

# COLLABORATION BETWEEN BORDEAUX-INP AND UTP, FROM RESEARCH TO EDUCATION, IN THE FIELD OF SIGNAL PROCESSING

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## ABSTRACT

The purpose of this paper is to share our positive experience about the collaboration launched a few years ago between UTP (Panama) and Bordeaux INP (France) in the field of signal processing. This collaboration involves research and education activities. This has led to numerous internships of French students in Panama, mobilities of researchers, common research papers, and the 1<sup>st</sup> double diploma signed between France and a country of Central America. Thus, this paper presents the various aspects of the collaboration.

**Index Terms—** double diploma, research, internships

## 1. INTRODUCTION

Nowadays, there are millions of mobile students. Indeed, on the one hand, the students are willing to broaden their horizons by discovering new countries as well as new cultures and by establishing lasting friendships with people based in many different countries. Studying abroad makes it possible to gain independence and challenge students to really develop as individuals. Spending a few months abroad is also a chance to develop language skills and to analyze problems differently. On the other hand, universities aim at becoming more and more attractive in order to attract the best students by presenting the relevance of their programs, their strong links with companies and research centers and alumnis, their labels of quality, the opportunities the students can have in terms of associations and clubs for humanitarian, cultural, sports, science and technical activities, etc. The main forms of internationalization are based on international student recruitment, joint degrees, scholarships or mobility programs. In this paper, we focus our attention on the collaboration between two institutions:

**1. UTP at a glance:** UTP is a public institution whose main campus is located in Panama City, Republic of Panama. Also known as "La Tecnológica", UTP has a national presence in seven regional centers in seven provinces, counting

more than 23,000 students in 2017. UTP has six schools in different domains including civil, electric, mechanic, industrial, computer systems and food engineering, offering undergraduate and graduate programs. In addition, it has six research centers: the experimental engineering center (CEI), the research center and hydro (CIHH), the agro-industrial production research center (CEPIA), the development and innovation research center in information technologies and communications (CIDITIC), the research center for electrical, mechanical and industrial innovation (CINEMI) and the center for innovation and technology (CITT). UTP is the national leader in research in the field of engineering. It is the center of reference and expertise in technology. Finally, UTP is directing a large part of its efforts towards development of scientific research, which represents a potential to meet the needs of the Panamanian society.

**2. Bordeaux INP and ENSEIRB-MATMECA at a glance:** Created in 2009, Bordeaux INP groups together five internal schools and three partner schools. These eight public engineering graduate schools count 3,400 students and offer nineteen engineering specializations including five through apprenticeship programmes in various fields: cognitics, biology, food sciences, chemistry, physics, geological resources, environment, electronics, computer science, telecommunications, mathematics, mechanics and biotechnologies. The programmes are supported by 11 joint research laboratories, with University of Bordeaux, Bordeaux Montaigne University, Arts et Métiers Paris Tech, INRA and CNRS. Bordeaux INP also provides a wide range of mobility opportunities for international students: exchange or dual degree programmes, individual enrollments (not through an exchange programme), master of Science, summer Schools and research projects.

Among these graduate schools of engineering, ENSEIRB-MATMECA was created 90 years ago. It is focused on electronics, computer science, mathematics and mechanics and telecommunications. The diploma of engineering delivered at ENSEIRB-MATMECA corresponds to five years of higher education. Students are admitted to school following two years of preparation in higher education, through the selective national exams for the French grandes écoles. The three years from BAC+3 to BAC+5 are designed to train top-level

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engineers. There are 1200 students and 350 diplomas of Engineering awarded each year. The teaching team aims at continuously updating the courses to reflect the rapid changes in the technological fields and has experimented with new teaching methods for the last years: active learning as well as active and cooperative learning (ACL) methods [3] which include massive open on-line courses (MOOCs), flipped classrooms and project-based pedagogy. Previous contributions consisted of a telecom show case [9] and small-group learning projects with industrial partners, namely *ORANGE*, *THALES* and *BULL-ATOS*. See [6] [7].

In this communication, various aspects of the collaboration between both institutions are presented. It is based on research and teaching activities.

The remainder of this paper is organized as follows. In section 2, the collaboration is presented in details. Conclusions and perspectives are then given.

## 2. VARIOUS ASPECTS OF THE COLLABORATION

The collaboration covers several aspects: research activities, education through the first double diploma signed between France and a country in Central America and student mobilities. In the following, details about each aspect are given.

### 2.1. Research activities including researcher mobilities

On the one hand, for a few years, *UTP* and the National Secretariat of Science, Technology and Innovation (SENACYT) of Panama have carried out a strategic plan to increase the number of specialists and researchers in several selected fields of sciences and technology according to the needs and projections of the country. For this reason, several *UTP* students were awarded with scholarships in order to prepare a PhD in well-recognized higher education institutions worldwide (*i.e.* Europe, America and Asia).

On the other, the French colleagues in Bordeaux developed various international collaborations with different institutions in the field of signal and image processing : University of Bologna, University of Coma, University of Lebanon, Al Quds University, etc.

In this context, 15 years ago, two candidates, one after the other, studied at *ENSEIRB-MATMECA* and at University of Bordeaux to obtain a master degree and then to prepare a PhD in signal and image processing. During this period, they were trained and became familiar with most research aspects: they participated in research projects, attended international conferences, wrote journal articles, among other activities. In addition, they were given the opportunity to give lectures at school. As part of the scholarship agreement, after their PhDs, they were asked to come back to Panama and to work in their field of expertise for a period of time. Then, they applied and were selected for positions of assistant professors at *UTP*. Since then, the French and the Panamanian have kept on working together. During the last 7 years, this led to various

stays of the French in Panama and conversely. During these visits, several aspects were addressed:

- Presentations of research activities each partner conducts with other people were scheduled.
- Common research activities were conducted leading to publications in international conferences.
- Pedagogical innovations were presented.
- Meetings with the French Embassy, SENACYT, the French alliance<sup>1</sup> in Panama, the heads of the academic institutions were done to exchange both on research and education.

### 2.2. Double diploma

#### 2.2.1. Preparing and promoting the double degree

With the help of IFAC<sup>2</sup>, a double degree agreement between *UTP* and Bordeaux INP was prepared. It was the 1<sup>st</sup> double diploma signed between France and a country of Central America. For this reason, an event was organized at *UTP* on December the 11<sup>th</sup> 2017 in the presence of the French ambassador, the head of the international office at *Bordeaux INP* and the head of *UTP*. See Fig. 1.



**Fig. 1.** Ceremony for the double degree agreement between *UTP* and Bordeaux INP (Photo courtesy of *UTP*).

It should be noted that this type of collaboration combining research and education is now promoted during workshops, organized by IFAC, with the French embassies of the countries in Central America (*i.e.* seven countries: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama). This was the case in Costa Rica on September the 26 – 27<sup>th</sup> 2016 and in Guatemala on March the 13<sup>rd</sup> and the 14<sup>th</sup> 2018.

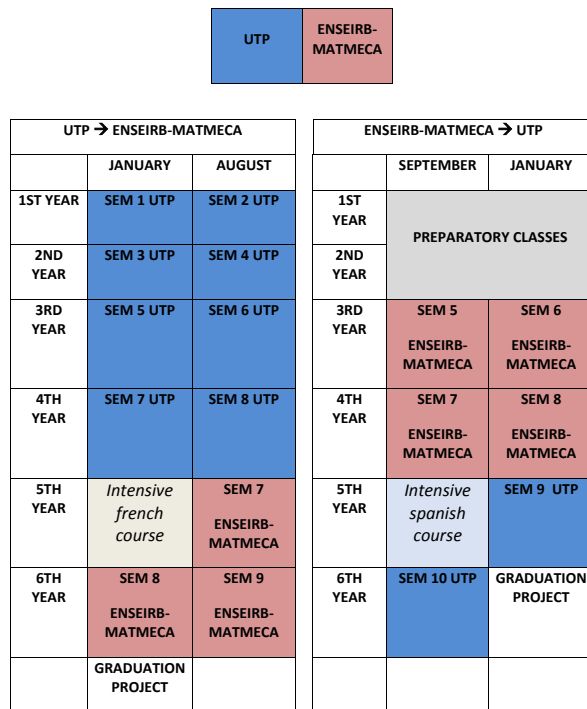
#### 2.2.2. Some details about the double diploma

This double degree program was based on the study of architectures of programs of this type between European and South American institutions presented in [19]. We also

<sup>1</sup>It is a Non Governmental Organization promoting the French culture and the French language and the diffusion.

<sup>2</sup>The French Institute of Central America (IFAC), based in San José, Costa Rica, is a structure of the French Ministry of Foreign Affairs and International Development (MAEDI) which promotes, drives and co-finances cooperation actions.

looked at previous programs existing between universities in France and universities of Colombia and agreements between *ENSEIRB-MATMECA* and some universities in Brazil, specifically for careers in engineering.



**Fig. 2.** Path for students following the double degree program. Both directions are presented.

The double diploma concerns the Bachelor's degree in Electronics and Telecommunications Engineering of the *UTP* and the Diploma of Engineer in Telecommunications or Electronics at the *ENSEIRB-MATMECA* [16]:

- The Bachelor's degree in Electronics and Telecommunications Engineering of the *UTP* has a program of studies that includes 10 semesters of courses and a graduation work. This program corresponds to a generalist training in telecommunications and electronics, covering aspects of analogical and digital electronics, networks, communications, antennas and signal processing.
- At the *ENSEIRB-MATMECA*, and more particularly in the departments of telecommunications and electronics, the students spend three years. The last semester corresponds to the final project of study to be done in companies or research laboratories. The curriculum in the Telecommunications department incorporates lectures in management, language and human communication and courses in three pillars: signal and

image processing including digital communications, computer and telecommunications networking, and computer science. It covers various aspects of the telecommunication systems together with the background necessary to understand them. Concerning the Electronics department, the pillars are analog and digital electronics, control and signal and processing.

The organization of the double degree is given in Fig. 2.

## 2.3. Student mobilities

### 2.3.1. Mobilities of the Panamanian students

Mobilities for Panamanian students are not mandatory. In addition, by now, only one internship lasting 6 months at the end of the curriculum is required. Students from *UTP* usually apply for financial support or scholarship programs to spend one to four years in France in order to prepare a MSc and a PhD. Therefore, there is currently one student who prepares a MSc in order to start a PhD degree in Bordeaux. Next year, another student will follow studies at the *ENSEIRB-MATMECA* in the framework of double degree program in telecommunications and electronics. She currently improves her skills in French.

### 2.3.2. Mobilities of the French students

#### General description

The policy run at the *ENSEIRB-MATMECA* is to ask the students to spend at least 3 months abroad. Therefore, since 2012, a presentation of the *UTP* has been organized at the *ENSEIRB-MATMECA* every year, usually with colleagues from Panama, most of the time, by using a video-conference. It is true that the French students are willing to discover countries like Canada, the United states or Japan. By now, the students mainly go abroad for an internship. However, more and more are willing to spend one semester in a foreign country or to prepare a double diploma. The collaboration with *UTP* covers now all these aspects. In this section, let us focus our attention on the organization we have for the internships of the French students at *UTP*.

Panama has become attractive for the following reasons:

- Subjects for internships are proposed every year. They are in accordance with the skills the students can have in the field of signal and image processing and mobile communication systems. In addition, some subjects are written by both the French and Panamanian partners.
- Some of their supervisors can speak French and know their curricula well. They also help the students find housing, etc.
- The students can submit a form to "aquiMob" (<http://www.aquimob.fr/>), which is a program providing financial assistance for an international mobility.
- Panama is a beautiful place. The students can organize nice visits on Saturdays and on Sundays.

- Year after year, the students communicate on their own experiences. As they enjoyed their stays in Panama, word of mouth is usually positive.

The selection of the students is based on the motivation in terms of professional project and adequacy between the desired profile for the internship and the skills of the candidate. After a few weeks in Panama, the students are welcome to the French Embassy. It is another way to inform the French authorities about our common activities and to look for new opportunities or projects. Finally, in August, before the end of the internship, a "Technological French Day" is organized at *UTP*. During this event, the French students present the topics they address and the results they obtain. There is also an overall view of the collaboration between *ENSEIRB-MATMECA* and *UTP*.

Since 2012, there have been 28 French students (4 to 5 each year) at the *UTP* from June to September. Since 2015, some other Panamanian colleagues have received French interns.

### Examples

The subjects of the internships are mainly in the field of signal and image processing and its applications. The topics deal with ongoing research projects and collaborations with research institutions in Panama and universities of other countries (Italy, Finland, etc.). In addition, they can involve industries. Finally, some of them led to publications in journals and conferences. In the following, some examples are given:

- *Identification of noisy autoregressive moving average (ARMA) processes using Error-in-variables (EIV) [1].* Estimating model parameters plays a key role in signal processing. Various works [11], [13], [21] were done on noisy for AR processes, especially by the French team with colleagues from University of Bologna, when the data are disturbed by an additive measurement noise [2], [5], [10], [18]. Then, they extended to moving average processes [20] This internship serves as a starting point of a scientific collaboration between *UTP*, *ENSEIRB-MATMECA* and University of Bologna, to address the extension of the EIV approach to noisy ARMA process identification. The preliminary results obtained during the internship were promising and led the partners to work together during a few months to propose a global algorithm. This led to a conference article [4]. Since then, the three colleagues work together and submit each year common research activities [8], [15].
- *Manatee vocalization modeling, representation, classification and clustering: application on population monitoring.* *UTP* has a collaboration with the Smithsonian Tropical Research Institute in the development of a scheme for the monitoring of manatee population by the analysis of underwater vocalizations produced by

this species. This scheme is the base of a nationwide program for the management and the protection of this vulnerable species. Three students have participated in this project. AR modeling, signal classification based on divergences, principal component analysis (PCA) for dimensionality reduction and representation, and clustering and data visualization algorithms are among the topics they addressed during their internships. Once again, these works served as a preliminary step. Since then, advanced approaches have been developed and a paper has been submitted [14].

- *Analysis of mass spectrometry data for insects identification.* *UTP* has a collaboration with the INDICASAT-AIP, a research laboratory in the field of biomedicine and biodiversity. This collaboration deals with the identification of field-collected insect species that transmit infectious diseases, such as mosquitos and ticks. It is based on the use of mass-spectrometry data obtained from the analysis of the insect tissue using matrix-assisted laser desorption/ionization (MALDI) equipment. Three French students worked on topics related to this project. More particularly, they had to work on the implementation of data reduction and data classification methods such as linear discriminant analysis and support vector machines. This led to the preparation of a journal paper submitted to Malaria Journal [12].
- *Implementation of a prototype for interference characterization.* Based on a collaboration with Aalto University (Finland) and Ericsson Finland, this project aimed at developing a configurable, open-source, open-hardware prototype. This device can receive and analyze radio frequency signals in tunable frequency carriers, different time slots, and with different bandwidths. It was designed and implemented using a software defined radio card and a reduced board computer [17]. A French intern was involved in the development of functionalities concerning the analysis of the receiver (*i.e.* power spectrum density estimation, cumulative density function and signal-to-noise ratio) and the implementation of cron job and data transfer functions. The implementation included that the functionalities were shown in a web-based interface.

### 3. CONCLUSIONS AND PERSPECTIVES

Our goal was to create a win-win relationship. The collaboration now covers several aspects from research to education activities. In addition, students are a breeding ground for the collaboration. As there are various funding streams available under Erasmus+, the next step of our collaboration is to prepare a mobility project for higher education students and staff. The latter will open to other topics such as applied geophysics and mechanics because there are both French and Panamanian colleagues who have common interest in these fields.

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