

Modern ways in welding education using computer-based training systems

Prof. Dr. Ing. Steffen Keitel, Halle (Saale), Germany

Dipl.-Ing. IWE Axel Börnert, Halle (Saale), Germany

For several decades the education of welders has been performed consuming a lot of material, energy and time. The integration of computer-based training systems offers a modern approach to reduce the expenditure of resources and to extend the education by modern media and educational methods.

Elements of the realistic education of welders and the computer based simulation are combined to educate welders near to practice. The construction of the current version of the welding training system will be explained.

1 Introduction

If we were to assume that there have been no fundamental changes in the methods used to train welders from the establishment of the first welding training and testing institutes in the 1930s to the start of this century, technical innovation and changes to this methodology would certainly be long overdue. Technical facilities for training welders have undoubtedly always been up-to-date and in line with the latest technology e.g. power sources, torches, extraction units. Computers too have long had a place in training but more as a work tool than a method of learning. However very little has changed in terms of the way welders are trained. The introduction of Virtual Welding Training Systems (VWTS) as part of the training has brought about technical innovation as well as a complete re-alignment of the methodology applied during the initial phases of welder training.

2 Present situation of the practical education of welders

For the people being trained their classical education starts in the welding booth the first day. Then he/she will be explained the relevant welding power source, the first surfacing beads will be shown and the participant will try to strike an arc and to keep it at a constant length, to keep a certain welding speed and to deposit the filler metal as well as to guide the torch in a correct arc inclination for the first time. Experience has shown that a quite considerable amount of parent and filler metals, if necessary, tungsten electrodes, shielding gas, electric current etc. are consumed.

3 The GSI-SLV-welding trainer

3.1 Built-up and function of the welding trainer

Using the welding trainer completely new possibilities have developed for the practical education, particularly in the initial phase.

The participant will learn the motoring processes with a real arc of very low performance, thus being able to use the "welding samples" for a high number of trainings. At the same time the main parameters of the process (welding speed, arc length, torch angle) will be monitored by a computer based camera and measuring system; deviations caused by the participant will be signalled at the same time. The working principle of the welding trainer is based on the acquiring of the most essential handling parameters of the trainer during the "welding process", the signalling of mistakes as well as archiving the parameters. Adjustable fields of tolerance for the setting of the parameters allow an adaptation to the current state of the training of the participant. If the admissible limits of the tolerances are exceeded, there will be an acoustic signal until the preset area has been reached again. At the same time the measuring values for the three main handling parameters are recorded. By this the participant is enabled to give an evaluation on his own and on the education trainers after having ended the "welding process" (fig. 1).

A further option is working using a training software where the trainee is guided to the topic of special welding knowledge that later will be treated in detail. In connection with the computer he will obtain a preliminary knowledge he can make use of in his special

training of knowledge. Trainees who up to now have not been familiar with computers will also receive a first knowledge of such a hardware.

The use of the welding trainer is also suitable for the determination of the already exist-

ing knowledge of the trainee as well as for the examinations of the manual skills of a trainee for the evaluation of the capability of a potential participant to be trained.

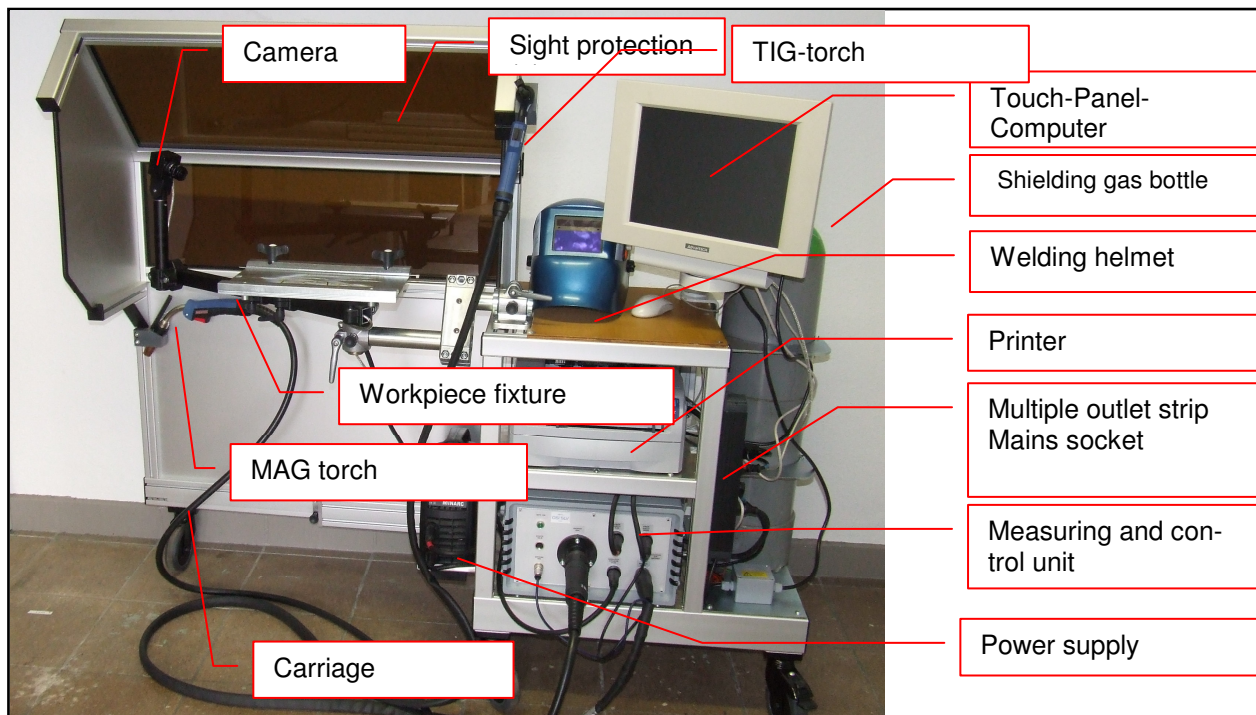


Figure 1: The built-up of the GSI-SLV-welding trainer

3.2 Technical further development of the welding trainer

In the new version (Version 4.0) now, in addition of the training possibilities up to now, now also MAG welding in the vertical-up position (PF) in the cover passes can be trained where a special oscillating movement is performed that is known as "fir tree welding" among many welders (figure 2). The filler pass will be "welded" to the root pass using the same sequence of movement.

In order to train welding when joining fine grained structural steels a special training module has been developed where the trainee has to weld a certain weld length within a defined period of time. (Figure 3)



Figure 2: Training of the welding position PF for MAG welding using "fir tree welding"

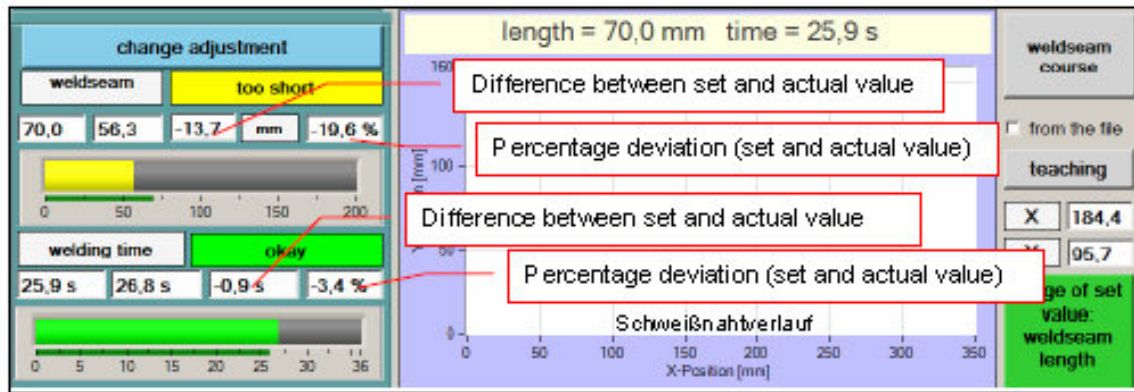


Figure 3: Training module for the welding parameters when joining fine grain structural steels

In the module MAG welding there are also exercises for adjusting the welding parameters voltage and current intensity. If the adjustment is correct, the position of the working point in the characteristic line for the

power supply is graphically represented and moreover high speed exposures of the drop-let transfer with the relevant arc are shown (figure 4).

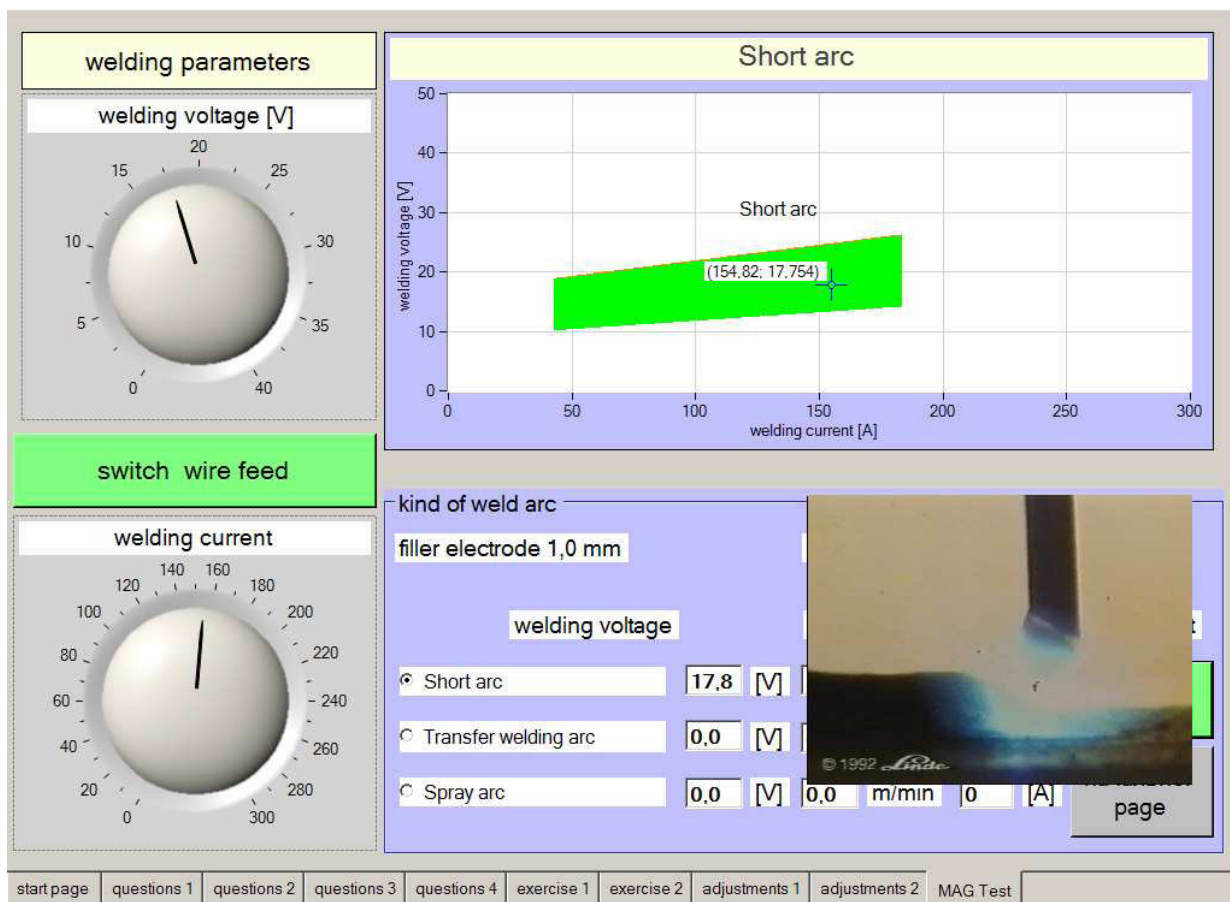


Figure 4: Exercises for the adjustment of welding voltage and welding current for MAG welding; the result with the correct choice of the parameters is represented

Having developed and consistently further developed the welding trainer a training medium has been developed within the last 5 years that will substantially change the classical education in welding. The use of this device is not only useful from an economic point of view, moreover it is a universal device for the education that will mainly arouse

the interest of young people to receive education as a welder. Due to its mobile construction the welding trainer can be flexibly used and applied as a modern educational device not only for the education of welders. Possible entrance tests for welding courses for apprentices, learning media for labour protection, all of these fields of application

can be thought of. When presenting companies on exhibitions or fairs or on the occasion of public events - the welding trainer will always arouse the interest.

3.3 Methodological and didactical innovation: The intelligent training plan

By a variety of presentations of the welding training system and from experience gained from users a number of ideas have resulted to supplement the educational medium usefully and user-friendly. Among others this is the development of an "intelligent educational schedule" and its integration to the teaching methods of this educational medium. One focus was the development of strategies to use the computer based GSI SLV welding trainer in the education of welding. To this end, the SLV Halle has worked on the topic of improving the communication between "human being and machine", i.e. between the future welder and the welding trainer thus leading the trainee through an extensive training program dependent on the state of education obtained and making him able to work on the welding trainer independently.

Depending on the state of skills obtained together with the relevant score the welding trainer automatically decides whether the participant has to repeat an exercise or whether he is able to continue with the next, more difficult, exercise. Hence, the welding trainer guides the trainee independently and directed through the training program without intervention from outside.

In order to support users in their use of the systems, issuing recommended actions alone was not deemed to be sufficient. Institutes had to carry out their own investigations when it came to using the GSI SLV welder trainer. The primary aim was to compile a training plan which would enable effective work with the welder training system, based on tried-and-tested threshold values. The instructor should only have to specify the training goal; the system should carry out the rest.

In technical programming terms, compiling such a training plan does not present any great challenge. Incorporating meaningful specifications into the training process proved to be complex. It finally became possible following endless tests with various test subjects, staggered over a long period of time. Experienced in-house welding instructors compared the identified threshold values and training plans with the real requirements of welder training. The result was the great-

est possible level of convergence between the adjustable parameters on the welder training system and the real conditions experienced in the welding booth.

The newly developed intelligent curriculum which underlies the 'training to plan' module brings together all the results of these extensive investigations. The instructor specifies the training goal in the system and the software prepares a suitable training plan. The trainees can work completely independently without the instructor having to intervene and implement the relevant settings. The 'training to plan' module works with levels, similar to computer games. After achieving the required number of points, the next difficulty level is automatically set, otherwise the participant is required to repeat the exercises until the required number of points is reached. The instructor therefore has the level of support required to use the GSI SLV welding trainer in his/ her training sessions without having to set up a training plan.

The benefits are clear: the users can concentrate on their tasks and do not need to waste any time when using the welder training system. Once the participant's training goal has been established, the system is informed of which welding process (TIG or MAG) and which welding position should be used. The 'training to plan' module prepares a training plan which is adapted to the training goal and automatically starts with easy exercises. As learning progresses, the system sets ever narrower boundaries. It starts with the arc length parameter and this is followed by welding speed and torch angle. By simulating the welding process, participants learn the motorised sequences used outside of the welding booth. The module provides instructors with considerable support in their use of the GSI SLV welder training system and instructors do not need to compile their own training plans.

4 Summary

The system presented offers excellent support of the education of welding personnel. At the moment we are at the starting point of the using of such systems that will improve our relation to our customers. The use of welding trainers in welding education will be the start of changing the whole system of welding education!

Contact: Dipl.-Ing. Axel Börnert, IWE
Marketing Manager
SLV Halle GmbH, Halle (Saale), Germany
boernert@slv-halle.de
www.slv-halle.de