

Promoting Vocation for Communication and Electronic Engineering

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Abstract — *In this work, the authors present the evolution of enrollment in Communication and Electronic Engineering studies in the Escuela Técnica Superior de Ingenieros de Telecomunicación (ETSIT) of the Universidad Politécnica de Valencia (Spain). The different reasons that have led to an important decrease in vocations for Information and Communication Technologies (ICT) are stated, and the actions that the ETSIT has taken to try to solve the situation are described. The work does not pretend to be a best practice manual, neither a solution for every scenario but it shows a set of actions in different fields that alleviate the problem.*

Index Terms — *comprehensive training offer, quality of teaching, promoting students mobility, recruitment of students.*

INTRODUCTION

The Escuela Técnica Superior de Ingenieros de Telecomunicación (ETSIT) was founded in 1991. It was the fourth University School where to study Communication and Electronic Engineering in Spain. In that moment, these studies had a high demand and that forced to be very selective with the candidates acceding the school. This led to have students with a very high profile. Unfortunately, now the situation has changed and the demand has decreased due to the following reasons. Currently, there are over 60 Schools in Spain where this kind of studies can be followed. Moreover, the students perceive that the curricula are very demanding and they do not have a short term reward, since in Spain the number of technology companies is not enough to absorb the graduates from the University and some of them have to look for a job abroad. To adapt to this new situation the ETSIT has tackled a number of actions in different areas:

- Actions to promote e-skills and the usage of information and communication technologies between teachers of primary and secondary schools: the ETSIT is located in an area of Valencia with a large amount of primary and secondary schools. Some of the teachers of these schools have found that their skills on ICT are very limited; in order to help them to overcome this situation, the ETSIT is undertaken some courses of ICT for teachers.
- Actions for the recruitment of students in the local environment: over 30 information conferences about the school have been done in the high-schools in an area of 200 Km around Valencia City. Moreover, the students of the high-schools of the region have visited the School during the “Open doors” days.
- Actions for professional orientation towards ICT: the Regional Government of Valencia has a program of professional orientation for students of secondary school. The ETSIT has promoted the inclusion of technology research institutions belonging to the University in this program.
- Implementation of a comprehensive training offer: engineering degree, professional master, and research master.
- Easing the inclusion in the university: first coursed students are tutoring by a final coursed student and a professor. The tutors help them to manage the tasks related with their new studies.
- Improving the quality of teaching by insisting on training transversal skills of the students [1]: special groups adapted to new teaching and learning methodologies, development of online materials for teaching and evaluating, adaptation of the infrastructures to new teaching methodologies, multidisciplinary innovation projects (e.g. the Theremin Project where students learn the operation of a theremin, teach others what they have learned and promote the knowledge with talks and concerts), improvement of the capabilities in foreign languages for the Spanish students and the capabilities in Spanish for foreign students, and more.
- Actions for promoting students mobility: the School has signed double degree agreement for the degree with the French Grandes Écoles (ENSEA, Supélec, Brest UFR Sciences et Techniques), German Universities (Stuttgart, Darmstadt), and Italian Universities (Torino).

ACTIONS TO PROMOTE E-SKILLS AND THE USAGE OF INFORMATION AND COMMUNICATION TECHNOLOGIES BETWEEN TEACHERS OF PRIMARY AND SECONDARY SCHOOLS

The ETSIT is located in an area of Valencia with a large amount of primary and secondary schools. Some of the teachers of these schools have found that their skills on ICT are very limited; in order to help them to overcome this situation, the ETSIT is undertaken some courses of ICT for teachers. The initiative is linked to another one: in the University there is a program for retired people, this program offers several subjects and syllabus, one of them is Internet for seniors. The professors of Internet for seniors were interested in adapting the contents of the course to the needs of teachers of primary schools. The course was developed in February and March of 2010, its duration was of 12,5 hours. In the course the following items were tackled: usage of internet resources of information (explorers, searchers, Wikipedia, multimedia repositories), usage of internet for communication (email, chat, blogs, videoconference), usage of internet for social networking, data protection and security in the internet, and e-administration. A very limited amount of teachers attended the course since it was just a pilot experience and the ETSIT did not published it, nevertheless the colleagues of the participants asked to enroll also in the course. In October 2010 the course will be repeated and offered to teachers of primary and secondary schools. The course in October will also include collaborative learning through internet, tutoring and evaluating, creation of professor web page and usage of smart boards.

ACTIONS FOR THE RECRUITMENT OF STUDENTS IN THE LOCAL ENVIRONMENT

The ETSIT is a small school in a public University, with around 1200 students in all the courses and degrees. Moreover the enrollment of new students has been decreased during the last years, as it is shown in Figure 1. The students mainly came from Valencia City and its region, as shown in Figure 2 and they choose to study in the ETSIT mainly for the prestige of the School and their own academic preferences, as shown in Figure 3.

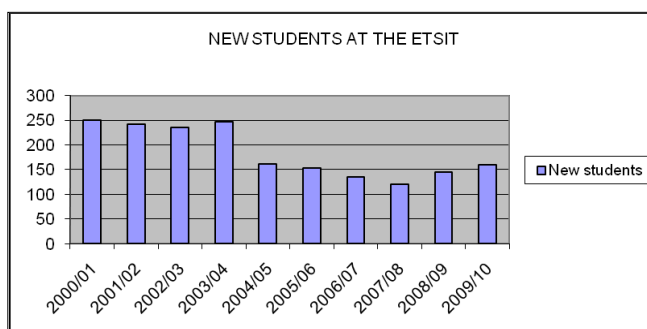


FIGURE 1
ENROLLMENT IN THE MASTER ENGINEERING OF TELECOMMUNICATIONS AT THE ETSIT

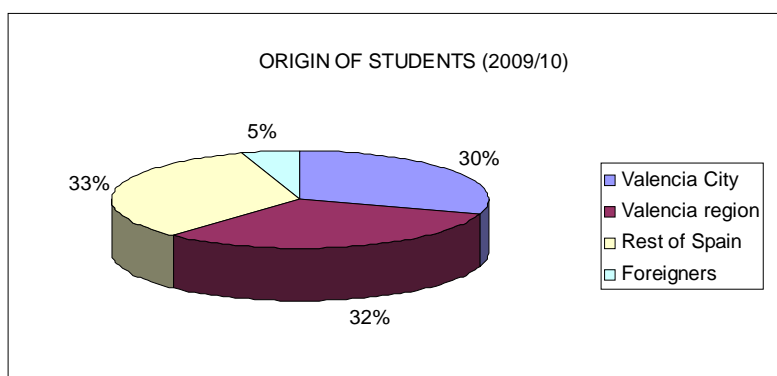


FIGURE 2
ORIGIN OF THE STUDENTS

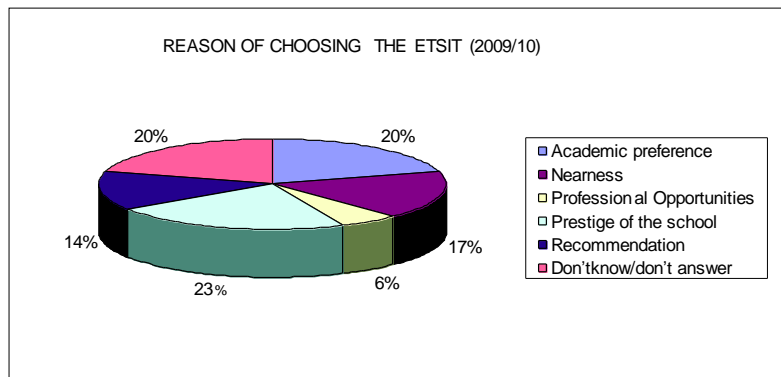


FIGURE 3
REASONS FOR CHOOSING THE SCHOOL

The ETSIT wants to increase the number of vocations in ICT sector, this is crucial for several reasons: a larger amount of new students enables to be more selective in the admission process, thus increasing the overall quality and maintaining the prestige of the institution, a key factor for future enrollment; moreover, the resources from the University and the diversification in the teaching offer are linked to the number of students. In order to get this increase, several actions at the local and global environment are being taken. The ETSIT has carried out many activities tied to the promotion of the studies of Telecommunication among the students of Baccalaureate.

- We have organized visits to high-schools to promote the studies of Telecommunication. Professors from the School have performed over 30 conferences in high-schools in an area of 200 Km. around Valencia City. This action began in 2007, the worst year for enrollment, and from then the number of newcomers have slowly increased.
- The ETSIT participates in the *Week of the Science* of the University, which is held in November each year, this is a special event that aims to promote science vocation among secondary school students [2].
- The ETSIT participated in the *I Encuentro TICnología* for students of secondary education [3]: this event was held on 01/20/2010 and was organized by the University Schools and professional organizations of the ICT sector in Valencia region. The aim of this event was to promote the new University Degrees related to the ICT. The event was attended by 500 student selected from different secondary schools of the region.
- The ETSIT has coordinated the *Open Days* (JPA) [4] for high-schools students and parents. During these Open Days several conferences about the new Degrees are given to the high-school students and parents and they also have the possibility to visit the ETSIT premises joined by a University student.
- ETSIT has taken part in the *Days of Orientation* for students of high-schools, this event is annually organized by all the Universities of Valencia [5].
- A new initiative consisting in taking part in the *Experimental Program of Professional Orientation* [6] of the Valencia Regional Government has started this year. In this initiative the students of secondary school will know the research and development institutes of the *Ciudad Politécnica de la Innovación*, the technological park of the University.
- Some promotional material of the School has been elaborated: folders and brochures, a video and some on-line multimedia material.

ACTIONS FOR PROFESSIONAL ORIENTATION TOWARDS ICT

The regional government of Valencia has a program for professional orientation; this program is addressed to students of secondary school. The name of the program is “QuieroSer” [6] what means *I want to become* and its main aim is to clarify the professional future of the students. The ETSIT contacted with the coordinator of the program and proposed him to include the research institutes related to Information and Communication Technologies of the UPV in the program as professional centers that the students can visit. The reason for doing this is that the ETSIT has strong links to the ICT institutes of the UPV, since its creation the ETSIT has acted as a seedbed of technology in the region and many of the ICT institutes of the UPV were created by professors of the ETSIT and employ now some undergraduates and graduates from the ETSIT working in research, development and innovation projects. The visits to ICT institutes were included in the program as a pilot experience which has involved three secondary schools and five ICT institutes. The research in the ICT institutes is focused in multimedia, electronics, mobile communications, antennas, microwave communications, photonics, nanotechnology, space and satellite communications, health caring technologies, signal processing, robotics, industrial computing, artificial intelligence, computing parallelization, artificial vision, communication networks and more. They do research, development, design and manufacture in some cases, and more than seven spin-off companies were created by their members. In the UPV the research institutes are located in a technological park, the CPI, Polytechnic City of the Innovation. The visits were performed in April and May of 2010. In the same event the

secondary-school students had the opportunity to attend to a talk which explained the premises, mission and projection of the CPI, after this they visited the five research institutes, where they talked to the researchers, had the possibility to see real experiments or manufacturing processes and could entered in a anechoic chamber or in a clean room for satellite components. A total of 115 students and 5 professors of the three secondary schools attended the visits and the opinions were so satisfactory that the professional orientation program will include the visits to ICT research centers for the course 2010-11.

IMPLEMENTATION OF A COMPREHENSIVE TRAINING OFFER

To understand the critical situation that the studies in Telecommunication Engineering are suffering in Spain during the last seven years, it is interesting to have a look to the national Information and Communication Technology (ICT) sector. The report [7] from the Spanish Society of ICT companies states that the ICT sector in Spain is mainly composed by small and medium sized companies (SME). More than 93 % of them are micro companies, many of them without employees, and 5,27 % are small companies, in this way the jobs in the sector are mainly supported by very small companies (e.g. in the case of the Communications subsector this happens in over 40 % of the cases). From a professional point of view, the size of the companies is conditioning the professional development of the employees. Currently there is an overflow of high profile engineers in the ICT sector in the Spanish job market. From the decade of 1990 the number of Schools that offered ICT studies has exponentially increased, from just over 15 at the beginning of 90s to over 60 in the last year. This has led to a high increase of the number of graduates: for the Master Engineering (what in Spain used to be named Engineering) during the first five years of 2000, 40.212 Master Engineers, facing the 35.837 Master Engineers graduated from 1995 to 2000, and 19.263 from 1990 to 1995. In this same period, the graduated in the Degree Engineering (what in Spain used to be named Technical Engineering) were 46.247, 35.919 and 17.401 respectively. In SMEs of the ICT sector, the Master Engineers are around 15 % of the staff, the graduated Engineers around 55 %, and the graduated in non university technical schools around 30 % [7].

Companies in Spain are demanding engineers with lower profiles but very specialized in a given field, even they are employing high amounts of graduates from technical schools without university formation. The offer of jobs for Master Engineers is easily covered by the graduates from the university, and many of them have to apply for low profile jobs in the same conditions than Engineers and technical professionals. In conclusion there is far much offer of good professionals than of good jobs. In this way some Master Engineers are employed at the end in low profile jobs, nevertheless their progress in the companies [7] is higher than the progression of lower profile employees, and they use to reach responsibility positions in the companies as team managers o project managers. Some of them also prefer to look for a better job abroad [8], Spain has recently become a country that exports high profile professionals in ICT. In some cases they decide to continue their studies to get a PhD, expecting that a higher qualification will provide better employability. Unfortunately the perception for the newcomers is that the short term reward for a very demanding study is very poor and Master Engineering is losing its attractiveness for new students. Nevertheless ICT sector is crucial for the economy of a country, it is the sector where research, development and innovation have increased more during the past 20 years [8]. The forecast is that this tendency will be maintained even increased in the following 10 years [7]. A country that proposes to follow the innovation path in its economy will need to have high profile professionals in the ICT sector. The study for the employment forecast in the European Union, in Figure 4, shows that the tendency is that the demand for high qualification professionals will increase, while the demand for medium profiles will be maintained and the low qualification will be reduced.

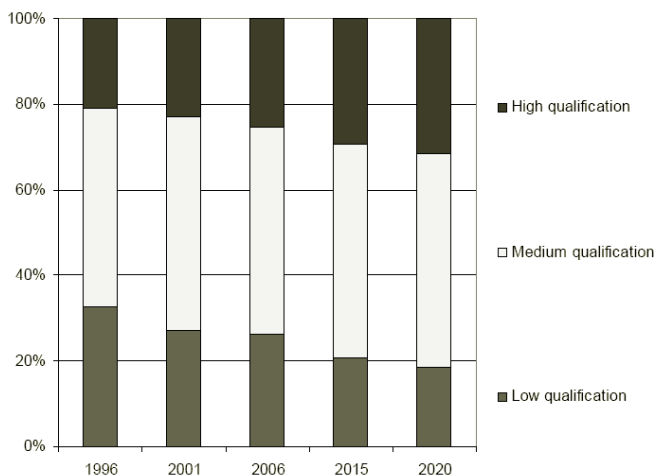


FIGURE 4
PAST AND FORECAST FOR DISTRIBUTION OF QUALIFICATION IN THE EMPLOYMENT FOR THE EU (SOURCE CEDEFOP [9])

In this changing scenario seems urgent to take actions to increase vocations for the ICT sector in new students. To the date the ETSIT had just offered a Master Degree for Telecommunication Engineering and a Master of Science degree for Doctorate studies in telecommunication. The demand for the Master Degree has changed from 250 new students accepted after a selection process during the 90s and first years of 2000, to a minimum of 120 students in 2007 (see Figure 1), the numbers in recent years have slightly increased. The demand for the Master of Science has also changed, from 10 or 15 students in the 90s, to over 50 in the last year. The Bologna Agreement [10], which aims create a framework for a common European Higher Education System and the educative reform that the Spanish Government has undertaken to fit that European System have enabled the path. The ETSIT is implementing a comprehensive training offer: an Engineering Degree of Telecommunications with high specialization in communication systems, electronic systems, telematics and image and sound systems. Moreover the Master Engineering Degree and the Master of Science will be maintained but adapted to the new European Higher Education System.

EASING THE INCLUSION IN THE UNIVERSITY

From the creation of the ETSIT until seven years ago, the demand of the studies was so high that the School only accepted candidates with high scores in the secondary education. The traditional training system based mainly on non interactive theoretical lessons given in crowd classes where attendance was voluntary, a demanding final exam and no supervision from the professors did not mean a big problem for these students: the desertion rates were behind 10 % and the satisfaction rates were over 85 % at the end of the studies. Nevertheless from then to now the situation has dramatically changed, since the demand of the studies have decreased so much, no selection in candidates is made, in this way high profile students jointly with low profile are mixed in the same classes. The traditional training system did not work anymore and the failure rates, desertion and dissatisfaction rapidly increased. When the problem was detected, some actions were taken. Four years ago, a program for improving the skills in mathematics and physics for first year students began. The program consisted in two additional courses for completing the skills in mathematics and physics that the new students would need. The courses were given during the first term of the first year. Before the course began the student had the possibility to make an exam, if the score of the exam was over 7 points (the Spanish system for scores is from 0 to 10, 10 is the cum laude qualification) the student was not requested to follow the course. The implementation of this program decreased the failure rates for the first year in mathematics and physics, but did not solved the problem in other subjects of the curriculum, as electronics or computing, neither in subjects of the second year, as electromagnetism, signal theory or digital systems. Moreover the University began five years ago a program for tutoring students of first course. The objective of this program is to ease the inclusion in the University: first coursed students are tutoring by a final coursed student and a professor. The tutors help them to manage the tasks related with their new studies. The attendance to the program is voluntary for the students, they get the tutoring and one ECTS. They are committed to attend five meetings with their tutors for discussing different aspects of the studies: knowing the School and the University facilities, time organization, strategies to face the final exams, managing problems, etc. During the course 2009-10, 143 of the 160 students of the first year, enrolled the tutoring program.

IMPROVING THE QUALITY OF TEACHING BY INSISTING ON TRAINING TRANSVERSAL SKILLS OF THE STUDENTS

This year a new pilot project has begun, the idea is to take profit of the experience and benefits of the special groups but overcome their drawbacks. The experience consists in creating a group for the first year of the Master Engineering, in which all the subjects are following an alternative teaching and evaluation methodology. The group is made of 60 students that have voluntarily enrolled. In this group the traditional theory classes are divided into expositive classes and interactive classes. In the expositive classes the professor teaches as usual with chalkboard, slides, animations and simulations. The interactive classes are different and the emphasis is made on the students work: solving problems, developing projects, presenting results to other students, assessing the progress made [11] are the activities that the students make in these classes. The number of students in these interactive classes needs to be reduced, so the group is divided into 3 groups of 20 students each. The attendance to the classes is mandatory and the professors supervise the work of the students. The evaluation is also different since a part of the final score (40 % to 60 % depending on the subject) is got from the continuous work of the student. Nevertheless the students of this group have also the same final exam than the other students, but the rate in their final score is different. The project has already got results from the first term and they are very promising. Subjectively the satisfaction with the initiative, in both professors and students, is very high, and the students of the course have officially asked the ETSIT to continue with the experience in the second year of the Master Engineering. Objectively the results are displayed in Figure 5, the figure shows the results of the different subjects of the first term of the first course, each subject has two different sets of columns: the first one corresponds to the students that have passed the subject over all the students enrolled in the subject, the second one is the students that have passed the subject over the students that made the evaluation. The results presented are for a traditional group, in blue, the pilot group, in red, and the overall of all the groups, which include results of the traditional and the pilot but also of the special group for students that failed the subject previously. The results are better in the pilot group for all the

subjects, and the most important thing is that in the pilot group the number of enrolled students that made the evaluation is around 80 % overall, while in the traditional group is around 50 % overall.

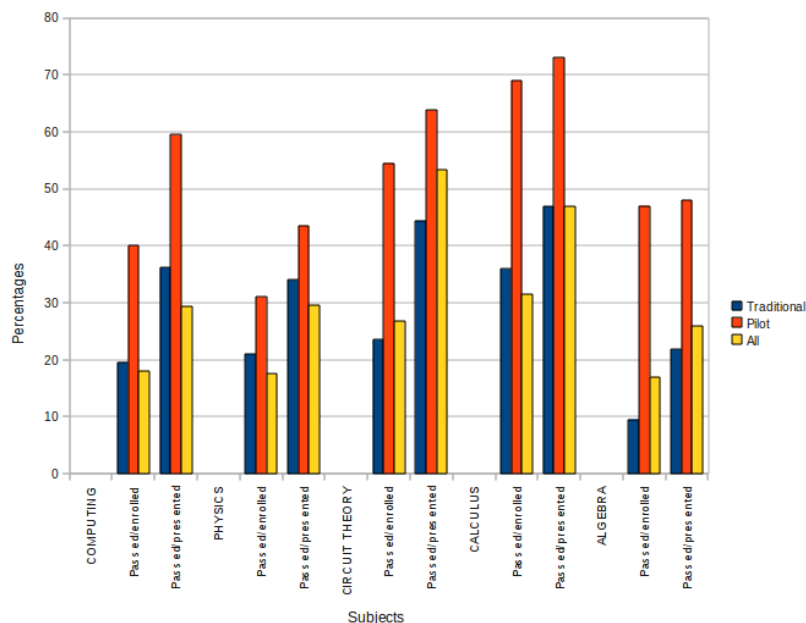


FIGURE 5
RESULTS OF THE SUBJECTS OF THE FIRST COURSE OF MASTER ENGINEERING

This initiative is not isolated in the framework of the University, but reinforced by some technological infrastructure that helps to provide teaching and evaluating material in alternative formats. The University has joined to the SAKAI Project [12], which main aim is to create the technological infrastructure to support teaching and evaluating through the WWW. Professors are encouraged to create on-line teaching and evaluating material and to make it accessible via PoliformAT [13] the interactive web platform of the University. The teaching materials include: collections of solved problems, multimedia material (videos and records), simulations and animations, slides, learning papers and documents, online learning modules, on-line OCW subjects [14], etc. Only during the past year 48 professors of the ETSIT created a total of 556 on-line teaching materials, involving 31 subjects, 20 % of the curriculum. The evaluating materials include: on-line tests, on-line interactive quizzes, on-line open answer exams, etc. During the last year 36 professors of the School developed those materials, involving 14 subjects, 9 % of the curriculum, and they were used for students' self-assessment of progress and also for evaluation. Since the mobility of students of the ETSIT is an important factor of its training offer, the study of languages is very important for the School, four different languages can be learned at different levels: English (6 subjects), French (3 subjects), German (2 subjects) and Catalan (1 subject). Moreover the training of languages is reinforced by the TANDEM action, which has two years of presence in the School. Each week, during three hours, the School enables some room and proposes a subject for language and cultural exchange between foreign students and native students, professors and administrative staff. Talking groups in German, Italian, French and English are created.

One of the most important activities in this subject is the *Classrooms of Business*. The Classrooms of Business are formative actions coordinated and given in the ETSIT, inside the framework of the activities of the Forum of Employment of the University. They are at the expense of professionals of diverse companies of the ICT sector established in the Valencia Region. They are formed by several seminars addressed to students of last year, in which the companies provide an additional training to the students from his own panoramic view, and focused in each case on the line of activity of each company. The above mentioned training includes topics as: current situation of the industries of the sector, organization and managing, services of telecommunication needed by the market, introduction of new designs and procedures in a competitive market, managing prospective in the next 5 years, etc. In these seminars the needs of employability of the companies are exposed, the professional profiles that match them, the type of professional career to develop, how to contact with the departments of human resources, and in many cases, how to send a CV to the company at the end of the seminar. The fundamental aim of the Classrooms of Business is to establish a link between the University and the companies. The action also provides additional training for the students, especially in those business aspects that shortly they are going to need for the incorporation to the job market. Besides providing certain key knowledge in practical aspects of company, the Classrooms of Business also allow the students to know more the companies that exist in the Valencia Region and also others companies in Spain inside the activity related to Telecommunication, Electronics and Computer science. Another important aim that is prosecuted with the program *Classrooms of Business* in the ETSIT is to be able to detect the lacks of specialization in the students training, in relation

to the activities that develop the main companies of the sector, and try to correct them by means of specialized courses. Sometimes actions posterior to the Classrooms of Business appear: as the elaboration of the Final Degree Project in companies by some students; collaboration scholarship grants and practices in companies. In the edition of 2009, 21 classified organizations took part in the action:

- Companies (16)
- Research institutes (3)
- Others (2)

It has to be remarked the presence of three spin-off companies created by professors of the ETSIT, which are employing engineers formed in our School as well as the participation of two companies created by students of the School.

ACTIONS FOR PROMOTING STUDENTS MOBILITY

The ETSIT has traditionally centered the recruitment of students in the international scenario through agreements with universities in different countries, mainly in France and Colombia. The double degree agreements with French Universities as the École Nationale Supérieure de l'Électronique et de ses Applications (ENSEA-Cergy, France), École Supérieure d' Electricité Supélec, and École Nationale Supérieure des Télécommunications de Bretagne (TELECOM-BRETAGNE) promoted an exchange of students in both directions since the 90s. Moreover the double degree agreements with Colombian Universities, as the Universidad de Santander and the Universidad Santo Tomás de Aquino (Bucaramanga), with an agreement also for the Master of Science degree, promoted a flow of Colombian students to the ETSIT, as an example, during the last course the 40 % of students of the Master of Science were from Colombia. The ETSIT has increased its double degree agreements, during the last year, the German Universität Stuttgart and Technische Universität Darmstadt, the Italian Politecnico di Torino, the Irish Dublin Institute of Technology and the US Illinois Institute of Technology (Chicago) have also signed double degree agreements with the ETSIT. Moreover a framework agreement for collaboration has been signed with The Bonch-Bruевич Saint-Petersburg University of Telecommunications (Russia). For the Master Engineering studies these agreements, jointly with the mobility programs (ERASMUS, VULCANUS, LEONARDO, SICUE, IAESTE, etc), means a negative balance for the ETSIT, i.e. during the last course 116 students from the ETSIT made a stage in a foreign university, facing the 93 students from other universities that came to the ETSIT. In this way they cannot be considered as recruitment mechanisms, nevertheless the possibility of obtaining a double degree of a European or US University is very well considered by our students and increases their chances for a high profile job [8]. On the contrary, the agreements with Colombian Universities mean an increasing flow of students to the ETSIT for the Master of Science. In order to promote the collaboration with Colombia, a network with Colombian Universities has been implemented: RIETI (International Network of Research and Teaching in Electrics, Electronics, Telecommunications and Computing). The ETSIT is planning to undertake similar actions with other Latin American countries and Morocco.

CONCLUSIONS

The fact that the number of vocations in ICT sector is decreasing is indisputable. Nevertheless this tendency must be reverted to maintain the progress in research, development and innovation. Actions at different levels are required. It is needed to increase the relationship with secondary schools to promote early technological vocations, to transfer the idea that the ICT studies are not impassable and to improve the satisfaction rates of graduated ICT students. It is also needed to approach the studies to the business world and to strengthen links with the research world. Finally the global environment can not be forgotten and a strategy for networking at international level must be followed. In this work the authors have described how some of these key factors have been applied in the ETSIT for promoting vocation for Communication and Electronic Engineering.

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