

Supervised internship data evolution and the internationalization of engineering courses

R. Vizioli¹

PhD student

Department of Mechanical Engineering at the Escola Politécnica of the University of São Paulo

São Paulo, Brazil

E-mail: rvizioli@usp.br

B. T. Enachev

Undergraduate student

Department of Mechanical Engineering at the Escola Politécnica of the University of São Paulo

São Paulo, Brazil

E-mail: bruno.enachev@usp.br

P. C. Kaminski

Full professor

Department of Mechanical Engineering at the Escola Politécnica of the University of São Paulo

São Paulo, Brazil

E-mail: pckamins@usp.br

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INTRODUCTION

In 2005, with the Global Engineering Excellence (GEE) initiative [1] and in 2008 with the Global Engineering Internship Program (GEIP) [2, 3], according to the authors of this paper, the Escola Politécnica of the University of São Paulo (EPUSP) has dimensioned with more precision, the importance of the internationalization of the engineering career.

Founded in 1893, the Escola Politécnica was incorporated into the USP in 1934. Today it is a national reference and it is considered the most complete engineering school in Latin America. The school has about 450 teachers, 4500 undergraduate students and 3500 graduate students. On graduation, 17 courses are offered, grouped into four broad areas of engineering: Civil, Electrical, Mechanical and

¹ Renato Vizioli
R. Vizioli
rvizioli@usp.br

Chemical. In graduate school, ten masters' degrees, nine PhD and two professional masters are offered.

With GEE and GEIP, EPUSP, along with seven leading universities in the world and a Germany-based automotive supplier (Continental AG), had the opportunity to approach important questions related to the globalization of engineering career and education [1]. This happened not only regarding a theoretical and conceptual point of view, but also a practical one, through a planning that included three main modules: academic program, international internship and an intercultural workshop. According to Anderl [1], "Many of today's global challenges can only be addressed through engineers working collaboratively in international networks." Four critical challenges for engineering graduates were identified in the initiative: making global competence a key qualification, allowing a transnational mobility for engineering students, encouraging a mutual commitment to partnership and correctly constructing the theoretical foundation on learning behaviours and models as well as on organizational processes and management methods focused on the global competence in engineers.

According to Parkinson [4], global competence is necessary due to the convergence of last decade's trends and events, including telecommunication advances, political events which have opened up many formerly closed societies, the adoption of economic policies which have promoted free trade and the expansion of multinational corporations.

The GEIP initiative, considering the changes in companies and in consumption behaviour – the way the global consumers act and their needs – allowed engineers, while graduating, to participate in global projects. They interacted physically or virtually with teams around the world, which included students and professionals in China, Germany, United States, Switzerland and Brazil.

Among the results of this initiative, it's important to highlight the experience exchanges related to each course of the involved institutions, which allowed them to improve some of the courses, giving more emphasis to certain aspects related to project activities, or to the engineering praxis, dealing with global questions and not only with local problems. Regardless of the international experience of the student, in his or her own environment, the engineering course tries to create opportunities to deal with open problems and with broader questions, involving not only technical issues, but also social, economic ones and the sustainability questions, the kind of issues that appear more frequently globally with varying intensity depending on the country's culture.

1 INTERCHANGE PROGRAMS IN THE EPUSP

The academic interchange in the EPUSP is consolidated, and has grown steadily since 2000. There are two main modalities of interchanges: the Dual Degree (DD) that allows the student to get both the course certificate in the EPUSP and in the partner institution, and the Credits Equivalence (CE), where the student attends courses at the partner institutions and gets the credit equivalency at the EPUSP.

Regarding the international experience, both modalities have very positive results, even if, in the case of the Credits Equivalence, the student stays in average one year abroad, whereas in the Dual Degree modality, this time is normally up to two years. Figure 1 shows how the number of students in interchange programs of the whole EPUSP has considerably grown in both modalities. This number has increased specifically since 2012 due to the governmental program called "Ciência sem Fronteiras" (Science without Boundaries): in 2011, only one student had used this

program's resources, but in 2012 the number jumped to 104, in 2013, to 148, and, in 2014, to 188, almost doubling the number of students who had the opportunity to enrol the interchange programs.

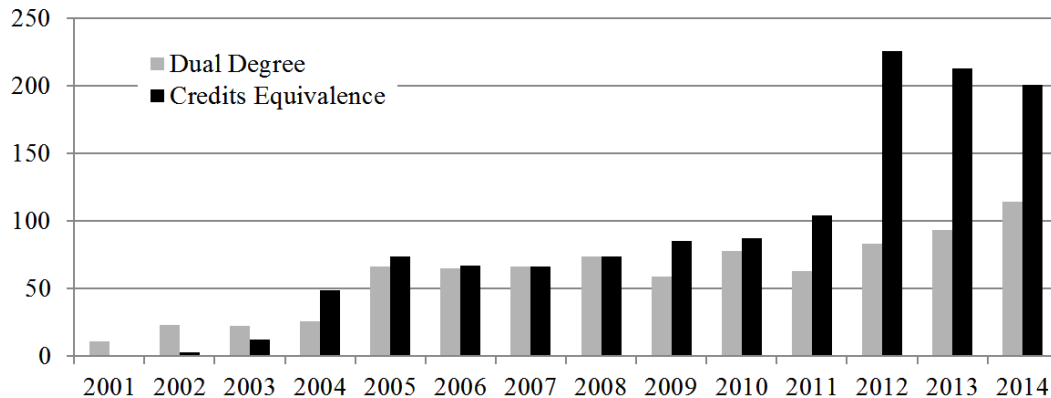


Fig. 1. Evolution of the number of students of EPUSP in interchange programs

In the Mechanical Engineering department, it was also verified a strong growing along these last years (Figure 2), although the impact of the program “Ciência sem Fronteiras” has been smaller than in the whole EPUSP. In 2014, there were 53 students of Mechanical Engineering studying abroad. Considering that there are 70 new students per year in the Mechanical Engineering course, this means that 75% of the students are currently taking part on the program, a rate that makes the interchange program almost an “obligatory step” in the curriculum.

For the students that choose not to go, some reasons can be investigated: Guest, Livett and Stone [5], surveyed Science students in Australia, who were asked what was the main reason for not participating on an interchange program. Some students stated that they were not interested because it would be too expensive, or because they were concerned about leaving family and friends or even because they were satisfied studying in Australia. Some of them cited potential semester clashes and a desire to complete their university studies as quickly as possible. These causes can also be suggested in this study, although, probably, the student's profile at the EPUSP is different. But the fact is that cost is an important reason, and the “Ciência sem Fronteiras” impact shows this clearly.

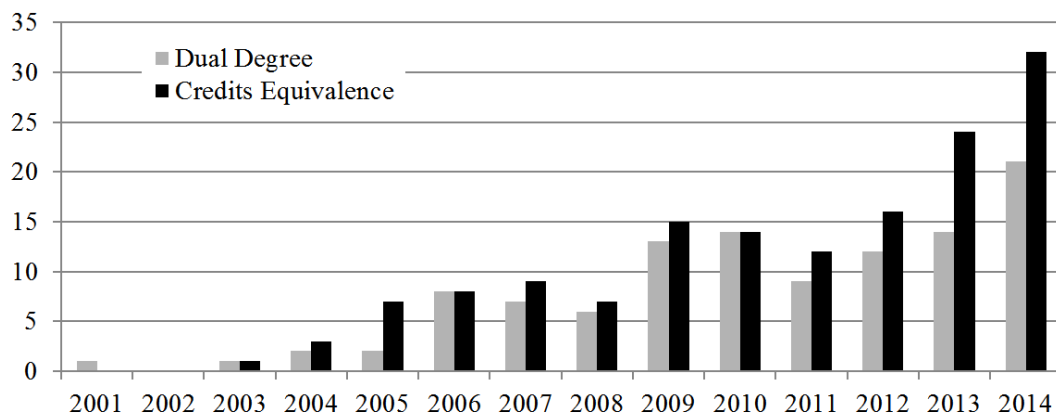


Fig. 2. Evolution of the number of Mechanical Engineering students of EPUSP in interchange programs

Regarding the interchange's destination, there are several partner institutions, in many countries. Table 1 shows most of the countries where Mechanical Engineering students go. Almost half of them goes to Germany, France and Italy – 28 out of 53 students in 2014 –, while the other half prefers different countries.

Table 1. Evolution of the number of Mechanical Engineering students, by country in DD and CE programs

Country/ Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Country total
Germany			4	4	9	2	8	8	8	9	11	14	77
France	1	2	4	6	2	5	5	10	6	6	6	9	63
Italy				3	4	4	8	5	4	4	5	5	42
USA						1	2	1	2	3	2	4	15
Canada		3	1		1		1			1	2	2	11
Australia										1	2	6	9
England										1	4	4	9
Netherlands							2				3	1	6
Portugal				3			1	1				1	6
Spain	1								1			1	3
Finland							1	1		1			3
Others						1		2		2	3	6	14
Year total	2	5	9	16	16	13	28	28	21	28	38	53	258

EPUSP maintains strong partnerships with Germany, France and Italy, due to the importance of these countries' educational institutions and to their traditional commercial and cultural interactions with Brazil. Nevertheless, the list of countries is extensive, including USA, Canada, Australia, England, Netherlands, Portugal and many others. This diversity of choice demonstrates the interest in and the need to interact with diverse cultures, not only with countries culturally similar to Brazil. In some cases, however, the opposite is observed, i.e., students with cultural ties who seek a more familiar environment, as, for instance, a Koreans' descendent student who prefers to do the interchange program in Korea.

2 THE ENGINEERING SUPERVISED INTERNSHIP

Rompelman and Vries [6] describe some benefits of the internship, as for instance, acquiring insight in the engineering profession, learning to “survive” in a different culture and learning to apply as well as broadening technical knowledge and skills.

Supervised internship is a course with credits but no classes, part of the compulsory curriculum in Mechanical Engineering (and other engineering courses), since its origins. As stated in the objectives of its program, the student enrolled in the course should undertake an internship with typical Mechanical Engineering activities, and a minimum of 160 hours. The obligatory internship is defined in the “Diretrizes Curriculares Nacionais do Curso de Graduação em Engenharia” (National Curriculum Guidelines for Undergraduate Program in Engineering) [7] in its seventh article:

“Art. 7 The formation of the engineer includes, as part of the graduation stage, internships under the direct supervision of the educational institution, through technical reports and individualized guidance during the realization of the activity. The minimum duration of the internship is expected to reach 160 hours.” [7]

Therefore, this applies to all engineering courses in Brazil, and sums credits for completing the curriculum. The collaboration of a coach is also suggested, in order to give greater consistency and credibility to reports.

There are no specific restrictions on undertaking the internship abroad, as long as it meets the standard requirements of the discipline, namely: the student must have completed a minimum number of curriculum credits (usually equivalent to 6 or 7 semesters) and the activities developed must be relevant to the scope of activities of a Mechanical Engineer as defined by CREA (Engineering Regional Council) [8].

Since 2006, data on the characteristics of the internships is collected and stored in the Department of Mechanical Engineering, including the students' final reports and questionnaires filled by them about the internship. This data was, compiled quantitatively since 2009, allowing the observation of trends, and, together with information regarding the evolution of Dual Degree and Credit Equivalence programs, and also the GEIP initiative results, make it possible a reflection on the subject.

In Figure 3 it's possible to see the evolution of students who did the supervised internship. There is a reduction after 2012, more accentuated in 2013. This is due to the fact that many students who couldn't yet enrol to an exchanging program took advantage of the resources of the governmental program "Ciências sem fronteira". The natural trend from 2015 on is to keep an average of 60 to 65 students.

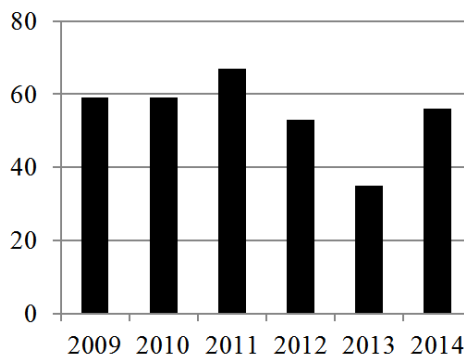


Fig. 3. Mechanical Engineering students who did the supervised internship

Regarding the kind of company, students choose more frequently – as seen in Figure 4 – larger companies and more or less, half of them, multinational or global (used here as synonyms) ones.

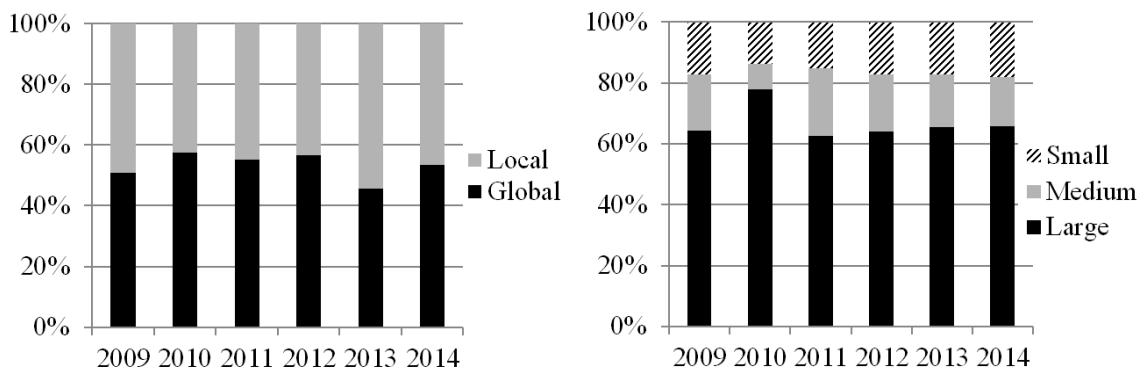


Fig. 4. Size of the company where Mechanical Engineering students did internship

It's possible to perceive that students prefer a company into a global context environment, where it is possible to apply the knowledge acquired in exchange programs, even if the interchange is done in Brazil.

Lately, it is possible also to verify a trend of increasing the number of internships abroad, most of them tied with interchange programs, but not necessarily. Figure 5

suggests that historically students that did Dual Degree were more willing to do also an internship abroad. However, last year data shows that students search for an internship abroad even if they were not enrolled on an international program.

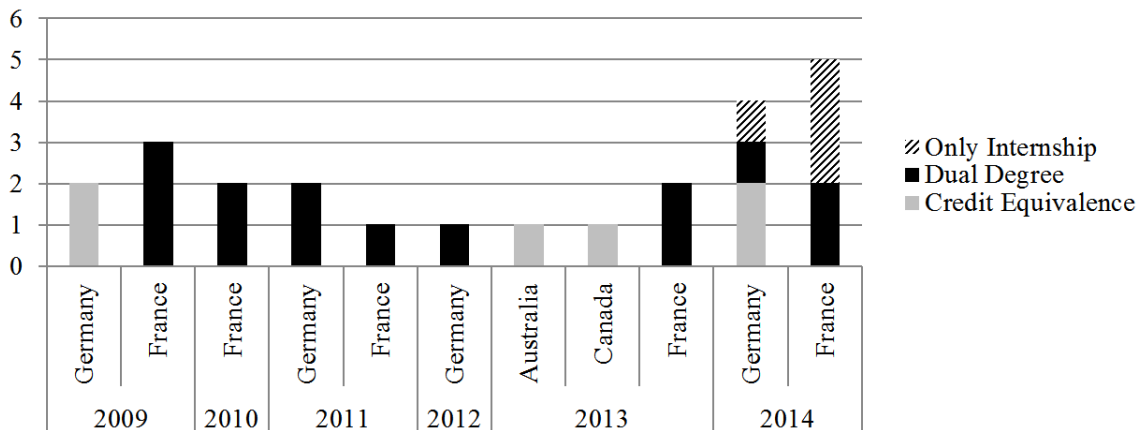


Fig. 5. Interchange modality enrolled by the students that did internship abroad, by country and year

Although Italy receives many students in programs, there is no register of internships done by Mechanical Engineering students in this country.

The internship duration is affected by the country and by the company's scale, as seen in Figure 6, where duration was shorter in Brazil (480 hours average between 2009 and 2014) and longer abroad (850 hours average in Germany and in France).

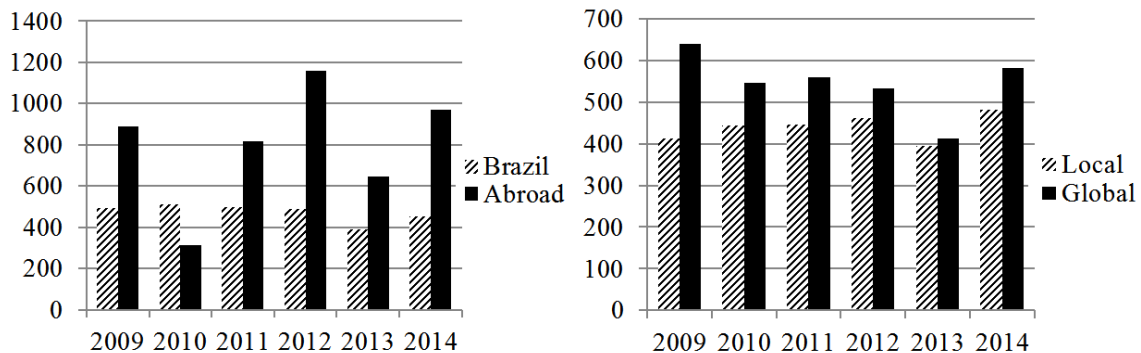


Fig. 6. Internship average duration in hours, according to the country and to the scale of the company

Global companies have also in average longer internships, than local companies, and internship programs in these larger companies tend to be better structured in terms of activities, broadness and career opportunities. Usually a second language is appreciated in global companies, and students who did some programs abroad take advantage of this acquired skill. The quality of the reports submitted at the end of the internship tends to be consistently better when the internship was done abroad, and this represents a maturity of the student which is important both in local and global terms.

3 GOOD PRACTICES OBSERVED IN THE DEPARTMENT AND IN THE EPUSP

GEIP and GEE have had an important role on the Mechanical Engineering programs' format, particularly on goal definitions and in some disciplines adequacies. Parkinson [9] has observed some of the best practices to structure a good interchange program in engineering courses. In Brazil, differently from in the US case, students are more

willing to study a second language, although the language learned is usually English. Since most of the EPUSP programs are in Europe, as seen in Table 1, learning languages like German, French or Italian, is a challenge. In Table 2, some of the practices adopted in EPUSP and particularly in the Mechanical Engineering Department are shown, based on the GEE experience described in the introduction, in the analysis of students' data and in Parkinson's best practices.

Table 2. Good practices in interchange programs and internship in abroad encouragement

Clear goals definition	Taking advantage of any university infrastructure already in place
<p>Some specific goals have to be defined, besides the course or the internship, as for instance, learning about the country culture, and how to behave in a different environment. Brigham Young University [6], suggests: 1) understand issues associated with a global product development environment, 2) understand design strategies associated with concept selection, product architecture, economic modelling, and prototyping and developing manufacturing systems for product development in a global environment, and 3) appreciate the challenges in managing product development issues across different countries, cultures and languages, and understand what tools and processes companies are using to address these challenges.</p>	<p>This seems to be obvious, but to find the synergies inside the institution is not a simple task. Most of times, great part of the organization efforts is concentrated on few people working to involve all needed parts. On a university, the infrastructure includes the possibility of a preparation for students on skills such as economy, language, countries' culture and history, communication and so on. Some good EPUSP examples are the language courses kept by the academic centre like the "Poliglota" and the "CFI", with very low prices and in suitable agendas.</p>
Recruiting students	Program scale and equivalence
<p>Most students are convinced that a study abroad program is a critical element of their education. EPUSP explains the rules of the programs in the beginning of the first year and students get involved in the process which consists of some tests (basically language) and interviews, and also depends on the student performance along the course. The iPoli – a student's initiative (http://www.ipoli.com.br/) – is an international office where current or former students of international programs can exchange experiences and suggest better options for those students who intend to enrol on an abroad program.</p>	<p>This is related both to the number of partnerships and to the number of students. The program, in order to be effective, needs to be interesting to EPUSP and to the partner institution, i.e., there should be a similar number of students going abroad and coming to Brazil. Considering that Portuguese is not a usual language course to students in abroad, it's important to give them some support in this field, as well as to teach German, French or Italian to Brazilian students.</p>
Coordination of the programs on a centralized office	Program evaluation and feedbacks
<p>Although this represents a structure with costs and extra people, there are some advantages, both to the students, who can easily get all information and services they need and to the institution, that can better plan and control all the issues related to the programs. The EPUSP's office is the CRINT (International Relations Commission).</p>	<p>Based on the established goals and on researches with the students and with partner institutions or companies (in case of internships), the centralized office can improve the programs, increasing quality, benefits and effectiveness, and reducing costs and correcting fails.</p>

4 CONCLUSIONS

Although students are increasingly looking for the internationalization of their education, either academically or in their early career on the internship, the participation of the university is, until now, essential in the search for international partnerships, in setting academic goals, in defining the profile of the engineer profession and in the perception of the market on a global scope.

The paths adopted and followed by the Mechanical Engineering students from EPUSP indicate an even higher growth in the number of internships abroad, from 2015 on, since the programs Dual Degree and Credit Equivalence have been consolidated and allowed most students to participate. Because of that, one of the differentiations in the formation of the Mechanical Engineering student could be in the internship phase, allowing, mostly due to the longer duration of abroad internships, the enhancement of technical and personal maturity, besides from knowledge of other cultures and languages.

The good practices observed are a key success factor of this trend, but, depending on the country (culture, language), institution (researches, fields) and students' profile (social class, academic performance, etc.) they have to be adapted to fit local needs.

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Positions and opinions advanced in this paper are those of the author(s) and not necessarily those of EPUSP or the Mechanical Engineering Department.