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"Developing the knowledge triangle through cooperation with industry"

Xavier Michel,

Director, Ecole Polytechnique, France

Introduction

Founded in 1794, the Ecole Polytechnique aims at educating the future leading executives in the industry, research and administration fields. Its pedagogical specificity is to maintain a balance between a multidisciplinary scientific curriculum, humanities and leadership training. The aim of this education in breadth and depth is to give students tools to learn fast.

We are a small-sized but highly selective university, with 2850 students, 30% international, within 3 graduate programs, *ingénieurs de grande école*, masters and PhD, and a 1700-person research center, run jointly with the CNRS.

As a technological University, we are focused more than in the past on interdisciplinary society relevant themes, such as energy, systems, …in an education-research approach. For a long time, we were mainly driven by education, where employers were mainly looking for high level students.

For the last ten years, it has hugely changed. Our research center is more and more involved in industrial collaboration to enhance the innovation process.

Collaboration with industry and private companies has been a key for Ecole polytechnique to conduct this evolution and thus construct the knowledge triangle, simultaneously strengthening interfaces between education, research and innovation.

This evolution was more than necessary, and we have still a lot to do, at Ecole polytechnique level and more generally in France.

As you know, the academic landscape, in France, is rather specific.

France has very strong national research institutions, such as the CNRS or the CEA, which concentrate most of the research resources.

For a long time, French scientific universities focused on training students wishing to have an academic career, putting more emphasis on knowledge frontiers than on technology.

Simultaneously, *Grandes écoles* developed curricula to answer companies' needs as regards scientific, technological and management qualifications.

However, up to now, innovation has been a weak point for the French higher education and research system, likely because of a faculty mainly oriented towards basic and theoretical sciences.

Collaboration with industry has been a key to Ecole polytechnique's evolution towards innovation

Within the French system, Ecole Polytechnique has settled into a unique position in France by integrating multidisciplinary science on a very fundamental basis and engineering.

Its relationship with industry is far greater than French scientific universities. Working with companies has become second nature for Ecole Polytechnique in the education field, mainly due to the high level of the students and willingness of companies to hire them.

These links have given us a strong support to build up a true innovation policy, involving education and research.

I'll begin with education, innovation coming from entrepreneurship training

Our curricula have always taken into account private and public employers' opinions, either from companies, research institutions or state administrations.

General opinion is obviously a tool to asses the employability of your students. Early September, we had the happy surprise in the last QS ranking that the employer review indicator put EP at 15th worldwide rank.

Qualitative opinions are more useful. We conduct yearly surveys to check on quality assessment by employers. We rely on a specific committee, composed of representatives of a wide panel of national and international employers, in order to anticipate the future needs in terms of scientific, technical and management skills we have to develop in our different curricula (i.e., engineer school and Graduate school). Of course, research plays a major part in these curricula through students' scientific projects and research work.

A strong advice from this committee was to develop specific courses to train students in innovation management and to provide skilled professionals such as intrapreneurs, or entrepreneurs. Courses are based on instilling the methodology of start-up foundation and accepting the innovation process in company strategy. We train students on real innovative projects, either with an industrial partner or a potential startup, with a focus on using acquired knowledge in "hardcore" science, corporate strategy, project management, including quality management, environmental issues, and societal impact.

At the same time, we developed innovation coming from technology transfer and research collaboration with industry

It was necessary to organize the Ecole in terms of innovation and technology transfer, beyond the mainly fundamental approach of its

research. In 2005, we created the “industrial relationship and partnership department”, Polytechnique’s Technical Transfer Office (TTO), to develop a general innovation policy, strengthen technological research and transfer to economy, through research contracts, patents applications, and start ups.

Based upon its patent portfolios, the technology transfer policy has been strengthened to enhance the extent of granting licences to newly founded and existing companies through the knowledge of market needs. Hence, the relations with companies has committed us to reinforcing the amount of collaborative research through the Carnot Institutes, which are state- incentive programs to help match market needs with research skills.

We also convinced some companies to move their R&D centers onto the Ecole polytechnique campus, and develop collaboration with labs, professors and students. In 2015, we should have 5 R&D centers on campus, Danone and Thales are already there, Horiba Jobin-Yvon in scientific optics is under construction, EDF and Total being scheduled for 2015. With each of these companies, we have collaborative projects, in education, research and innovation. I will give 2 examples later.

Merging the two aspects of research and education, we have set up long-term philanthropic industrial agreements, dedicated to funding specific educative programs and collaborative research in a specific field. Their duration is basically 5 years. With this kind of agreement, companies can forecast their future recruitment and thus, participate in upstream research in fields of interest. These *long-term agreements* are quite efficient in changing the way both academics and companies understand one another and work together. Going back and forth from science to technology and implementation becomes a natural process, which frames education and research.

I would like to give two examples of this fruitful cooperation with industry, one in lasers, the second in photovoltaïcs.

The Apollon laser

Ecole Polytechnique, which has been at the frontiers of optics, especially for high intensity and high energy lasers, is conducting a major research project related to Extreme Light and its applications, with several scientific partners on campus Paris Saclay. This is part of the ELI European project, involving 13 countries.

The first objective is to develop a laser which will deliver pulses down to 15 fs in the 10 PW regime, making this laser unrivalled in terms of performances and allowing the exploration of a new physic regime, unreachable today. This 50 million-euro project will make possible the delivery of the first photons by the end of 2013.

It would not be feasible without the full involvement of both the scientific world and major companies in the field (Thales, Horiba Jobin Yvon, Quantel, Amplitude, ...). You may note that two of these, Thales and Horiba, have their R&D centers on EP campus.

Their participation was necessary to reach the specifications of the new but also critical components defined by the academic experts. More than 10 technical challenges had been identified; about the laser materials, crystals, large size gratings and mirrors, high intensity damage threshold optics but also about pumping lasers. Through collaborative developments, competitive dialogues and development contracts, all the technical challenges are about to be solved.

This collaboration has two consequences. First, it makes the construction of the Apollon 10PW laser possible. It also opens new markets to the industrial companies which decide to pool their efforts in this adventure; fostering innovation by industrial companies, and generating returns from industry to scientific establishments. We are working upstream and downstream with the industry, which has to come along with something which doesn’t exist yet.

The short/medium -term demand in this type of laser comes from the public sector, considering the idea to build a facility around such a laser

to carry out research in new fields; the demonstration of new phenomena and applications – societal, medical but also industrial.

For those reasons we have decided with industrial companies, especially from the French part of the laser industry, to consider the best way to address this demand. It includes:

- *technology transfers of key parts of this type of laser to quickly allow industry to duplicate the Apollon laser and propose it to potential customers. The technology transfer will consist in transfers of licences on patents, but also of software, knowhow, expertise, access to platform etc.*
- *access to the expertise related to the use of such a facility and then to the associated requirements,*
- *support to start addressing the first potential customers.*

Following the win-win development of the Apollon laser, this technology transfer appears a new win-win cooperation by encouraging at the same time the promotion of the technological choices made for Apollon, the advent of new markets for industrial companies supporting our research activities, and a potential financial return for research.

The IPVF case

EP and CNRS operate a Joint Research Unit, in plasma synthesis, thin film deposition and characterization, and nanomaterials. This lab organises its research by applications, and targets Nanoelectronics, Large Area Electronics including but not limited to Flat Panel Displays and Thin Film PhotoVoltaics (TF PV).

After several years of fruitful collaboration, EP CNRS and TOTAL created a joint Research Team called “NanoPV” which is located on Ecole Polytechnique campus. The scientific research program covers silicon thin film technologies and explores new concepts for high yield PV cells, like using silicon nanowires or plasma epitaxial growth.

Simultaneously, TOTAL and EP set up a philanthropic long-term agreement to develop a master program on Renewable Energies Sciences and Technologies. This master will be the French link to a Sino-European master on Renewable Energies, set up at the request of the European Union.

Moreover, EP, CNRS, TOTAL, EDF and other companies are in the process of creating a joint Photovoltaics institute on the EP campus. It is a 140 M€ project which will help to organize on a major scale an organic link between research and innovation in this field.

3 Paris Saclay

I cannot end –up this presentation without a few words about the way we plan to expand the knowledge triangle on a bigger scale with the building up of the Campus Paris Saclay.

6 national research institutions, 2 universities and 11 *Grandes Ecoles* will participate. It will include 68000 persons, of which, 12000 will be researchers and 50000 students. The key objectives are focused on finding out the best way to harmonize the educational and research fields among them in order to better the innovation processes;

As an example, these universities are to mutualise all the TTO's and the industrial contacts to enhance the global overview of all the patents filed and pinpoint the synergies regarding the most innovative markets.

This new organization aims at optimizing industrial collaboration and start-up creation, within a technological cluster France wants to develop around Paris Saclay. The moving of R&D centers to EP are the beginning of the process. EP campus capacity in higher education, research and innovation should have quadrupled in 2018.

No doubt that we'll have a new innovation model by then, and also a new economic model to fund education and research. Moreover, it has to support the French economic growth and maintain the hiring of new talents in the country.

Conclusion

The knowledge triangle has become a reality for Ecole Polytechnique as a technological university. To be more efficient in our innovation policy, we had to develop new courses and a new industrial strategy. The first results have already appeared but in the current relatively difficult economic context, we have to link with other universities to become stronger and be able to face worldwide competition.