

Welding simulators - green training for top welders

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Aimée Schmelzer

VWTS

VWTS – Virtual Welding Training System

- welding simulators based on digital reality technologies



Extended Reality (XR):

- refers to all real- and virtual environments generated by computer graphics and wearables
- the 'X' in XR is simply a variable that can stand for any letter
- XR is the umbrella category that covers all the various forms of computer altered reality reality, including:
 - Augmented Reality (AR)
 - Mixed Reality (MR)
 - Virtual Reality (VR)

From yesterday to today

The first welding simulator was patented and produced in 1990 under the name **Device** for training welders in the company LENCO Inc. (St. Louis, MO, USA).

Today, there are many VWTS manufacturers on the market.



What can we do with VWTSs?

1. Promote among the younger generations (Gen Alpha) welding as a good choice of profession in the future. How? Through games and competitions!
2. In VET and adult education: skills training in integrated interactive training with real welding.
3. In welding companies: training to maintain skills and correct welding techniques, as well as training for new welding processes.



Didactic model



Training

A virtual trainer ("ghost") helps in mastering the basics of welding technique

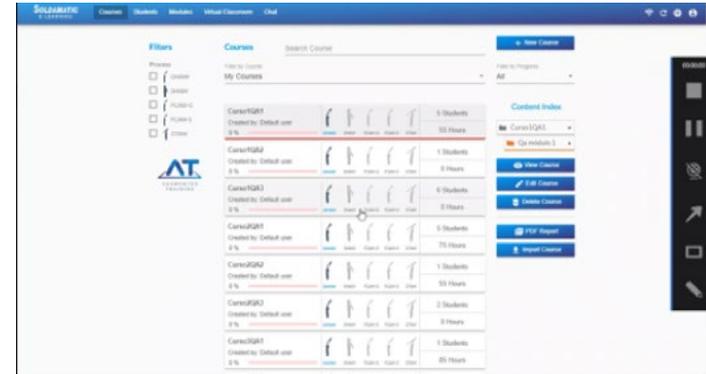
Simulation

Virtual training in a real welding situation (without the help of a "ghost")

Who does what

Training manager

- Manage education according to the target group
- They determine the training content
- They set the degree of difficulty (pass level)
- Manage participants via the log-in function
- They save training data for individuals and groups



Participants:

- get basic information about welding topics
- learn everything about different welding positions
- receive information about the current training content and training tasks
- can view their training progress at any time
- can use the playback function to see where there is room for improvement



VWTS results

➤ Objective and transparent assessment of results

- comparison of training results
- objective point system

➤ Ranking scale

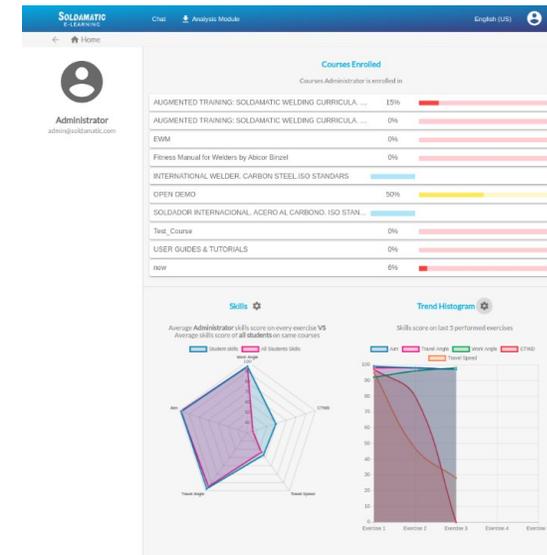
- automatically generates the order and simplifies the evaluation

➤ Playback function

- every weld is recorded and can be reproduced and analysed

➤ Motivation of participants

- they can compare with each other and encourage each other
- the dynamics of the group improves



VWTS skills training

Research conducted on more than 600 trainees and 100 experienced welders related to the optimal share of training on VWTS in welder training gave the following results:

In the interactive integrated training on the VWTS system and devices for real welding, the share of training on the simulator amounts to:

For trainees/beginners:

- for MMA welding process: 50%
- for MIG, MAG, FCAW welding process: 40%
- for TIG welding process: 60%

For experienced welders:

- for all welding processes: 100%

VWTS training: health and ecology

HEALTH:

A completely "clean" procedure. There are no negative effects on welder's health. There is no heat radiation, splashing of molten metal, smoke, gases, flashes and all other incidental phenomena.

There is no initial "tingling" in the eyes, burns from molten metal, nausea from gases and steam.

ECOLOGY:

There is no pollution of space and environment.

There is no preparation of base material, handling of shielding gases, radiation, flashes and excessive noise. There is no waste.

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Example of CO2 emission

1 welding machine per hour produces 6kg of CO2

Source: Master Thesis paper by Vladislav Kadochnikov, Esslingen University

Full training MMA/MAG/FCAW (IW for tube) amounts to: 540 hours

Full training TIG (IW for tube) amounts to: 400 hours

Reduction of CO2 emissions per training session:

1. MMA (VWTS 50%): $540 \times 50\% \times 6 \text{ kg} = - 1,620 \text{ kg CO}_2 / \text{welder}$

2. MAG (VWTS 40%): $540 \times 40\% \times 6 \text{ kg} = - 1,296 \text{ kg CO}_2 / \text{welder}$

3. TIG (VWTS 60%): $400 \times 60\% \times 6 \text{ kg} = - 1,440 \text{ kg CO}_2 / \text{welder}$.

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VWTS – economic benefits

Costs are reduced proportionally to the participation of VWTS in the training of welders for the following items:

Basic material, filler material and consumables:

- MMA: - 50 %
- MAG/MIG-FCAW: - 40 %
- TIG: - 60%

Trainer: (- 30 %) – (- 50 %)

Fewer device repairs and servicing

Lower energy consumption

What we get from training on VWTS

- ▶ green training (training without radiation, fumes and danger for the user)
- ▶ significantly cheaper training
- ▶ the technique of working with a torch or an electrode holder
- ▶ maintenance of welding parameters at the given level:
 - welding speed
 - distance of the electrode from the work piece
 - inclination of the torch/electrode holder
- ▶ correct positioning of the welder in different welding positions.



We get a beginner/trainee fully prepared for training on real welding devices.

CONCLUSION

1. It is indisputable that welding simulators must be introduced into the lifelong education system of welders. In addition to quality skills training, three factors contribute to this:

- ▶ Safety, from the aspect of health and safety at work for all participants - especially for trainees,
- ▶ Environmentally friendly - no waste materials, no shielding gases, reduced energy consumption, etc.
- ▶ Economically, because the cost of training trainees and experienced welders and testing the competences of welders is significantly reduced.

CONCLUSION

2. Not even half of the standard welding machine manufacturers are currently involved in simulator development. However, these companies have a great responsibility to carry the development of simulators in order to bring the digital reality as close as possible to the real one.

This means that:

- ▶ Simulators must be closer to actual welding devices in terms of appearance and method of selecting welding parameters;
- ▶ Graphical - visual interfaces must be intuitive and easy to use;

CONCLUSION

- ▶ It is noticeable in all simulators from this review, that the control of the electrode holder / burner does not achieve sufficient interaction between man and device (computer), i.e. there is insufficient communication between the welder and the welding pool, resistance and force are not felt during welding. This means that a further step in the development of this type of simulator is in the application of haptics, i.e. haptic interfaces, that will achieve the necessary human-device interaction.
- ▶ Electrode holders and torches must match those used in real conditions (e.g. as does the Soldamatic with Abicor Binzel burner);
- ▶ Glasses or screens should be placed inside welding helmets.

