

SUCCESS FACTORS OF INTERNATIONAL EDUCATION AND TRAINING NETWORKS

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ABSTRACT

In the last decade, several international education and training networks have been established in the nuclear field, striving to support – in general terms – the availability of qualified human resources in nuclear facilities (including research centers). Recently, several cooperation agreements have been signed between different networks with the aim to further boost the impact and effectiveness of their work. The networks have become active in different geographical regions of the world, and their creation has been supported by different international organizations. Consequently, for stakeholders in the nuclear field it is increasingly difficult to receive an overview, and to differentiate substantially between the education and training impacts on their own human resource issues.

In order to present an overview and a clearer view on existing education and training networks, and to assess the potential benefits of their work for concerned stakeholders, this paper presents 2 examples (European Nuclear Education Network / ENEN, European Fusion Education Network / FuseNet), comparing their history, their target groups and their members, their mission and objectives, their activities and working mechanisms, as well as their information and communication (websites).

The objective is to develop criteria and in particular success factors that may provide guidance for further development of international education and training networks.

1. Introduction

The Lisbon EU 2000 summit proposed the strategic goal for the European Union to become the most competitive knowledge-based economy with more and better employment and social cohesion by 2010. It said: “Although the number of nuclear scientist and technologist 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 programs 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.”

Consequently, different developments in the last decade made it necessary to enhance the capabilities of existing education and training institutions in Europe. For example, activities were undertaken to further harmonize educational curricula in Europe (Bologna and Copenhagen process) aiming at facilitating international mobility of the labor work force and enabling lifelong learning paths in response to continuous development of businesses and industries.

Driven by different challenges in the nuclear fission area – expected shortages of human resources and their competences for new built, plant modernization or decommissioning projects – and in the fusion area – expected shortages of human resources and their competences for the path to fusion power -, the European Union undertook appropriate actions early enough to meet these challenges.

Funded by different projects in Framework EC Programs (FP) 5 and 7, the implementation of education and training networks was supported by the European Commission. Two examples are presented in this paper; they shall serve to present at an overview level their missions and objectives, their working mechanisms, and their contribution to meeting the challenges as mentioned above:

ENEN - the European Nuclear Education Network,
FuseNet - the European Fusion Education Network.

This systematic overview shall serve for appropriate conclusions and a better assessment of other education and training networks.

2. History of networks

ENEN:

The “European Nuclear Engineering Network” (ENEN) project was launched under FP5 in January 2002, with the involvement of 18 European universities and 4 research institutions from 18 countries. Its main objectives were

- to deliver a European MSc degree in nuclear engineering and promote PhD studies,
- to promote the 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 European Nuclear Education Network (ENEN) Association was established afterwards by the partners of the project. It was given a more permanent character and a legal status by the foundation of the ENEN Association, a nonprofit international organization, on 22 September 2003 under the French law of 1901. Currently its executive office is hosted by the Institut National des Sciences et Techniques Nucleaires at the Commissariat à l'énergie atomique et aux énergies alternatives (CEA), Saclay site in Paris.

FuseNet:

The “European Fusion Education Network” (FuseNet) Project started in October 2008 as a Coordination and Support Action under FP7. The project consisted of eleven work packages, with a total budget of €2 Million. The project ran until October 2013 and has brought together a representation from the European fusion community with 36 participants from 18 countries, of which 22 Universities and 14 EURATOM research associations.

The project consisted of four groups of coordination actions:

- the establishment and running of the FuseNet network;
- development of individual learning opportunities and common educational goals;
- development of educational materials and hands-on experiments;
- and funding of joint educational activities

In continuation of the project, the FuseNet Association was founded in December 2010 under Dutch law as an independent legal entity. Currently its executive office is hosted by the Eindhoven University of Technology, Fusion / Applied Physics Department.

In summary, both networks were founded on the basis of research and development projects funded by the EU. The clear benefit of this approach was that during the course of the projects this enabled the founding members to develop a common understanding on the mission and objectives of the networks to be created. In parallel tangible results were developed that could then be further used by the new networks. Furthermore, the projects helped substantially in building international networks of different institutions that had a common high interest in education and training issues in their respective subject matter area, while relying greatly on the personal relationships built up during project execution.

3. Target groups and members

ENEN:

Currently there are 67 members of the ENEN association. The members are public or private corporate bodies that have a legal status, namely universities, research organizations, nuclear industry, and/or any other organizations involved in the application of nuclear science and ionizing radiation.

The members provide academic or professional education and training in the application of nuclear science and ionizing radiation, and/or commit themselves to supporting the ENEN Association, have a firmly established tradition of relations with some of the members in the fields of education, research and training, and are based in the European Union or in one of its associated or candidate member countries.

One has to distinguish between normal members / member institutions from outside Europe without voting rights / international institutions without voting rights. The last two member types must have a Memorandum of Understanding in place with ENEN, e.g. the Tokyo Institute of Technology, the International Atomic Energy Agency, or FuseNet. All members could also be grouped into the categories “education and training providers” and “end users”.

Members are located mainly in EU member states where nuclear energy contributes to a large extent to the provision of electrical energy; however, including also institutions from Japan, Russia, South Africa, Ukraine that are connected to ENEN via memorandums of understanding.

FuseNet:

Currently there are 59 members of the FuseNet association. They include university members, research institute members, industrial or other organization members (like the ITER Organization), but may also be grouped into the categories “education and training providers” and “end users”.

In regards to education, FuseNet activities shall address all education levels, from Master and PhD students to Post-docs. By the connection to industry, FuseNet wants to close the bridge between the educational system and the engineering needs in industry, aiming at developing a new generation of high quality students that are ready for large projects such as ITER, Wendelstein 7-X, or DEMO¹.

¹ See, e.g. <https://www.euro-fusion.org/programme/>

As fusion related research and development is undertaken in nearly all EU member states, either by research centers or directly by universities, members are distributed nearly homogeneously over the EU.

4. Objectives of networks

ENEN:

The mission of ENEN is the preservation and the further development of expertise in the nuclear fields by higher Education and Training.

Consequently, ENEN activities shall achieve the following objectives:

With respect to the education and training providers:

- to develop a more harmonized approach for education in the nuclear sciences and nuclear engineering in Europe,
- to integrate European education and training in nuclear safety and radiation protection,
- to achieve better co-operation and sharing of academic resources and capabilities at the national and international level.

With respect to the end users, such as nuclear industries, research centers, regulatory bodies and nuclear applications:

- to create and maintain a sustainable basis of nuclear competences in the EU,
- to maintain an adequate supply of qualified human resources for design, construction, operation, maintenance, and decommissioning of nuclear infrastructures, industries and power plants,
- to maintain the necessary competence and expertise for the continued safe use of nuclear energy and applications of ionizing radiation and nuclear techniques in agriculture, industry and medicine.

FuseNet:

The mission of FuseNet is to stimulate, coordinate and enable the best possible fusion education in Europe with the aim to enhance the expertise in the fusion area by higher Education and Training.

Consequently, FuseNet activities shall achieve the following objectives:

With respect to the education and training providers:

- to coordinate and facilitate fusion education in Europe,
- to share best practices
- to jointly develop educational tools,
- to jointly organize educational events,
- to provide matchmaking services with the end users.

With respect to the end users, such as industries, research centers, regulatory bodies and further fusion related organizations:

- to initiate research collaboration for PhD students,
- to support individual learning opportunities,
- to mediate internships for students,
- to identify fusion related competence needs and to initiate appropriate remedial measures.

In addition, the students have a central role in the FuseNet view and the student support schemes are the most visible and successful activities of FuseNet, with the aim to attract the best students and stimulate them to have access to excellent education.

With its current wide membership and support, and based on the specific competences on education and training embodied by its members, FuseNet can be considered as the European umbrella organization on fusion related education and training.

5. Activities of networks and working mechanisms

Both associations have as general structure a *General Assembly* (GA) that meets annually (in February / March), elects the members of the *Board of Governors* (BoG), and is the highest institution for deciding generally on the association, and in particular on its recurrent and specific annual activities. The BoG manages the association in the period between the GAs, it is led by a President (ENEN) respectively by the Chair (FuseNet), supported by the Executive Office (located at the site of the association) and a Secretary General.

The central hubs of information and communication (with private areas reserved for the normal and for the BoG members) are implemented via the respective web sites:

ENEN: <http://www.enen-assoc.org/>

FuseNet: <http://www.fusenet.eu/>

Apart from the basic operations that are mainly funded by the membership fees and that are needed to keep the associations alive, the activities of the associations, through which they aim to implement their mission and achieve their objectives, may be classified as follows:

- a) Delivering certificates for Masters or even PhD theses based on specific criteria, with the purpose to stimulate international education or training activities while introducing a uniform high quality standard that make 'nuclear engineering' or 'fusion' a quality brand apart from a specialization,
- b) Live meetings of members (GA preceded by a special event that is dedicated to a specific education and training topic) as well as of Masters or PhD students, e.g. in connection with a conference and handing over the certificates,
- c) Specific projects that will contribute to achieving the objectives of the associations, and that are funded by external sources, providing a unique opportunity for the members to cooperate while also following their own specific interests in education and training.

ENEN:

The General Assembly 2015 decided on an Action Plan for 2015-2016, for its implementation six Working Areas have been defined for the period 2015-2016:

1. ENEN Management Area
2. Quality Assurance Area
3. Teaching and Academic Affairs Area
4. Advanced Courses and Research Area
5. Training and Industrial Projects Area
6. Knowledge Management Area

As for activity class a):

ENEN awards the *European Master of Science in Nuclear Engineering* (EMSNE)², i.e. a certificate, if a set of requirements have been fulfilled, namely at least 5 years university education, at least 60 ECTS must be "purely nuclear", 20 ECTS must be obtained from a "foreign" (different country) institution that is a member of ENEN, Masters thesis.

Furthermore, an *ENEN PhD Prize*³ is awarded to young scientists that start their career finishing their PhD. The prize is based on the judgment of a jury that evaluates submitted papers and the live presentations of the respective PhD theses during the *ENEN PhD Event*.

² See <http://www.enen-assoc.org/en/emsne/information.html>

³ See <http://www.enen-assoc.org/en/phd/announcement.html>

As for activity class b):

In 2016, the GA was hosted by the European Commission JRC-IRMM in Geel, Belgium, providing the opportunity for a technical visit of the IRMM, in addition to the Special Event (presentations by invited speakers) on “E-learning and MOOCs for nuclear education and training, preparing for ANNETTE”.

As for the EMSNE laureates, each year they receive the Certification diplomas in a relevant ceremony. In previous years this ceremony has been held, with the support of the IAEA Nuclear Knowledge Management section, as a side event of the IAEA General Conference, in Vienna, Austria.

The *ENEN PhD Event* is a 1-2 days session where 10-12 PhD Finalists, nominated by ENEN Members and selected by the ENEN PhD Prize Jury, present their research in a competitive but friendly environment.

As for activity class c):

Currently ENEN is involved in 4 education and training projects (ANNETTE, NUSHARE, PETRUS III, EUJEP 2)⁴, all funded by the European Commission as Coordination and Support Actions, ENEN being the Project Coordinator while (some) ENEN members participate as partners in a project specific consortium.

FuseNet:

The General Assembly 2015 decided on Work Packages to be implemented in the period 2016 – 2017, see below. They are divided into a set of core activities (Basic Operations) and all other activities (Extended Operations), and each one is managed by its own Work Package leader. The Basic Operations are largely covered by the membership fees. The Extended Operations are intended to further achieve the objectives of the association and initiate, coordinate and execute activities for the benefit of fusion education and training in Europe. FuseNet looks for external sources to fund these activities, currently this is done by EUROfusion and the European Commission.

Basic Operations (Recurrent)

WP1 Management and Support

WP2 Funding Opportunities

WP3 Website and Outreach

WP4 Academic Council

Extended Operations - EUROfusion contract B

WP5 Organization of annual Fusion PhD event

WP6 Support to PhD students

WP7 Support to the development of new educational activities

WP8 Development of Joint Educational Tools

WP9 Industry and Training

WP10 Consultancy for PhD programs

WP11 Support to Master students

Extended Operations - ANNETTE (EC) Project

ANN ANNETTE Project

As for activity class a):

FuseNet has established academic criteria for the award of European Fusion Doctorate and Master Certificates. The purpose of these criteria is to stimulate a high level of fusion educa-

⁴ For more information on these projects, see <http://www.enen-assoc.org/en/training.html>

tion throughout Europe, introducing a uniform high quality standard that make 'fusion' a quality brand apart from a specialization.

Here, the Academic Council of FuseNet advises on all academic matters, including the joint criteria for the European Fusion Master and Doctorate and the accreditation of educational institutions or individual theses according to the joint criteria.

Furthermore, within Europe there are several doctoral training networks in the field of fusion. Whereas these networks are quite distinct in character, geographical spread and funding structure, there are also strong links between them through FuseNet, as representatives of these networks are members of the FuseNet BoG. All training networks comply with the joint criteria for the award of the European Fusion doctorate certificate, namely the

- Fusion Doctoral Training Network (UK),
- Erasmus Mundus Fusion Doctoral College (Universities from Gent, Madrid, Stuttgart, Lorraine),
- European Doctoral Network (Padova-Lisbon-Munich).

As for activity class b):

In 2016, the GA was hosted by the ITER Organization in Cadarache, France, providing the opportunity for a visit of the ITER construction site.

The European Fusion Master and Doctorate certificates are handed out to nominated European students that obtained a Master or PhD diploma in Fusion Science and Technology and that have fulfilled the related criteria. The ceremony is held at a fusion related site in combination with a specific event, e.g. in 2015 after the GA in JET, Culham, UK.

Additionally, FuseNet coordinates and supports the organization of the annual FuseNet PhD event. The events provide an opportunity for European PhD students to discuss their work with each other and with researchers from the international fusion community, and it gives them the opportunity to make useful contacts for their professional career. The 2015 edition of the event was organized by Czech Technical University in Prague, Czech Republic. With an attendance of 130 PhD students, the fifth FuseNet PhD event in fusion science and engineering was the largest up to date.

As for activity class c):

Currently several activities of FuseNet are funded via a contract awarded by EUROfusion, see list of Work Packages above. These mainly deal with activities that are closely connected to fusion master and PhD students, e.g. the certificates and events already mentioned, but also the financial support to students to give them access to excellent training and educational activities.

Here, another important Work Package deals with industry, with the objective to involve fusion related industry in the training of engineers and students, and to establish links and collaboration with industry to identify short / middle / long term education and training needs.

Finally, FuseNet also executes a Work Package of the ANNETTE⁵ project, namely the nuclearization of fusion – an important issue with high impact on design and construction of fusion power facilities.

⁵ See for example <http://www.fusenet.eu/node/1073>

6. Network information and communication (websites)

ENEN:

The website provides important information about ENEN – its mission and objectives, its activities (in particular the projects it is involved in), its members and its international partnerships. Furthermore it provides information about future important education and training events, e.g. conferences or summer schools. And finally the ENEN database allows users to search for education and training courses that are offered by ENEN members.

As a matter of course, it also provides a private space where information for normal or BoG members is made available.

In parallel to the ENEN web site, ENEN runs a dedicated channel on YouTube, as well as Facebook, Google+ and Twitter accounts.

FuseNet:

As in the case of ENEN, the website provides important information about FuseNet – its mission and objectives, its activities (in particular the projects it is involved in), its members and its international partnerships. Furthermore it provides information about future important education and training events, e.g. conferences or summer schools, but also a lot of information about bachelor and masters study opportunities, PhD and PostDoc positions, etc. You can also find teaching materials here, and you can learn about the possibilities to get financial support.

The website also serves as the matchmaking platform where students can find industrial internships, as well as places where fusion PhD and PostDoc positions are advertised. All information on other activities of FuseNet may be found on the web site, too. Finally, the web site presents articles on recent developments in fusion, ‘eye-witness reports’ of participants in FuseNet activities, ‘photo-of-the-month’ etc.

Like with ENEN, it also provides a private space where information for normal or BoG members is made available.

Also FuseNet can be connected to via Facebook, and can be followed via Twitter. In addition, the FuseNet web site allows users to register and to open a blog, or to post comments.

7. Conclusions

Assessing education and training networks that are aiming at developing and maintaining competences of human resources in a specific technical domain – as presented in this paper - the following factors appear to be crucial for their success:

1. Public education and training related activities that provide appropriate diploma or certificates in line with the network’s mission,
2. An effective, up-to-date hub of information and possibly also communication between the members and outsiders,
3. Projects in which members of the network are involved in, and that develop tangible results to achieve the network’s objectives.

Ensuring the success of an education and training network certainly requires the engagement of their members. Although the effectiveness of an executive office will contribute to a great deal, this effort – the basic operation - can only be funded partially by the membership fees. Consequently, the network must be involved in externally funded projects that are in-line with its objectives. Currently, only this mechanism supports the long-term operation of the network.

As regards ENEN and FuseNet, the presentation in this paper shows that their long-term operation definitely will contribute successfully to the long-term sustainability of human com-

petences in the area of nuclear and fusion, assuming long-term availability of projects or more sustainable funding.

Finally, the scheme used in this paper can be applied to assess other education and training networks, possibly also to identify areas of further improvement.

In closing this paper it is worth mentioning that ENEN and FuseNet signed a Memorandum of Understanding in Culham, UK, in February 2015. This represented an important step for the cooperation of the two networks, which are aiming at leading education and training in the two respective nuclear fields in Europe in the years to come.