

The use of new technologies in the welding training field.

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Abstract

The use of the new technologies are taking a main role in our day-to-day and the welding sector shouldn't be an exception. This is the reason why the new technologies should be applied from the beginning and lowest level, it means from the training of welding staff, not only as a research and development tool for new techniques and/or materials.

The use of new technologies in the training field can be put into practice at the different steps of training, either for welders, inspectors, engineers, technicians, specialists or welding coordinators, etc.

This paper describes how welding training is developed by CESOL based on the new technologies available.

Introduction

One of the main action sectors of CESOL is the training of personnel related with welding coordination and inspection. The principal target of CESOL is to provide a training with the best quality as possible. This doesn't mean to provide only a clear and complete didactic material. In order to obtain quality, we think that is a very important to supply the pupil with the highest number of tools and facilities for to realize the training, taking into a count that most of the students are working, and so they have to combine the training with their daily jobs. Since several years ago, CESOL is introducing the International Welding Engineers/Technician/Specialist training online and semi-presential way by e-learning, in order to help the pupils to combine their training and actual jobs

Another field where CESOL takes part is the training of welders through a co-participated society, with CEFOIM, called CAFSOL (Advanced Training Centre for Welders).

CESOL and SIMFOR-CEFOIM also have developed together the welding simulator "RV-SOLD" for the purpose of training future welders.

Nowadays CESOL is participating in a European Project cooperating with other European Welding Federation members. This project consists in the development of a multimedia and multilingual dictionary called "WELDICTION PLUS", which is the continuation of the dictionary "WELDICTION", result of another previous European Project. The other collaborators are: VUZ from Slovakia (coordinator), EWF, ISQ from Portugal, and CWS-ANB from Czech Republic.

It is scheduled soon the beginning of an European Project called "EUROPEAN TRAINING UNDER EN-ISO 3834" and its purpose is the harmonizing of staff which is involved in the management and control of the welding process around the standards EN-ISO 3834. One of the most important items of this project is the creation of a website, on continuous evolution, where the basis for that harmonizing actions are consolidated. The project members are: SRE (project manager), CESOL and CNFPO from Spain, EWF, ISQ from Portugal, VUZ from Slovakia, ASR from Romania and ISP from Poland.

"RV-SOLD" Simulator.

To have welders' staff with an adequate training is without doubts one of the most important problems to which currently have to face the companies, due to the shortage of personnel with adequate training and the costs that this training process entail for own staff.

The practical training for welders is extremely expensive. The workshop, welding equipment, parent materials, filler materials, gases, etc, costs, are added to personnel costs, related to the time used in the training.

Due to the previously said, an interesting problem is presented: how can we obtain an adequate training of welders at the least costs as is possible?

The answer for this question is based on the use of new training tendencies like to develop virtual environments that allow us to simulate the welding process, decreasing training times and the cost related with the material consumption.

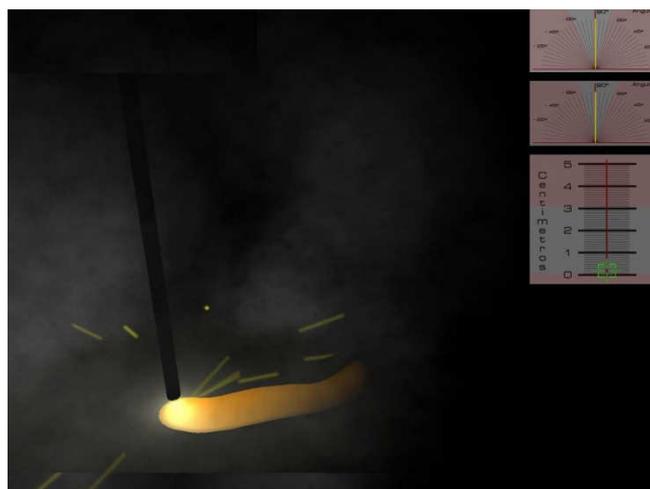
RV-SOLD advantages:

- Decreasing of learning time: to perform more practices on lower number of hours.
- The accidents connected with the welding work due to inexperienced welders are removed.
- The pupil can see his mistakes and so he can learn how to correct them easier.
- To reduce the training costs.
- To allow the simulation of inadequate or dangerous processes, without any danger.

In a conventional welding course, the effective time that a pupil spends is around 30-50% from the total time in which he uses the welding equipment, due to an important portion of the total time is spent in the preparation of the specimens and other activities like to make the edge preparation with grinder, interpass cleaning, etc.

To work in a virtual environment allows that the pupil spends around 95-100% of the time in welding and obtaining a higher skill on the use of the welding gun in less time. This means that an hour using the simulator is equivalent to 2 hours of workshop job, but unfortunately is not convenient to substitute all the time spent on workshop jobs by training with the simulator, but it is possible to reduce this time around 40-50%.

On the other hand, the use of a simulator involves an important economic saving because there is a lower consume of materials, fillers, gases, etc, because all these items are not necessary in a virtual environment.



Figures 1 & 2: Simulation during the welding and the appearance of the seam. The appearance of the seam is simulated by the system in function of the welder movements, travel speed, etc.

Previous figures represent the simulation during the welding and the appearance of the resulting weld bead.

Equipment characteristics.

The main system characteristics are as follows:

- Photorealistic simulation of the welding process.
- Simulation scope:
 - Welding processes: SMAW and MIG/MAG.

- Welding of tubes and plates.
- Welding on all positions.
- Practice activities with progressive difficulty.
- Automatic mistakes detection: The most frequently mistakes made by the welders are interpreted by the system, such as:
 - Inadequate settings of the welding parameters.
 - Deviation from the welding gun orientation: angle, arc length...
 - Deviation from a given welding trajectory.
- Recording/playing of the practice activities.
- Real-time graphics which represent the differences from the ideal model.
- A file of the pupil in which the monitoring of his training process is represented: practices passed, time per practice, mistakes, etc.

An important advantage is that the software from the system allows to correct the mistakes or deviations during the welding. The aim is to work with a virtual teacher who is correcting the movements, parameters, etc, according to the values set up in the equipment and this way, the pupil has a supervision on his exercise during its execution.

To use a combination of practices with the simulator and real practices in workshop will improve the quality of the training process and on the other hand do it faster and easier.

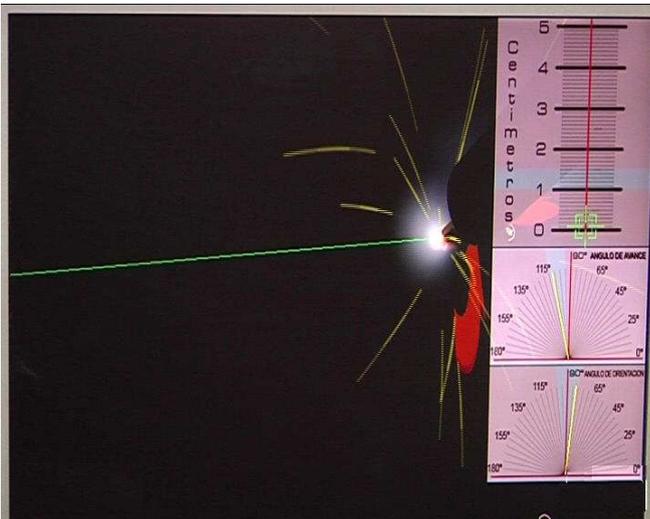


Figure 3: Detail of the simulation during welding. The system allows controlling the deviations from the control parameters, making easier the welding development with different type of graphics.

Economic details.

The main advantage of the simulator is the economic savings produced by it use. As already mentioned, it's estimated that the training time on workshop is decreased from 40% to 50%.

The average cost estimated for each course of 400 hours, in materials, filler metals, gases, electricity, etc, with a final qualification test, is around 1000€ per pupil and course.

As a consequence, the use of RV-SOLD would entail a saving from 350€ to 500€ for each pupil and course, considering only materials and consumables and not taking into account the time saving. In following table is indicated this comparison:

	Conventional Training.	RV-SOLD training.
Theory hours.	40	40
Workshop hours.	360	180- 216
Simulator hours.	-----	50-75
Total hours.	400	270-291

Using RV-SOLD the time spent in workshop is decreased around 40-50%. This reduction of time is based on the use of the simulator due to its a higher performance for real hours welding, allowing to reduce the total time of the course.

Taking into account a cost of 15€/h, the use of RVSOLD would represent a saving of around 1000€ or 1200€, due to its reduction in the total time of the course.

On the other hand, the average cost of a simulator is around 14.000€, so, 12 pupils would be necessary for the simulator be profitable. In case that the time cost isn't considered, only taking into account the material saving, 42 pupils would be enough for the simulator be profitable; so each pupil above 42 would provide profits to the training centre, which could offer these courses cheaper and it would improve its market share.

Finally, the decreasing in training costs would improve the training demand by companies, so the number of qualified workers would be higher and their costs would be reduced.

On-line training (DL).

Scheme.

The on-line training or e-learning is a tool, which CESOL puts on the pupils hands in order they could combine two important items in their working life: the daily job and the

need to complete their training through IWE, IWT, IWS courses.

In accordance with the IAB Guidelines, CESOL's IWE / IWT / IWS DL Courses are taught in about one natural year, through 5 parts:

- Module 1: Welding Processes and Equipment
- Module 2: Materials and their Behaviour During Welding
- Module 3: Construction and Design of Welded Joints
- Module 4: Welding Fabrication and Applications
- Practical Training

This scheme is the same for IWE / IWT / IWS courses, with more subjects and more learning hours for the IWE / IWT courses than for the IWS one; the IWE course and the IWT course are essentially the same, but with different examinations.

Documentation.

CESOL's DL courses documentation has been created adapting and updating the documentation that CESOL has been using for years for its classroom education courses (in accordance with the requirements in IAW and EWF Guidelines), complemented with practical sessions (workshop training, welding demonstrations and laboratory exercises) in the subjects that could not be carried out satisfactorily solely by distance learning techniques.

In order to adapt CESOL's documentation to an Internet online basis, the subjects of each course have been resumed and complemented with interactive graphics and animations, and also with short video clips when it has been considered useful to achieve a complete understanding of the techniques and processes.



Figure 4 – Example of interactive graphic from CESOL's DL online platform (Spanish language).

This adaptation from classroom education to a blended-learning technique, has been done in cooperation with Bureau Veritas-Formación, a firm specialized in distance learning, whose distance learning software platform houses CESOL's DL courses at the URL www.bureauveritasformacion.com.

Description of the Online Learning Platform.

The contents is set up so that the subjects of each module have been divided in several Cognitive Units ("Unidades Didácticas"), each one of them with the following structure:

- Introduction ("Introducción").
- Learning Objectives ("Objetivos").
- Knowledge to achieve ("Conocimientos").
- Skills to achieve ("Habilidades").
- Aptitudes to achieve ("Actitudes").
- Test questionnaires ("Test").

Also, the software platform provides several useful tools to facilitate the students learning and communication and their monitoring and supporting by the assigned teachers:

- Messaging system for tutorial support ("Mensajería")
- Students-teachers forum ("Foro")
- Course related news system ("Noticias")
- Additional interactive tests and exercises ("Casos Prácticos")
- Complete unit download in PDF format ("Descarga la unidad")



Figure 5 – Access to additional learning tools of CESOL's DL online platform.

This learning is completed with a full week when the most used industrial welding process can be practised by the pupils in a workshop.

Monitoring and Evaluation of the Students.

The students have been encouraged by their tutors to actively participate.

Nowadays a personal tutorials system are being improved by CESOL through videoconferencing in which the pupil obtains a better and customized training.

To fulfil the IAB requirements and in order to obtain, if appropriate, their IWE, IWT or IWS diploma, CESOL's DL students have been compelled to:

- Answer effectively the online obligatory tests (for example, 60 questionnaires for the IWE DL Module 1, a total of 300 test questions just for that Module 1).
- Attend the face-to-face classroom, laboratory, demonstrations and practical sessions.
- Pass one exam per Module. This exam is exactly the same as for presential courses, in accordance with IIW-IAB requirements.

Comparative Evaluation of CESOL's DL Qualification Results.

The following data and graphics allow to compare the face-to-face examination performance of CESOL's DL students with the performance of face-to-face classroom students, from two Spanish ATBs authorized for face-to-face classroom teaching of IWE / IWT / IWS courses.

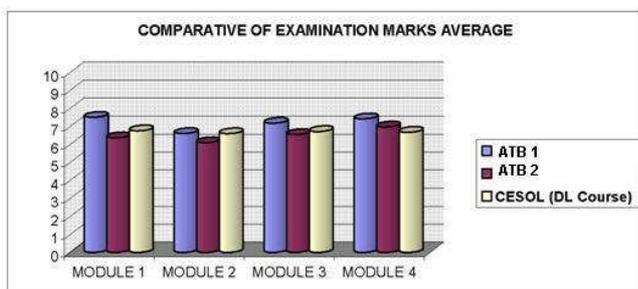


Figure 6. Comparative of examination marks average (Maximum possible mark = 10 points for each module). (Minimum possible mark = 6 points for each module).

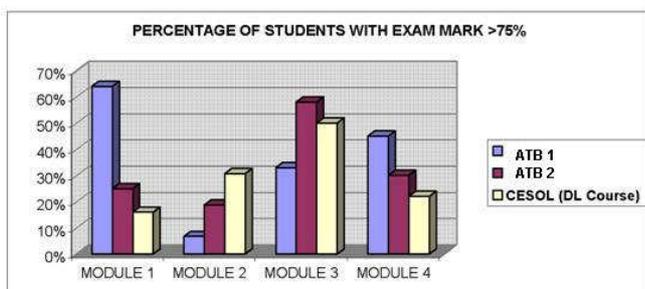


Figure 7. Percentage of students with exam mark >75% (Dispensed from the oral examination part in that module).

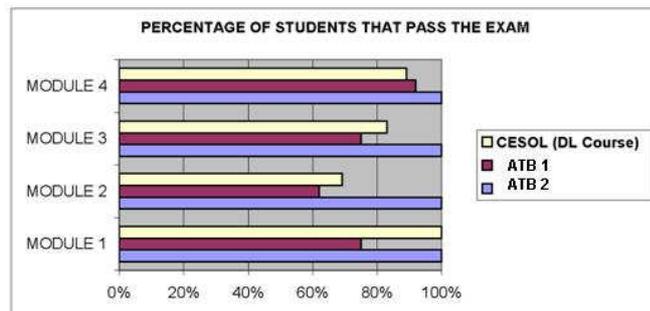


Figure 8. Percentage of students that pass the exam: total pupils with or without. (Exam mark >60% in that module)

We can conclude that the performance of DL pupils is the same as for face-to-face classroom pupils.

Weldiction Plus.

“WELDICATION PLUS” is rather a search tool instead of a training tool.

Weldiction Plus is a multimedia and multilingual dictionary in which it is possible to find the most important welding terms. The different languages that appear in this dictionary are: English, Spanish, Portuguese, Czech and Slovak. With Weldiction Plus it is possible to find several translations that not always are easy to find in common bibliography. Weldiction Plus allows us to know three simultaneous translations at the same time, on every screen.

All terms are divided in different general items in order to the search will be easier and faster:

- Process.
- Equipment.
- Consumables.
- Practice.
- Materials.
- Testing.
- Imperfections.
- Others.

In Weldiction Plus not only we find the translation of the different terms, also we can find short definitions about the meaning of the corresponding term. Frequently, these terms have enclosed a photo and/or a video on which it is easier to understand the meaning of the different terms.



Figure 9 – Interactive display of Weldiction Plus.

Once we have adapted to these new conditions, we shouldn't stop here. We have to understand them and use them as a normal tool in order to make our work easier and with a higher quality.

This project is on development stage yet, but by the end of present year it will be possible to find it on DVD format and visiting its website, which is under construction. The finishing of the project is scheduled for the end of 2010, but it is intended that this dictionary will be on continuous evolution

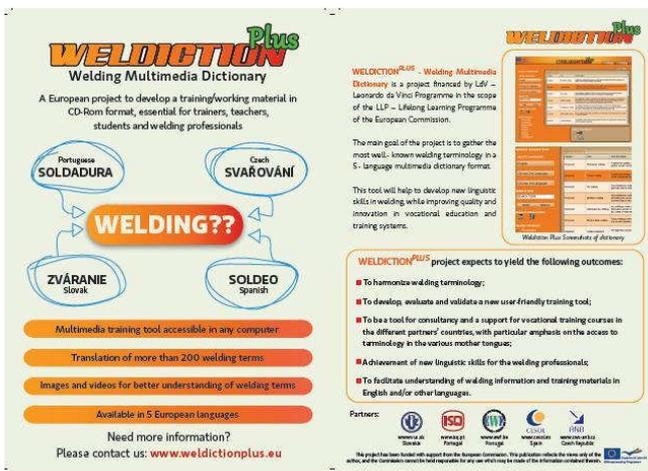


Figure 10 – Weldiction Plus Flyer.

Conclusion.

The world is suffering evolutions constantly, so we should adapt to these changes. All these ones act over every aspects of the life and training is included, so this sector has to adapt as much as possible to these changes.