to participate in R&D projects in partnership with enterprises through IPN. This participation, where they benefit simultaneously from the scientific research method and orientation of senior researchers from the University and from the practical needs and ways of industry, provides them with an invaluable opportunity to develop skills that are essential for success in our society. The growing demand by engineering students to be involved in these projects is a clear indication of the interest of this contribution to their training. The results are very encouraging.

They have also the opportunity to develop an entrepreneurial spirit, that is very important in a society where many will need to create their own employment. Spin-offs from the university are an immediate result, where the incubator plays an essential role. When inquired if the they would create their firm without the IPN incubator, most answered negatively.

Therefore we may conclude that, in spite of its short life, IPN as an ISTT, through its close relationship to FCTUC has increasingly fulfilled an important gap between university and industry, and played an essential role on engineering education both for students of FCTUC and for

updating engineers already in the profession, providing training courses and opportunities.

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