

# Addressing the Need for Student Engagement and Cost-Effective Training Experiences in the Welding Classroom



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Faced with limited resources and increased demand for training a more talented welding workforce, welding instructors and school programs are being challenged to prepare students faster, more cost-effectively and efficiently than ever.

**BY JASON SCALES PH.D.**



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**A**s record numbers of baby-boomers get set to retire from the welding profession in the next several years, they are leaving behind a deep void of industry knowledge and years of experience. To lessen the ill effects of a diminishing skilled workforce, new approaches to welding education are needed to prepare more highly skilled welders to join a wide range of fields. Coupled with the appeal to address the country's infrastructure needs and ramp up manufacturing efforts, considerable pressure is being placed on welding schools and instructors to train new welders to effectively address the demand for higher levels of productivity and quality.

computer graphics and rendering techniques have given rise to a significantly more sophisticated brand of VR. Today's technology so vividly mirrors real environments and situations that it has been applied to an increasing number of professional settings – from teaching surgeons how to successfully separate conjoined twins, to preparing astronauts how to successfully leave a spaceship and conduct a spacewalk<sup>1+2</sup>.

The expanding role of VR in the learning process further exemplifies a transition from the so-called "information age" to the "experience age," in which technology has now made it possible

## Using VR technology, novice welders can quickly pick up and develop the same sophisticated motions and processes used in the real welding environment.

One exciting new approach to welding preparation that has gained more widespread attention for its versatility and skill-building capacity in recent years is the application of virtual reality (VR) in the welding classroom. Using VR technology, novice welders can quickly pick up and develop the same sophisticated motions and processes used in the real welding environment.

Ever since the 1960s, the concept of VR and its potential to enhance the learning environment has existed in some way, shape or form. But in the last 10 years, considerable innovations in

to learn by doing in a more cost-effective way than ever before. From medicine and robotics, to foreign language, architecture and design, VR has been heralded for promoting a more active learning environment, helping students to retain and apply newly acquired skills to the real world with a heightened level of confidence and success overall<sup>3</sup>.

## Challenges and Solutions

Traditional welding-only training programs pose several significant challenges to educators and welding learners, including safety, cost of operation and limited practice time. In this white paper, we address six of the most common challenges in the traditional welding education setting and explain how the addition of a VR trainer can help instructors maximize learning, increase welder certification rates and fill a critical skilled labor shortage.

### 1 Student enrollment and diversity in traditional welding training programs is hindered by lack of awareness, opportunity and accessibility.

When it comes to traditional welding programs, many students will have decided through personal experience or research that welding is a potential career interest. But there are many other students who, if given the opportunity to “try it out,” and see what welding is like, could find welding to be a rewarding and realistic career path. In the traditional setting, this typically can’t be accomplished until after a student makes the decision to attend a welding program and has completed a safety orientation. Further compounding this problem is the fact that these programs are not perceived the same as a traditional pathway in the public school setting, and therefore students must be motivated or somewhat informed about their existence ahead of time.<sup>4</sup>

VR welding training machines promote a greater level of student engagement because they make welding more accessible and “real” to a larger group of students. By eliminating some of the more intimidating components experienced in the traditional welding classroom (sparks, heat, etc.), students who would otherwise pass up the opportunity can consider welding as a potential career option. Some brands of VR training machines are designed with mobility in mind, so they can be moved from classroom to classroom and be deployed easily in a number of settings. This provides instructors and schools with a way to introduce the welding profession to more students in a more relaxed and approachable setting. In addition, for students who haven’t experienced it, the VR technology delivers an initial “wow-factor” that generates excitement, encourages student engagement and stimulates further curiosity.



## 2 When conducting traditional welding training, students must have an appropriate welding environment and they must fully understand welding safety.

Arc welding is a safe occupation when sufficient measures are taken to protect the welder from potential hazards. When these measures are overlooked, however, welders can encounter such dangers as electric shock, overexposure to fumes and gases, arc radiation, fire and explosion; which may result in serious, or even fatal, injuries.

A VR trainer from a verified welding manufacturer takes the traditional welding hazards out of the equation so students can focus more on developing critical welding skills. Using a VR trainer, students can learn to weld with the correct material type, process, gas flow, amperage/voltage and wire-feed speed, and reinforce good welding technique, such as work angle, travel angle, travel speed, distance and position in the joint – without the risks posed by the real welding environment. When used in conjunction with the proper Personal Protective Equipment (PPE), a quality VR trainer can provide a highly responsive and realistic experience for the welding learner.



**10-15 sec**

Average time to complete a VR simulated coupon



**10-15 min**

Average time to prep and weld an actual welding coupon



**\$1-\$240**

Price range for mild steel coupons



**\$15,000**

Average cost of a fully equipped welding booth

**A quality VR trainer can provide a highly responsive and realistic experience for the welding learner.**



### **3 Demonstrating proper welding techniques in a group setting isn't helpful for everyone in a traditional welding training program.**

Another responsibility of the welding instructor involves demonstrating how to lay a proper weld. This can be difficult to achieve in groups. If the average welding class contains 12 students, making sure each one has an unobstructed view of the quarter-inch-sized welding puddle can present a real challenge. While distinguishing between bad and good welds can be accomplished by inspecting the welded coupon afterward, this still does not sufficiently allow students to learn what they need to effectively replicate the weld.

Some advanced VR trainers, such as Lincoln Electric's VRTEX® welding simulators, come equipped with graphically enhanced

welding demonstration videos. This feature allows students to study different welding techniques up close and in a variety of different positions, on different materials and using different welding processes. This provides a visual aid that helps students better understand what a particular weld is supposed to look like. Using this feature, they can identify proper pacing, orientation, how close to place the welding gun to the weld joint, among other indicators of good welding. "Replay mode" is another valuable feature which allows students to re-watch their own welds and compare discontinuities and other variances, further aiding in the development of fine motor skills, depth perception, hand-eye coordination and the ability to manipulate a welding torch with small hand movements.

# 4

## Performance assessments in traditional training programs yield inconsistent results.

Another problem experienced in the traditional welding classroom is the absence of a consistent method of evaluation. In traditional welding programs, instructors typically provide feedback based on what they interpret in the weld after the process is completed. This is a less than objective and consistent means of reviewing a weld and can cause confusion among welding learners.

VR trainers with tracking and scoring capabilities can record the telltale movements of a weld in real time, and can be used as a much more

reliable and controlled process for welding skill evaluation. Aimed with these capabilities, welding instructors can provide instant feedback to the student so they can more quickly correct bad habits and improve their welding technique.

It is important to note that not all VR trainers on the market come with these functions. In addition, VR trainers with responsive and realistic sounds and visuals of the welding puddle offer a better learning platform than other trainers. These features are critical because they give learners an opportunity to train their ear and eyes to detect some of the same signs all welders need to recognize in order to self-correct.

## VR trainers with tracking and scoring capabilities can record the telltale movements of a weld in real time.



# 5

## Traditional welding training environments inherently limit the amount of practice time welders-in-training are exposed to.

Ask any seasoned welder, and they will tell you the No. 1 indicator of welding talent is time spent in the welding booth. Because nearly 80 percent of welding must be learned individually and by hand, welding students need to maximize the amount of time they have to practice repeated movements so they can improve their welding technique. Due to the requirements for setting up a welding coupon (which may include the use of a grinder, chipping hammer and wire brush) in the traditional classroom, the welding student may be able to complete a weld every 10-15 minutes.

On VR trainers, such as Lincoln Electric's VRTEX welding simulator, the process of welding on a simulated coupon can take place much quicker – as fast as 10 to 15 seconds. This provides the

welding student with a real advantage in that they can complete considerably more welds in a much shorter amount of time. According to an independent study conducted by Iowa State University, welders who were taught using a blended model of traditional/virtual welding instruction were able to complete their hands-on training requirements 23 percent faster and increase certification rates by 41.6 percent when compared to their counterparts<sup>5</sup>. This process can be streamlined even further with the addition of a dual VR trainer, allowing students to train two at a time on the same machine.

## A quality VR trainer can provide a highly responsive and realistic experience for the welding learner.



**23%**

Faster training blending VR with traditional training



**42%**

Increased certification blending VR with traditional training



**80%**

Percent of welding learned by hand



**\$30,000**

Average cost to train one student in a year long program

# 6 Expenses for material, equipment, welding booth construction, gas and electric can cost you more in the long run.

Expenses in the traditional welding program can add up quickly when you factor in all the materials, consumables, gas and electricity required. By some estimates, it can cost as much as \$30,000 to train one student in a year-long welding program. This figure also includes the cost and life expectancy of PPE, chipping hammers, wire brushes, grinding wheels – and the building maintenance and infrastructure requirements necessary for fume control.

coupon. Expenses for consumables – the wire or electrode rod used in combination with the welding gun – can also add up, especially considering all the different wire types and sizes that may be needed to handle a specific Welding Procedure Specification. For example, the cost per pound of 5/64-inch diameter UltraCore® 70C used in Gas Metal Arc Welding (GMAW or MIG) sells for about \$2.00 per pound. And compared to a VR machine, such as Lincoln Electric's VRTEX welding simulator, transformer-based welders can cost 33-43 cents more per hour in electricity when the transformer is turned on, but not in use.



And while many welding programs aim to teach all of the core welding processes, Gas Tungsten Arc Welding (GTAW or TIG) isn't typically the most feasible process to teach, due to the financial investment that must be incurred. GTAW, which is used in the motorsports and aerospace industries, can be one of the most expensive welding processes, simply due to the cost of the torch and materials involved (which can be as much as \$8,000 per machine depending on the material used and weld quality desired).

By incorporating a VR trainer into the welding classroom, instructors can significantly reduce the material costs of spent steel and metal alloy welding coupons, which can cost between \$1.00 for a 10 gauge mild steel tee joint up to \$240.00 for a 12 inch Schedule 40 pipe

In addition, many VR trainers come equipped to teach multiple welding processes, such as Shielded Metal Arc Welding (SMAW or Stick), GMAW and Flux-Cored Arc Welding (FCAW). There are also a limited number of new VR trainers, which have been updated to incorporate GTAW in the virtual world. However, educators and welding professionals should pay close attention to the quality of the experience and what can actually be achieved with virtual GTAW, as some brands do not simulate GTAW as accurately as others. For example, some trainers do not feature the use of the consumable and foot pedal – two key components used in the real GTAW welding environment.

# The application of advanced VR technologies not only makes welding more accessible to a wider group of students, it promotes critical confidence-building opportunities and streamlines the development of skills.

## Conclusion

While all welding learners must eventually weld in the traditional environment, the addition of a virtual trainer encourages greater potential for success by giving welding learners more time to practice, while reducing the risk of hazards. From the point of view of the instructor and administration, these machines can also be used to mitigate expenses in terms of wasted materials and consumables, and in some cases, the need to construct a complete welding booth from the ground up (at an average cost of \$15,000). In addition, the ability to view and evaluate welding performance more consistently than traditional means helps provide for a better training experience overall.

A company that sells VR trainers that accurately mimic the processes, environment and all the real-life welding conditions presents a great deal of flexibility

and learning potential for the welding instructor. This, in conjunction with the ability to track not only performance, but cost savings, offers instructors a valuable tool that can be used to address learning gaps more effectively and from a fiscally responsible standpoint. Additionally, the application of advanced VR technologies not only makes welding more accessible to a wider group of students, it promotes critical confidence-building opportunities and streamlines the development of skills necessary for conducting a real weld on the jobsite quicker than the traditional method.

## About the Author

Jason Scales, Ph.D., is the Business Manager for Lincoln Electric's Education products and services. His background includes teaching as a former welding instructor, high school agriculture teacher and college professor. In his current role, Scales oversees Lincoln Electric's Welding Technology & Training Center in Euclid, Ohio, and the development of advanced training products, curriculum books, technical documents and specialized training programs for customers and welding education groups.

## SOURCE LINKS

1. <https://www.forbes.com/sites/charliefink/2017/09/28/how-vr-saves-lives-in-the-or/#4603d15a3099>
2. <https://www.theverge.com/2017/8/22/16178138/nasa-virtual-reality-lab-mars-rover-simulator>
3. <https://thejournal.com/articles/2018/01/11/making-virtual-reality-a-reality-in-todays-classrooms.aspx>
4. <https://www.brookings.edu/research/what-we-know-about-career-and-technical-education-in-high-school/>
5. [https://lib.dr.iastate.edu/irmse\\_pubs/114/](https://lib.dr.iastate.edu/irmse_pubs/114/)