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## Engineering Course Specially Designed to Face Retention Issue

**C. R. Brito<sup>1</sup>**

President of IEEE Education Society  
President of Science and Education Research Council - COPEC  
São Paulo, BRAZIL  
E-mail: [drbrito@copec.eu](mailto:drbrito@copec.eu)

**M. M. Ciampi**

President of World Council on Systems Engineering and Information Technology  
Secretary of IEEE Education Society  
São Paulo, BRAZIL  
E-mail: [drciampi@copec.eu](mailto:drciampi@copec.eu)

**R. M. Vasconcelos**

Board of Governors of IEEE Education Society  
President of Pedagogical Council of the School of Engineering at University of Minho  
Guimarães, PORTUGAL  
E-mail: [rosa@det.uminho.pt](mailto:rosa@det.uminho.pt)

**L. A. Amaral**

President of Computer Graphics Center - CCG  
Professor of Information Systems Department at University of Minho  
Guimarães, PORTUGAL  
E-mail: [amaral@dsi.uminho.pt](mailto:amaral@dsi.uminho.pt)

**H. D. Santos**

Vice President for Conferences of IEEE Education Society  
Director of Information Systems Department at University of Minho  
Guimarães, PORTUGAL  
E-mail: [hsantos@dsi.uminho.pt](mailto:hsantos@dsi.uminho.pt)

**V. A. Barros**

Executive Secretary of Science and Education Research Council - COPEC  
Researcher of Information Systems Department at University of Minho  
Jataí, BRAZIL  
E-mail: [victor@copec.eu](mailto:victor@copec.eu)

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<sup>1</sup> Claudio da Rocha Brito  
C R Brito  
[drbrito@copec.eu](mailto:drbrito@copec.eu)

## **ABSTRACT**

Many engineering colleges have been facing the retention problem in engineering programs due to difficulties and lack of knowledge about what really means being an engineer. It is mainly due to the fact that the first 3 years are particularly intense and hard. A possible way to overcome this period is to implement a new kind of course more attractive and dynamic, which is the idea of COPEC's engineering education research team, to embed a course with a more interesting activity for students in the first year. It is a short-term workshop in order to show the students the possibilities of performing as engineers in a global environment – a project developed for a private university in order to augment the retention rate in their engineering courses.

Conference Key Areas: Curriculum Development, Attractiveness of Engineering Education.

Keywords: engineering retention, project development, real world work, international skills, innovations.

## **INTRODUCTION**

Fortunately, the rich base of research and practice in engineering education provides clear clues of what is needed, as long as we are willing to step out of the box to tap knowledge and techniques that have previously been on the fringes of practice.

Today, more than ever, a nation's prosperity and security depend on its innovative spirit, technological strength and entrepreneurial skills. To capitalize on opportunities created by scientific discoveries, the nation must have engineers who can invent new products and services, create new industries and jobs, and generate new wealth.

It is also a fact that “under skilled” workers are disappearing, due to automation and low-cost labour markets abroad. Nations worldwide recognize, (particularly in the western part of the globe) that it is urgent to train a larger number of engineers with technical knowledge and soft skills.

In general, engineering programs are full of important core subjects, however it is necessary to innovate and find ways to embed the curricula with important topics to attend the current global trends. Another important fact is that once engineering skills are internationally portable, leading to international mobility that engineering can easily provide and it is, in fact, an increasing trend. Intercultural skills, knowledge of languages and cultural prejudice management are very important because the opportunities are broad less and it is important to be able to adapt to any different cultural environment.

Another fact, which is not new, is that many engineering colleges have been facing the retention issue, due to the difficulties and lack of knowledge about what being an engineer really means. The first 3 years are particularly intense and hard. A possible way to overcome this period is to implement a new kind of course, more enticing and dynamic. This is one of the proposals of COPEC's engineering education research

team: - to embed a course with a more interesting activity for students, sooner, in the first year. It is a short-term workshop in order to show the students the possibilities of performing as engineers in a global environment – a project developed for a private university in order to reduce retention rate among students of engineering courses.

It is a 3 months' period in the second semester of the 1st. year, when the students have different classes, which are more dynamic due to the mix of site visits, lectures, project proposals, travel period and project presentation. It is a very dynamic experience that provides the students a clear view of what it is to be an engineer and what their possibilities for the future are.

The main objective of this project is to provide a sophisticated period to implement integrated environments for teaching/learning systems. It is in fact a way to reduce the evasion of engineering courses, showing a glimpse of what it is to be an engineer and the wide varieties of opportunities worldwide.

## **1. COPEC: SCIENCE AND EDUCATION RESEARCH COUNCIL**

The importance of professional work is observed in the results of projects and actions. In order to accomplish the difficult task of increasing the retention rate of a program the COPEC – Science and Education Research Council has been hired with this objective. COPEC is a multi-disciplinary organization that is a leader on advance science and its application to the development of technology serving society. It started its activities sixteen years ago and, since then, this organization has made a major contribution to the development of science and education, working to increase the best practices in several research fields.

Integration activities, promoted by COPEC, provide qualified coordination and building partnerships, because COPEC is an organization that brings together scientists, who share the mission of promoting and developing science, technology and education.

The objectives of COPEC are to promote professionalism, integrity, competency, and education; foster research, improve practice, and encourage collaboration in different fields of sciences.

Contents, tools and services provided by COPEC, through courses, publications and consultations, with national and international experts, contribute to the promotion of the professional who wants to be privy of new achievements and service of men to technology.

COPEC enjoys respect and recognition internationally characterized by the open discussion, the free exchange of ideas, respectful debate, and a commitment to rigorous inquiry. Its IIE – International Institute of Education – is a bold and resilient source of innovation in higher education [1].

## **2. ENGINEERING EDUCATION TRENDS**

Engineering practice, in our changing world, requires an ever-expanding knowledge base requiring new paradigms for engineering education and research that better link scientific discovery with innovation. The complex challenges that nations worldwide are facing will require engineers with a much higher level of education, particularly in professional skills such as innovation, entrepreneurship, and global engineering practice. So, engineering practice, research, and education must adopt a systemic,

research-based approach to innovation and continuous improvement of engineering education. Working closely with industry and professional societies, higher education should establish graduate professional schools of engineering that would offer practice-based degrees at the post-baccalaureate level as the entry degree into the engineering profession.

Work environment worldwide has changed drastically, and today millions of professionals are also unemployed, even in advanced economies. On the other hand, businesses in economically advanced countries claim that they are often not able to find workers with the required skills. It is a fact that, this is a symptomatic dysfunction due to the structural changes that are transforming the nature of work and reshaping employment opportunities. This shows that organizations and policies are not keeping up with the changes in business practices and new technologies are defining what kind of jobs will be created and where they will be located. So there is a need for companies to redefine how and where different tasks have to be carried out, requiring new skills and new employer and employee relationships [2]. Although it has not been quantified it is clear by the number of jobs that are not filled because of a lack of qualified professionals principally in technological fields.

Generally speaking, the most imperative challenges facing the nation—global competitiveness, health care delivery to an aging population, energy production and distribution, environmental remediation and sustainability, security, communications, and transportation all set complex system challenges that require both, new knowledge and new skills for engineering practice.

Although governments need to invest in the entire system, which builds workforce skills, in some places it is up to private initiatives to offer opportunities for young ambitious talented professionals, who can cooperate for a better future of generations to come. There is no better place than universities to offer these opportunities, pushed by the enterprises. It is important for nations to train highly skilled native-born citizens as well as to attract highly skilled immigrants in order to be competitive in a global scale and assure a future for people [3].

Finally, government agents should be aware of the fact that: if there is no production system, there will be no financial resources to maintain the social assistance system. This idea of an innovative office will help to generate more quality services to improve industry service, as well as the production system, generating opportunities and jobs, which is a need everywhere in the world today [4].

### **3. DEFINING THE PROBLEM – NEW DEMANDS FOR ENGINEERING PROGRAMS**

Engineering is a challenging and dynamic profession, however, it is unknown mainly for young population. Some very bright students are advised to pursue medicine or Engineering. For those who choose engineering however the first three years are not charming and do not show what it is to be an engineer. It does not show the students the very important work that they might accomplish in their lives. How much they will help human beings in daily life and how much engineering is important for the world and especially for the world in which people live today.

It is a perception problem; young people have negative perceptions about engineering and segments of the public at large. These negative perceptions are compounded by the fact that the public has a generally narrow understanding of what engineers actually do.

If some students think engineers are much smarter, creative and imaginative than just being good at math and science, many young people also think that engineers only sit at their desks or computers and have little interpersonal contact in their work.

Besides it is facts that presently in accordance with some reports hiring managers have to look far beyond to find the right candidates to fill open positions in several engineering sectors. One of the main reasons is because many of the responsibilities required for these engineering positions will change by the time employees are even hired.

Based in these facts COPEC team considers that currently requirements for good engineering training emphasize the importance of engineers' skills to:

- Apply knowledge of science, mathematics, and engineering;
- Design and conduct experiments and analyse data;
- Design a system, component, or process to meet desired needs;
- Function on multi-disciplinary teams;
- Identify, formulate, and solve engineering problems;
- Understand professional and ethical responsibility;
- Communicate effectively;
- Understand the impact of engineering solutions in a global/social context;
- Engage in life-long learning;
- Exhibit a knowledge of contemporary issues;
- Use the techniques, skills, and modern engineering tools necessary for engineering practice.

#### **4. THE PROPOSED COURSE**

Many studies about engineering education have suggested that profound transformation is necessary in engineering education to prepare engineers for a rapidly changing world.

So, the proposed course promotes and allows students to get to know what it is to be an engineer. It is a short-term workshop in order to show the students the possibilities of performing as engineers in a global environment with the goal to reduce the retention rate in engineering courses. The idea is to take the chance to work with a course in a civil engineering program that already exists and that is having difficulties to increase the number of students who finishes it.

It is a 3 months' period, during the second semester of the 1st year, when the students have different classes, which are more dynamic, due to the mix of sites visits, lectures, project proposal, travel period and project presentation.

Besides the proposal of a project, which students have to develop, the course includes a short study abroad period, preferably in Europe. It happens between the project proposal and the presentation of it, after the trip, ending in October before the tests period.

The period abroad includes Technical, Academic, Social and Cultural activities, all very important to have a real experience, however brief, and to understand a little about the lifestyle, history and culture of a country elected by COPEC education team.

All activities are performed within two weeks of intense work, generally in September. During this period, student also have lectures, visits to companies, universities, as well as social and cultural activities, which will provide students with a great experience and discover a different world.

It is a very dynamic experience that provides students a clearer view of what it is to be an engineer and what their possibilities for the future are. The students acquire inputs and ideas that instigate their imagination.

The period abroad can be done in more or less days according to the needs of the course proposal for the period. Activities can be altered to fit the availability of organizations and people involved, as well.

## **5. APPROACH**

The course has three phases:

Phase 1 – when the students have lectures of industry, preferably, and are challenged to develop a project proposal in a specific engineering theme.

Phase 2 – when the students go abroad for a short period.

Phase 3 – when the students present their project proposal to a group of invited professionals who evaluate them.

The course has been designed to introduce the world of engineering to the students and also to present them a bit of another culture, touring through several academic and business environments, developing cultural activities, exploring the history, experience local public services, where engineering plays an important role. The proposed course consists of an opportunity to improve the training of engineering students, providing them with an excellent experience, by meeting the practice of engineering in many sectors as well as providing them an experience abroad.

The students are graded and the best project group is invited to have an internship in one of the enterprises of the region, interested in having some of these students for a training period.

## **6. DETAILS OF THE PERIOD ABROAD**

The period abroad includes lectures, visits to companies, universities, as well as social and cultural activities, which will provide students with a great experience and allow them to discover a different world.

The course can be done in more or less days according to the availability of the group of students. Activities can also be altered to fit the goals of the course. It is in fact a very flexible part of the course.

Within the academic activities, students have classes and participate in activities in different universities.

Technical activities include visits to some companies of the visited country. The lecturers are very technical in content in general, being some of them of administration aspects of projects and business generated from them.

Visits to laboratories and research centers are the main activities developed in a framework pre-established in accordance with the objectives of the program. In general, they follow the main theme developed by the students' groups in their project proposal. For example, "the development of sensors for data collection in subway fluxes in rush hours", one of the main themes developed by the groups in the year 2015.

During social activities, students have the opportunity to visit some local meetings with other students in a friendly environment.

Cultural activities provide students with concepts of history and art, as well as the way of life, including guided tours, visit to museums, and other related activities.

All proposed activities take place in a way that students can experience the educational environment, business, culture and lifestyle of the country.

The proposed course consists of an opportunity to improve the training of engineering students, providing them with an excellent experience abroad and to acknowledge the international career that an engineer can develop. Besides the technical knowledge they acquire in site.

The course has the reputation of being demanding, rewarding and intense providing a challenging educational environment by following high quality standards. The course is also developed to provide the participants also some free time to relax and enjoy the city and all it can offer.

Accommodations could not be better; students stay in comfortable hotels with all facilities in downtown areas of cities [5].

September						
2016						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	1 <sup>st</sup> . Day 3
						Evening ✓ Leave for Abroad
2 <sup>nd</sup> . Day 4	3 <sup>rd</sup> . Day 5	4 <sup>th</sup> . Day 6	5 <sup>th</sup> . Day 7	6 <sup>th</sup> . Day 8	7 <sup>th</sup> . Day 9	8 <sup>th</sup> . Day 10
<b>Morning:</b> ✓ Arrival ✓ Trip to main city ✓ Check in Hotel ✓ Rest time, unpack <b>Afternoon:</b> ✓ Walking tour to acknowledge the surroundings of hotel <b>Evening</b> ✓ Dinner with typical food	<b>Morning:</b> ✓ Visit to University ✓ Lunch <b>Afternoon:</b> ✓ Lecture: <b>Evening:</b> ✓ Free	<b>Morning:</b> ✓ Visit to enterprise ✓ Lunch <b>Afternoon:</b> ✓ Lecture: <b>Evening:</b> ✓ Free	<b>Morning:</b> ✓ Trip to city 1 ✓ Visit to University ✓ Lunch <b>Afternoon:</b> ✓ Lecture: ✓ Ride back to main city <b>Evening:</b> ✓ Free	<b>Morning:</b> ✓ Trip to city 2 ✓ Cultural walk ✓ Lunch <b>Afternoon:</b> ✓ Lecture: <b>Evening:</b> ✓ Trip back to main city	<b>Morning:</b> ✓ Cultural Trip ✓ Lunch <b>Afternoon:</b> ✓ Visit to Churches ✓ Visit to small business <b>Evening:</b> ✓ Trip back to main city	<b>Morning:</b> ✓ Lecture: ✓ Lunch <b>Afternoon:</b> ✓ City Tour in city 4 ✓ Trip back to main city <b>Evening:</b> ✓ Free
9 <sup>th</sup> . Day 11	10 <sup>th</sup> . Day 12	13	14	15	16	17
<b>Morning:</b> ✓ Free <b>Afternoon:</b> ✓ Free <b>Evening:</b>	<b>Morning:</b> ✓ Leave to Airport ✓ Get into airplane					

Fig. 1. Schedule for 2016/2017

## 7. COURSE SPECIFIC OBJECTIVES, GOALS AND EXPECTED RESULTS

The primary goal of the course is to foster curiosity and passion for the engineering profession. To provide engineering students an opportunity to experience different environments in the chosen profession.

Furthermore, the course aims to:

- Improve the academic and leadership skills;
- Living in different cultures;
- Strengthen their career goals;
- Search;
- Travel;
- Global experience;
- View new opportunities;
- Enrichment of life [6].

The project goals are:

- Providing an international academic experience;
- Make the students feel what it is to be an engineer;
- Assist in the development of critical analysis;
- Provide the overall experience.

The expected outcomes of the extra academic classes are:

- Dynamism for undergraduate careers;
- Long-term friendships;
- Technical skills and knowledge;
- Experience different cultures and histories;
- Enrichment of life;
- Valuing the profession [7].

## 8. PARTIAL RESULTS OF THE COURSE

2016 is the third year of this 1st year effort program and the results are as follows:

*Table 1. 1<sup>st</sup> year effort program and the results*

<b>YEAR</b>	<b>1<sup>st</sup>. year students number enrollment in Engineering</b>	<b>*students number enrollment in the special course</b>	<b>% of enrollment rate</b>
<b>2014</b>	213	68 students	31.92%
<b>2015</b>	225	77 students	34.22%
<b>2016</b>	236	95 students	40.25%

The College conducted a survey among the students participating in this program and the results are as follows:

*Table 2. Survey among the students participating in the Program (2014-2016)*

<b>Questions</b>	<b>2014</b>	<b>2015</b>	<b>2016</b>
<b>Satisfaction with knowledge acquisition</b>	56%	64%	72%
<b>Satisfaction with international experience</b>	62%	68%	69%



<b>Satisfaction with acquired skills</b>	<b>65%</b>	<b>79%</b>	<b>81%</b>
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For the year 2017 (by the presentation of this work) the proposal is to have a complete chart with statistics about the retention rates acquired with this program so far. The decision relies in the fact that it is necessary at least three years of program to have significant data.

## 9. CONCLUSION

At such a technological singularity, the paradigms shift, the old models must be discarded, and a new reality appears, perhaps beyond our comprehension. It is clear that, along history, universities have become international organizations, not only receiving students from all parts of the world, but also through international research partnerships and providing students opportunities. No doubt that this role has become imperative for countries in order to keep up with the challenging and global educational and research environment. Best universities attract the best students and best students make the university better.

The enhancement and promotion of students' quality training, as well as employability, brings financial resources, increases teacher's quality and promotes regional development, along with the future professional, no matter the field, but mainly in engineering. It is necessary to adopt a systemic, research-based approach to innovation and continuous improvement in engineering education, recognizing the importance of diverse approaches.

And so, this course, in particular, promotes engineering courses, trying to overcome the retention issue, providing the students a glimpse of what it is to be an engineer and increases their possibilities of finishing the program and also developing an international career besides its contribution for the betterment of human kind.

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## REFERENCES

- [1] "COPEC," *Science and Education Research Council*, 2017. [Online]. Available: [www.copec.eu](http://www.copec.eu).
- [2] T. Heick, "10 Characteristics of a Highly Effective Learning Environment," *Teachthought*, Jun-2014. [Online]. Available: <http://www.teachthought.com/learning/10-characteristics-of-a-highly-effective-learning-environment/>.
- [3] A. Smith, "U.S. Views of Technology and the Future," *Pew Research Center*, 2014. [Online]. Available: <http://www.pewinternet.org/2014/04/17/us-views-of-technology-and-the-future/>.
- [4] M. Ciampi, C. Brito, R. M. Vasconcelos, L. A. Amaral, and V. Barros, "Science, Engineering, and Technology Innovation for Global Human Challenges," in *2016 ASEE Annual Conference & Exposition Proceedings*, 2016.

- [5] C. da R. Brito, M. M. Ciampi, V. F. A. Barros, L. A. M. Amaral, and R. Vasconcelos, "Engineering the engineering program: The year of discovery," in *2016 IEEE Frontiers in Education Conference (FIE)*, 2016, pp. 1–4.
- [6] M. M. Ciampi, C. da R. Brito, R. M. Vasconcelos, L. A. M. Amaral, and V. F. A. Barros, "Shift For Engineering Horizons," in *44th SEFI Annual Conference*, 2016, no. September.
- [7] M. M. Ciampi, C. da R. Brito, L. A. M. Amaral, R. Vasconcelos, and V. F. A. Barros, "Engineering Challenging Entrepreneurship Practice," in *Interactive Collaborative Learning: Proceedings of the 19th ICL Conference - Volume 2*, M. E. Auer, D. Guralnick, and J. Uhomoibhi, Eds. Cham: Springer International Publishing, 2017, pp. 444–452.