Project Final Report

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Classification* / Dissemination level:

- **PU =** Public
- **PP =** Restricted to other programme participants (including the Commission Services)
- **RE =** Restricted to a group specified by the consortium (including the Commission Services)
- **CO** = Confidential, only for members of the consortium (including the Commission Services)

Change Control

Version	Date	Author	Organisation	Main change(s) made
1.0	29-08-2016	Ni Yan	TUD	First draft version
1.1	30-01-2017	Rudy Konings	TUD/JRC	Complete draft version
1.2	01-02-2017	Jan Leen Kloosterman	TUD	Review draft
1.3	10-02-2017	Ni Yan	TUD	Finalise report
1.4	14-02-2017	Alan Tkaczyk	UT	Review
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FRONT PAGE

PROJECT FINAL REPORT

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Table of Contents

1 Final publishable summary report

1.1. Executive summary

The GENTLE coordination and Support Action is a joint effort by leading academic and research institutions in Europe to coordinate an E&T programme in the field of nuclear fission technology. The project has been executed in the period 2013 to 2016 during which it has contributed to lifelong learning in the field of Nuclear Fission Technology. The GENTLE consortium has successfully implemented the following E&T tools:

- Student research experiences (SREs), which have facilitated students from the universities to have hands-on experience in Europe's unique and specialised academic and research laboratories and participate to cutting-edge research. During the course of the project 76 students participated to the SRE program.

- Inter-semester courses for graduate and post graduate students on special industry related topics, which were provided by academics and specialists from research and industry. Seven courses were developed and organised during the course of the project.

- A Massive open online course (MOOC), which has allowed hundreds of learners worldwide to enhance their knowledge and understanding of nuclear reactors and fuel cycles. The MOOC was hosted on the edX platform from October to December 2016.

The continuation of these tools beyond the GENTLE is partially guaranteed. The SRE concept is an important element in the ENEN+ and ELINDER proposals for the 2016 H2020 Euratom call. Some of the inter-semester courses will be continued by the organising GENTLE consortium members. The MOOC will continue to be available on the edX platform, and will start as a self-paced course in March 2017.

1.2. Summary description of project context and objectives

The project was designed in 2011, in a time when several organisations (OECD/NEA, IAEA, G8, European Commission) expressed their worries about the development of the nuclear workforce in Europe, and other developed countries. Highly skilled and well informed workers are essential to maintain the current civil nuclear reactor fleet safely, decommission obsolete plants, be involved in new build where policy dictates, and deal with the legacy and future radioactive waste. These concerns are well summarized in the in the OECD/NEA report[1] *"Nuclear Training and Education. Cause for Concern?".* They led the Council of the European Union to conclude that it "*is of the view that it is essential to maintain in the European Union a high level of training in the nuclear field*"[2]. Also the Working Group on Education, Training and Knowledge Management (ETKM) of the Sustainable Nuclear Energy Technology Platform (SNETP) recognised the risks of loss of nuclear knowledge if no measures are taken, and stressed the need for involvement and cooperation between key public and private organisations and stakeholders in the field of Training and Education.[3]

[1] http://www.nea.fr/ndd/reports/2000/nea2428-education.pdf
[2] http://register.consilium.europa.eu/pdf/en/08/st15/st15406.en08.pdf
[3] Nuclear Education and Training. Key elements of a Sustainable European strategy. www.SNETP.eu

In the light of this, the GENTLE Coordination and Support Action, a joint effort by leading academic and research institutions in Europe, was proposed in the frame of the Euratom Fission Training Schemes to coordinate an E&T programme in the field of nuclear fission technology. The overall objective of the project was to create a sustainable lifelong E&T programme in the field of Nuclear Fission Technology that meets the needs of the European stakeholders from industry, research and technical safety organisations. The specific goals of the GENTLE project, which were adjusted to the new reality of the nuclear industry in Europe after the Fukushima disaster, were the successful implementation of the following joint E&T tools:

- Student research experience projects (SREs) to facilitate students from European research institutes to get hands-on experience in Europe's unique and specialised laboratories and participate to cutting-edge research, increasing the value of the students' curriculum significantly.

- Inter-semester courses for graduate and post graduate students on special industry related topics, which will be provided by academics and specialists from research and industry.

- Massive open online course (MOOC) to educate and train students and young professional to enhance their knowledge of nuclear reactors and fuel cycles. This MOOC will serve as an introductory course to more in-depth training courses on the key topics in the nuclear technology field, such as the GENTLE Inter-semester courses or courses developed in other EU-funded nuclear training projects (see section 1.2) .

1.3. Description of the main S&T results/foregrounds

Student Research Experiences

The implementation of the SRE programme in GENTLE proved to be more complicated than anticipated, primarily as a result of legal status of students:

- Not all graduate and post-graduate students have a contractual relationship with their academic institution.

- The status of PhD students is different in the European countries; in some they are students, in others they have a contractual relationship with the universities.

To cover the liability issues for user access in some of the nuclear installations concerned in the GENTLE project, the legal frame between the hosting institution, the sending institution and the student had to be arranged through a (user-access) contract. However, this implied that a young scientist without an academic or professional employer could not participate to the SRE program of GENTLE. Because these user-access contracts were arranged locally with the hosting institution, a uniform reimbursement of the travel and subsistence costs was not possible.

Once implemented, the SRE program proved to be very successful. The anticipated budget for this work package (380 k€) has been used for 93% to support the 74 students accepted during the four-year period of the project.

Inter-semester Courses

The inter-semester courses were intended for graduate and post graduate students and addressed special nuclear technology topics. In total seven inter-semester courses were organised during the four-year period, some of which were held two times. The teaching was provided by academics from the consortium organizations and specialists from research and industry. The courses had a duration of typically one week, and were attended by 10-20 students, with a maximum of more than 30. A total of 133 students attended the courses, with very positive feedback. The possibility to visit operating experimental facilities such as accelerators, hot laboratories, nuclear laboratories where radioactive material can be handled, was seen as very important.

Massive Online Open Course

The MOOC Understanding Nuclear Energy was conceived as an alternative to the originally planned executive master course (exMC) for young professionals, for which the interest appeared to be very low. This decision was taken in 2015 after the course content of the exMC was established by the consortium, and preparation was about to start. The structure of the MOOC followed the overall approach of the exMC but the level was adapted to the MOOC (early bachelor) with six themes:

- Radioactivity
- Reactors
- Safety
- Fuel Cycle
- Societal Aspects
- Future reactor concepts

Each theme consisted of a number of video-lectures by GENTLE teachers, on-line exercises, and a discussion forum. The MOOC was completed by an online test and the possibility to get a proof of attendance (verified certificate).

The MOOC was offered on the edX platform through the Delft Extension School. More than 4000 learners registered for the course, about 1000 learners started, and 400 stayed active during the complete course. 65 learners paid and received a verified certificate for the course attendance, of which 50 completed and passed the MOOC. The percentage of active learners and number of requested certificates were well above the average for edX courses, and the responses received from the learners have been very positive.

1.4. Potential impact

- GENTLE has demonstrated that the student research experiences are an efficient tool for student access to the European nuclear research infrastructure. The SREs not only gave student the opportunity to experience a nuclear working environment and performing high-level research, but also stimulated joint research between academic and research organisations. The money invested in the SREs has proven to be a very good investment for nuclear safety research. The impact is also clear from the fact that the SRE concept is an important element in the ENEN+ and the ELINDER proposals for the 2016 H2020 Euratom call.

- The MOOC "Understanding Nuclear Energy" has been one of the first of its kind in the nuclear domain and has shown the effectiveness of this educational tool. The European education organisations involved in the production of this MOOC have learned about the potential of this tool, and this has stimulated them producing further on-line training. Also the success of the MOOC "Understanding Nuclear Energy" will positively influence the training tools in future Euratom E&T projects.

- In Deliverable 6.2, the GENTLE consortium has suggested a comprehensive approach for life-long learning for nuclear energy technology. The approach should consist of hybrid educational tools, i.e. a mix of passive and participatory teaching methods, as well demonstrated in the educational pyramid. Distance education is well suited as a passive method for introductory and basic topics of general interest, classroom teaching as a passive method for advanced topics for specialised learners, whereas hands-on training is intended as the participatory method for special knowledge and skills. In short:

    - MOOCs can serve at the entry level as an appetizer and student catcher for a specific topic. These MOOCs can be very general in nature and attract a broad and large audience, i.e. an introductory course suited for vocational learners interested in extending their professional knowledge as well as for bachelor students.

    - The second level should be composed of courses addressing basic knowledge at a more specialised level. Distance education would still be a preferred modus for these courses, for example in the form of on-line Professional Training.

    - The third level should address detailed knowledge and how to apply this knowledge to technical problems. Classroom teaching (passive) and working and discussion groups (participatory) seem to be the preferred method for this as direct knowledge transfer from teacher to learner is most efficient and guarantees active learner participation.

    - The fourth level is the teaching of practical skills in a professional environment. This can be on-the-job training, as is usage in many companies, but also dedicated training by professionals, or internships.

1.5. Project public website

1.5.1 Public website

The address of the project public website is: http://gentleproject.eu/.

1.5.2 Contact details

The contact information can be found on the website: http://gentleproject.eu/contact/.

For information on the project, please contact:

Scientific Coordinator	Project Manager
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For questions regarding the project website, please contact:
Toomas Välja
E-mail webmaster@gentleproject.eu

1.5.3 Project logo

For project logo can be seen on the top-left corner of the website: http://gentleproject.eu/.

1.5.4 List of beneficiaries

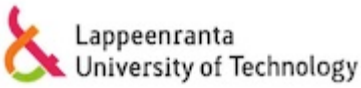
The list of beneficiaries with the corresponding contact names can be found on the website: http://gentleproject.eu/network/, which is also listed below:

1. **Delft University of Technology (TU Delft) – The Netherlands**

2. **Budapest University of Technology (BME) – Hungary**

3. **CIRTEN - Italy**

4. **Lappeenranta University of Technology (LUT) – Finland**



5. **Joint Research Centre (JRC) – European Union**

6. **Karlsruhe Institute of Technology (KIT) – Germany**

7. **SCK•CEN – Belgium**

8. **Technical University of Madrid (UPM) – Spain**

9. **University of Manchester – United Kingdom**

10. **University of Tartu (UT) – Estonia**

11. **Paul Scherrer Institute (PSI) – Switzerland**

Consortium Partner Representatives:

Partner No.	Partner short name / Name		Representative
1	TUD	Delft University of Technology	Jan-Leen Kloosterman
2	BME	Budapest University of Technology	David Legrady
3	CIRTEN	CIRTEN	Marco Ricotti
4	LUT	Lappeenranta University of Technology	Juhani Hyvärinen
5	JRC	Joint Research Centre	Concetta Fazio
6	KIT	Karlsruhe Institute of Technology	Volker Metz
7	SCK•CEN	SCK•CEN	Michèle Coeck
8	UPM	University of Madrid	Diana Cuervo
9	UMAN	University of Manchester	Sarah Heath
10	UT	University of Tartu	Alan Tkaczyk
11	PSI	Paul Scherrer Institute	Marco Streit

2 Use and dissemination of foreground

The use and dissemination of foreground in the GENTLE project has been relatively straightforward as the project focussed on education and training and not on research. Course material has been distributed to course participants in case of the inter-semester courses, and is available on-line for the MOOC "Understanding Nuclear Energy". The research results from the SREs are published in summary in one of the project deliverables, but will also find their way into the scientific literature via scientific publications of the students in the coming years.

2.1. Section A (see online full list of A1 and A2)

Dissemination measures have been described in the bulleted list at section 2. The detailed list of dissemination through publications in international peer reviewed journals as well as at international conferences is included in templates A1 and A2 respectively. The data has been input directly through the ECAS website.

The complete list of A1 (publications) and A2 (dissemination activities) can be found online.

- A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

2.2. Section B (see online version)

3 Report on societal implications (see online version)