

EUROPEAN MASTER OF SCIENCE IN NUCLEAR ENGINEERING

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Abstract. The need to preserve, enhance or strengthen nuclear knowledge is worldwide recognised since a couple of years. It appears that within the European university education and training network, nuclear engineering is presently sufficiently covered, although somewhat fragmented.

To take up the challenges of offering top quality, new, attractive and relevant curricula, higher education institutions should cooperate with industry, regulatory bodies and research centres, and more appropriate funding a.o. from public and private is to be re-established. More, European nuclear education and training should benefit from links with international organisations like IAEA, OECD-NEA and others, and should include world-wide cooperation with academic institutions and research centres.

The European master in nuclear engineering guarantees a high quality nuclear education in Europe by means of stimulating student and instructor exchange, 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. Some of the advanced courses also serve as part of the curricula for doctoral programmes.

A second important issue identified is Continued Professional Development.

In order to achieve the objectives and practical goals described above, the ENEN association was formed. This international, non-profit association is to be considered as a step towards a

virtual European Nuclear University symbolising the active collaboration between various national institutions pursuing nuclear education.

1. ENEN - European Nuclear Engineering Network

Within the 5th Euratom research and training programme on nuclear energy (1998 – 2002), the European Commission supported a project on nuclear engineering education. A representative cross section of academic institutions and research laboratories of the EU-25 participated.

The major outcomes of the project are:

A coherent and practical concept for a *European Master of Science in Nuclear Engineering*, compatible with the Bologna philosophy in Europe.

The ENEN partners organised themselves in a sustainable *non-profit-making association called ENEN*, European nuclear education network, to deliver the European Master of Science degree, to promote PhD studies in nuclear engineering, to encourage exchange of students and teachers participating in the network, to establish a framework for mutual recognition, to foster and strengthen the relationship with research laboratories, industry and regulatory bodies.

The *pilot sessions* on nuclear engineering education performed within the ENEN-project evidenced processes of *qualification, mutual recognition and mobility*.

The present day reflections on nuclear knowledge management and the different initiatives taken, definitely catalyse networking in the nuclear education and training domain. *The approach stimulates in an organic fashion, the proces of identifying centres of excellence in the different disciplines of nuclear education and training*. The approach also stimulates related disciplines e.g. radiation protection to develop similar strategies.

2. European master of science in nuclear engineering

Based upon a year-long exchange of views between the partners of ENEN, a coherent and practical concept for a European master of science in nuclear energy emerged. The concept is compatible with the Bologna philosophy of higher education for academic engineers in Europe, a bachelor of science after six full-time semesters and a master of science after a further four full-time semesters.

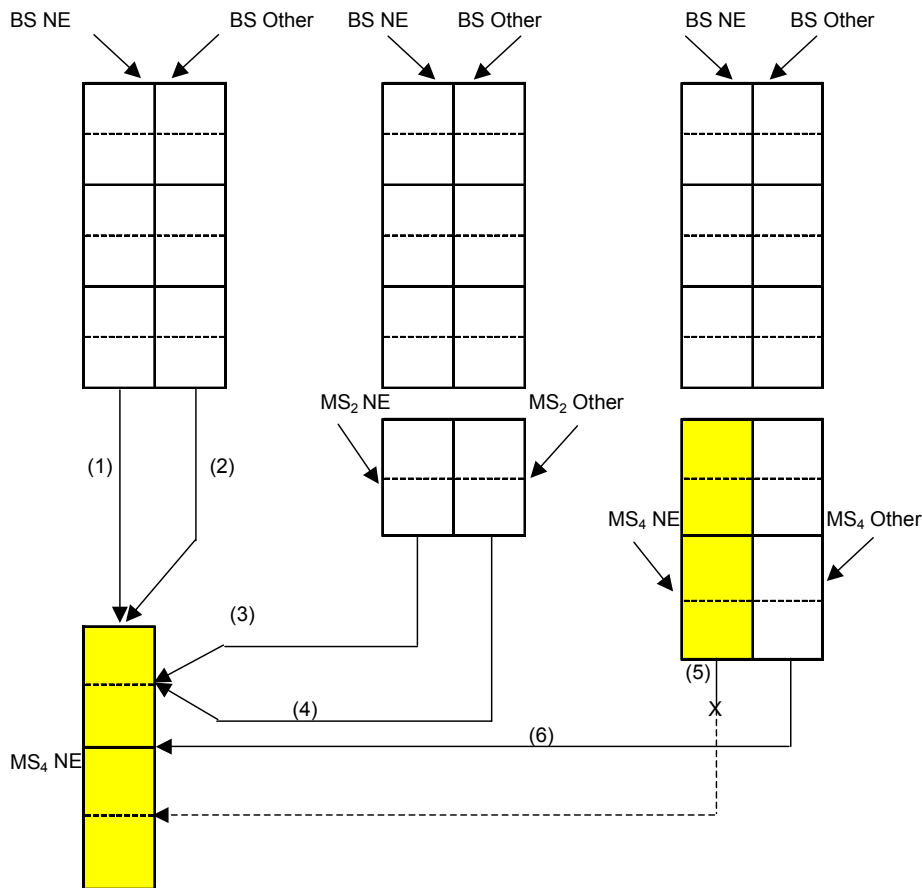
A master of science in nuclear engineering can only be granted after having obtained a full-time load of ten semesters beyond secondary or in other words 300 credits engineering academic level studies. One credit amounts to a student load of about 30 hours and a full semester corresponds to 30 credits or about 900 load hours. A minimum of two semesters equivalent or 60 credits must be obtained in strictly nuclear subjects.

Students register in one ENEN-accredited "home" institution. The home institution grants the formal degree of master of science in nuclear engineering, based upon the formal recognition of credits, very much similar to the ERASMUS philosophy. The quality label *European master of science in nuclear engineering* is granted if a substantial amount (some 20 to 30) of credits have been followed at an ENEN-institution other than the home institution. Typically these credits might be obtained by performing "abroad" the project work or master thesis, topped up with some related advanced courses.

European Master of Science in Nuclear Engineering

Minimal Requirements for EMSNE:

- At least 300 ECTS university-level study
- At least 60 ECTS purely nuclear engineering (NE) oriented
- At least 30 ECTS in other ENEN institution than "home institution"



- (1) 48-60 ECTS non NE; 48-60 ECTS NE (partly tradeable); 12-24 ECTS Thesis (NE);
 (2) 48-60 ECTS non NE; 48-60 ECTS NE; 12-24 ECTS Thesis (NE)
 (3) 24-30 ECTS non NE; 48-54 ECTS NE (partly tradeable); 12-18 ECTS Thesis (NE);
 (4) 24-30 ECTS non NE; 48-54 ECTS NE; 12-18 ECTS Thesis (NE)
 (5) only for "European" quality label; extra 30 ECTS "abroad"
 (6) 42-48 ECTS NE; 12-18 ECTS Thesis

Figure 1 Typical full program variations.

3. Evidencing the processes of qualification, mutual recognition and mobility

The processes of qualification, mutual recognition and mobility are evidenced by successful programmes. Spring 2003, some 20 students from about 10 countries, participated in the "Eugene Wigner" course; mainly performing nuclear reactor physics experiments under stewardship of the universities of Budapest, Bratislava, Prague and Vienna. The ENEN partners rated the course between 6 to 8 credits or an equivalent student load of some 180 to 240 hours. The course was successfully organised again in 2004. See http://www.reak.bme.hu/nti/Education/Wigner_Course/index.htm

Fall 2003, the courses on Nuclear Thermal Hydraulics, 6 credits and Nuclear Reactor theory, 8 credits, both part of the Belgian interuniversity program on nuclear engineering were

organised in a residential way to facilitate participation of "foreign" students. The calendar of the Belgian "additional master" program in nuclear engineering (BNEN) for the upcoming academic year is even more modularly structured to facilitate and enhance participation of foreign students and professors. BNEN is an interuniversity initiative of five Belgian university and the Belgian nuclear research center. The programme, taught in English, extensively benefits from the staff, the research programs, the laboratories and the lodging facilities of the Belgian nuclear research center. See <http://www.sckcen.be/BNEN>

4. The ENEN – association

The ENEN partners organised themselves in a sustainable non-profit-making organisation called ENEN, European nuclear education network, to deliver the European master of science degree, to promote PhD studies in nuclear engineering, to encourage exchange of students and teachers participating in the network, to establish a framework for mutual recognition, to foster and strengthen the relationship with research laboratories, industry and regulatory bodies. See <http://www.enen-assoc.org>

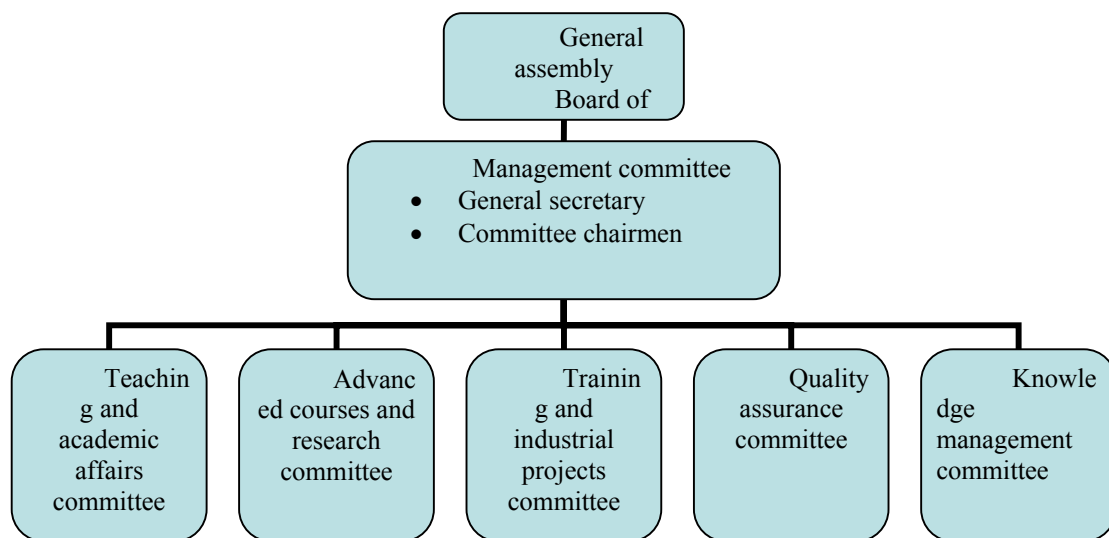


Figure 2 Simplified organizational chart of the ENEN-association.

The *general assembly* is composed of all members. Eight members reside in the *Board*. The *general secretary* performs the day-to-day management and chairs the management committee.

The *teaching and academic affairs committee* defines the way to implement the degree of "European master of science in nuclear engineering", this means amongst others: to establish the equivalence between the curricula in nuclear engineering education and credits, to approve the equivalence of admission criteria and to define the mandatory courses corresponding to the student's background.

The *advanced courses and research committee* ensures the link between ENEN members and research laboratories. It identifies master thesis opportunities in research centres and industry, encouraging student mobility. The committee also pushes ahead PhD research, advanced courses and summer schools.

The *training and industrial projects committee* identifies the industrial needs for continued professional development and organises corresponding training sessions and courses.

The *quality assurance committee* examines the quality assurance practices adopted in each member institution. It monitors the quality of current and proposed members.

The *knowledge management committee* identifies and monitors deficiencies in scientific knowledge relevant to nuclear technology and safety. It prepares, maintains and implements a

nuclear scientific knowledge preservation plan a.o. publishing (new) books on relevant subjects for students and engineers working in the nuclear field.

More, although in early youth, the ENEN association is recognised as a strong partner in nuclear power technology education by the Asian network for education in nuclear technology (ANENT). The ENEN association implements the "training and education" packages in Euratom sponsored research projects e.g. Eurotrans.

5. NEPTUNO – Education and training in nuclear engineering and safety

Within the 6th Euratom research and training programme on nuclear energy, the European Commission supports the project: "Nuclear European Platform of Training and University Organisations, NEPTUNO". See <http://www.sckcen.be/NEPTUNO>. NEPTUNO strives for education and training in the perspective of Continued Professional Development. The rationale is based on internationalisation and globalisation of the nuclear industry and nuclear energy production. Within NEPTUNO, proposals are formulated for best practices for mobility, accreditation and recognition of qualified licensed staff and in general all staff needing some form of education, schooling or training before operating in the nuclear industry. The ongoing trends towards co-operation between training organisations, research institutes and academia are facilitated. Amongst others, attention is also given to the re-training of trainers and to modular schemes for staff not requiring the full academic program, in other words contributing to life long learning schemes. "Training" is the terminology used in the NEPTUNO initiative to describe the schooling activities other than the regular academic education schemes. The NEPTUNO project strives for training (technicians, engineers) and education (master, PhD, post-doctoral) on equal terms of quality.

6. Conclusion

The present day reflections on nuclear knowledge management and the different initiatives taken, definitely catalyse networking in the nuclear education and training domain, internally in several countries as well as on inter-academic level as between academia, research centres, regulatory bodies and utilities. Examples can be identified in a.o. Belgium, Germany, Slovakia, Slovenia, Spain, Sweden, United Kingdom, Asia, ...

The approach stimulates in an organic fashion, the process of identifying centres of excellence in the different disciplines of nuclear education and training. The approach also stimulates related disciplines e.g. radiation protection to develop similar strategies.

However, the key question remains: "Do we attract more of the better students?". Although the process is still too young to draw solid conclusions, preliminary observations indicate a positive evolution as well in quantity as in quality of students.

Acknowledgement

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ENEN project – partners: Belgian Nuclear Research Centre (B), Budapest University of Technology and Economics (HU), Czech Technical University (CZ), Institut "Josef Stefan" (SI), CEA-INSTN (F), Kungl Tekniska Högskolan (S), K.U.Leuven Research and Development (B), Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare (I), Universiteit Gent (B), Slovak University of Technology (SK), Swiss Federal Institute of Technology Zürich (CH), Delft University of Technology (NL), Helsinki University of Technology (SF), Atominstitut der Österreichischen Universitäten (A), Université Catholique de Louvain (B), University of Birmingham (UK), University Politehnica of Bucharest (RO), Universidad Politecnica de Madrid (E), National Technical University of Athens (EL), Technische Universität München (D), Ustav jaderného vyzkumu REZ (CZ), Centre of Technology and Engineering for Nuclear Projects (RO).

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