G. Van Goethem, Session 6, invited (Paper 1)

Towards a nuclear "European Higher Education Area"

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ABSTRACT

A European strategy for nuclear knowledge management is discussed, based on the "*knowledge triangle*" (i.e. *research, education and innovation*), proposed by Science and Research Commissioner, Janez Potočnik. The emphasis is on the component "education", which rests actually on 3 principles: common qualification (delivery of a quality label), mutual recognition (Bologna 1999 mechanisms) and mobility of teachers and students (practical instruments at European level). Some achievements are presented, such as the degree "*European Master of Science in Nuclear Engineering*", developed by the legal Association ENEN, and similar initiatives related to waste management and radiation protection. Finally, conclusions are drawn regarding achievements and prospects of Euratom research and training.

Key Words: Euratom, knowledge management, research, education and innovation

A. INTRODUCTION : lifecycle of a Community research project under FP-6

The knowledge triangle (KT): research, education and innovation (i.e. respectively, production, dissemination and exploitation of knowledge)

The knowledge triangle (KT) strategy that was first proposed in FP-6 (2003-2006) will be continued under the next FP-7 (2007-2013) in line with the proposed "Knowledge for Growth Pact". The aim of the KT approach is to ensure a strong coupling between the three poles research, education and innovation (in other words, between production, dissemination and exploitation of knowledge). This knowledge management policy is also sketched in Figure 1 (http://europa.eu.int/comm/commission_barroso/potocnik/research/philosophy_en.htm).

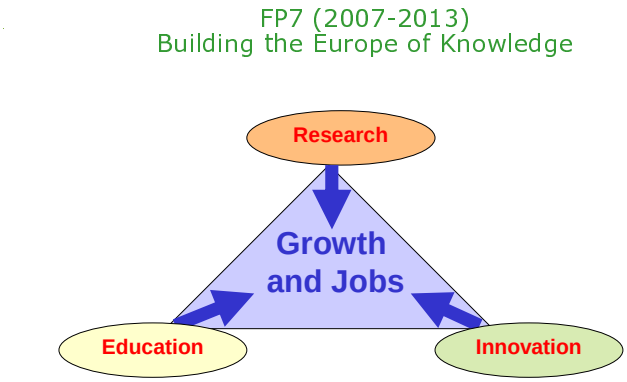

Figure 1 - "Knowledge for Growth Pact" based on the knowledge triangle

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A.1 Research (i.e. production of knowledge) in the Lisbon 2000 Agenda

Research (i.e. production of knowledge) has been a specific Community policy since the Lisbon European Council of 23-24 March 2000 (also short-named "*clean, clever and competitive*" policy). At that summit, a strategic goal was proposed for the European Union: *"to become the most competitive* ***knowledge-based economy*** *with more and better employment and social cohesion by 2010"*. The current knowledge-based economy moves the development of the traditional industrial sector - abundant in labour, raw material and capital – to areas whose products, processes and services are rich in technology and knowledge.

The conclusions of the Lisbon 2000 Council emphasised that if Europe is to meet the challenge of globalisation, Member States need, *inter alia*, to adapt their research and training programmes to the demands of the knowledge society. Regarding EU research, it was also claimed, for example, that by the year 2010, an additional 700 000 researchers would be needed. In line with the Lisbon 2000 objectives and as a response to the pressure exerted by industrial-economical (e.g. completion of EU internal market) and socio-political (e.g. preparation of last EU enlargement) factors, the European Commission launched in 2000 the **European Research Area** (**ERA** - http://europa.eu.int/comm/research/era/index_en.html). The ERA initiative calls for a more coherent use of public and private instruments, for a better involvement of all stakeholders in the Community research decision making process, and for more abundant and more mobile use of human resources grounded in common values.

A.2 Education (i.e. dissemination of knowledge) in Community policies

The ERA and the dissemination of knowledge (*a.o.* through education and training / E&T) are amongst the general aims of the research and innovation policy of the European Union, as they are written in the "*Treaty establishing a Constitution for Europe*", approved at the intergovernmental conference on 18 June 2004 (CIG 87/04, 6 August 2004) / Article III-248 : *"The Union shall aim to strengthen its scientific and technological bases by achieving a* ***European research area in which researchers, scientific knowledge and technology circulate freely****, and encourage it to become more competitive, including in its industry, while promoting all the research activities deemed necessary by virtue of other Chapters of the Constitution."* (http://europa.eu.int/eur-lex/lex/en/index.htm).

Focussing on nuclear matters, under Title I "*Tasks of the Community*", the **Euratom Treaty** (Rome, 25 March 1957) states that "*in order to perform its task, the Community shall, amongst other things,* ***promote research and ensure the dissemination of technical information****, …"* (http://europa.eu.int/abc/obj/treaties/en/entoc.htm).

A.3 Innovation (i.e. exploitation of knowledge) in energy and industry

Exploitation of knowledge can take several forms: either for deepening a research domain (usually long-term governmental programmes) or for commercial purposes (usually short-term industrial applications). In many scientific domains, the potential end-users are concerned about the unfair balance between supply (e.g. by universities) and demand (e.g. from industry) of knowledge, and about the relatively poor impact of research on technological and societal changes. Therefore, innovation which is one the most visible ways of exploiting research is at the heart of many EU policies (in particular, energy and industry).

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All FP-5 project final summary reports are posted in http://www.cordis.lu/fp5-euratom/src/lib_finalreports.htm), whereas all financed FP-6 projects and summaries of their planned work programme are posted in http://www.cordis.lu/fp6-euratom/projects.htm. The EU research policy is discussed in http://europa.eu.int/comm/research/energy/index_en.htm.

B. NUCLEAR KNOWLEDGE MARKET IN EUROPE (SUCCESS CRITERIA AND STAKEHOLDERS)

Under FP-6 (2003-2006), a European strategy is proposed for nuclear knowledge management (in particular for E&T). Historically, a number of criteria are needed to ensure the success of European policies, namely: (1) common needs should be identified; (2) there should be a shared vision and (3) implementation instruments should be proposed (see e.g. http://europa.eu.int/comm/archives/commission_1999_2004/lamy/speeches_articles/spla163_en.htm). The 3 above success criteria apply, in particular, to the organisation of the nuclear knowledge market (i.e. balance of supply and demand of nuclear knowledge and know-how).

Obviously all stakeholders (on both sides, supply and demand) should be involved in the above discussion. Who are they in the particular area of nuclear fission and radiation protection research ? What is their primary objective in Community research programmes ?

- The nuclear regulatory bodies and technical safety organisations (confirmatory research)
- The electrical utilities, waste management agencies and nuclear medical associations (operational research)
- The manufacturing industry and architect-engineering companies (exploratory or promotional research)
- The research organisations (public/private) and training services (applied research)
- The academia or higher level education institutions (fundamental research).

The main stakeholders were consulted and have expressed their common needs and priorities in Euratom actions. A common vision is slowly developing, driven by a number of national and international "integrators" (in particular, academic networks at national level and "end-users" initiatives at European level). Common implementation instruments are also discussed (primarily: the EU research framework programme and accompanying measures).

Challenge: win-win game in the "coopetition" amongst FP-6 research contractors

In most of the modern theories of business, competition is seen as one of the key forces that drive innovation and keep companies alive. That emphasis, however, can be challenged: businesses can gain advantage by means of a judicious mixture of competition and cooperation. Cooperation with suppliers, customers and firms producing complementary or related products can lead to the expansion of the market and the formation of new business relationships, perhaps even the creation of new forms of enterprise. The neologism ***coopetition*** applies for this concept (a blend of ***cooperation*** and ***competition***). The concept seems to have been taken up most enthusiastically in the computer industry, where strategic alliances are common in order to develop new products, particularly between software and hardware companies. Coopetition is actually at the heart of Community research actions: the contracting organisations are usually competing with each other in some areas (outside the EU projects), while cooperating – quite satisfactorily - in others (e.g. within the EU projects).

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C. INTERNATIONAL CONCERNS ABOUT NUCLEAR KNOWLEDGE MANAGEMENT

A number of international organisations, concerned about the safe maintenance of nuclear installations, have expressed the need to create and integrate a secure skill and knowledge base. Interesting opinions were expressed by OECD/NEA, EURATOM and IAEA, such as:

- The OECD / Nuclear Energy Agency produced in 2000 a report to alert the national authorities responsible for education and nuclear safety: *"Nuclear Education and Training: Cause for Concern?"* (http://www.nea.fr/html/ndd/reports/2000/nea2428-education.pdf).

  "Although the number of nuclear scientists and technologists may appear to be sufficient today in some countries, there are indicators that future expertise is at risk. In most countries, there are now fewer comprehensive, high quality nuclear technology programmes at universities than before. The ability of universities to attract top quality students, meet future staffing requirements of the nuclear industry, and conduct leading-edge research is becoming seriously compromised".

- The European Commission Programme Committee CCE-FISSION set up in 2001 a Working Group on Nuclear Education, Training and Competence with the aim to produce a reflection paper on this issue: *"How to maintain nuclear competence in Europe"* (http://www.cordis.lu/fp5-euratom/src/lib_eag_fission.htm). Most strategy documents produced by the EC Programme Committees (STC, EAG Fission, and CCE Fission) can be found on http://www.cordis.lu/fp5-euratom/src/library.htm.

- The IAEA established in 2002 knowledge management as an Agency-wide cross-cutting activity since all Major Programmes are engaged in activities to address preservation and promotion of knowledge and maintaining competence in nuclear science and technology.

  "*Like any highly technical endeavour, the use of nuclear technology relies heavily on a vast accumulation of knowledge - volumes of scientific research, engineering analysis, operational data, regulatory reviews and many other types of technical information - combined with a complex assortment of people with the requisite educational background, expertise and acquired insight to apply that body of knowledge safely and effectively. The effective management of nuclear knowledge includes ensuring the continued availability of this essential reservoir of qualified personnel. As the nuclear workforce ages and retires, and support decreases for university programmes in nuclear science and engineering, this issue is becoming critical to ensuring safety and security, encouraging innovation, and making certain that the benefits of nuclear energy - related to human health, food and agriculture, water management, electricity supply, and a host of other applications - remain available for future generations.*"

  M. ElBaradei, Director General of the IAEA (see http://www.iaea.org/km/).

More generally, regarding the role of the EU in education, it is worth mentioning Article III 82 of the above "*Treaty establishing a Constitution for Europe*": " ……*The Union shall contribute to the development of quality education by encouraging cooperation between Member States and, if necessary, by supporting and complementing their action. It shall fully*

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respect the responsibility of the Member States for the content of teaching and the organisation of education systems and their cultural and linguistic diversity…..
Union action shall be aimed at: (a) developing the European dimension in education …..; (b) encouraging mobility of students and teachers, inter alia, by encouraging the academic recognition of diplomas and periods of study; (c) promoting cooperation between educational establishments; ….. (f) encouraging the development of distance education;…..".

Hereunder are two web addresses of particular interest for Community E&T initiatives, related to graduate and post-graduate levels:

- EC (DG EAC) programme SOCRATES / ERASMUS for graduate level (http://europa.eu.int/comm/education/programmes/socrates/erasmus/charter_en.html and http://europa.eu.int/comm/education/programmes/mundus/index_en.html)

- EC (DG RTD) programme MARIE CURIE for post-graduate level (http://europa.eu.int/comm/research/fp6/mariecurie-actions/indexhtm_en.html. More information is given in the websites http://www.cordis.lu/improving/ and http://www.cordis.lu/research_openings/fellowships.htm: the next cut-off dates for Marie Curie fellowships is 11 April 2006.

D. EU STRATEGY FOR EDUCATION AND TRAINING (INTEGRATION, NOT ASSISTANCE)

D.1 Towards a European strategy for nuclear education and training, based on common qualification, mutual recognition and mobility of teachers and students

For the sake of clarification, education and training are defined as follows:

- Education is a basic or life-long learning process: education is broader than training and encompasses the need to maintain completeness and continuity of competences across generations (it is essentially a knowledge-driven process, involving academics as suppliers, and students as customers).

- Training is learning a particular skill required to deliver a particular outcome: training is about schooling activities other than regular academic education schemes (it is essentially an application driven process, involving industrial trainers as suppliers, and professionals as customers).

In the specific area of nuclear fission, the goal of the FP-6 Euratom programme for education and training (in collaboration with the above SOCRATES / ERASMUS and MARIE CURIE) is to provide the EU nuclear community with a list of high-quality teaching modules. These modules can then be assembled into either Euromaster programmes (usually at the academic level, i.e. rather fundamental knowledge) or into higher level training packages (usually at the industrial or regulatory level, i.e. rather applied knowledge).

The proposed nuclear E&T strategy is based on the following three principles:

1. COMMON QUALIFICATION *(i.e. award a "quality label" to the proposed E&T module - a task that requires scientific skills)*

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- Quality criteria for the contents of the teaching modules and estimate of value for money, similar to the questions related to the above "Erasmus University Charter"
- Examination of students and teachers' performances ("internal" and "external" assessments, e.g. quality and quantity of staff, involvement of students, etc)
- Evaluation of practical aspects of the proposed E&T modules: e.g. pedagogy (learning and teaching process), language (English ?), e-technologies, practicals.

2. MUTUAL RECOGNITION *(i.e. the European dimension of the modular approach - a task that requires political skills)*

- Establishment of a "measurement" unit for the contents of the teaching modules (e.g. European Credit Transfer System points /ECTS/ under Bologna 1999)
- Review mechanisms by external end-users or peers, and formal acceptance by accreditation boards or "de facto" recognition by the stakeholders community
- Assembling process of the proposed E&T modules into either Euromaster programmes (one academic year = 60 ECTS) or higher-level training packages.

3. MOBILITY OF TEACHERS AND STUDENTS (*i.e. ensure practical implementation - a task that requires organisational skills)*

- Characteristics of hosting organisations (e.g. type of classrooms, laboratories, accommodation, language courses, social events)
- Organisation of technical visits to research institutions, industry, nuclear medical services or regulatory bodies
- Cost of mobility of teachers and students: what is a reasonable amount for travel and accommodation (depending on local conditions) ? who is paying for it ?

D.2 Examples of national and international "integrators" (in particular, academic networks at national level and "end-users" initiatives at European level)

In countries with strongly deregulated and privatised electricity markets, the nuclear research and training budgets both in the public and private sectors have been drastically reduced and the degree of nuclear competences might fall beneath critical level.

At the national level, in several EU countries, a set of interesting initiatives, using mixed public / private funds, was launched with the aim to compensate for declining research budgets and to ensure a fresh supply of talented graduates for recruitment. Here is a short description of some of these national initiatives.

NTEC (Dalton Nuclear Institute) and BNFL University Research Alliance in UK

In the United Kingdom, the University of Manchester's Dalton Nuclear Institute (founded in 2004) is working to set up a UK Nuclear Technology Education Consortium (NTEC) - see http://www.ntec.ac.uk/. In addition, BNFL has established strategic alliances with leading UK universities to undertake fundamental research into key areas that underpin its business. Their University Research Alliance (URA) programme consists of 4 research topics: radiochemistry (1999, with Manchester University); particle technology (2000, with Leeds University); waste immobilisation (2001, with Sheffield University) and materials performance (2002, with UMIST at Manchester) – see http://www.bnfl.com.

Kompetenzverbund Kerntechnik in Germany (distributed approach)

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In Germany, the "*Kompetenzverbund Kerntechnik*" (Alliance for Competence in Nuclear Technology) was launched in 2000, under the umbrella of BMWA, with the aim of ensuring a high-level of nuclear competence until the end of the decommissioning process of all nuclear installations. In January 2004, the electrical utilities agreed to take care of research and training through a twinning scheme, namely : RWE ⇔ Aachen region (i.e. RWTH Aachen, FH Aachen/Jülich + FZJ); EnBW ⇔ Karlsruhe / Stuttgart region (i.e. TU Karlsruhe, Univ. Stuttgart, Univ. Heidelberg + FZK); E.ON Energie ⇔ Munich region (i.e. TU München + GRS); and Vattenfall ⇔ Dresden region (TU Dresden, FH Zittau//Görlitz + FZR). More information is in http://www.grs.de/en/working_fields/research_management.html?pe_id=50.

INSTN in France and BNEN in Belgium (centralised approach)

In France, the *Institut National des Sciences et Techniques Nucléaires* (INSTN – see http://www-instn.cea.fr), a service of CEA, was created in 1956 with the aim of disseminating the knowledge produced at CEA through post-graduate education and professional training activities. In France, INSTN is the main institution authorised to deliver master degrees in nuclear fission technologies. Similarly (on a lower scale, however), in Belgium, under the impulse of the FP-5 project ENEN, five Belgian universities (two Dutch, two French, and one from Brussels) decided in 2002 to join resources to define one single curriculum for a nuclear Euromaster degree of the Bologna 1999 type, taught in English at SCK-CEN Mol (BNEN – see http://www.sckcen.be/bnen/courses.html), cosponsored by the nuclear industry.

SKC in Sweden and STUK in Finland (distributed approach)

Amongst the Scandinavian countries (Sweden, Finland, Norway, Denmark and Iceland) longstanding collaboration exists in the framework of the Nordic Nuclear Safety Research (NKS) association. In Sweden, in particular, research and training activities are financed by the Swedish Nuclear Technology Centre (SKC / see http://www.nuclear-tech-centre.org), created in the mid-1990's and composed principally of SKI, Westinghouse-Atom AB and all Swedish NPPs. Finland is faced with urgent demands for nuclear research and vocational training as a consequence of their recent decision to build a fifth NPP. Their training activities are cosponsored by industry and safety authorities (see http://www.stuk.fi/english/).

CIRTEN in Italy (distributed approach)

Even though they stopped all production of nuclear fission electricity on their territory in 1986 (despite their pioneering role in nuclear fission in the 1950's), Italy decided to maintain a high level of nuclear competence. The universities of Milano, Torino, Padova, Palermo, Pisa and Roma-la Sapienza created in 1994 the "*Consorzio Interuniversitario per la Ricerca Tecnologica sull' Energia Nucleare*" (CIRTEN) with the aim of maintaining a critical mass able to respond to international Calls for Tenders (http://www.cirten.it/).

At the European level, two associations are worth mentioning, because of their scientific interest in nuclear developments and their driving role in the nuclear fission community.

EUR. In Europe, the major electricity producers decided in 1991 to discuss common "European Utility Requirements" (EUR) and to produce a document with the aim of harmonising design targets for future advanced (evolutionary) LWRs, i.e. the so-called "Generation III$^+$" reactors. The EUR group includes 12 utilities: British Energy (UK), Suez-Tractebel (BE), Electricité de France (FR), NRG (NL), IBERDROLA (ES), VGB PowerTech (DE), SOGIN (IT), Vattenfall (SE), TVO and FORTUM (FI), Swissnuclear (CH) and Rosenergoatom (RF). Following a rather prescriptive approach, a total of approximately 4 000

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individual requirements have been fixed in the EUR documents, that deal with all the topics a utility has to address to have a LWR developed and built. The market at stake is naturally wider than Europe. EUR organised recently in collaboration with NEPTUNO an interesting Eurocourse 2005: "*Levelling the Playing Ground for New Nuclear Power Plants in Europe*" (6-10 June 2005, Helsinki, Finland) – see http://www.europeanutilityrequirements.org.

WENRA. The Western European Nuclear Regulators' Association (WENRA) was founded in 1999 and is composed of representatives from the following regulatory bodies: FANC (Belgium), STUK (Finland), ASN (France), BMU (Germany), APAT (Italy), CSN (Spain), SKI (Sweden), HSK (UK), KFD (Netherlands) and HSK (Switzerland) – recently expanded to the new EU Member States. They discuss in depth commonalities and differences between national safety requirements and develop common strategies. They focus on the following safety areas: safety management (safety policy and operating organisation); design (verification and improvement of the design); operation (beyond design basis accident management); and safety verification (probabilistic safety analysis and periodic safety review). They agreed on common "reference levels" that are in the "highest quartile" of national requirements (http://www.avn.be/uk/7_publications/9_2_articles_etudes.asp). They are also examining some of the above-mentioned EUR documents. Another interesting European integrator on the side of the regulators is EUROSAFE (group of Technical Safety Organisations) who is focusing on research and training (http://www.eurosafe-forum.org/).

E. EDUCATION AND TRAINING ACTIVITIES IN EURATOM FP-5 AND FP-6

E.1 ENEN and the "European Master of Science in Nuclear Eng." under FP-5

The first and central issue of the FP-5 (1998-2002) project ENEN (European Nuclear Education Network), made of representatives from 17 European countries including Switzerland, was to establish the degree of *European Master of Science in Nuclear Engineering*. The concept developed is compatible with the harmonised European architecture for higher education defining Bachelors and Masters degrees (Bologna 1999). The basic goal is to guarantee a high quality nuclear education in Europe by means of stimulating student and teacher exchanges, through mutual checks of the quality of the programmes offered, by close collaboration with renowned nuclear-research groups at universities and laboratories. The concept for a nuclear master programme consists of a solid basket of recommended basic nuclear science and engineering courses, but also contains advanced courses as well as practical training.

A second important issue identified is Continued Professional Development. The design of corresponding training courses responds to the needs of industry and regulatory bodies, and a specific organisation was set up to manage the quality assessment and the accreditation.

In order to achieve the important objectives and practical goals described above, the legal Association ENEN, a non-profit association under French law, was formed in September 2003 (http://www3.sckcen.be/enen/statutes.html). This international association can be considered as a step towards the creation of a virtual European Nuclear University symbolising the active collaboration between national institutions pursuing nuclear education. More details about the legal Association ENEN and the modalities for registration are given on the website www.enen-assoc.org (or can be obtained from enen.sec@cea.fr).

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E.2 NEPTUNO and the application of the ENEN scheme to other areas of nuclear fission and radiation protection under FP-6

NEPTUNO (*Nuclear European Platform of Training and University Organisations*) is a FP-6 coordination action, initiated in January 2004 for a period of 24 months (with a total budget of 0,8 M€, entirely Euratom funded) and co-ordinated by CEA-INSTN / Centre de Saclay (Paris) (http://www.sckcen.be/neptuno/). The project consortium consists of 35 partners, including 25 universities, and 10 research institutes or private companies from 19 countries. Twenty-six of the partners are also members of the above legal Association ENEN.

The NEPTUNO project brings together all aspects of European education and training in nuclear engineering, nuclear safety and other nuclear disciplines. Its main objectives are to ensure that the courses in nuclear education offered by European universities are of a high quality and are compatible with the Bologna declaration, and to harmonise professional training and accreditation schemes in the sector. The project will deliver an operational network of institutions for academic education in nuclear studies at the master, doctoral and post-doctoral level that is complemented with research organisations, regulatory bodies and industrial partners supporting research and development, bench-training and continuing professional learning schemes. A common knowledge base for nuclear fission, using multimedia, is available (http://neptuno.ike.uni-stuttgart.de/cocoon/neptuno/index.html).

A "Computer Supported Collaborative Work" platform is under development to host all activities related to the Euratom E&T activities). Its communication system integrates e-learning with conventional teaching methods and education and training actions from other European research projects (http://w2ksrvx.ike.uni-stuttgart.de/sinter_neu/index_sinter.html.

The **"***European Master of Science in Nuclear Engineering*" curriculum continues to be developed on the basis of the qualified courses offered by ENEN members and NEPTUNO partners. The qualifications and training required for key professional functions in the nuclear industry, regulatory bodies and in other relevant nuclear professions is currently assessed.

Worth mentioning is the co-operation of NEPTUNO with the World Nuclear University (WNU), an initiative of the World Nuclear Association under the umbrella of the IAEA, launched in September 2003 (http://www.world-nuclear-university.org/).

In line with the ENEN / NEPTUNO philosophy, Euratom FP-6 launched a number of nuclear E&T activities dealing with waste management, medical applications and radiation protection, such as:

*1 - Co-ordination Action on Education and Training in Radiation Protection and Radioactive Waste Management (**CETRAD,*** coordinator = University of Wales (UWC) – Cardiff School of Engineering (http://www.grc.cf.ac.uk/cetrad/)

*2 - Securing European Radiological Protection and Radioecology Competence to meet the Future Needs of Stakeholders (**EURAC**),* coordinator = Middlesex Univ. (n.priest@mdx.ac.uk)

*3 - European Master of Science Course in Radiation Biology (**MSCRB**),* coordinator = Gray Cancer Institute, Northwood, Middlesex (http://www.gci.ac.uk/education/index.htm)

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*4 - European Network on Education and Training in Radiological Protection (**ENETRAP**)*, coordinator = SCK-CEN Mol, Belgium (http://www.sckcen.be/enetrap/).

Besides the above-mentioned projects (NEPTUNO, CETRAD, EURAC, MSCRB and ENETRAP), fully dedicated to the qualification of E&T in their respective areas, it is worth mentioning the training activities proposed as work packages in some large FP-6 projects.

In the integrated project, **PERFECT** (http://fp6perfect.net/), resources are assigned for training in advanced numerical simulation tools for irradiation damage. The proposed tools will allow students to perform "virtual irradiations" on "virtual reactors" and analyse the resulting evolution of mechanical properties and microstructure. Indeed, it is almost impossible for them to carry out experiments aimed at systematically assessing the cross-influence of parameters.

In the network of excellence, **SARNET** (http://www.sar-net.org/), an education and training programme is foreseen directed at young scientists. The aim is to consolidate European excellence in the long-term in the areas of experimental and numerical simulation as well as in level 2 probabilistic safety assessment methods and in mitigation techniques related to severe accident management.

In the integrated project, **RAPHAEL** (http://w2ksrvx.ike.uni-stuttgart.de/ghtrn/), a number of major industrial issues are discussed in connection with future energy policies (e.g. energy and fresh water supply, climate change, natural resource preservation). Special attention will be paid to education in innovative nuclear heat production technologies and communication with the public at large.

In the integrated project, **EUROTRANS** (http://nuklear-server.fzk.de/Eurotrans/), there are 17 universities, represented by the above mentioned ENEN Association. An important goal of this project is to provide education and training (E&T) in advanced innovative nuclear systems to young researchers. At least 5% of the budget in each domain is assigned to PhD students, whereas an additional 300 k€ is reserved exclusively for E&T activities.

F. The 7th EC research FP (2007-2013) and the 7th Euratom FP (2007-2011)

On 6 April 2005 the European Commission announced its proposals for the Seventh Framework Programme 2007-2013 (FP-7) for EC and Euratom research, accompanied by a Communication setting out the policy objectives, "*Building the ERA of knowledge for growth*". The proposal provides new impetus to increase Europe's growth and competitiveness, recognising that knowledge is Europe's greatest resource. The programme places greater emphasis than in the past on research that is relevant to the needs of European industry, to help it compete internationally, and to develop its role as a world leader in certain sectors – see http://www.cordis.lu/fp7/.

On 21 September 2005 the European Commission approved its proposals concerning the Specific Programmes implementing the **Seventh Framework Programme (2007-2013) of the European Community for research, technological development and demonstration activities**: Cooperation, Ideas, People, Capacities and by the JRC.

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The Commission identified six potential themes around which Joint Technology Initiatives (JTIs) could be established. To prepare this proposal, a previous Communication noted that, "*at the initiative of the Commission and industry, "Technology Platforms" are being set up, which bring together companies, research institutions, the financial world and the regulatory authorities at the European level to define a common research agenda which should mobilise a critical mass of - national and European - public and private resources*." - see http://www.cordis.lu/technology-platforms/.

On 21 September 2005, the EC approved also the Euratom specific programme for direct (DG JRC) and indirect (DG RTD) research actions. The objectives of the **Seventh Framework Programme (2007-2011) of the European Atomic Energy Community (Euratom) for nuclear research and training activities** are the following:

- to establish a sound scientific and technical basis for the safe long-term management of hazardous radioactive waste
- to promote safer, more resource-efficient and competitive exploitation of nuclear energy
- to ensure a robust and socially acceptable system of protection of man & the environment against the effects of ionising radiation.

The main areas proposed are as follows:

- geological disposal of long-lived radioactive waste and the reduction of toxicity of radioactive waste through partitioning and transmutation
- operational safety of existing reactor systems and the potential of future reactor systems for safer, more efficient power plants and competitive nuclear industry
- radiation protection – especially risks from low doses, medical uses, emergency management and mitigation of the impact of radiological terrorism.

Key cross-cutting activities are:

- support for research infrastructures
- retaining competence and know-how in all areas of nuclear science.

This is, however, the very preliminary stage: the final decision is pending on the budgetary discussions of the European Council and Parliament (to be finalised in late 2006).

G. CONCLUSION

This paper discusses the objectives and some preliminary achievements of a European strategy for nuclear knowledge management, based on the "*knowledge triangle*" (i.e. research, education and innovation), proposed by Science and Research Commissioner, Janez Potočnik. The emphasis is on the component "education". A European education and training strategy is proposed with the aim to ensure "common qualification, mutual recognition and mobility of scientists". As the three "historical" success criteria for any European policy (i.e. common needs, a shared vision and implementation instruments) are satisfied, the strategy proposed for nuclear E&T looks quite promising. A number of achievements under FP-6 were presented. More is available in http://europa.eu.int/comm/research/energy/pdf/nuclear_fission_en.pdf).

It is worth recalling, however, that, at European level, strictly speaking, education (in particular, higher education) is not subject of a « common European policy » : **competence for the content and the organisation of studies remains at national level**. The Community,

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however, has a complementary role to play: *to add a European dimension to education, to help to develop quality education and to encourage life-long learning* (see Article 149 under "Education, vocational training and youth", Nice Treaty, *OJ C 325 of 24/12/2002*).

Besides the framework programme instruments, the implementation of the strategy proposed for nuclear knowledge management should take advantage of synergies of public and private initiatives (so-called "integrators" discussed in the paper). Public initiatives, usually for education, are proposed by the governments and by the EC. Private initiatives, usually for training, are proposed by industry in partnership with research institutions.

Community research may help solve some of the current nuclear challenges. The success or failure of Community research depends largely on the stakeholders' participation. The main stakeholders are represented around the central cycle "research – education – innovation" of Figure 2 below. Some participants in the Euratom Framework Programme have made a cost/benefit analysis of their participation in Community research actions: what is the "value for money" or are there other benefits in EU programmes ? It is worth reporting the conclusion of a large European utility: *"To give an idea of the quantitative benefits which can be obtained from sharing costs in the framework of European programmes, we can mention a few illustrative figures: in the nuclear field, in 2002, we brought about 3,5 M€ and got access to R&D results worth 36 M€. This factor of 10 is obviously a strong incentive for a utility to get actively involved in the European Research Area !"* (introductory lecture at the FISA-2003 Symposium / EC Luxembourg, November 10-13, 2003 / OPOCE Luxembourg 2004 – see http://www.cordis.lu/fp5-euratom/src/ev-fisa2003.htm). Nuclear E&T will be further discussed at FISA-2006 together with the current (GEN II and III) and future (GEN IV) reactor systems – see http://www.cordis.lu/fp6-euratom/events.htm (13-16 March 2006).

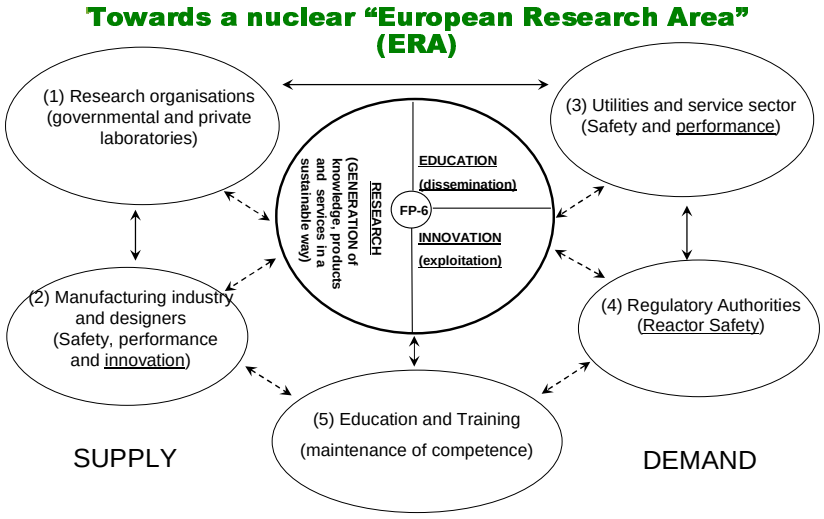

Figure 2 – Role of stakeholders in nuclear research, education and innovation