

COLUMBUS STATE

COMMUNITY COLLEGE

Rethinking Welder Training

USING ADVANCED TECHNOLOGIES TO COMBAT WELDER SHORTAGES



C O N T E N T S

The Innovation	1
LEVERAGE EXISTING TECHNOLOGIES	1
CREATE MASTER WELDER PROFILES	2
The Pilot Applications	3
TRAIN WELDERS FASTER	3
EVALUATE WELDER SKILLS	4
HIRE & PROMOTE WITH CONFIDENCE	5
The Future	8

Columbus State Community College is one of the largest, most comprehensive community colleges in Ohio. With two campuses and six regional learning centers, it serves more than 25,000 students representing all 88 counties. It offers more online learning opportunities than any other college in the state, and contributes nearly \$1 billion in regional economic impact. Since 2014, the Welding program has grown from 10 to 21 courses that span the gamut from introductory to intermediate skills, and it has expanded to include five technical certificates and a Welder AAS degree option. In 2018, Columbus State became an accredited test facility (ATF) for the American Welding Society, and it achieved coveted M-List status.

Scott Laslo, Assistant Professor and Welding Program Coordinator, has been a driving force behind these advancements. He conceived the idea of using the Power Wave® C300 and RealWeld® trainer in tandem to optimize the full potential of the two technologies for training, evaluation, hiring and promotion, and he continues to explore ways to leverage the possibilities they offer. With more than 22 years of hands-on welding experience, Laslo holds a Masters in Science & Management (MSM), and he's a Certified Welding Inspector (CWI), Certified Welding Educator (CWE), certified Welder, and certified Journeyman Sheetmetal Worker.

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The Innovation

Skilled welders are in high demand and short supply. In central Ohio, this problem has plagued employers for years, and it's projected to grow worse. Why? More than half of skilled welders are at or near retirement age, and for decades the number of individuals entering the welding career pipeline has declined.

This means employers large and small are facing skill deficits as their most experienced welders exit the workforce, while they also deal with a shrinking pool of workers competing for entry-level positions. These realities not only hamper day-to-day operations, they pose a threat to regional vitality and growth.

By rethinking traditional welder training, Columbus State has developed an innovative pilot program that leverages advanced technologies to combat welder shortages. The goal is to digitally capture the unique talents and techniques of an employer's most highly skilled welders and translate these criteria into master welder profiles (MWP).

These profiles establish crucial benchmarks that allow employers to more accurately and efficiently train, evaluate, hire, and promote. Because the profiles are effective at all skill levels from beginner to master welder, employers can preserve quality standards while they save time and money.

LEVERAGE ADVANCED TECHNOLOGIES

The Lincoln Power Wave® C300 industrial-grade machine supports multiple welding processes, captures data on all

Worker Shortage Could Hamper Construction Boom

WOSU Radio, 2018

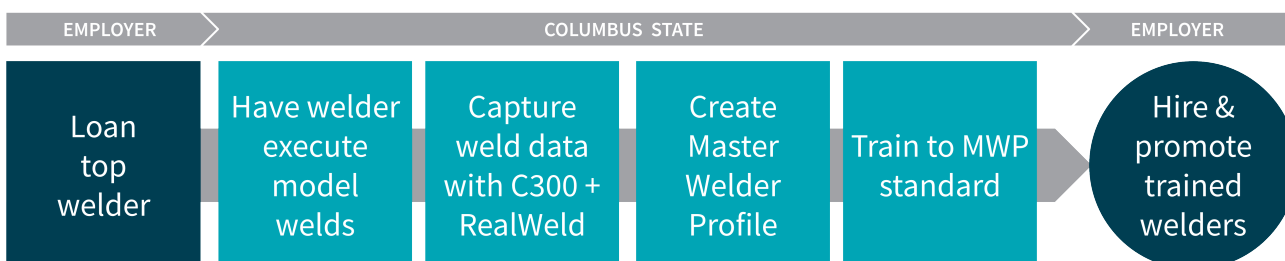
Shortage of Construction Workers Leading to Project Delays

WSYX News, 2017

Welders, America Needs You

Bloomberg, 2014

THE INNOVATIVE PROCESS



MASTER WELDER PROFILES

Power Wave® C300**Captures up to 200 data points**

- Voltage
- Amperage
- Process
- Deposition rate
- Consumption rate
- Gas flow rate

**RealWeld® Trainer****Monitors**

- Motion
- Location
- Time
- Deposition rate
- Consumption rate

Provides real-time feedback on

1. Work angle
2. Travel angle
3. Contact tip to workpiece distance
4. Travel speed
5. Position in weld

welds made, and generates a quantitative score reflecting the caliber of each one. The data can be used to identify areas for improvement, compare performance over time, measure proficiency in different welding methods, and establish weld standards for skills assessment, hiring, and promotion.

The RealWeld® trainer incorporates several technologies that help students master welding fundamentals. Motion-capture technology tracks and records five key parameters: work angle, travel angle, contact tip to work piece distance, travel speed, and position in weld. These parameters are tracked on an integrated display to provide constant visual feedback, while the built-in audio coach delivers real-time guidance to the user. The trainers generate an overall weld score and graph performance on the five parameters.

CREATE MASTER WELDER PROFILES

The Power Wave® C300 and RealWeld® trainer were designed as stand-alone systems, but by using the arc monitoring data and trainer capabilities in tandem, the college has created an integrated strategy that's more powerful and effective than either system on its own. To leverage this capacity, the college has taken the concept one step further and used these tools to create master welder profiles (MWPs).

The process is simple and effective. Employers send their best welder to the college's lab, where the welder uses the Power Wave® C300 and RealWeld® trainer to execute a series of model welds that conform to the employer's required methods and quality requirements. The C300 generates an overall weld score, while the trainer's motion-capture capability documents every action at each step of the process.

In total, more than 200 data points can be collected to define an MWP tailored to the employer's needs. By practicing against this customized baseline, trainees become master welder clones who are able to match the employer's specified skills, techniques, and quality standards. ■

The Pilot Applications

While the innovative pairing of the Power Wave® C300 and RealWeld® trainer offers extraordinary possibilities in the long run, the pilot effort focused on the top employer concerns. The challenge was to develop useful strategies to help them train welders faster, evaluate welder skills more efficiently, and hire and promote with confidence.

TRAIN WELDERS FASTER

As employers strive to make the most of the welding workforce they have, targeted fast-track training solutions offer a time- and cost-effective solution.

Challenges. With traditional instructional methods, the instructor moves from booth to booth, observing each student in action, and providing guidance and correction as appropriate. Welding booths are noisy, which makes oral communication problematic, and the instructor has a limited view of the weld in progress, which makes it challenging to identify specific variables contributing to flaws. It's common, therefore, for an instructor to visually inspect a weld and recommend students try to incorporate five or six changes to correct flaws.

In a typical four-hour lab with 10 students, individuals may receive only five minutes of one-to-one instruction each hour for an average of 20 minutes per lab session. The average student may spend an hour practicing incorrect methods before the instructor circulates to their booth, making it more difficult to adjust techniques to achieve the desired result.

Those who are struggling may not receive the personal time and attention they require to learn the specific changes they need to make to improve performance. Overall, the approach is time- and people-intensive, costly, and emphasizes trial-and-error tactics that can lead to frustration.

MWPs ADDRESS TOP EMPLOYER CONCERNS



Benefits. The RealWeld® trainer solves these challenges, because there's a virtual instructor in the booth. The built-in audio coach supplements in-person instruction by providing real-time guidance on speed, angle, aim, contact tip to work piece distance, and position in the weld. The trainer's integrated display gives students continuous visual feedback on these critical parameters, while the Power Wave® C300 provides an overall weld score comparing the student's weld to the established benchmark. With this feedback, students can adjust their welding technique before poor habits become ingrained.

Once the welder profile has been loaded into the system, the trainer pinpoints the variables contributing to flawed welds, so instead of a laundry list of possibilities, the instructor knows which techniques to emphasize. The combination of continuous audio feedback and specific guidance from the instructor shortens learning curves, improves outcomes, and boosts success.

skill acquisition is

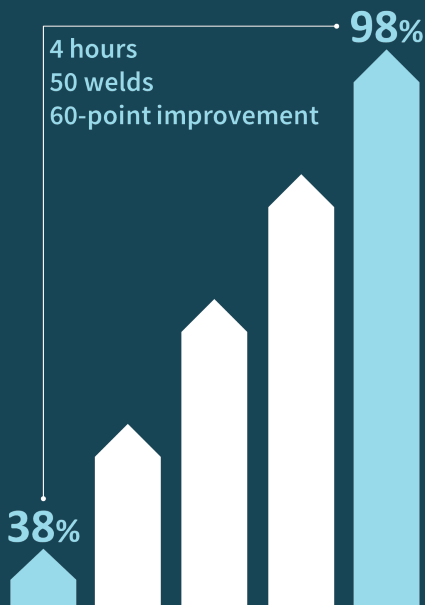
25%

faster than traditional methods

The way we train our welders is unique. We leverage our equipment and advanced technology to enable our students to learn faster.

Scott Laslo, Assistant Professor

SKILLS IMPROVE DRAMATICALLY



As a result, skill acquisition is 25% faster than traditional methods. This accelerated rate applies throughout all phases of training and across all student types, from new learners to experienced welders who want to build skills or polish existing ones in preparation for certification tests.

In one instance, the trainer consistently rated a student's welds at 38%. The student was having difficulty spotting and correcting flaws, so while the unit continued to provide performance readouts, the instructor provided visual comparisons and oral coaching to help the student identify imperfections and adjust his technique to prevent these issues. By the end of a single lab session, the student had completed 50 welds, improved his score by 60 points, and was dependably producing welds rated at 98%.

Opportunities. Students who have the opportunity to use the RealWeld® trainer throughout one four-hour lab receive more than 10 times the amount of real-time audio feedback compared to those using the C300 alone. At present, the college has 20 Power Wave® C300s, but only two RealWeld® trainers. Outfitting the labs with 18 additional trainers would leverage the full potential of the technology and allow the college to roll out the strategy to all welding courses.

These technologies are already beginning to change the way welding is taught and judged. In preparation for the South Central SkillsUSA welding competition, a series of performance tests are being created. Expert welders are executing the welds to establish MWPs for each one, and next spring, participating students will be evaluated in real time against these professional standards.

EVALUATE WELDER SKILLS

Accredited test facilities (ATFs) such as Columbus State conduct welding qualification and certification tests in accordance with established codes. These codes determine if welds must be verified through destructive tests that stress them to the failure point to determine if they meet specifications.

Challenges. Not all welding jobs require certifications, but all employers utilize some form of hands-on qualifications test. The costs associated with destructive testing can quickly become prohibitive for the employer or independent welder who bears the expense. This is especially true when a welder has to retake a test in order to pass.

While destructive tests for specific qualifications average about \$175 per bend test specimen, many certifications average about \$375 and can rise as high as \$700 or more. Shipping weld samples to an external evaluator adds to the expense, and it may take up to five business days to receive official results.

Benefits. Combining the capabilities of the C300 and RealWeld® trainer offers significant advantages. In the pilot, one employer required AWS certification for employment, while two used qualifications tests to verify candidates could produce welds that physically and cosmetically matched those of their top welders.

Once the physical traits and failure points of specific welds have been established, these parameters can be used to evaluate weld caliber without destructive testing. Students can repeatedly practice meeting these criteria, while the data for every weld they execute is recorded and scored against the weld standard. This provides a clear chronicle of performance, while audio coaching, visual feedback, and overall weld scores ensure each student has the support needed to improve, along with a solid grasp of how their welds compare to the established criteria.

For both qualification and certification exams, those with lower scores are encouraged to postpone testing and continue practicing until they consistently demonstrate mastery of the requisite skills. This increases success, reduces frustration, and saves time and money for all involved.

Opportunities. For some time, motion-capture technology has been used in advanced manufacturing to assess the caliber of robotic welds. Now, the same technology can be used in lieu of destructive testing to evaluate manual welding processes.

Currently, many qualification and certification procedures require destructive testing. In the future, this may change as digital assessments become an

The RealWeld® trainer helps you get the feel of the torch angle and travel speed you need to perform proper welds ... With the trainer talking to you as you weld, it can show you what you can't see while welding and help you correct the problem.

WB, Welding student

accepted evaluation option, representing a significant time- and cost-saving measure for employers and welders.

HIRE & PROMOTE WITH CONFIDENCE

Master welder profiles can be used to establish a performance-based gold standard for hiring and promotion, which helps employers accurately and efficiently grow their workforce.

Challenges. One of the challenges facing industry is the fact that there's no uniform approach to welder training and education. While some welding programs create their own criteria, the most respected ones incorporate industry standards established by recognized code-setting organizations such as the American Welding Society (AWS), American Society of Mechanical Engineers (ASME), and American Petroleum Institute (API).

73%

of Ohio contractors
have difficulty filling positions such as
welder and pipefitter

*Our organization has a
tremendous need for welders.
We're always striving to
eliminate outsourcing and
bring the talent in house ...*

Roby L. Durr, Supervisor
Building Maintenance
Columbus Regional Airport Authority

by 2027,
regional demand
is expected to grow by

7%

Solid and time-tested, these standards are generic. They establish minimum benchmarks that provide some consistency, but there's no core curriculum to guide instruction. Welders are trained on theory and technique, but receive little industry or product-specific training. According to employers, therefore, welders acquire sufficient ability to pass standardized tests, but lack essential skills required for success on the job.

Benefits. Master welder profiles (MWP) close the gap between employer expectations and welder capability. They're based on the skills and techniques utilized by the employer's top welders, and constitute a manufacturer-specific benchmark that can be incorporated into the core curriculum, used to anchor a custom training program, or both.

MWPs can be shared with all C300s in the lab, so whether the college is offering a welding course or custom training program, participants can be trained to execute welds that meet or exceed the real-world standards. In combination, the two technologies assess student welds, compare work to the established criteria, and generate a percentage rating to indicate how closely each weld conforms to the defined benchmark. Content and techniques can be tailored to ensure both new and incumbent welders develop skills employers value, and it offers employers an accurate, objective means of evaluating potential new hires or promotion candidates based on their ability to meet quality standards vital to the company's success.

As part of the pilot process, Amsted Rail and Franklin International sent their top-notch welders to establish MWPs for the Welding: Intro to Stick course. The Power Wave® C300 and RealWeld® trainer captured data as each expert welder performed model welds to establish quality benchmarks appropriate for their employer and process. These data enrich the program, respond to real employer needs, and constitute a one-of-a-kind advantage found only at Columbus State.

MWPs streamline hiring by offering employers a means of communicating real-world performance standards to prospective candidates, along with an objective method for identifying those who meet the skill baseline established by their own top welders. Employer confidence is high, because training, assessment, and credentialing processes incorporate meaningful criteria.

Opportunities. So far, master welder profiles have only been established for the Intro to Stick course, but the college plans to continue working with regional employers to develop and incorporate MWP into its 21 welding courses. The existing Welding curriculum meets industry standards and has been validated by employers, but integrating MWPs would ensure every course responds to specific employer needs at various skill levels.

Equally important, master welder profiles offer an exceptional opportunity to provide highly targeted training tailored to an individual employer's particular needs. From entry level to advanced skills, MWP-based training ensures welders hone precisely the skills required to succeed in a specific setting.

At Daifuku, for example, welders must master pulse spray GMAW in a vertical up position, a technique not typically taught as part of most welding programs and one which is a struggle for many. Daifuku loaned their top welder and the MWP was developed as part of the pilot process, so it's in place and represents a realistic standard for the college to use to develop company-specific training when the need arises.

Amsted Rail, on the other hand, requires welders with the ability to repair stainless steel ladles. Using their expert welders, the college can build an MWP and construct a focused training program to help more welders acquire these select skills.

The ability to establish real-world benchmarks is particularly important in highly specialized fields such as nuclear energy and ship building. At present, skill development requires decades of training and experience. Custom MWPs offer the opportunity to shorten training timelines and ensure objective, competency-based employment criteria, both of which will be vital as retirements continue to deplete the most experienced welder pool. ■

I've been pleased with what I've seen just in the Intro to Stick class. We had a self-taught welder, who was very proficient ... It was nice to see some of the adjustments and basics he was able to learn.

Roby L. Durr, Supervisor
Building Maintenance
Columbus Regional Airport Authority

INDUSTRY PARTNERSHIPS

Amsted Rail

Builds railcar wheels, axles, bearings, brake systems, bogies, bolsters and more.

Daifuku

Builds material handling systems for manufacturers, transportation centers, warehouses, and more.

Franklin International

Manufactures commercial and industrial adhesives.

Lincoln Electric

Designs and manufactures a wide range of welding equipment and supplies.

Columbus State Community College is a good place to watch the evolution of higher education in Ohio.

ColumbusCEO, 2018

THE FUTURE



by 2026,
the gap between
skilled welder demand and supply
is projected to reach

375,000

The Future

Three exciting endeavors offer opportunities to pursue the promising possibilities the pilot effort has demonstrated.

In respect to industry, for example, the college is working to develop targeted training for employers with more advanced demands, whether that's welding plate, tube, or stainless steel, or mastering pulse spray GMAW. By establishing specialized MWP's for these and other production welding needs, the college can design and deliver customized training programs that help ensure regional employers are able to efficiently train, evaluate, hire, and promote the full spectrum of welders they require to thrive.

At the same time, the college is seeking funding to develop a standardized welding curriculum that's employer validated and regionally relevant. The goal is to partner with employers and use their top welders to establish MWP's and real-world criteria for each welding course currently offered. The result will be a comprehensive curriculum that creates a cohesive regional training strategy and accurately reflects local employers' authentic needs.

The MWP benchmarks can be utilized by the college's campuses and learning centers, plus they can be shared with partner high school and vocational programs. This fact is especially important, since roughly 85% of all welder training occurs at the high school level. MWP's can also be shared with four-year institutions that offer welding engineering and similar degrees, to create a well-defined 2+2+2 strategy that emphasizes common standards and extends from high school through college.

At the national level, the college's innovative approach is attracting attention. George Washington University has invited Columbus State to collaborate on an upcoming nationwide study focused on the use of advanced trainer technology and its impact on students, instructors, and the welding instruction landscape.

The inventive pairing of the Power Wave® C300 and RealWeld® trainer is at the heart of these endeavors. By coupling existing technologies with master welder profiles and utilizing the combination in creative ways, the college has conceived a breakthrough strategy that has the potential to accelerate skill development, transform welder training, and close the gap between skilled welder demand and supply. ■

REFERENCES & RESOURCES

- A New Approach to Welding Skills Validation
The Fabricator, 2018
- Higher Education: Lessons Learned
ColumbusCEO, 2018

DATA

- American Welding Society (AWS)
- Associated General Contractors of America (AGC)
- Ohio Labor Market Information

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