

## New Information Technology in an International Context

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### Abstract

As the world undergoes the phenomenon of « globalization », more and more colleges of engineering have given their courses an international flavor by offering modules which, traditionally, had no place on the « old style » engineering syllabuses. In a European context, these innovations include :

- The study of Foreign Languages.
- Elements of Economics and Business.
- Short courses involving Interpersonal Communication and Negotiating Skills.

Links with other European partners have been forged, exchanges of students and faculty have become almost commonplace, and schemes have been established allowing the transfer of academic credit units across international borders.

The next logical step appears to be the creation of *International Master's Programs* in engineering. This is particularly true in a European context, where political and economic objectives are leading to greater integration within the fifteen Member States which currently make up the European Union. In the past, many European graduates have, for various reasons, been attracted to Master's courses in North American universities. With the notable exception of certain *European Business Schools*, very few international Master's programs currently exist in the Old Continent.

The **Ecole Nationale Supérieure des Télécommunications de Bretagne** (ENST Bretagne), a French Graduate School (*Grande Ecole*) in Information Technology, has decided to open two *International Master's Programs* at the beginning of the academic year 2000-2001 :

- A dual degree : French *Master in Telecommunications* and American *Master of Science (M.S)* in Computer Science/Electrical Engineering.  
(Partner University: Texas A&M).
- *European Masters in Optical Data Communications and Telecommunication Networks*  
(Partner University: University of Bristol, UK).

This paper will attempt to describe how these programs were designed and how they may develop over future years. A general overview is also provided of how new information technology can be used in an international context.

### 1) Introduction

The **Ecole Nationale Supérieure des Télécommunications de Bretagne** (ENST Bretagne) is a French *Grande Ecole* specializing in all aspects of Information Technology. Founded in

1977 in Brittany-France, it has two campuses (one in Brest, the other in Rennes) and recruits around 150 students into its 1<sup>st</sup> year after a national competitive examination (*Concours Commun*) which takes place two years after the French High-School leaving examination called the *Baccalauréat*. Competition for places is stiff, with around 10% of candidates finally gaining a place. A further 70 students are recruited directly into the 2<sup>nd</sup> year of the 3-year course. These students, known as *Admis sur Titres*, have previously studied in the French University system (as opposed to the *Grandes Ecoles*) and enter ENST Bretagne with a French *Maîtrise* ( B.Eng Honours degree) after a rigorous selection process at the end of 4 years' in the French Higher Education System.

Figure 1 gives an approximate comparison of the educational systems for engineering training in France and the UK/USA.

ENST Bretagne produces around 220 graduate engineers every year (*Diplôme d'Ingénieur*) as well as 70 graduates from its one-year, independent Master's programs, while an average of 35 Ph.Ds are awarded every year. The college is made up of some 780 students and 100 full-time professors, lecturers and technicians. During the academic year 1998-99, a total of 132 members of the student population were non-French (around 17%) from 30 different nations throughout the world. The college also maintains very close links with industry by inviting industrialists to participate in the design of the curriculum, to teach courses and to be members of the Board of Examiners. ENST Bretagne also runs a flourishing *Continuing Education Department* which organizes short, one-week courses for professional engineers at various locations throughout France (Brest, Nantes, Nice, Rennes, Paris, Toulouse ...).

## 2) International components in EE/CS education

Telecommunications is a truly « global » activity. One only has to look at the front page of any newspaper to read about events concerning the Internet, alliances, mergers and joint-ventures between huge, international communication companies, a local pavement being dug up to install optical fiber cables, or a list of complaints about various aspects of the mobile telephone. The world of communications pervades many aspects of our everyday lives. Consequently, any college involved in teaching and research in the field of Information Technology should provide an education which covers the international features of the profession.

Apart from the more traditional modules of an education in Information Technology, the syllabus at ENST Bretagne also contains the following activities :

- a) Foreign Languages
- b) Economics and *The Industry of Telecommunications*
- c) A mandatory internship abroad
- d) Dual degree programs with non-French partners.

### a) Foreign Languages

On choosing to come and study at ENST Bretagne, every student at ENST Bretagne knows that (s)he will have to study two Foreign Languages up to « Level 4 », on a scale in which Level 1 = Beginner's Level and Level 5 = Bilingualism.

Just as the syllabus contains mandatory modules in Signal-Processing, Computer Science and Networks, so two Foreign Languages must be studied and a high level attained. The award of

the college *Diplôme*/degree has frequently been deferred because students have not reached the required level in Foreign Languages. Seven hours per week (almost 25% of the total number of student contact hours) are devoted entirely to the study of Foreign Languages, with all the consequences involving timetables, funding and staff. Proficiency in the various languages is tested in external examinations, such as :

- The Cambridge First Certificate/Proficiency (English)
- TOEFL (English)
- Goethe Institut (German)
- European Chamber of Commerce (Spanish)
- Examen d'Arabe Littéral - (The Sorbonne) (Arabic)

The students have the choice of two of the following languages :

- French (compulsory for all non-French students)
- English (compulsory for all French students)
- Arabic
- German
- Italian
- Japanese
- Portuguese
- Russian
- Spanish

The main objective of language classes is, of course, to enable every student to become proficient in the everyday spoken aspects of the language (s)he has chosen, but language classes are also used to examine the cultural elements of the countries/zones whose languages are taught. On entering professional life, a sound knowledge of the mechanics and culture of a language can be most useful to the telecoms graduate. It even helped to save the life of one of our Arabic-speaking students when, four years after graduation (while working for a telecommunication equipment manufacturer), he found himself caught up in a bombing raid in the middle of Baghdad during the Iran-Iraq war !

In the first twenty years of its life, ENST Bretagne has produced some 2,000 graduates many of whom are now working outside France. In an attempt to improve the quality and content of our language teaching, we recently opened an Internet Users' Group specifically designed to attract comment from our expatriate « Old Boy/Alumni » community. Contributions have been received from students as far afield as Colombia, Australia, Norway and Japan and the topics covered in our debates have been centered around the idea of the perceived advantages/disadvantages of working outside the « home » country. Ideas exchanges have included :

- More challenging jobs
  - Higher salaries
  - Not getting stuck in a rut
  - Better quality of life
  - Cultural enrichment.  
(Perceived positive points of working abroad)
- 
- Problems with healthcare

- Children's education
- Retirement pensions
- Infuriating foreigners !  
(Perceived negative points of working abroad)

b) Economics and *The Industry of Telecommunications*

For the reasons stated earlier (Mergers, Alliances, Company Strategy ...) any telecoms engineer, whatever specialization (s)he may choose in the final year at ENST Bretagne, must possess more than a nodding acquaintance with the Business of Telecoms. With this in mind, certain mandatory modules in Economics form part of the *Common Core Program* at ENST Bretagne, while greater specialization in this field is offered in the final year specializations in *Business Engineering* and *Design and Marketing of Information Systems*.

The main components of the *Common Core Program* in Economics include the following features :

- The Economic Circuit
- The Private and Public Sectors
- The Marketplace
- Currencies
- Macro-Economic Models.  
(Semesters 1 + 2)
  
- An Economic and Strategic Analysis of New Information and Communication Technologies involving « Case Studies » (Sun/Canal +/BT).
- A one-week « game » lasting 24 contact hours, during which the students work in teams (under the supervision of 10 lecturers and industrialists) to invest on the Stock Market and make decisions involving company strategy. The winners at the end of the week are the team with the greatest profit.
- Communication Theory as seen through the eyes of Psychologists and Sociologists.  
(Semester 3)

Two final-year electives complete the Economics and Marketing-oriented courses :

i) *Design and Marketing of Information Systems*

- Developing the Concepts of the Service Economy
- Assessing the Implications of Information Services
- Designing and Managing Information Services

ii) *Business Engineering*

- European Construction and the Globalization of the Marketplace
- Economics, Law and Management
- Networks
- New Markets and Professions in Business Engineering

c) A mandatory internship abroad

On choosing to study at ENST Bretagne, every student knows that the syllabus requires a high level to be reached in two Foreign Languages, as well as a two-month internship which must be performed abroad. It is up to each student to determine how (s)he attains these objectives.

The College has initiated the following programs to help the students perform their internship abroad :

- Short summer internships in industry. (Duration : 2 months).  
Around 100 students spend part of their summer vacation working in companies outside France, using the college's data-base to obtain their placement, or finding the placement themselves, often by using the web.
- Semester 4 can be spent at partner institutions in other European countries. (Duration : 4 months).  
Around 20 students per year currently use this program to register for courses in engineering colleges in Germany and Spain. Plans are being made to develop this program to other partners in Europe and North America, possibly on a « Student Exchange » basis. We are busy looking for potential, new partners !
- Final year projects may be performed in companies or research laboratories abroad. (Duration : 6-10 months).

In 1998-99, sixty final-year students performed their project abroad in 13 different countries.

- A « Sandwich Year » (*Jeune Ingénieur*) exists between 2<sup>nd</sup> and 3<sup>rd</sup> years which enables around 50 students per year to go and work in industry. (Duration : 12 months).  
Around 20 students per year choose to perform this year in companies outside France.
- Complete academic years abroad. (Duration : 13 months).  
The European SOCRATES program has enabled around 30 ENST Bretagne students to « disappear » to one of our partner institutions every year. Often, they will register for a Master of Science course abroad. On obtaining the M.Sc, they will also be awarded ENST Bretagne's own degree, the *Diplôme d'Ingénieur*. This scheme now works with partners in Finland, Germany, Spain, Sweden and the UK. Plans are being made to extend this scheme to universities in other parts of the world on a « Student Exchange » basis.

Non-French students coming to France can obtain either the French *Diplôme d'Ingénieur* (2 years) or one of the college's six *Mastère* degrees (1 year).

d) Dual degree programs with non-French partners.

With the notable exception of many *Business Schools*, very few dual degree programs appear to exist in Europe. The « language problem » is certainly one of the reasons but, with European integration becoming a feature of our everyday lives, it would seem logical (and perhaps even « profitable ») to develop the idea of dual/common Master's degree programs or even a European Ph.D. In a European context, many of our brightest engineering students (at least, those who do not wish to start earning high salaries immediately on graduation) decide to perform their postgraduate work elsewhere in the world, while many European and American colleges of engineering are finding it increasingly difficult to attract good, « home » candidates for Ph.D. theses.

Consequently, beginning in the academic year 2000-2001, ENST Bretagne and two of its non-French partners have decided to open *International Master's Programs*, the aims of which are to provide a high level education in certain aspects of engineering in which we think we are more than competent. These programs will provide a truly international environment for those students who register and, in the longer term, may be opened to a much wider audience.

i) *Texas A & M University*

The aim in this venture is to give access to a dual degree :

- The French *Mastère* in Telecommunications.
- The American *Master of Science* (MS) in Computer Science / Electrical Engineering.

Courses will be undertaken at both institutions and will be validated by both partners, thus allowing joint allocation and transfer of credits.

ii) *European Masters in Optical Datacom and Telecommunication Networks* (ENST Bretagne and University of Bristol, UK).

This 13-month course should begin in September 2000 and will lead to a degree which, hopefully, will carry the name of *European Masters* although no jurisprudence appears to exist to accredit such a title at the present time. Alternatively, the degree awarded could be the French *Mastère* in Optics and/or the British *Master of Science* (M.Sc) in Optics. Accreditation and logistic problems still have to be solved, but both partners are very keen to launch the course in September 2000.

3) Using the web for international activities

a) Teaching and Research

The web has opened up vast, new horizons for pedagogy. Until recently, designing a new course required an enormous effort from the faculty member. Nowadays, we can investigate how other colleagues (anywhere in the world) have approached the problem when they designed a similar curriculum. Books play a major role to gain access, as, in many cases, they convey a pedagogical approach as well as a well-defined program and schedule.

The web and the wide availability of resources open up new approaches, as large amounts of information and course materials can be found. For example, the World Lecture Hall (<http://microlib.cc.utexas.edu/world/lecture>) provides an interesting set of pointers to obtain various, on-line, pedagogical materials. This availability is important in those fields in which technical advances require a permanent updating of materials and content. This approach can be envisioned as a « community effort », in which obtaining the « right » web address is the necessary starting point. This has created an interesting side effect, since it is important to appear as the source and reference for any subject. Some people have played a major role by giving their material to the whole community, a practice which was very unusual just a few years ago. In fact, this is similar to the « Xerox activity » : when a student is given any material, he/she might distribute it on any scale and reuse it. Web distribution can appear to be another form of advertising and promotion of the authors. Moreover, the initiators of the process have their web-server addresses in numerous databases and appear as the reference.

This is the case, for example, of OMG CORBA and the Washington University in St Louis. Many search engines have their web sites as references and direct requests to them, thus making their team the *de facto* references and promoting their research.

Faculty members may have some concern about their material being reused by others without knowing it. Nevertheless, the indirect benefits of this practice are huge and go well beyond proprietary concerns.

ENST Bretagne is involved in *distance learning projects*. The web and high speed networks have enabled us to solve many problems concerning lecturing :

- Videoconferencing systems make it possible to have professors in one city and the students in another. This is of particular interest for our institution which is located 450 miles west of Paris. Even if the college can be reached through a one-hour plane flight from Paris, any trip requires at least a full day stay.
- High speed networks make it possible to transfer large quantities of multimedia information, thus giving the students a certain quality of delivery.
- Distance learning provides a good opportunity for R&D, since several technical issues have to be solved. This is one of the objectives of the *CANDLE* project described below.
- Distance learning is a new field and being the initiator of such a project can ensure involvement in other, similar developments.

The « classical » students have found such initiatives very beneficial, and further developments are likely to appear in the field of *Continuing Education*. For example, an employee can « attend » lectures without leaving his/her company. New international, virtual universities are beginning to appear.

ENST Bretagne is heavily involved in international and European projects performed in cooperation with academic and industrial partners. One such project is *CANDLE* (*Collaborative And Network Distributed Learning Environment*) whose main objective is to use the web and multimedia technology to improve the quality and reduce the cost of ICT (Information and Communication Technologies) teaching in Europe. *CANDLE* should facilitate cooperation between universities and industry by producing learning material and improving the quality of delivery. The project members are a group of universities and research centers who have similar levels of expertise, who are also partners in an academic consortium and who have been working experimentally together for the past five years. ***The CANDLE Project has received funding worth around 3-million EURO from the European Commission for the period 2000-03.*** The consortium will create :

- A tool-set containing an information broker as well as authoring, navigation and course organization tools.
- A methodology for course module organization, authoring and use of metadata in the specific context of networks and communication media.
- An extensive set of course modules for basic and advanced courses in the ICT area.

- An in-depth evaluation of tools and courses.

The results of the project will be made available under the « open course-ware » umbrella. This should contribute to the massive use of the products and the associated methodologies.

Primary outputs of the CANDLE Project are both practical and theoretical. In addition to research output, we intend to produce systems and content for educating European researchers and engineers.

The expected benefits of the CANDLE Project are as follows :

- The project will build communities between students, research engineers and industrial partners across Europe.
- With its metadata model and systems, the project will make a major contribution towards a standardized model with standardized applications for computer-based learning on a global basis.
- The participants are actively involved in improving education in ICT, in supporting continuing professional development (life-long learning) and research in ICT.

The CANDLE Consortium is a good mixture of :

- Industrial partners to guarantee relevance and applicability, and also to evaluate the products in the context of the continuing education framework.
- Leading European universities in this field, thus guaranteeing high-quality content from well-known experts.
- Researchers who will guarantee the state of the art systems for network-based teaching and learning.

#### b) Job Recruitment, Selection for Internships and Alumni Relations

The web is proving to be a powerful tool in enabling the students at ENST Bretagne to fulfill all the requirements for graduation, especially those involving internships outside France. It is also increasingly being used by companies for recruiting our graduates on a full-time basis.

In this context, the **positive** points of the web are perceived as follows :

- Students gain rapid access to an overview of details concerning the addresses and major activities of many companies, thus providing them with a much wider choice of possible internships and full-time jobs throughout the world. Students are able to reach a quick conclusion as to whether they are interested in a company or not.
- Companies have access to a vast pool of future, high-level, graduates.

The **negative** points of the web are frequently seen as being :

- A lack of personal contact within the company.



- The impression of a certain anonymity, of being a simple number in the vast lottery of finding an interesting internship or full-time job.

It should be noted that, in the past, many members of faculty had established fruitful, personal relationships within various companies, both at the level of research teams as well as with the Graduate Recruitment Service/Human Resource Center of each company, representatives of which would often visit the college to interview students on a personal basis. This « individualized » selection process is currently being lost, as many companies appear to evaluate and select their potential recruits on the basis of the resumé sent by email attachment. A few companies will, however, select students for a more personal interview, often conducted by telephone or by videoconferencing.

Conclusion : The onus for achieving a satisfactory solution for all concerned in the selection process probably lies with the companies, who must provide a more personalized approach to recruitment.

The use of the web for contacts with and between « Alumni » is certainly far less developed in Europe than in North America. Until recently, many European universities tended to neglect this very important aspect of relations between the Institution of Higher Education, its current students and its graduates.

ENST Bretagne is approaching the problem in two ways :

We organize an annual « Alumni Day » attended by around fifty of the college's graduates who are all practicing engineers in industry or in the academic world. Short presentations are given by the alumni, who then discuss their careers on an individual, more personalized basis with any interested student registered at the college.

As the effects of « globalization » begin to hit us, a web site is being created specifically for the benefit of any alumnus registered with the official « Alumni Association ». Ex-students working in any part of the world are invited to « join the club » and volunteers have been sought as « Regional Representatives » of a particular country, continent or zone. Alumni can, therefore, inter-react among themselves, while any student registered at the college can have access to his/her peers throughout the different countries/continents/zones featured on the lists. A French student wishing to work in the USA, for example, can contact the « Regional Representative » for that country, gain access to the list of all past students working in the USA and discover the advantages and drawbacks of living and working there. Contacts can be individual or in the form of « User Group Email ». Recent themes concerning working in the USA have included the following topics :

- Job stability
- Salaries
- Employment conditions
- Pension problems
- Health care problems
- Social security
- Insurance
- Children's education
- Violence in American society

- Re-integrating French companies and France after several years in the USA

An annual meeting of this « International Alumni Association » was held in Paris, in December 1999.

#### 4) Conclusions

In a European context, integration is fast approaching, economies are becoming increasingly inter-dependent and no nation can now afford to ignore what is happening outside its own borders. Globalization has arrived. Engineering is one of the most « global » and wealth-generating activities in any economy. It pervades every aspect of our everyday lives, from making the coffee, to plugging in to the Internet or using transport systems and other communication devices as we travel to our workplace. Training competent engineers who have a strong perception of all aspects of their profession (scientific, ergonomic, economic, ethical...) is surely an absolute necessity for those of us involved in engineering education.

An American recruitment agency recently published a list of the « Top Ten Reasons to Hire International Students and Alumni for Your Foreign Subsidiaries ». Among the reasons were the following :

- International students are, generally speaking, more aggressive, more productive and more independent than the countrymen they left behind... traits they demonstrated by taking the risk of going to another country (i.e. the USA) for higher education.
- They face no « culture shock » or many of the other issues that are often faced by American expatriates relocating to a foreign country for the first time.
- They know the language(s) and social/business customs in their home countries.
- An international student will continually act as an « ambassador » for the US company (and generally for the USA) in his/her home country.
- Students with an « international culture » are highly valued by future employers and we should, therefore, try to expose our students to an international environment during their engineering courses. We can achieve this objective by :
  - Creating an International Office in our Schools of Engineering in order to coordinate our international activities.
  - Establishing exchanges of students with our foreign partners and validating in our home institution the « credits » obtained while studying abroad.
  - Encouraging faculty to take their sabbaticals abroad.
  - Encouraging faculty to play a leading role in supervising the work of incoming foreign students and to become involved in multinational research projects.
  - Making the study of one or more Foreign Languages an integral part of the engineering syllabus.

- Developing common/dual degree programs in engineering with our foreign partners.
- Associating industry with all of the above measures, for it is the industrialists who benefit most from the skills acquired by our students during their education.

Figure 1 - Engineering education in France, the USA and the UK

Years	Qualifications awarded			
	France	USA	UK	
9	Doctorat		Ph.D.	
8				
7			Ph.D.	
6		MS		
5	Diplôme d'ingénieur	Diplôme d'Etudes approfondies (DEA)	(MS)	M.Sc.
4		Maîtrise	BS	M.Eng.
3		Licence		B.Sc.
2	Competitive Entrance Exams to <i>Grandes Ecoles</i>	Diplôme d'Etudes Universitaires Générales (DEUG)  DUT/BTS	Associate Degree	
1				
<b>Years</b>	<b><i>Grandes Ecoles</i></b>	<b>Université</b>	<b>University</b>	<b>University</b>
	Baccalauréat		High School	A Levels

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