Innovative Simulator Tools for Quality Management Production Process Training in VET (iQSim)

Progress Report  Public Part
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Executive Summary

AIMS
iQSim aims to develop and disseminate a new generation of training methodologies that are applicable to European wide mechanical industry sectors, including fabrication industries, Vocational Education and Training (VET) schools and SME’s. Within this perspective, an online simulator service has been developed as a tool for all stakeholders involved in the training scenario.

RESULTS
The 6 basic components of the simulator services are:

- Defining material constants
- Selecting geometries
- Fine-tuning the geometry
- Selecting welding method
- Displaying temperature in HAZ
- Performing cost and economical calculations

Picture 1: Comparing the effects of geometry on the economical cost calculation.

Evaluation tools that include the most frequently used welding methods:
- MMA, TIG, FCAW and MIG/MAG

Tools for evaluation of the most frequently used joint configurations or bevels:
- Square butt (I-bevel)
• V-bevel
• Fillet weld
• X-bevel

Calculation of production costs for the four welding methods and bevel configurations above. Online evaluation services provide quality assurance design by including students evaluation with results into the training environment. New pedagogical methodologies improve the quality assurance process of industrial production process training. Development of instructional video material for demonstration of skills, training methods, and evaluation of tools and services. Raise awareness of and deliver instructor training to welder trainers. Deliver training courses to welders. Arrange seminars, conferences and exhibitions for transfer of knowledge to stakeholders in Europe.

Picture 2: Calculating the production costs.
IMPACT
Welding institutes, VET schools and companies may utilize the new online evaluator learning environment in combination with the new pedagogical methods to offer a broad range of specialized courses at a European level.

The teacher and students may play with the variables dynamically, using sliders in order to create "what happens if" scenarios, such as:

- What influence will the root gap have on the economy?
- Does tolerances in the bevel angle influence the welding costs?
- Which welding methods give the widest set of production tolerances?
- Which of the welding parameters have the greatest influence on the heat input?
- Which welding parameter is the most important one if the HAZ value is to be maintained?

Picture 3: Practical testing of the proposed solutions from the iQSim online services, in the welding laboratory.
Table of Contents

1. PROJECT OBJECTIVES ................................................................. 7
2. PROJECT APPROACH ................................................................. 8
3. PROJECT OUTCOMES & RESULTS .............................................. 10
4. PARTNERSHIPS ........................................................................... 15
5. PLANS FOR THE FUTURE ............................................................ 16
6. CONTRIBUTION TO EU POLICIES .............................................. 18
1. Project Objectives

Aims
iQSim develops and disseminates a new generation of training methodologies that are applicable to European wide mechanical industry sectors like fabrication industries, Vocational Education and Training (VET) schools and SME’s. Innovative online simulator services that are interconnected to state-of-the-art Computer Algebra Services provide easy to use graphical interfaces that optimize cost- and time effective transfer of industrial production process and technology know-how to VET students. The combination of new pedagogical methodologies and simulator services, extend existing training methods by offering Quality Assurance of production process training when it starts, during a training session, and when it has been completed.

Objectives
The iQSim actions include:
- Development of simulator services for i) square butt, ii) v-bevel, iii) fillet, iv) x-bevel, and v) calculation of production costs for the four joint configurations above
- Develop new pedagogical methodologies by using simulation tools in combination with for instance Activity Based Training, that help improving the Quality Assurance through industrial risk analysis of production process training by highlighting the total production costs
- Delivery of welding training courses to mechanical industry companies for validation of methodology and the pedagogical benefit of including instructional online simulator tools into training
- Raise awareness of the beneficial impact of (pedagogical sound) implementation of modern simulator tools and use of new training and educational technologies, e.g. by using high quality online streaming video solutions to provide hands on experiences
- Validation and dissemination of a new competence training model to VET schools and mechanical industry companies offering certification of welders in Norway, Sweden, Lithuania and Hungary, by arranging local and regional seminars and/or exhibitions for dissemination and transfer of knowledge to stakeholders at national level.
2. Project Approach

iQSim is a Leonardo da Vinci Development of Innovation pilot project that brings together 6 partners from Norway, Sweden, Lithuania, Hungary and Greece.

The services use Flash and Flex; are prepared for presentations on digital blackboards, and all mathematical calculations are embedded into the software. The services have the advantage that students and instructors may use learning activities where they use sliders to “play” dynamically with the essential welding parameters in order to observe the tolerance window occurring in real-life production facilities.

It’s possible to investigate the influence of a number of variables in order to figure out which variables have the biggest impact on the quality of the final products. From an instructional point of view, the evaluator helps to reduce manufacturing defects by making up alternative decision routes that include both technical and economical production tasks.

The foreseen main target group is welders working in the mechanical industry, which is the second largest production sector worldwide; their instructors, and the VET schools that need to educate 50,000 welders per year. To evaluate the project results, the consortium will apply the proposed competence transfer models and simulator services to the welding industry, which is part of the wider mechanical industry sector. The following user groups will be involved in the user requirement specifications, as well in the evaluation of project results.

- Mechanical industry welder specialists and welder engineers, who are required to meet high performance standards for the industry, possibly at a remote location, which for instance produces components for a large and global company.
- Mechanical industry trainers: i) employees within large mechanical industry companies, ii) employees of small training institutions, which typically do not have the capacity to have full-time training employees
- VET schools offering in-company training programs

iQSim develops a brand new solution to the welding sector, by adapting and transferring existing process solutions in mathematics and physics. The solution for the welding sector contains 2 key tasks: development of web-based simulator tools, and deployment and utilization of them in combination with development of new pedagogical methodologies. The new pedagogical methods includes further development of the Activity Based Training methodology developed within the Leonardo da Vinci pilot project MECCA (2005-2007), by adding quality management assurance designs into industrial production process training activities that follows the production schedules by utilizing work orders and work packages.
Picture 4: Training of instructors that are going to use the iQSim simulator services in Hungary by use of two way videoconferencing from Trondheim to Hajduszoboszló, 11.09.2009
3. Project Outcomes & Results

iQSim develops advanced online simulator tools that display the results of complex mathematical calculations that belie welding processes, by utilizing easy to use graphical interfaces. Computer Algebra Tools will be used in order to offer welding students, welding instructors and VET trainers web-based access to high-level graphical interfaces where they manipulate the main welding parameters interactively, and immediately observe the results online. iQSim provides the following outputs:

1. Simulator tools that include the most frequently used joint configurations: i) square butt, ii) v-bevel, iii) fillet, iv) x-bevel, and v) calculation of production costs for the four welding forms above.

   The simulations handle the following main critical parameters in an industrial production process environment:

   I) The volume that must be welded depends on the angle and the thickness of the plate
   II) The added material depends on the number of layers
   III) The number of staff hours and the total production costs are affected by I and II
   IV) The maximum hardness in the Heat Affected Zone (HAZ) and the extent of this zone

   The web-based simulator service offers stakeholders i) activation of prior experiences, ii) demonstration of skills, iii) application of skills and iv) inclusion of skills into real-world descriptions. They provide quality assurance design by including risk analysis into the training environment.

2. New pedagogical methodologies offer Quality Assurance to industrial production process training in VET schools by utilizing interactive simulator tools, in combination with for instance Activity Based Training (ABT). ABT follows the industrial production processes, by utilizing work orders and work packages. The final result of the training is a complete product. The training method may be utilized in a blended learning framework consisting of face-to-face on-site training, e-learning solutions, high quality video streaming, and video conferencing. ABT may be utilized in Skills Upgrading Processes where theory and practice are closely connected.

3. The iQSim training delivery uses simulator tools to add Quality Assurance (QA) to an industrial training production process, as well as QA of the final welded product.

4. High-quality instructional video material (streaming or DVD) for demonstration of skills, training methods, simulator tools etc. It will have an orientation towards a train-the-trainer approach in order to motivate VET schools and instructors to look into the new proposed training environment.

5. User requirement specification report
6. Pedagogical Methodology report
7. Simulator tools implementation report
8. Project website with all the project results such as reports, multimedia material, course material, evaluation of results, dissemination activities, and simulator services
9. 4 types of industrial welding courses in Norway, Sweden, Lithuania and Hungary
10. Leaflet and poster for dissemination of project results
11. Evaluation strategy outline report and Evaluation report
12. Produce a quality management handbook specification
13. Write at least 10-12 scientific articles that will be published in proceedings from international conferences or in journals
14. Arrange one national seminar for instructors and welders in Norway, Sweden, Lithuania and Hungary
15. Large scale dissemination of project results at major international conferences in Europe: MACTECH, Computing in Welding, International Institute of Welding General Assembly, On-line Educa, IADIS e-learning conference, Lietuvos suvirintoju asociacijos konferencija arba litexpo Balttech’2010, etc.

Some screenshots of the iQSim simulator are shown below:

Figure 1: Defining the geometry
Figure 2: Selecting the welding method

Figure 3: Displaying the Heat Affected Zone
Figure 4: Calculating the costs
Innovative Simulator Tools for Quality Management Production Process Training in VET

iQSim
Innovative Simulator Tools for Quality Management Production Process Training in VET
 Leonardo da Vinci Development of Innovation Pilot Project 2008 - 2010

Figure 5: The iQSim poster outlines the main components of the simulator services.
4. Partnerships

The consortium consists of:

- Sør-Trøndelag University College, Trondheim, Norway
- HiST Contract Research, Trondheim, Norway
- Centrum for Flexible Learning, Söderhamns kommun, Sweden
- MHTE, Budapest, Hungary
- Klaipeda University, Klaipeda, Lithuania
- University Thessaly, Volos, Greece

The consortium has a strong industrial presence and includes partners with strong ties to the mechanical industry and industrial networks. These partners have experience in training standards with regards to VET in the welding industry, as well as experience in interacting with the European Welding Federation, of which MHTE is a member. The participating welding training organisations have a large number of contact points throughout Europe. This industrial approach ensures that the results will be implemented into practical industry cases, as well as in additional knowledge transfer programs.

The iQSim project results have been presented at all the main welding events during the first year of the project. This includes the European Welding Federation General assembly, the International Institute of Welding General Assembly, as well as the 2 major international welding conferences in Europe.

Furthermore, iQSim has also during the first year of the project, been presented at major international conferences within the e-learning sector, including Online Educa in Berlin.
5. Plans for the Future

iQSim will carry out testing and validation of the services as specified in the contract, and complete the development of new training methodologies. The closure of the project will be done at MachTech in Budapest next year. MachTech is the largest welding conference in Eastern Europe, and the second largest in Europe.

We would like to mention that the international welding society has shown a lot of interest for the iQSim project. After 12 months, out of this 2-year project, organisations from 37-39 countries in America, Europe and Asia have stated that they want to test and exploit the simulator services.

Due to the limited size of the project, we have to reduce this number. For the moment we plan on testing and exploitation of project results from the following organizations within the welding sector, which are not part of the project:

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<th>Country</th>
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The iQSim project will during the second year try to let as many as possible of these organizations test and use the services for free, if they provide feedback to the Consortium such that we may improve the services. We have made up a separate agreement for this testing.
6. Contribution to EU policies

iQSim addresses the development of innovative ICT-based content by developing a brand new type of simulator tools that improve existing training materials and study paths, in combination with development of new pedagogical methodologies. iQSim offers easy access to the best cost-efficient production process solutions that minimize welding defects, while maintaining the best tolerances of the welding parameters. The innovative content means developing state-of-the-art tools that help to improve and carry out quality assurance of mechanical industry training programs development in VET institutions. iQSim provides the management and quality assurance of vocational training in mechanical industry with an effective tool, such that VET schools, instructors, students or welder professionals select and obtain the most time- and cost-efficient production methods and processes.

iQSim supports improvements in quality and innovation in VET systems by promoting a new type of training and learning environment that utilizes the advantage of online simulator tools, where the students and instructors improve the quality of their work by dynamically playing with the essential welding parameters in order to visually understand the tolerance window occurring in real life production facilities, and make up alternative decision routes that handle both technical and economical production tasks. It is very important to reduce failures related to cracking due to increased hardness in the material, which usually must be followed up by expensive repair procedures.

It is of major importance to support the development of innovative ICT-based content and services by providing a new type of training and learning environment where the simulator tools hide advanced mathematical calculations. iQSim utilizes new Flex- and Flash-based online services where the mathematical calculations are embedded. In this way, skilled welders who don’t have any special mathematical knowledge may use the tools by accessing easy to use graphical interfaces. This ensures that European VET institutions may enter the competitive education market through a quality approach guaranteeing that the simulator services conform to explicit international guidelines and quality standards in welding.

iQSim develops a learning environment that provides single point of access to innovative web-based simulator tools, which is suitable to improve the teaching quality management of the learning environment of VET training programs and training materials targeting mechanical industry. The simulator services will support the application of quality assurance services for institutions dealing with vocational training within the welding sector, whereby it promotes the establishment and development of quality management control culture into industrial production processes training. The principles for designing and utilizing the simulator tools as quality assurance designs in practical oriented industrial production process training are generic, whereby they may be transformed to other fields within skills upgrading processes. Thus the proposed new learning environments and simulator tools will have the potential to help transforming education and skills upgrading processes in Europe according to the Lisbon strategy. They improve the quality and effectiveness of EU education and training systems.
It is expected that the iQSim learning environment will improve the quality management of welding education, by providing new simulator tools that help students obtain a deeper theoretical knowledge within basic industrial fabrication processes without getting into complex mathematical calculations. The tools and services are online and offer vivid high-end graphical interfaces, whereby we expect that it will motivate students to become more interested into technical education, and welding in particular. The tools may be used for both welder specialists and welder engineers, whereby they may help boosting the participating rates in technical education.

Thus iQSim provides a new learning environment for improved transfer of theoretical knowledge and competence within welding sciences by offering welders and their instructors a new training environment where they may play dynamically with the essential welding parameters. From the industrial fabrication process point of view, it's very important to improve learning environments that reduce failures related to cracking due to increased hardness in the material, which usually must be followed up by expensive repair procedures.