EDUCATING THE NEXT GENERATION

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Abstract : The INSTN, a higher education establishment, has an original place in the French and European education system. Placed within the CEA, the French nuclear research organization, it is under the supervision of the Ministries in charge of industry and of education. Originally, it was created to train engineers, technicians and researchers needed for the energy development of France, as neither universities, nor Schools of engineers had developed the necessary skills.
Half a century later, the INSTN set up academic curricula organized by itself or in cooperation with Universities and High schools of engineers as well as a broad range of professional and continuous training courses, using the skills available within the CEA, other research organizations, industrial companies (EDF, Areva...) or public authorities.
Moreover, on behalf of the CEA, the INSTN acts as a doctoral college, ensuring the selection, management and training of PhD students and post-doctorants.
At the international level, the INSTN provides training courses aimed at foreign professionals in cooperation with the IAEA. It is also strongly involved in the education and training aspects of FP6 European projects, especially Euratom projects, and in the Erasmus program.

1. Introduction

The INSTN was created in 1956; it is a higher education establishment placed within the Atomic Energy Commission (CEA) and under the joint supervision of the Ministries in charge of education and of industry.
It has been established at Saclay, then branches were created at other CEA centers, Cadarache, Grenoble, Rhône Valley (Marcoule) and in Cherbourg..
Calling upon more than 1000 teachers per year, the INSTN benefits from the participation of the best CEA specialists, either fundamental researchers from the Material Sciences (DSM) and the Life Sciences (DSV) Directorates, or, for more applied fields, engineers from the Nuclear Energy (DEN), the Technological Research (DRT) and the Military Applications (DAM) Directorates.
Also contributing to education and training (E&T) at the INSTN are university teachers, researchers from public organizations or from the industry, and, regarding the nuclear field, engineers from the electricity production company (EDF) and from industrial companies involved in nuclear reactor fabrication or in the fuel cycle (Areva group).
One of the main characteristics of the INSTN, whose staff is about 120, is therefore to have very few permanent teachers but to call upon a large range of specialists, researchers, engineers, doctors, thus ensuring courses to take into account the last developments of sciences and technology and programs to be best adapted to the needs of research and of industry.
Its locations provide students with easy access to the experimental facilities of CEA research laboratories, but it also has its own equipment: nuclear experimental reactor Ulysse, PWR simulators (SIREP for normal operation and SIPACT for accidental conditions), a 2 MV Van de Graff accelerator, transmission and scan electron microscopes, nuclear measurement laboratories, biology and active chemistry laboratories, radiation protection training facilities...
The mission of the INSTN focuses on nuclear power: worth mentioning is the organization of a post-graduate course in nuclear engineering (approximately 80 graduates per year); however, new fields investigated by the CEA research teams are now taught at the INSTN.

An important aspect of the CEA policy is to develop cooperation with Higher Education Institutions: along the years, INSTN has developed strong links with the universities in several regions of France where CEA is located, Ile de France, Rhône-Alpes, Provence-Alpes-Côte d'Azur and Languedoc-Roussillon. As a result, 37 graduate courses (DEA and DESS) were jointly organized for approximately 700 students per year. These courses are currently being transformed into ten Masters to fulfil the Bologna requirements for the European harmonization process: the INSTN thus actively participates in the construction of the European higher education and research area .
Also worth mentioning are the specialized courses developed in the field of health disciplines, nuclear medicine and radio-pharmacy for which INSTN delivers the theoretical courses at the national level, as well as a post-graduate course aimed at training medical physicists whose diploma is delivered by the INSTN.
Continuous and professional training is another important activity of the INSTN; it also relies on the skills of the CEA and its industrial and public authority partners. The INSTN offers some 150 training courses aimed at nearly 8000 trainees per year at its five locations. Most of these courses can be arranged in consistent sets, even in complete cycles, allowing trainees to progressively acquire basic, complementary and thorough knowledge.
Lastly, at the crossroads of initial education and continuous training, the INSTN also offers technical curricula among which radiation protection (approximately 20 graduated technicians and 30 graduated high-level technicians per year) has the major part.

2. Higher education

2.1. Post-graduate Diploma in nuclear engineering

The Nuclear engineering course, is given at Saclay since 1956 and at Cadarache since 1978.. It is the only course, in France, leading to a nuclear engineer diploma. Figure 1 shows the number of students per year since 1956.
The follow-up of graduates shows that they easily find jobs, with a search time for a permanent job presently lower than 6 months. Approximately half of the graduates are recruited by main French nuclear companies like EDF, Areva and, indeed, the CEA
The "European Nuclear Education Network" (ENEN) has been created a few months ago: with 22 university partners from 17 European countries. The INSTN is the leader of this association.
The objective of this network, created through a FP5 action, is to maintain and develop to the highest level education and training, and consequently skills, in the nuclear field. In particular, through the definition of a common framework for mutual recognition of modular curricula, cut out in ECTSs, a new European Master in nuclear engineering will be set up within ENEN.

2.2. *Initial education in nuclear medicine, radio-pharmacy and medical physics*

Nuclear medicine and radio-pharmacy have been recognized as a speciality in France; since then, INSTN has been entrusted with teaching them at the national level to ensure an homogeneous quality level of the courses.. Courses include, in addition to the clinical applications, fundamental matters not, or few, addressed in traditional medical courses, in particular radioactivity, radiation-material interactions, dosimetry, the biological effects of ionizing radiations. They lead to the diploma of specialized studies in nuclear medicine (DES), and to the complementary diploma of specialized studies in radio-pharmacy (DESC). Besides, within a network associating French, Belgian, Portuguese, Danish, Greek, Hungarian, Italian, Romanian Universities, a European course in radio-pharmacy has been set up and is taught at INSTN.
At last, a post graduate course, aimed at students graduated with a master in radiological and medical physics, leads to the medical physicist diploma accredited by the French Ministry of health (DQPRM). Medical physicists ensure the quality and the safety of the use of ionising

radiations. They are responsible for the calculation and the measurement of the doses delivered to patients in radiotherapy and nuclear medicine. Their number in French hospitals is presently much too low and the number of students in the course is increasing.

2.3. *Masters*

In accordance with its mission of knowledge development and dissemination, and in close connection with the CEA research laboratories, the INSTN is involved in organizing graduate courses, a number of them dedicated to training future PhD-students who will then become researchers at the end of their thesis.

The set of courses thus offered addresses various fields, in relation to the fundamental as well as technological research fields of the CEA.

Changes are currently being made to implement the European harmonization process of diploma, L/M/D: former courses are gradually converted into master degrees. Table 1 shows the INSTN's initial education offer for 2004-2005. This will be supplemented, in the years to come, by other courses, especially in the field of " Knowledge Economy and Technological Innovation Management Sciences ".

2.4. Decommissioning and nuclear waste management School (EN4D)

To address the needs generated by the programs for decommissioning the first generation of nuclear reactors and fuel cycle facilities in France, courses were set up at all levels in these particular fields for initial as well as continuous E&T. This consistent set of courses is known as EN4D as it is built according to the directions given by a steering committee composed of a majority of industry representatives who also follow-up their implementation.

The same needs arise in Europe and a European Master will be developed within an ERASMUS project recently accepted by the European Commission; the INSTN and the Joseph Fourier Grenoble University will contribute to it with their existing French Master course on Nuclear decommissioning and waste management; they will be associated to the Scottish Millenium Institute, the Italian universities of Pavia and Rome La Sapienza and the Lithuanian technological university of Kaunas; research organizations and industrial companies from those countries involved in these activities also support this project.

Besides, within the FP6 EURATOM programme, professional training courses on nuclear decommissioning will be developed and implemented (Eundetraf-II project).

3. Undergraduate Technical Education

Apart from its involvement in higher education, the INSTN also organizes courses for technicians.

These lessons are at the crossroads of initial education and continuous training. They allow students or professionals to acquire a qualification and to obtain either a diploma or a title approved by a ministry or a certificate recognized by industry companies.

3.1. High-level technician training in radiation protection

The courses allow to understand the theoretical, practical and legal aspects of radiation protection. Students are prepared to implement the radiological control techniques and the prevention provisions adapted to the situations encountered, to define protocols for monitoring nuclear installations and to ensure the follow-up of interventions in incidental or accidental conditions.

Graduates from this course are particularly appreciated in the nuclear industry (CEA, Areva, EDF...), intervention companies, hospitals and companies or laboratories using ionizing radiations.

3.2. Technicians training in radiation protection

This course aims at teaching how to analyze situations with radiological exposure hazards, to carry out prevention calculations as well as current radioactivity control measurements.

Graduates easily find jobs in the nuclear industry. Some of them, already professionals, follow the course upon request of their employer, to get a specialization in radiation protection.

The technician diploma can be prepared either as continuous or initial training and, since 2003, through apprenticeship.

3.3. First level in radiation protection

This course was set up to address the needs expressed by the profession. It is a first level general training allowing trainees to acquire theoretical and practical knowledge necessary to become a field radiation protection person. Contrary to the preceding courses, it can only be accessed as continuous training and accommodates trainees of various origins: employees wishing to acquire a qualification, people looking for a job or carrying out a reconversion.

3.4. Nuclear medicine technician course

This teaching is intended to supplement the initial training of the ancillary medical personnel - technicians or nurses - called to use radioisotopes, in particular in the nuclear medicine services.

It includes theoretical courses at the INSTN and a practical training period in a hospital and covers all situations met by technicians: handling of radioactive tracers, installation of protections adapted to the radioisotopes used (including PET transmitters), realization of diagnostic examinations, care-taking and information of patients, implementation of radiation protection regulations

3.5. Nuclear reactor Instrumentation and control course

This course allows the future operators of nuclear experimental reactors to acquire the knowledge needed to better understand and control their activity. It is not limited to the single instrumentation and control aspects but also addresses basic principles of reactor physics and of safety.

Teaching does not relate to a specific installation and is therefore adequate for personnel called to operate varied types of reactors: the certificate they receive enable them to obtain an operating qualification.

The technicians trained since more than five years have a refreshing training course the contents of which are adapted to the operating characteristics of their installation.

4. Continuous professional training

Apart from initial higher or technical education intended to prepare and obtain a diploma, the INSTN proposes to public already involved in professional life shorter training sessions aimed at updating their knowledge or at initiating them to new techniques. The fields covered in these sessions are as varied as in initial education courses (nuclear power plants, materials, nuclear fuel cycle, environment, safety, quality, radioactivity, radio-isotopes in biology...).

As for other E&T activities, the continuous professional training is supported by the skills of the CEA and the industrial and public authority partners.

Every year, nearly 8000 people participate in 3000 sessions covering 150 different topics. This continuous training activity is carried out with a quality management approach and is currently certified ISO 9001. This results from the will to provide participants with teaching in accordance to the last technological and legal developments, delivered by trainers using the best teaching methods. New communication and information technologies are gradually introduced as an assistance to teaching.

5. Training through research

In addition to the selection and the management of the some 900 PhD-students working in the CEA laboratories, the INSTN acts as a "Doctoral School" by training them during of their 3 years thesis. The aim of this training is to help them with their future professional insertion.

6. Organization of the INSTN

Located on five sites (figure 2) in France, the INSTN is organized

- in teaching units corresponding to its various fields of activities:

  Reactors and engineering techniques

Material physics
Chemistry and nuclear fuel cycle
Radiation protection, biology and medicine
Technology and innovation management

- and in geographical branches

Its permanent staff is approximately 120 and it calls upon more than 1000 teachers or researcher-teachers,

The INSTN's main assets are its teaching network, its unique equipment, its original and privileged position between research, university and industry, and its autonomy of action.

7. Conclusion

The INSTN, as a higher education establishment responsible for disseminating the knowledge and know-how from the CEA laboratories, carries out its E&T missions through partnerships and networks which it currently develops at the European level.

Its activities are supported by a knowledge and information sharing approach, and carried out within an organized network of actors.

Training and educating the future engineers, researchers, specialists require to define priorities. Those are implemented with a management by projects approach within a quality process, allowing for the sharing of good practices.

Sharing and disseminating knowledge, but also capitalizing and managing skills, which are the base of Knowledge Management, should allow the INSTN to become a center of production and dissemination of teaching resources.

If, inside any organization, human relations are the key factor of success, these should help strengthen the dynamics of knowledge sharing, of quality knowledge recording, of collective intelligence creation and of networking.

Within this framework, communication has, indeed, a paramount role.

In an evolutionary world, this is how the INSTN will consolidate its place and its identity.

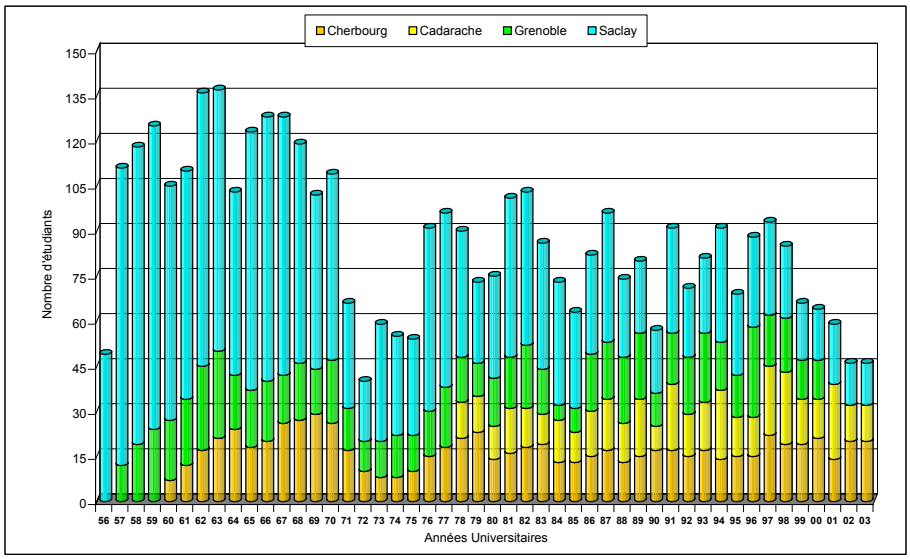

Figure 1 – Number of students per year since 1956

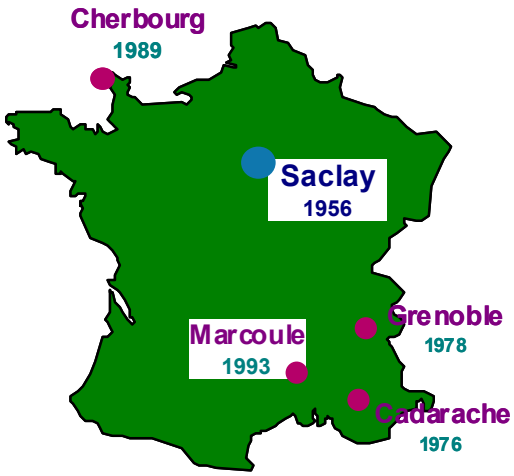

Figure 2 –INSTN locations

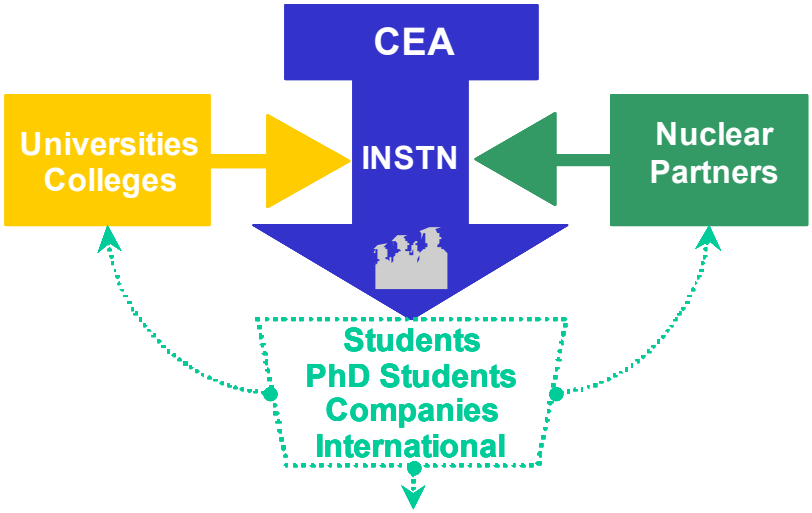

Figure 3 – The INSTN, an interface for nuclear knowledge diffusion

Mention	Spécialité	Université - Ecole - Partenaires
Ingénierie, traçabilité et développement durable	Assainissement, démantèlement des installations nucléaires	Grenoble 1
	Gestion scientifique et technologique des déchets radioactifs	Grenoble 1
Biologie, santé	Imageries médicales	Tours
	Ingénierie structurale et fonctionnelle des bio molécules	Paris 11, Paris 5, ENS Cachan, Ecole Polytechnique
	Génomes et protéines	Paris 7, ENS Ulm
Physique médicale	Génie biomédical	Nice Sophia-Antipolis
	Radiobiologie et Radioprotection	Paris 11
	Imagerie médicale	Paris 11
	Radiophysique et imagerie médicales	Toulouse 3, Paris 11, Nancy INPL, Bordeaux 2
Chimie et applications	Chimie et procédés	ECP, ENSCP
	Réactivité moléculaire et matériaux	UVSQ, Université de Florence, Université de Regensburg
Physique et applications	Noyaux, particules, astroparticules et cosmologie	Paris 7, Paris 6, Paris 11, ENS Ulm, ENS Cachan
	Rayonnement et énergie	Paris 11
Mathématiques et applications	Modélisation et simulation	ECP, ENSTA, ENS Cachan, UVSQ
Sciences de l'environnement	Interactions climat-environnement et télédétection	UVSQ
Sciences économiques et gestion	Analyse économique et gouvernance des risques	UVSQ
Systèmes d'information	Sciences de l'électronique, de l'électrotechnique et de l'automatique	Paris 11, ENS Cachan
	Information scientifique et technique	Université Marne la Vallée, CNAM
Matériaux	Matériaux, technologies et composants	UVSQ, ENS Cachan, Paris 11
	Matériaux pour les structures et l'énergie	Paris 11, ECP, ENSMP, ENSCP, Paris 12, Ecole Polytechnique

Table 1 – INSTN Master offer for 2004-2005