Combining Undergraduate Research and Industrial Practice: A successful Approach to University – Industry Relationship

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Abstract *— The Electrical and Computer Engineering (ECE) Department of the University of Puerto Rico at Mayagüez (UPRM) in collaboration with renowned engineering companies has developed and implemented an educational model joining traditional co-op education and undergraduate research experience. The model has evolved into a well-rounded learning program with important benefits for all parties involved: students, academia, and employers. The approach consists in three basic steps: A pre-coop involvement in a particular project, development of the research project followed by a mentor from industry during the working stage, and a post-coop period in which the final reports, and communications are generated. This approach has been very beneficial for all, attracting funds to the department and support for short courses and laboratories from industry, better learning for students, and so on. The success of this project has provided with insights of what could be used to start up similar approaches in other places. An analysis of the factors that have helped vis a vis the actual availability is taken into considerations when suggesting steps to set up a program like this one.*

Index Terms *— Industry-university relationship, Student industrial experience, undergraduate research.*

INTRODUCTION

Much has been said about the role that government, industry and universities have in the development of a society [1]. . Cooperation among the three players is very desirable and setting a model of cooperation that could guarantee a smooth interaction of the roles would be wonderful. However, it is clear that there is no one unique model for those roles, and many factors affect the objectives that a player can set to be part in the goal of development, as well the manner in which such objectives will be pursued Listening to arguments stated by social, industrial and university leaders, all we can find in common for all cases can be summarized in the following: Universities provide education to continue development, in addition to other skills and knowledge necessary for social continuity and order; industries provide economical tools for development and/or social well being, at least at the level of employment providers; governments act as a facilitator for the other players, and will take part in several ways, depending on the degree of involvement that players and leaders alike are willing to accept.

But general common grounds are extremely vague and give no guide for interaction; even a common goal cannot guarantee joint participation. Thus, any plan of interaction must consider similarities and, above all, differences. There are several differences that are worth mentioning for the purpose of this presentation. Some are of regional type, other are more individualistic.

On the regional type, one is the degree of development of the country. Industrialized countries devote much more importance to research and development than developing countries, which consider more manufacturing and maintainance as important factors of education. The economical development is therefore a key factor, since it determines very much the type of industry a country has and therefore the economical policy of government and the educational stress of universities.

Cultural differences are another key factor affecting policies. Taking three industrialized countries, for example USA, an European and an Asian country, it is quite easy to find large dissimilarities in the way the goals are pursued, and oddly enough, also several similarities. The dissimilarities arise from cultural and historic factors, social perception of development, perception of roles of industry and university, among several other causes. This is of course also true for developing and underdeveloped countries. Even those countries in which one could expect a lot in common, say between Latin American countries, cultural differences become key issues in setting common tasks.

But in one country, it is easy to find differences too, which are of the individualistic type. Industries in a same field of activity may have a completely different corporate culture. Thus, even if the product is the same, and supposedly so should

be the goals, the internal structure and policy will affect severely what an interaction with universities will be. Ditto for universities. There are those clearly oriented toward pure teaching, and those with a heavy research component. Other differences could include student body background, teaching policy, orientation of studies, and so on. Two different government administrations will look at the government role and government interaction with industries and universities, under different perspectives, perhaps opposed ones. This government perception is particularly critical in developing countries, where government policy is crucial to businesses and education.

Despite differences, and many other important issues that make university-industry relations difficult to implement, it is believed that some perspectives can be established. The Electrical and Computer Engineering (ECE) Department of the University of Puerto Rico at Mayagüez (UPRM) in collaboration with renowned engineering companies has developed and implemented an educational model joining traditional co-op education and undergraduate research experience. The model has evolved into a well-rounded learning program with important benefits for all parties involved: students, academia, and employers. The model has been described in [2]. The approach consists in three basic steps: A pre-coop involvement in a particular project, which will be further pursued while the student is in industry. Development of the research project followed by a mentor from industry during the stage, and a post-coop period in which the final reports, and communications are generated. This approach has been very beneficial for all, attracting funds to the department and support for short courses and laboratories from industry, better learning for students, and so on. The success of this model has lied on the confluence of favorable factors such as the Coop program, which is well established in the US, active industries who already have a strong policy in university relationships, and a flexible program of studies of the ECE Department at UPRM. A direct extension to other universities, industries and countries is therefore not easy to do.

In general, most countries, specially developing countries, have no similar programs, even though some American and European companies with plants outside their countries have contacted particular universities, mostly graduate studies institutes or departments, from other places to provide co-op experience to few students in the US or Europe plants, but almost none does it in the country of origin of those students. Also, some universities require practical experience as part of the requisites for graduation, but no particular advantage is obtained from these practices. To add to the picture, many students who acquire some work experience during their undergraduate years do it at a personal level, with no repercussions for the university they study at. This is especially true in developed countries

The purpose of this work is to extrapolate two different experiences, that of the ECE Department at UPRM described in [2], and that of the Center for Development of Technology (SARTI) of the Polytechnical University of Cataluna, which follows a successful interaction at a different level. The objective of this extrapolation is to highlight the philosophy and benefits described more in detail in [2], and set some guidelines for similar programs, thinking especially in the case of developing countries.

SUMMARY OF THE ECE-UPRM EXPERIENCE

The model described in [2] is makes use of the Cooperative Program (Coop) that was devised at the University of Cincinnati, Ohio, in 1906 [3]. Co-op education is usually defined as a structured educational strategy integrating classroom studies with learning through productive work experiences in a field related to a student's academic or career goals. It provides progressive experience in integrating theory and practice [4]. Despite this academically focused definition, the level of success of a co-op program is often measured by the benefits derived by all involved parties, namely employers, university, and students. These parties, however, use different metrics to judge the accomplishments of such programs.

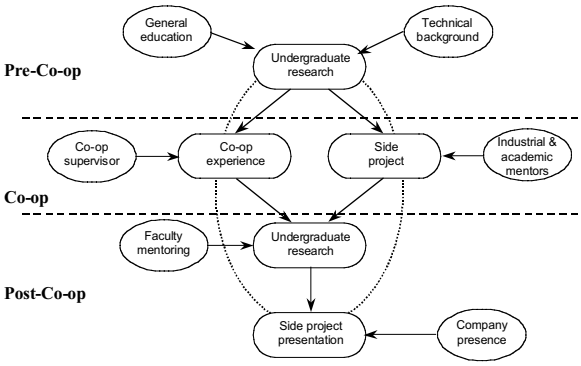
Students aim at gaining meaningful practical experience and maximizing career opportunities. For universities, successful co-op education reinforces industrial partnerships, enhances curriculum, and provides students with professional experience and background. Employing institutions aim at improving recruiting practices, and co-op students provide them with an efficient way of generating a pool of in-job trained, potentially permanent employees. Thus, employers measure success through the student's work performance, the ability of the program to attract new students, and the retention rate, i.e. the number of students who become permanent employees.

Now, the model structure that was developed in particular with some industries, followed three stages as illustrated in figure 1. In the pre-co-op stage, students enter into the program participating in a faculty assigned undergraduate research project. The faculty guidance in this stage is a key element to focus the student work.

In the co-op stage, as in any other cooperative education model, students perform duties assigned by their co-op supervisors. In addition, the student also works in a side project, either individually or as part of a team. This side project can be either an extension of the undergraduate research project from the previous stage, or a new project defined in coordination with an industry mentor and a faculty member back at the university. The side project is completed in a post-coop stage at the university under the guidance of the faculty member, and presented to the student community and general public. This communication stage is important, not only as a component of the student's education, but also serves as an exposure of the companies and the program.

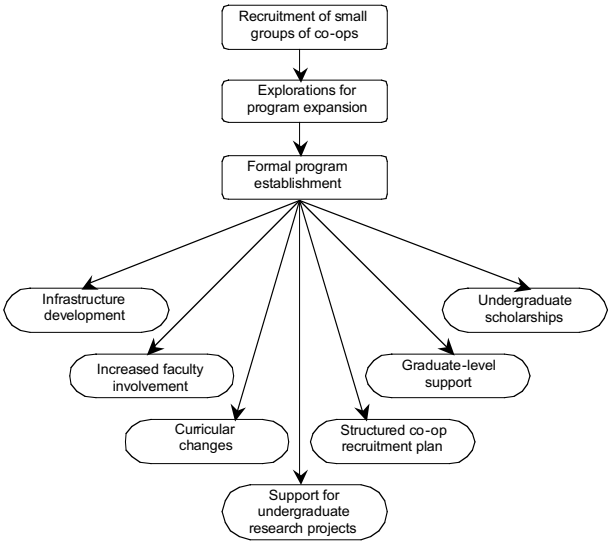
This model has had positive impact at the companies, students and academic faculty, who have benefited from it. The details of these benefits can be consulted in [2].

FIGURE 1.
COOPERATIVE MODEL USED FOR UNIVERSITY-INDUSTRY RELATION



Now, it is important to stress that the model was developed through different stages that arrived at a full interaction. This is illustrated in figure 2. Here, notice that the beginnings are very modest, without any strong investment from industry. It is a stage of persuasion, for both the university and the industry. A major benefit must be seen from the industry viewpoint. This is discussed further in the following section.

FIGURE 2
SUMMARY OF MODEL DEVELOPMENT AND BENEFITS



Now, there are some benefits obtained by industry, as different from normal coop recruitment that has made this model interesting them. First, the recruited coops will be professor recommended. The professor has worked with the student in a previous stage to coop, where skills have been tested and mentoring has been offered. As a consequence, the learning time of the student at industry is greatly reduced, and students become fast and more easily involved in normal engineering tasks. Second, the student becomes more acquainted with the field as a consequence of an exposure to an experience of his/her own interest, using resources that the company utilizes. This further increases the value of the student as a potential employee. Third, sometimes the side project can look for a solution of a problem in a company project. Since the side project is to be communicated elsewhere, the problem should not contain proprietary information.

Once the industry has understood the value of the process, it becomes easier to interact at another levels, as illustrated in figure 2.

EXTRAPOLATING EXPERIENCES

As mentioned before, the success of the experience described in [2] depended heavily on lucky factors that were advantageously combined. The existence of a Coop program provided an infrastructure for the participation of students in industry. The flexibility of the program at ECE allowed easy introduction of courses that were of interest for the companies, and yet general enough to become part of the normal curriculum as elective courses. The industry already understood the importance of university relations, and was open to conduct a business with our university. This confluence of good factors is not easy to find elsewhere.

Nevertheless, the experience has provided insights on the mechanisms and backgrounds that have allowed the development of the model. These insights serve as a starting point of discussion for issues that should be considered to extrapolate this model under other circumstances. This discussion is necessary because it is believed they constitute the unseen background of the model, and must be taken into consideration for a similar program elsewhere. The Electrical and Computer Engineering Department at UPRM also has collaboration on a research basis in a more traditional way with other companies, as well as with government agencies, but the discussion of this issue is accessory within the frame of this work and will not be addressed in particular.

To yield a good result, the program or model of cooperation should address the needs of the industries, the students, the faculty and the university. This consideration is very important since the program depends heavily on the participation of faculty professors. This is a feature that distinguishes it from the traditional Coop program in USA, or from required industrial experience in other countries.

The discussion focuses next on interests of the different players that should be considered to set up a similar program. Namely, on industry, faculty, students and university.

Addressing Industry needs

Industries have several drives that count for interaction with universities to take place. All programs can satisfy not all, but any attempt must address at least the minimum. The experience with ECE and interaction with industry people points to two major interests: business and students. Research, so cherished by faculty professors, is not a priority for most industries, especially in developing countries, except for particular problems. For these problems, an industry usually contacts previously identified professors or institutions.

By business, it is meant to keep in mind that industry is a for-profit organization and, with the exception of especial cases, it will not embark in a program where no advantage is seen. If the target industry has a tradition of student sponsorship, it will be easier to set up a program, since there is already a conscience of economical advantage in student involvement.

Most industries need skilled employees. New employees should usually go through a learning stage, which, depending on the type of engineering duties, may go from one month to one year. Students as prospective employees become a good target for industries at the moment they recognized the economical value that hiring and training a student has. More over, a good student can become recognized early and targeted as possible employee, with already added value from the beginning with a substantially shorter learning period, if any.

On the other hand, even if research is not a priority of industry, the side project can be used to solve minor problems. Remember that this is an undergraduate focused program, and the side project is to be realized in a relative short time.

Before any agreement is reached, professors and industry should give the program a try in a small scale, so the industry can evaluate better the advantages and background of students who will be participating in the future.

Addressing Student needs

Students will appreciate the exposure to industrial experience, which is very important. Notice however two differences with respect to traditional Coop or practical experience requirements. First, the program is not open to all students, but only to those that are invited by professors through some mechanism. . Second, only those that are judged capable are recommended. This is indeed an added value for industries to consider.

Students need to bring up experience to his/her resume and this is a good opportunity. As competition for jobs after graduation gets tougher, this experience before graduation enhances the curriculum vitae beyond practical experience required by the academic program.

Addressing Professor needs

The program should be established by interaction of professor or a group of professors, more than by the department or faculty. By doing so, the loss due to unnecessary paperwork is reduced. Professors usually need publications, research activity and other requirements for academic advancement. A program like this one provides with opportunity to work with students who can help in these tasks. Thus, both professors and students alike win.

A program like this one cannot have the participation of many professors, although the benefits from the relationship is extended to the department, and thus indirectly to other professors. However, particular projects can be carried out under the mentoring of professors outside the program, whenever there is interest in doing so.

Addressing University needs

The department involved in a program will establish a good relationship with the industries and will definitely gain from this interaction. This gain could come in the form of laboratory improvements with industry funding, program development, professor continuing education and so on. These improvements do not appear spontaneously and may take some time to come, but they will finally appear. It is clear that laboratories, courses, short seminars and so on are related with the industry needs, yet of interest to public in general.

To get ready to participate in such a program, the department must provide mechanisms to give credit to students and professors for their involvement, to provide the necessary infrastructure to deal with donations, and to be flexible to adapt the career to changes in a relative short time. Not all universities, especially public ones in developing countries, provide with these necessary arrangements.

FINAL CONSIDERATIONS

Once the particular needs of the involved parties are recognized, the process to start a program like the one described in [2] is not necessarily straightforward. The most difficult step is perhaps to start. Some suggestions in this respect are given below:

- If there is no infrastructure available at the university for student participation in industry, the first step is to work this problem with pertinent university administrators. This program is impossible without such infrastructure.
- Identify the most probable industry as a target. This can be done considering the expertise, previous contacts, experience, and so on.
- Do not stress research or problem solving. Industries have their own policy regarding how to approach these problems. Any interest on research should be negotiated in other environment.
- The first contact should aim a modest beginning: Industry has to recognize the value of students and professors must evaluate if the contact is worth continuing. Not all industries have friendly environment.
- Not every industry would accept students working a side project while at their facilities. However, the pre-participation project is still important to evaluate students, allowing development of professors' interests. Industry must recognize the added value of the student recommended by this process.
- One industry at a time: each company has its own culture, and it would not be possible to deal with different unknown approaches at once. If no such a program was in place at the university, there is no need to run in the first place.
- After two or three first student groups, there should be reciprocity of industry to university. Industries realize quickly the advantages of receiving professor recommended students who have undergone training through especial mentoring. Yet, it is not the professor duty to work for a particular industry, nor the university goal to provide free support. If industry refuses to get involved, abandon that industry.

The process to build the program is not straightforward, and tough lobbying must be needed. But there is a price worth the effort for everybody. This is a win-win program.

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