

PRACTICAL TRAINING IN THE CURRICULUM OF THE CIVIL ENGINEERING EDUCATION

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Abstract

This paper is intended to show the importance of the practical training activities in the civil engineering education process. The incorporation of such activities within the undergraduate curriculum, allows students to face real engineering problems in early stages, which provide them a valuable experience for their future professional career.

Different types of activities can be found in the current civil engineering curriculums to accomplish out these goals. In this paper the experience of both prestigious universities in the USA and emerging universities in developing countries, are taken into account to show the benefits of considering practical training for the students while they are still being taught.

Both the Department of Civil and Environmental Engineering of the University of California in Berkeley and the Department of Civil and Coastal Engineering at the University of Florida, consider the co-op internship as an optional activity to provide practical training. On the other hand, the Civil Engineering Department at the Universidad Catolica del Norte (Chile) and the Civil Engineering Department at the Mahanakorn University of Technology (Thailand) include two or more professional practices as a requirement to complete the undergraduate program.

According to the analysis, the main differences between both systems are the fact that practical training in the American universities can last as much as one term, whereas in the developing countries, they are no longer than two months. Moreover, co-op internship can be performed in any term and they may or may not account for credits. Practices in both Chilean and Thai universities are developed in the summer term, so that they do not interfere with regular courses. In both Chile and Thailand, practical trainings account for few credits but it is a requirement to get the bachelor's degree.

Practical experience in the civil engineering field has proved to be an important component of the civil engineering education. For American universities, the next step is considering this activity as a requirement to get the bachelor's degree. For the universities in the developing countries, the challenge is to improve the relationship between universities and private sector to provide more opportunities for the students.

Introduction

Practical training has shown to be an important component in the civil engineering education by facing students with the professional work in early stages. Because practical experience is a desirable characteristic for engineers, both American universities and universities abroad have put great effort in improving the relationship with private and government agencies to achieve the goal of proportioning enough variety of field where students can practice to prepare them for the future professional life. Civil engineering is essentially a practical career where the theoretical knowledge has to be always accompanied by practical applications. It is very important that students can see real application of the topics being taught in classes so that they can understand the phenomena and its relationship with

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other related fields. Even though Lab classes are intended to show students the practical application of specific phenomena, they are usually not enough to show the whole frame. The main reason for that is the fact that lab classes focus in a particular and aisled concept, which sometimes produce the loss of the general vision. On the other hand, in terms of cost it is difficult for universities to duplicate the large-scale laboratories and industrial systems. It is also difficult to simulate the interpersonal affiliations and economic concerns which are an essential part of successful industrial activity. Universities in one way or another encourage students to participate in practical training to achieve the following goals [5]:

- Improve the skills of working in groups
- Improve communication skills
- Gain valuable practical work experience prior to graduation
- Acquire new technical skills and useful tools
- Gain self-confidence with on-the-job success
- Be in contact with professionals in their same field
- Earn money for college expenses
- Define direction for future graduate studies
- Learn how to produce effective resume an prepare them for interviews

The accomplishment of all this objectives is a function of the type of practical training. The more the variety of positions for the students, the more the possibilities of achieving good results. Practical training can vary from direct field experience by interacting with worker force, to desk work by performing design or planning.

Opportunities to develop these activities are the main difference among countries with different culture and civil engineering process. This paper is intended to compare the experience of American universities and universities in developing countries to achieve the same goal of promoting the practical training to ensure the success of the students in the professional work.

Practical Training description

Practical Training in American Universities

Practical training in American Universities is developed by means of internships and Co-Op (Cooperative Education), in which students participate in a long period program of practical training in the private sector or governmental agencies.

At UF internships are one-semester long whereas Co-op rotate one semester of work with one semester of school, i.e., students alternate between full-time semesters of work and full-time semesters of academic study. To complete the co-op program, three alternating semesters of work are required for undergraduate engineering students [6]. The work experience is conducted under approved industrial, business, institutional or governmental agency supervision. Interns are considered to be valuable work experiences, but cannot be included as part of a student's co-op program, due to its discontinuity. The premise of the Co-op program is the perfect balance between the students' work experiences and the academic coursework, so that it facilitates a developmental relationship and greatly enhances the overall educational experience. As the Co-op or Intern positions are expected to improve the student's education, some positions are not eligible for these programs (blue-collar work, technician, data entry, clerical, part-time) [6].

All students applying for participation in the cooperative education program or internship are required to complete the first year and be approved by the student's academic department prior to registration. In addition, it is required that the student have a minimum grade point average of 2.0, even though some companies require a higher grade. For interns, students work an average of 20 hours per week within commutable distance of the Gainesville area, while continuing to attend class full time [6].

Students at UF can find job positions for both Intern and Co-Op in lists published by the Career Services Center and from bulletin posted on the department. They are also able to find positions by personal contact with companies [6].

By participating in the programs for co-op and internships, students find a source for paying most of their expenses in their schools. Salary usually ranges between \$8 and \$10 an hour. However the most notable aspect involved in these activities is the acquisition of the career-related work experience that strongly enhances the performance of the future engineers. Practical training as either intern or Co-op often results in a position within the hosted company [6]. In the case of the Department of Civil and Coastal Engineering at UF, most of work experience obtained by practical training account for credits to students.

At the University of California in Berkeley the engineering cooperative education program is a 6-month period intern full-time in the private or public sector intended for students to gain practical work experience in their chosen field of interest. Two work periods are offered during the academic year - January through June and June through December. By definition, Cooperative Education involves a three-way partnership between the university, employer and the student. The focus of this partnership is to provide an educational, pre-professional training experience for the student to complement their academic education with paid practical experience [5].

Like UF, Co-op employers can be from the private industrial sector, public utilities or government agencies. Employer size may vary from a small business to a large multi-national corporation. Unlike UF, Co-ops in Berkeley considers position out of California State. Under certain circumstances, students may be able to arrange to earn credit on an independent basis through their academic department [5].

Even though students can find positions by looking in the long list of participant companies, students can also get their own position through a variety of ways, like visiting career fair or exploring in the Internet. Like UF all co-op positions are paid and salaries can be negotiated between the company and the student. The position may also consider benefits, such as vacation and sick leave, health and life insurance [5].

Practical Training at the UCN (Chile)

The Universidad Catolica del Norte is the most prestigious public university in the north region of Chile. The Civil engineering undergraduate program has been offered for 22 years and it has been characterized for preparing very competitive professionals to work mainly in the region. The undergraduate program has a total duration of 6 years with one additional year to develop a comprehensive research work to finally obtain the engineering license. During the undergraduate courses, students are required to develop three pre-professional practical training. They are mandatory activities that account for credits to complete the undergraduate program. The practical trainings are described in the following paragraphs [1].

Survey Practice: this is a field-based practical training totally addressed by the Civil Engineering Department, which provides all the necessary logistic to complete a one-week survey work in a determined area of the region. The practical activity includes both the field work and the final report. The field work is performed in groups of 5 students and the final report must be submitted individually. This training is developed after completing the two first years of the undergraduate courses and it has as a pre-requisite passing the correspondent Topography class.

Technical Professional Practice: this is a two-month practical training in which students should experience work field with concentration in fundamental activities. Pre-requirement for this activity is the completion of preliminary engineering courses, like materials, reinforced concrete, steel design and soil mechanics. This training is monitored by the Civil Engineering Department by providing the necessary paper work for the student to be accepted in the private company or government agency. The students must obtain the training position by themselves, but once accepted they must submit all the information about the company to the Civil Engineering Department. At the end of the period, the students must submit a report describing the experience gained in the training and present this report in front of a committee which grades the entire activity. An additional evaluation of the practical training realized by the company is a requirement for the successful completion of the activity. This practical training is developed after completing the fourth year of the undergraduate program.

Engineering Training Practice: this is a two-month practical training developed toward the end of the undergraduate program. The purpose of this training is to allow students to get involved in both the design and the planning process, and facing students with the complex task of working with people. Like the previous practical training, students are required to submit a report and present it before a commission. The evaluation of the company is considered and important part of the final grade.

The civil engineering undergraduate program at the UCN does not consider summer terms, so that this period is used by most of students to perform practical trainings. As mentioned before, the last two practical training are monitored, but only at the beginning and at the end of the activity. Even though companies use to promote practical training by making contact with the university to accept students, this official offer is not enough to satisfy the total demand of positions required every semester. For this reason, students are encouraged to find their own position and they must start looking for them in early stages so that they can assure practical trainings for the summer period. There is no pre-established deadline to complete the last two training activities, but they must be performed in sequence and both must be completed before finishing the undergraduate courses.

As a part of the evaluation of the practical training, companies must submit an evaluation of the student performance, taking into account not only the knowledge and competence shown by the student, but also how well he or she behaved regarding to the interpersonal relationships. Post evaluation of practical trainings in the civil engineering department has shown that students perform very well in terms of both technical knowledge and capacity to face different problems with few resources.

Unlike the American case, practical training at the UCN may or may not be paid. A great range of salaries among companies has been observed. Even though some big and prestigious companies do not compensate directly wage to students, they prefer performing practical training in them, due to the possibility of participating in large scale and very interesting projects and also the certain possibility of staying in the company with a permanent job after graduation. To select practical training students also take into consideration the possibility of developing the final research in the selected company. Most of the times the research work deals with topics related to the previous practical training.

Practical Training at the MUT (Thailand)

The Mahanakorn University of Technology (MUT) was found in 1990 as a new generation of private university in Thailand. The Department of Civil Engineering was among the first departments at the university. Currently, the department of Civil Engineering has more than 30 faculty members in 6 technology areas. The main reasons to establish the department of civil engineering at the MUT were to develop the social needs of capable and knowledgeable professionals in science and technology (and especially civil engineering). The public universities cannot provide and to be essential in modern society due to the students' understanding of basic science, their keeping up with modern technology and their skills in experimenting and solving real life problems [2].

There are two different programs in the undergraduate. One is a regular program, four years of study with 150 credit hours and the other one is a three-year program for technical students, who had studied in technical colleges for two years before getting to the university. The students in the second program have to earn 108 credit hours before getting a bachelor's degree in civil engineering [2].

The students can graduate only with at least 30 professional training days (8 hours account to be 1 training day). The training for every civil engineering students before the last year of undergraduate studies is a part of an integrated educational system. Leading industries and companies are contacted to provide first hand professional experience to the students. MUT has a tradition of sharing and imparting explosive growth of knowledge and providing unique learning opportunities to its faculty and students. For this reason, practical training at the MUT may or may not be paid as an objective of continuing the tradition of sharing to the society [4].

Similar to the UCN, the confidential report from organization need to be sent to the department for evaluating the students' performance both in the technical knowledge and competence issue as well as the student behaviors during the training. The department may give an interview to some students depending on the recommendation in the report for finalizing the credits toward degree for the students [4].

Practical Training Comparison

Table 1 summarizes the main characteristics of the practical training in the different universities. This table emphasizes the fact that practical training is a requirement for graduation in universities of developing countries and may or may not be paid.

Table1: Characteristics in Practical Training of the Universities

University	Period	Credits toward Degree	Required for Graduation	Training Appraisal	Salary
- University of Florida at Gainesville, USA	3 semesters	May or may not	No	Report	Always Available
- University of California at Berkeley, USA	6 months	May or may not	No	Report	Always Available
- Universidad Catolica del Norte, CHILE	> 60 days	Counted	Yes	Report	May or may not
- Mahanakorn University of Technology, THAILAND	> 240 hrs	No	Yes	Report	May or may not

Practical Training is more critical in developing countries where universities issue the license to work as a professional engineer. This is the case of both Chilean and Thai universities. In Chile, after completing 6 years of undergraduate courses and successfully presenting the research work (called thesis), students receive both the bachelor's degree and the professional engineer license. This is similar with the 4-year program in Thailand. Since universities have the dual mission of preparing and issuing the permission to work, they have to put a great effort in providing as much practical training as possible, so that students can face the professional life in a good standard at the beginning of their career. The American case is somewhat different since universities are not responsible for issuing the license for professional permission. After graduation American bachelors in civil engineering have to spend between 3 to 5 years in an official practical training in either private companies or governmental agencies, to become Professional Engineer (PE). This means that American universities share the function of training student with the exterior. This is perhaps one of the reasons why the co-op activities in American universities are not a requirement for graduation.

UCN also complements the practical training with additional project-oriented courses. According to [3], the extra courses that students at the UCN must take beyond the fourth year are equivalent to study a master in American universities. The two last years in the civil engineering program at the UCN contain only professional courses with a remarked practical training so that the potential lack of experience of the bachelors can be made up. However the Chilean experience has clearly demonstrated that there is no substitute for out-class practical training and students need to experience the real work before they start working. In Chile, it is not easy for graduate students to find a job as soon as they receive their bachelor's degree. There is a great demand for jobs and as the graduates shows good competence and ability, they have more possibilities to finally get the job and start their career.

For American students it is not so difficult to find jobs as soon as they complete the bachelor degree. It is not difficult either to find a job as a co-op activity and this drastically contrasts with the Chilean reality where students sometimes cannot develop the official practical training due to the lack of training positions. Also a lack of communication and agreements between universities and the private sector has been noticed lately in Chile, which, if reversed, could greatly improve both the quality and the quantity of practical trainings.

In the case of the Thai students, the connection between university and the organizations where students have the practical training program plays an important role not only on the opportunity to get the job but also a good relationship for continuing the tradition of sharing to the society [5].

Even though American students are required to complete an official training, once graduate, to get the PE, the experience in both universities mentioned in this paper has shown that practical training as a co-op activity strongly

enhances the learning process. This improvement is not only related to the knowledge itself, but also related to the personal relationship when working in groups. Surveys developed among students that experienced the co-op activities recognize that the adaptation to the professional work is much easier when students are faced to real engineering problems in early stages of the undergraduate courses.

Conclusion

In this paper the different characteristic of the practical training in both American universities and universities in developing countries are described. The purpose is to remark the different conditions in which practical trainings are developed and the importance of these activities in the civil engineering education. For the comparison the experience of the University of California at Berkeley and the University of Florida are taken in consideration, as representative cases for American universities. On the other hand, the case of the Universidad Catolica del Norte in Chile and The Mahanakorn University of Technology in Thailand were taken into account to represent the experience of emerging universities in developing countries. Main differences among universities is the fact that for developing countries practical training has turned into an essential component of the civil engineering education since universities issue the license for professional engineers. Unlike American universities, both UCN and MUT have to provide as much practical experience as possible while students are still being taught, so that they can conform to a good standard the professional work. Whereas for Chilean and Thai universities practical training is a requirement to complete the undergraduate program, in American universities they may or may not be accounted for credit and they are still optional activities for the students. Even though American universities can arrange the practical training in the private sector and governmental agencies after students graduate, they have undertaken the mission to provide practical training in early stages with the purpose of improving the process of insertion of the student in the labor field. The next step for universities in developing countries is to improve the relationship between university and private sector, so that more positions could be available for students after graduation. For American university, the introduction of practical training as a requisite to pursue the bachelor degree should be a goal to achieve.

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