International Journal of Engineering Education Vol. 29, No. 5, pp. 1172–1183, 2013
Printed in Great Britain

0949-149X/91 $3.00+0.00

How Can Engineering Students Learn Leadership Skills? The Leadership Development Program in Engineering (PROLIDER) at EESC-USP, Brazil*

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This article aims to describe the Leadership Development Program in Engineering (PROLIDER)—a partnership between the Sao Carlos School of Engineering (EESC), University of Sao Paulo (USP) and Brazilian Companies. The PROLIDER has gained importance with its partners because it assists engineering students to develop leadership and management skills still during their undergraduate course. Since 1999, approximately 150 engineering students from two public universities located in Sao Carlos, Brazil (250km far from Sao Paulo City) have taken part in this Program. The undergraduate students are usually involved in the program during the last year of their course and are employed as trainees by the partner companies, which provide financial support for the program. At the end of each year of the program and after finishing their engineering degree, the students are ready to be employed by these companies as engineers (junior analysts, consultants, etc.). The retention rate is extremely high during the transition of the students from the program to the companies that participate in each yearly program. After some years, it is normal that some engineers change their jobs, but the retention rate still remains satisfactory. The industry partners of the program have also observed a faster development of these newcomer engineers in order to assume management and leadership roles. In general, the program benefits engineering students in terms of intensive development in leadership and managerial skills. The program also has a positive impact on students because it encourages discussion to improve the curricula of the engineering courses of the Sao Carlos School of Engineering at the University of Sao Paulo including more leadership skills content. Companies are also benefited by the program as there are more prepared newcomer engineers for their strategic job positions. Researchers can also obtain results from this program by doing multidisciplinary research in areas such as engineering education in leadership, leadership development for engineers, and so on. Therefore, universities and engineering courses should encourage professors and researchers to pay more attention to this kind of initiative that demands time and effort.

Keywords: engineering education; leadership; leadership development program in engineering

1. Introduction

In recent years much has been written on the importance of leadership teaching in engineering courses. Technical competence may be the attribute that the general public most closely associates with successful engineers. However, according to Russel and Yao [1, p. 18], in fact, it has been said that "an engineer is hired for his or her technical skills, fired for poor people skills, and promoted for leadership and management skills". In the same article, these authors presented a model that can describe an ideal undergraduate engineering student profile (Fig. 1).

Even though this model was proposed more than 15 years ago, it can be observed that most of the engineering courses around the world have not followed such guidelines as a reference to improving their curricula. They still continue to concentrate on technical knowledge and less attention has been paid to other issues of engineering education. However, as the society changes and enterprises need more complete professionals, traditional engineers have suffered to adapt themselves to the current marketplace requirements. In the article entitled "How newcomers learn the social norms of an organization: a case study of the socialization of newly hired engineers", Korte [2] investigated how newly hired engineers learned job-related tasks and the social norms of the organization. Among the various conclusions of his paper, it can be said that engineering students, in general, are not prepared for a social system. When they start their job, they are supposed to put into practice many social skills they are not prepared to use. Consequently, it is supposed that they need to learn such abilities in practice, just by doing.

The importance of new skills for students involved in technical courses such as engineering has been extensively discussed. Topics as personal and interpersonal skills [1], teamwork [1, 3, 4], problem solving [5], leadership [1, 5], communication [1, 4], management knowledge [1, 4], entrepreneurship [4, 6], ethics [1], new teaching-learning approaches such as Problem/Project Based Learn-

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* Accepted 11 March 2013.

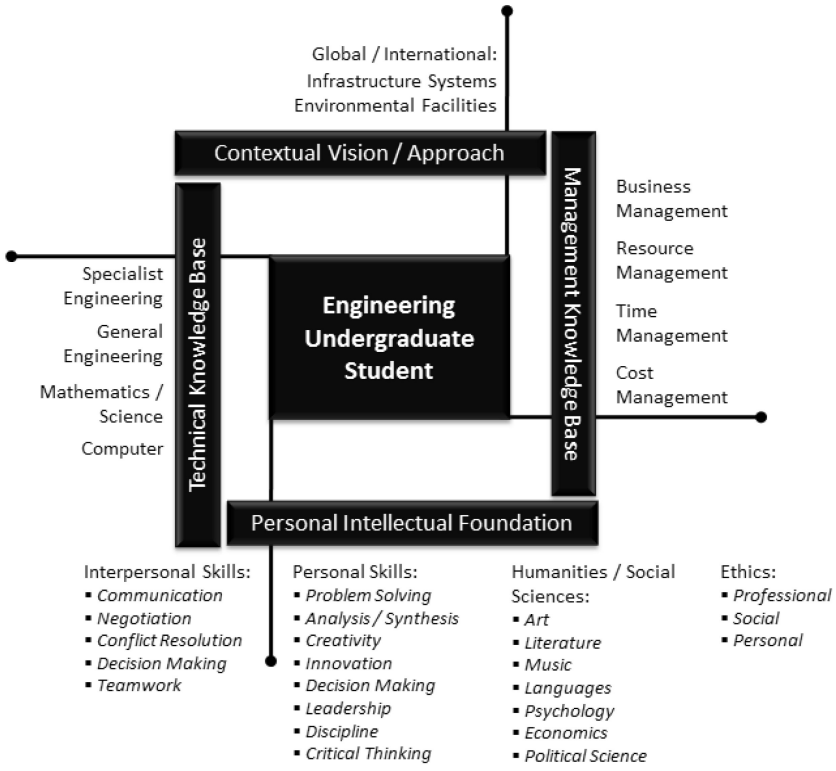

Fig. 1. Ideal Engineering Student Profile (adapted from Russel and Yao, 1996, p. 24).

ing (PBL) [3, 4, 7], engineering students' motivation [7], university-industry partnerships [8], among others have been often cited on the Engineering Educations' literature.

As important as the other issues on engineering education, leadership has received special attention both from the industry and academia. Developing future engineers as intellectual leaders requires skilled and well prepared professionals, who are creative, know how to work in teams and how to communicate with people in other areas. Therefore, a framework is necessary where technical competence represents its core and it surrounded by technology, human factors and market opportunities [3].

According to Jablokow [5], the difficulty and complexity of today's problems, mandate the need for engineers who are both advanced problem solvers and leaders within their profession. Understanding that the knowledge and skills of engineering students must extend beyond the traditional technical subjects, this author presents a framework for problem solving, providing inputs to a new curriculum that was initiated and developed at Penn State University. The author emphasizes the importance of problem solving as a cognitive process and its effectiveness in leadership, considering both problem solving and leadership as two of the most important non-technical skills required by engineering graduates nowadays. Delivering these two key themes in combination, i.e. problem solving and leadership, is the main aim of the Penn State Problem Solving Program; facilitating the match of people to problems and managing the gaps between them lie at its core [5].

In a recent paper Soltani et al. [8] studied the relationship between employers and students during their undergraduate study. According to these authors, university programs must recognize the real and continuously growing requirements of industry. This can be reached by [8]:

- developing students in line with these requirements,
- attracting and maintaining the inspiration of students, and
- providing students with practical and innovative problem solving skills to work effectively in industry.

Amongst the most important findings of this study, the following can be listed according to the companies' perspective [8]:

- improving the structure of courses to make them relevant to the business and attractive to potential students,
- providing employers with early access to the good quality students,
- supplying good quality engineers,

- raising students' awareness of their roles and responsibilities in industry,
- providing continuous follow-up and feedback on the performance of the programs, and
- facilitating the University-Industry relations to minimize the time and resources commitment by the parties.

Companies should be more aware about the success of programs, especially the economic benefits in order to encourage them to extend their links with universities through sponsorship [8]. Looking at the University's perspective, the sponsorships need to be evaluated in order to identify how successful they are in helping the departments and employers to achieve their objectives, and students to acquire employability skills [8].

Looking at the curriculum of the Engineering courses at the Sao Carlos School of Engineering, at the University of Sao Paulo (the best university of Latin America according to Webometrics Ranking of World Universities, CSIC, 2011 [9]), an excessive focus on technical knowledge can be observed (see Fig. 2).

In fact, management and leadership are not included in the agenda of most university decision makers in engineering courses. The universities that start this change now will have advantages in the near future providing more prepared engineers for the market place. Some universities have already started programs to teach leadership skills for engineering students. An overview of leadership programs in engineering can be observed in the white paper: "Engineering Leadership Education: a snapshot review of international good practices" [10].

Further publications can also be found which enhance and justify the importance of why leadership is so relevant for engineers. Bayless and Robe [11] observe that engineering courses has often neglected leadership education which has been seen academically as a soft skill not relevant. Furthermore, they argue that technical competence is fundamental for engineers but not sufficient for carrying out their professional responsibilities of today's challenges, being likewise important for them to learn how to work with and through other people [11]. Companies which employ engineers have been seeking for graduates who are not merely experts in design and analysis, but who possess leadership skills to apply their technical knowledge [12]. Hinkle [13] considers influence as one of the most important abilities of leadership that engineers need to learn. Considering not only engineering students, but students of higher education in general, Greenwald [14] argues that, nowadays, all of them need training on leadership. A great effort can be seen in order to professionalize the field, but still, leadership has not been considered a serious discipline by others in higher education [14]. Moreover Greenwald attests that each institution needs to define leadership in a meaningful way before it can develop a meaningful curriculum for it students—a leadership program should be based on the values and the mission of the university [14]. Today and in the near future students will have multiple jobs and even multiple careers during their lifetimes (many will work for small firms and a growing percentage will be consultants and freelancers for most of their working lives). Consequently they will need the skills, knowledge, and qualities that leadership programs cultivate: self-reliance, social and cultural capital, appreciation for lifelong learning, creativity, conflict resolution and team-building skills, ethics, understanding of economics, and more [14].

It is important to note that engineering leadership

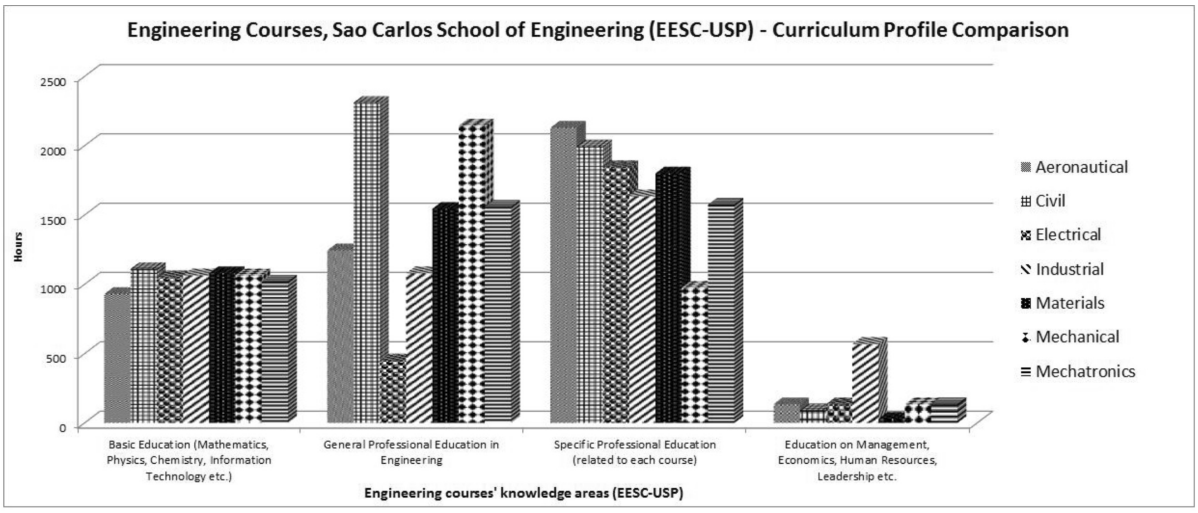

Fig. 2. Profile of Knowledge Areas of some Engineering Courses (source: Sao Carlos School of Engineering, University of Sao Paulo).

skills are critical at all levels of professional engineering [15]. The National Society of Professional Engineers (NSPE), through its Licensure and Qualifications for Practice Committee (L&QPC) has defined leadership as follows [15]:

> ''In an engineering context, leadership incorporates a number of capabilities which are critical in order to function at a professional level. These capabilities include the ability to assess risk and take initiative, the willingness to make decisions in the face of uncertainty, a sense of urgency and the will to deliver on time in the face of constraints or obstacles, resourcefulness and flexibility, trust and loyalty in a team setting, and the ability to relate to others. Leadership skills are also important to allow engineers later in their careers to help develop and communicate vision for the future and to help shape public policy. These leadership capabilities are essential for the professional practice of engineering and for the protection of public health, safety and welfare.''

Therefore a relevant question that arises from this earlier discussion can be: *How can engineering students learn leadership skills?*

Considering this, in 1999 the Department of Production Engineering at the Sao Carlos School of Engineering (EESC), at the University of Sao Paulo (USP), Brazil proposed a program for developing leadership skills in engineering students. Since then, the program has been working as a complementary mechanism of developing leadership and interpersonal skills in groups of interested engineering students. Therefore, this article aims at describing the Leadership Development Program in Engineering (PROLIDER), which is a partnership between the Sao Carlos School of Engineering and Brazilian Companies. The PROLIDER has gained relative importance with its partners because it assists engineering students to develop leadership and management skills still during their undergraduate course. At the end of each yearly program, the students are employed by the companies that are partners and finance the program.

In order to serve the established purpose of this article, a literature review on the subject of leadership in engineering was firstly introduced. Next a detailed description of the PROLIDER will be presented considering: its initial motivation, its history from 1999 until now, its physical and organizational structures, the roles and responsibilities of people involved, its main phases of operation and the leadership skills development activities. Afterwards, the results of a survey carried out with students, and some testimonies of students, engineers, partners and professors who participated in the program are also presented. Finally, this article will discuss and conclude some benefits and hindrances in terms of operating the program, as well as future opportunities and guidelines for maintaining and improving the program.

2. The leadership development program in engineering (PROLIDER)

In view of the fact that leadership learning has become even more important for engineers, as previous mentioned in this article, the main purpose of this topic is to describe the Leadership Development Program in Engineering (PROLIDER). It is important to highlight that the University of Sao Paulo (USP) has been recognized during the last years as the best university of Latin America and one of the best universities in the whole world. Consequently, it is supposed that employers, who hire these professionals and remunerate them with a salary higher than the average, expect much more than pure technical knowledge from these newcomer engineers.

2.1 General description and objectives of the program

The mission statement of the program can be defined as: ''to develop leadership skills in people with technical education''. As a result, the main objective of the PROLIDER is to develop leadership and interpersonal skills in final-year undergraduate students of courses that emphasize mainly technical education. Most of the cases are engineering students from various fields (e.g. aeronautics, electrical and electronics, mechanical, mechatronics, industrial engineering). Sometimes, students from other courses such as Computer Science are also admitted to the program. In the current model, students from the Universities of Sao Carlos (University of Sao Paulo—USP and Federal University of Sao Carlos—UFSCar) are eligible to join the program. The program enables the students to conciliate the learning of both technical and behavioral skills and it is expected that they will become able to assume leadership and managerial positions in the near future. During the last year of their degrees, the students spend some of their time in the University developing their leadership skills and some of their time working as a trainee in a company.

The program is necessary for some partners because they have reported that this subject is missing from the curriculum of most engineering courses where they search for professionals (including the engineering courses at EESC-USP). Each yearly program has been worked out with innovative enterprises or companies that consider the students' intellectual ability as one of the most important issues for competing in their market

place. The program is a non-profit initiative and has been financed 100% by the industry partners.

Finally the PROLIDER is coordinated by Professors and Graduate Students of the Department of Production Engineering at EESC-USP.

2.2 History and initial motivation

PROLIDER began in 1999 as an initiative of the Department of Production Engineering at EESC-USP in order to promote an environment for promoting more integration between theory and practice in engineering students and also to contribute to their behavioral development having in mind that their technical knowledge was already competent. At that time, some industrial university partners had complaints about how unprepared the last year engineering students were for the market place.

Considering this initial motivation, the program was created. Its initial name was "Leaders for Enterprise Integration" and it was supported by the Brazilian Regional Office of the SAP Company which financed the program and employed the first group of students. Later, other companies contributed to the program such as Axia Value Chain, Deloitte Consulting, Faber-Castell, IDS-Scheer, JBS-Friboi, among others. From 2001 until 2010, the program was called Leadership Building Program, and since 2011 a new name was chosen in order to embody its more current and future needs: Leadership Development Program in Engineering (or simply PROLIDER).

2.3 Operation phases and leadership development activities

The program is basically structured using two main operational phases (see Fig. 3):

- Preparation Phase—during the first semester of year zero (0), companies who are interested in becoming partners agree to participate and finance the program. Then, during the second semester students are selected to start the leadership development at the beginning of the next year. The first year is called "zero" because the yearly program has not yet started for the students.
- Development Phase—this phase occurs in year one (1) and is totally oriented to the students who receive training and education in technical, managerial, social and interpersonal competences.

The preparation phase consists of various activities carried out mainly by the program coordination team and partners. Among the most important activities are: partner prospecting, estimating the amount of students, defining scenarios for investment, signing agreements between the university and industry partners, defining the exact number of students and the budget of the program, advertising the program and selecting outstanding students, as well as planning for the development phase.

The development phase refers to the most time-consuming phase. It consists of four sub-phases:

1. Planning and Integration—as their initial activities, the students are welcomed by the program coordination, they participate in a team-building activity and are responsible for preparing an initial annual plan of their activities. This sub-phase takes one week.
2. Contacting the Company—after planning and integration, the students go to the company that is sponsoring the program and stay there for approximately two months in order to know the

Fig. 3. PROLIDER Operational Phases.

company's policies, procedures, technical areas and other important information for their trainee program. The students present their initial plan to the Company (Human Resources team and Managers of different Areas). The planning is reviewed and validated so that the students come back to the university for the next sub-phase.

3. Developing Leadership Skills—this sub-phase represents the most differential stage of the program and characterizes, in fact, the greatest difference between the PROLIDER and other normal trainee programs conducted by companies. It takes about four months (from March to June). At the beginning of this sub-phase, the students have to develop a detailed plan for these four months, including all the courses they intend to do. To do this, a budget of the program (about US$ 5,000,00) is for the students who are responsible for managing this financial resource so that they can contract the most appropriate experts (for giving specific courses) according to their wishes and company's needs. They also have to decide and communicate a detailed calendar of activities and meetings for the four months. In order to develop leadership-oriented skills in the students, a group of activities are conducted to promote technical, managerial, social and interpersonal competences in the students, as follows:
   - developing and presenting technical and managerial seminars. The students are challenged to choose, study, prepare and present a topic of interest to the university community and the academia in general. This is normally an individual activity.
   - the students participate in various development courses in different categories such as social and interpersonal skills (e.g. public speaking, interpersonal abilities), managerial knowledge (e.g. project management, change management, organizational culture), and technical knowledge (e.g. life-cycle engineering, sustainability, Excel training, Simulation in Arena).
   - another responsibility of the students is to develop real projects. They have to do this activity in groups and each group is responsible for conducting two different projects. One project is related to the solution of a technical problem in a company in Sao Carlos or the region. There is no commercial relation between the company and the university or between the company and the students. The agreement is that the students learn from experiencing a real situation. The company, on the other hand, although conscious about the objective of teaching the students, sometimes obtains very good results from the students' ideas and solutions. This project has normally a technical-oriented problem, for example, in logistics and production (e.g. stock management or production planning and control), or in technology information (e.g. defining requirements for system information). The coordination normally selects the regional partners and chooses interesting projects that can provide situations to the students in which they will face in the near future. The other project is a social and/or environmental challenge. Here, the students are responsible for finding a local institution in order to build up partnerships and implement an initiative. One of these institutions is a non-profit old people's home in which social projects are conducted by the students for some years. Examples of projects are organizing food stocks and shelf-life control because most of the food come from donations and the shelf-life control must be managed very well, or improving the information system of the organization to control visitors and accessing family contacts. Other kinds of institutions are non-governmental organizations that carry out social or environmental initiatives in the region.
   - finally, the students have to participate in weekly meetings with the coordination who follow up the activities and check if some critical resource is lacking. At the end of the four months, the students have to prepare and present all the carried-out activities and the results to the coordination team and to the company that is sponsoring the program.
4. Acquiring Experience—During the last six months of the program, the students are involved in trainee activities and participate in projects which now directly benefit their employer (program industrial partner). It is a very important phase for the students because they will be working almost full time with their employers and have the chance to show how competent they are. At the end of the year, when the students conclude their undergraduate courses, it is supposed that the company will employ them as junior engineers, analysts or consultants.

2.4 Infrastructure

Every year, the program is run in the Department of Production Engineering at EESC-USP, Brazil. There is a specific area reserved for activities such as

projects and programs. In this area, there are two rooms, one of them for administrative activities and the other one for developing students' activities (courses, projects and other tasks). The administrative support provides a general computer, a printer, a camera, a multimedia projector, a library on Leadership and Management, among other resources. Besides this specific area, the University also provides others rooms and resources when required by the students, for example, in order to carry out a seminar week on technical and managerial themes for the university community.

2.5 Organizational structure, roles and responsibilities

PROLIDER presents a student-centered organizational structure (see Fig. 4).

In order to run the program, the industry partners have to agree with the program proposal and to participate actively in the most important development stages. As the industry supports the program financially, each yearly program only starts if there are industry partners supporting it. The coordinator, who is responsible for prospecting partners, initiates the first phase of the program: acquiring operational and administrative support from the university, communicating the new PROLIDER edition for the students and giving support for students' recruitment and selection processes. During the development phase, all stakeholders work together to guide the activities concerning student responsibilities as described in the previous section about "developing leadership skills". It is important to highlight that the students assume co-responsibility for planning their development activities and help to manage part of the financial resources available for the program. At the developing leadership skills stage, there is a specific activity for developing interpersonal skills in the students as a result of a partnership between EESC-USP and the Psychology Department of The Federal University of Sao Carlos (UFSCar). This activity is called Interpersonal Professional Development Program (PRODIP). The psychologists often monitor the students during the entire program and assist them giving tips and providing tools to improve their communication, assertiveness, dialog, among other skills. A Professor of the Department of Production Engineering at EESC-USP is responsible for giving Project Management courses and also for evaluating each stage the students make in their technical and social projects. Finally, the participation of local partners (companies and others organizations) is critical for providing real situations to the students, where they can implement their technical knowledge and observe the effectiveness of their leadership skills to conduct the projects.

3. Results and discussion

The Engineers' Leadership Foundation [16] published a survey on its internet site with almost 200 senior engineering managers and leaders. The results of this survey are published in a report called "Jump-Start Your Career as a Professional Engineer" and it is available at http://www.engineersleadership.org/. While none of the engi-

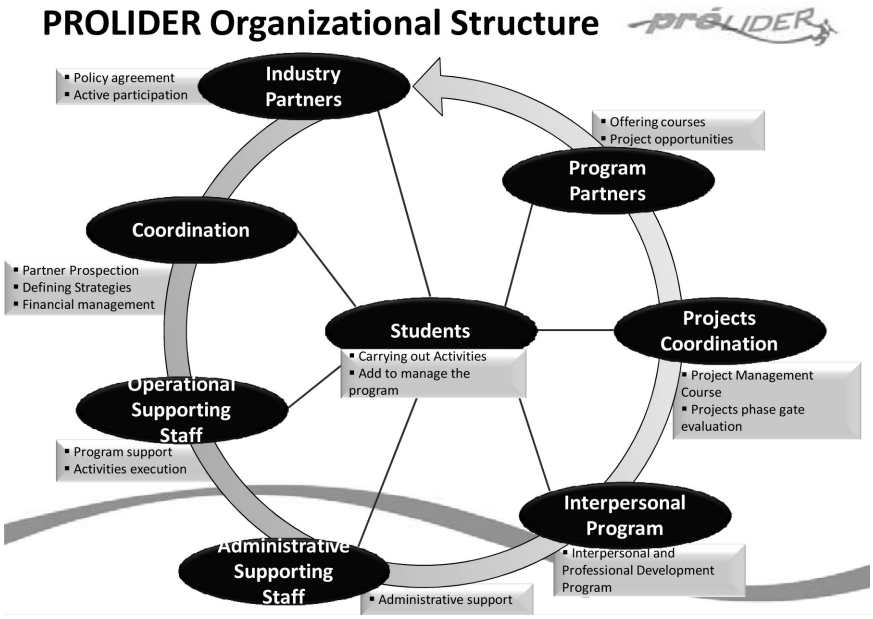

Fig. 4. PROLIDER Organizational Structure.

neers disagreed that engineering knowledge has been essential for their careers, almost all agreed that they would have achieved leadership positions much faster and more effectively if they had engaged in more non-technical activities, such as management, public speaking, and association involvement. One of the principal recommendations of this report attests that [16, p. 16]: ''Your technical education is extremely important, and you need to keep at it on a lifelong basis. But lifelong learning applies to more than technical issues. To become a leader, you also need to develop 'people skills'; the ability to relate well to other people, and especially to communicate effectively, in writing and orally.''

As stated earlier, there is a clear necessity of rethinking education in engineering to consider the current and future trends the engineering professionals are going to face. PROLIDER is trying to fill this gap. The main results gained from this program, since its beginning, include:

- approximately 150 engineering students were trained in leadership skills from 1999 until 2012;
- high student retention rate, i.e. the students, who have been supported by the companies in the program during the last year of their courses, are usually employed by this same company;
- a faster development process in leadership and management skills is observed in these students;
- spillover actions from the program into classrooms.

The main benefits of the program will be shown next using two analyses: Firstly, a survey carried out with the former students will be presented describing their impression of having participated in the program. Some reports are presented describing the opinion of people who have been involved with the program since the beginning.

3.1 Quantitative results

The data for this section were drawn from a mail survey done to evaluate the importance of the program to the students. For this reason, a questionnaire was mailed to 134 professionals who participated in the program as trainees from 1999 to 2012. We received a total of 42 replies which correspond to a 31.4% response rate.

Most professionals who replied to the survey (88.1%) work for private organizations; the remainder work for public organizations or are self-employed (4.8% and 7.1%, respectively). In terms of the respondents' position in the company, only 26.2% have an official leadership job title (i.e. managers, supervisors). However, 90.3% of those respondents who do not occupy a leadership position (73.8%) stated that often they have to assume a leadership role in their work environment, especially because of their technical skills. These results show that leadership skills are requested even to those professionals who do not officially have a management position.

Concerning those respondents who have a management position in the organization, most of them (75.0%) held this position with less than 3 years after starting their professional activities, as can be seen in the pie chart below (see Fig. 5).

These results indicate that newcomer engineers are eligible to hold managerial positions in a short timeline. Taking this into account, it can be said that PROLIDER has an important role in providing necessary skills to them. Interestingly, this importance is highlighted in another part of the survey where the respondents were asked to indicate to

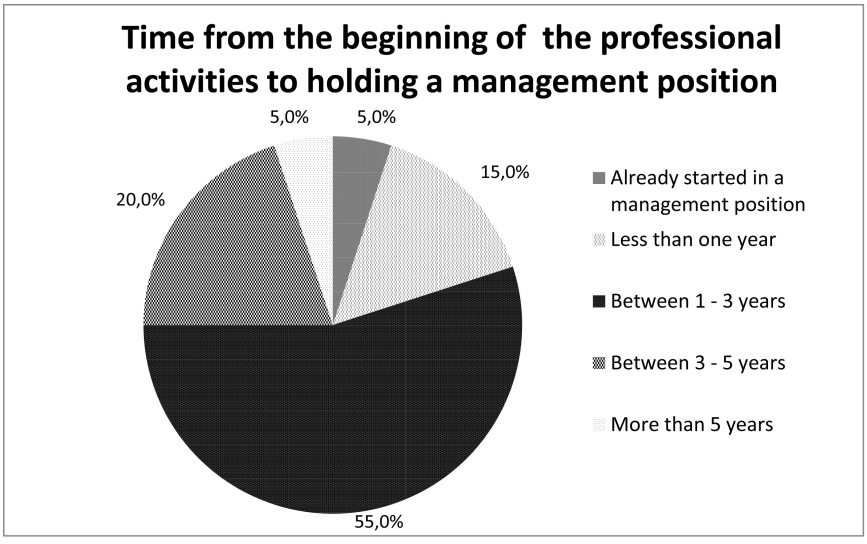

Fig. 5. Time from the beginning of professional activities to holding a management position.

Table 1. Importance of PROLIDER for the professional development of the respondents

Questions	Strongly Disagree	Disagree	Neither Agree/ Neither Disagree	Agree	Strongly Agree
1—PROLIDER was important to accelerate my professional development.	0.0%	0.0%	4.8%	**47.6%**	**47.6%**
2—PROLIDER provided a complementary background to that provided by my undergraduate course, which was fundamental to my professional development.	0.0%	0.0%	2.4%	**57.1%**	**40.5%**
3—PROLIDER provided a complementary background to that provided by my undergraduate course, however without any impact on my professional development.	**57.1%**	**40.5%**	2.4%	0.0%	0.0%
4—My undergraduate background was enough to perform my professional activities.	**26.2%**	**50.0%**	0.0%	19.0%	4.8%

which extent they agree with statements about the importance of the program. Table 1 shows these results.

It can be seen from the data in Table 1 that most of the respondents agreed or strongly agreed that the Program was fundamental for their professional development, as shown by questions 1 and 2 (95.2% and 97.6%, respectively). This claim is reinforced by the results of question 3, where the respondents strongly disagreed or disagreed (97.6%) that the Program did not have any impact in their carriers. Question number 4 shows that 76.2% of respondents disagree or strongly disagree that the undergraduate course has been enough to perform their professional activities. This result highlights what has already been discussed before: undergraduate courses do not recognize the considerably growing requirements of the companies. That is, so far, the background provided by the university needs some complementary activities.

As shown in Table 2, PROLIDER was cited by the respondents as the main useful activity to develop interpersonal skills, management knowledge, leadership skills and teamwork (45.2%, 43.9%, 51.2% and 34.2% respectively). To develop oral skills, the Program also appeared as one of the most useful activities (39.0%). These results demonstrate that the final results of the Program are aligned to its purpose.

All respondents answered that they would recommend the Program not only for companies, but also for engineering students. Some of the reasons are listed below:

- partnership between company and university which promotes teaching-learning results;
- professional orientation from the members of university (i.e. professors, post-graduate students) aligning technical and practical knowledge;
- interpersonal skills development;
- support from coordination team of the trainee program;
- trainee empowerment to plan and perform their activities;
- low investment if compared with the return on student qualification;
- accelerate the students' learning curve.

3.2 Qualitative results

Here are some reports of students, engineers, partners and professors who participated in the program:

> "I participated in the first yearly program. The program was very important for my career because I was able to develop my leadership skills in an environment which was both very demanding and with excellence supervision. . . Now I am a manager of a multinational consulting firm and I also teach on one of the best MBA

Table 2. Activities versus skills development

Main useful activity to develop the skills listed below	PROLIDER	Undergraduate course	Extracurricular activities	International exchange
Technical skills	0.0%	**85.7%**	11.9%	2.4%
Oral skills	39.0%	4.9%	**53.7%**	2.4%
Interpersonal skills	**45.2%**	7.1%	38.2 %	9.5%
Management knowledge	**43.9%**	19.5%	36.6%	0.0%
Leadership skills	**51.2%**	4.9%	43.9%	0.0%
Teamwork	**34.2%**	31.7%	31.7%	2.4%
Organizational theory	28.2%	**48.7%**	20.5%	2.6%

Brazilian Programs. I thank PROLIDER for that.'' (Industrial Engineer at EESC-USP, Student Participant, 1999).

''During the first months of the program, I was involved with lectures, courses and small projects where I could acquire competences related to management, strategy, communication and negotiation; these kinds of competences I had not acquired during my mechatronics engineering course. I am sure PROLIDER had a fundamental importance in my preparation for professional life.'' (Mechatronics Engineer, Student Participant, 2008).

''PROLIDER is a distinct Program! It enables us to learn and develop what the engineering faculty does not teach: how to deal with a leadership position that a good engineer will probably assume in a company. Besides that, the Program helped me to develop abilities that I will take with me in my whole life. Day by day I can perceive how much I developed participating in this Program. I am very grateful to the Program!'' (Industrial Engineer at UFSCar, Student Participant, 2011).

''PROLIDER promotes the development of technical knowledge and interpersonal abilities and also transmits to the students values of responsibility and sustainability. Many of the practices developed in the Program could be used in the classroom in order to stimulate leadership attitudes in our students. Besides that, social and environmental activities carried out by the students integrated the students' technical competences with Brazilian reality. Finally, it is essential to highlight that this initiative of complementing the engineering students' education reinforces their technical knowledge and expands on their professional possibilities of action.'' (Professor at USP, Former Program Coordinator).

''As businessman and program customer, I am sure about the great difference the program makes in students' attitudes. I sincerely feel that they finish their engineering courses much more prepared for and aligned with organizational needs, increasing their productivity and reducing the time required for their development.'' (Customer of the Program).

The interviewees were also asked their opinion about the importance of the partnership between the company and university. Even though the results of the survey demonstrate that all the respondents consider this relationship important or very important, it is far from ideal. As stated by some respondents, most Brazilian companies did not recognize the University as a partner:

''I consider that the partnership University-Industry is still weak in Brazil. Companies could stimulate the university to offer courses according to industry demand. This would fit the students profile and the company's needs. The university could also carry out applied research so that Brazilian companies could innovate more frequently.'' (Survey respondent).

''The University-Industry partnership should consider the following: companies should contribute with financial resources and practical knowledge while the university could offer theoretical knowledge and research. However, it is important that the knowledge generated from this partnership is open to the whole society. Besides the knowledge, the enterprises could also benefit from good students, i.e. future professionals.'' (Survey respondent).

3.3 General discussion

As previously presented, PROLIDER offers complementary education on topics such as leadership, management and so on to the engineering students. These kinds of themes are so far not yet well-explored in engineering courses curricula in Brazil or worldwide. However, the program can be used by courses as piloting to test new teaching contents and methodologies. By doing this, the curriculum of each engineering course could be improved based on real tests.

Additionally, some challenges could be pointed in order to promote improvements in research, teaching and community outreach as follow:

- Research: to transform the program content into engineering education multidisciplinary research topics (for example ''leadership in engineering'') involving different departments at the Sao Carlos School of Engineering.
- Teaching: to transform the content of the program into curricular activities (initially as optional and mandatory in the long term) for all engineering courses at EESC-USP and other Brazilian engineering courses.
- Community outreach: to attract more industry partners which believe in the program proposal and also want to invest in universities and engineering education, regardless of the fact the students will or not be employed by their companies.

Despite the fact that the program has existed since 1999, it is always difficult to convince companies about the real benefits it can provide to them since some results come in long term and are intangibles. Moreover, some companies which participated of the program did not adhere to its philosophy: for example, in the current model, students have to stay away from the company for four months (sub-phase 3 of the Development Phase). Some companies do not agree that they will not have this ''labor force'' during this time. Others do not agree of having access only to regional students (at EESC-USP and UFSCar). Finally, an investment is required in order to run the program and the companies must be aware about this necessity.

Another limitation of the program is the small number of students that have participated in the program since its beginning. One hundred and fifty students is a reasonable number, but when compared with the amount of engineers from Sao Carlos

universities that look for work on an annual basis, it can be seen that there is an enormous opportunity to involve more and more students. With the growth of the Brazilian economy, the country has expanded its engineering courses in all regions. Sao Carlos now offers almost one thousand places annually. However, this limitation is closely related to the Brazilian public universities' structure which does not emphasize community outreach as being so important for professors and researchers as research is. Researchers have been particularly pressurized to publish and therefore do not spend time and energy to dedicate to initiatives such as PROLIDER. Nevertheless, we see it as vital to strengthen the relationship between universities and industry.

4. Conclusions

According to our experience of running the Leadership Development Program in Engineering (PROLIDER) at the EESC-USP, we hope to contribute to the discussion about how engineering students could learn more leadership skills during their undergraduate courses.

In order to achieve good results, we would recommend that a leadership development program should have a clear statement of their objectives. Moreover, the program phases should be established, communicated to all stakeholders and tightly controlled by coordination. Roles and responsibilities should be as well clear for everybody, i.e. for students, industry partners, program coordination and other partners. An appropriate infrastructure for supporting the program operation might be available. Finally, the leadership development activities should provide for the students opportunities for: learning more technical knowledge, managing and carrying out technical and social projects, having responsibilities for managing financial and other critical resources for operating the program, having to account for their choices and performance, giving and receiving feedback, and continuously improving their personal and interpersonal skills.

We expect that this paper contributes to highlight the importance of taking not only technical issues into account but also issues related to the development of leadership skills in the engineering courses improving their curricula and, consequently, the qualification of their students. Additionally, describing the PROLIDER, it provides an example of a frame that supports the development of those skills which are suitable to the requirements of the companies which even more pursuit the balance between technical and interpersonal competences.

As discussed before, some challenges regarding the PROLIDER are clear, i.e. how to include those activities into the regular curriculum in the engineering courses and how to increase the interest of the companies in that? Nevertheless, the benefits are clear as presented in the quantitative and qualitative results section where the most of interviewees agreed that the Program was fundamental for their professional development. Besides that they also agreed that the background provided by the university needs some complementary activities.

Several results—for instance: faster development in leadership skills, newcomer engineers more prepared for the industry challenges, short timeline to hold managerial positions, recognition of the program importance for the engineers' professional life—have shown us that the benefits for the students are perceptible and initiatives such as PROLIDER could be a stimulus for other universities starting to develop leadership skills in their engineering students. In summary, the program is important in a theoretical perspective since it provides a structured program to help the Universities in reconsidering their curricula and, in a practical perspective, it contributes to provide more skilled engineers according to the current industry needs.

Acknowledgements—To the Sao Carlos School of Engineering (EESC), University of Sao Paulo (USP), to the Companies which have believed in and supported the Program, and to all the respondents who have contributed to this paper.

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