

# **LINCOLN ELECTRIC** **EDUCATION SOLUTIONS**



## **GRANT-WRITING GUIDE**

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# LINCOLN ELECTRIC COMPREHENSIVE EDUCATION SOLUTIONS PORTFOLIO

Students of all levels need to gain experience utilizing the equipment they will use in their future careers. By using professional-grade equipment from industry leaders, students can be better prepared for their first job and beyond. Lincoln Electric offers a wide range of welding and cutting equipment suitable for both basic and advanced training. Additionally, we offer virtual training tools such as the VRTEX® 360 Compact virtual trainer, Robotic Trainers and a virtual reality career exploration teaching tool to introduce welding to young students. Our team of Environmental Specialists can assist with designing welding labs and fume extraction systems. Our sales team, trained in the latest equipment and education solutions, can help schools design a program that meets their needs and the needs of the community. When seeking funding for a new welding lab or expanding an existing one, it is crucial to consider all potential costs, including facility construction to meet building codes and laws related to the welding industry.



A close-up photograph of a hand placing a red puzzle piece into a white puzzle. The red piece is in the center, and the word "Overview" is printed on it in white. The surrounding puzzle pieces are white and have a wavy, interlocking shape. The hand is visible in the top right corner, with a thumb and index finger holding the red piece.

**Overview**

A red graphic element at the bottom of the page, consisting of a large arrow pointing to the right. The arrow has a white outline and a dark red fill. The text "GRANT-WRITING GUIDE OVERVIEW" is written in white, bold, uppercase letters across the arrow.

**GRANT-WRITING GUIDE  
OVERVIEW**



## Grant-Writing Guide Overview

The grant-writing guide showcases some Lincoln Electric products that were depicted in the products section of the guide that a community college, vocational/technical school or other training entity may want to acquire to start, re-tool or expand the capability and capacity of its welding, cutting and automation programs. Some of these products could also be part of a mechatronics program, a career exploration program including STEM, a program that targets ex-offenders (including during incarceration), and skills upgrading programs for industry.

For this section, the following products will be showcased throughout the grant examples. Samples of potential language that grant writers (both novice and experienced) can be used in responding to Requests For Proposals (RFPs) or Funding Opportunity Announcements (FOAs) will be provided.



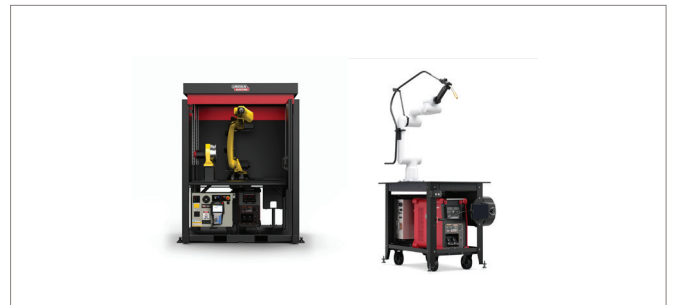
**VRTEX® 360 Compact-Bundle of 5** (other bundles and accessories available)



**Weld Booth Assist** - Aids instructors in monitoring students in a 10-cell traditional welding lab



**Torchmate® 4000 TC** - 4 x 4 Torchmate Cutting Table with starter pack educational software, supplies, and 3 days training for faculty



**ClassMate® Cobot Automated Welding System**



**Intermediate Personal Protection Equipment Ready-Paks®** and a **U/LINC curriculum software** package for 120 students that is tied to LEEPS and prepares instructors to deliver curriculum

In addition to the equipment and software, we will be working from an assumption that the fictional community college in the examples will use approximately \$5,000 in consumable supplies per year. This does not include gases for cutting.

Throughout this grant-writing guide, there will also be mention of the use of Voyage™ Arc Virtual Reality Welding Headsets. Those units will be used typically for the recruitment of potential students for longer-term welding education programs. The Voyage Arc units will be used with students who are exploring careers in welding, as well as incarcerated youth and adults.

The responsibility for verifying the accuracy and correctness of the information lies solely with the grant writer. Adhering to our recommendations does not guarantee the success of any grant application. It is the sole responsibility of the grant writer to ensure that all grant requirements and conditions are fully satisfied.

### **The ACC Training Scenario will be used as follows:**

This application will help Anywhere Community College (ACC) expand and improve its CNC manufacturing and allied trades training to better serve local manufacturers. Local employers, including Able Automotive Components and Delta Appliances, are expanding their plants and workforces and need a pool of well-trained potential employees for high-demand occupations including Computerized Numerical Controlled (CNC) machinery. This project will help increase the number of local residents who are qualified for advanced manufacturing jobs at these and other plants throughout the region.

To meet the industry standards for modern manufacturing jobs, workers must possess a range of skills, including design, production, analytical and computer skills necessary for operating CNC equipment. Anywhere Community College aims to address these needs by offering hands-on experience with a variety of industry-level manufacturing equipment as part of its advanced manufacturing technology program.

For this project, ACC will purchase a Torchmate CNC Plasma Cutting System and a Flexcut® Plasma Automated Power Source. The newly acquired equipment will provide students with the opportunity to gain hands-on experience in designing, laying out, setting up and producing manufactured parts using an industrial CNC tool. The system includes a table to hold the material being worked on, a gantry fixed on rails above the table that can hold a number of optional accessories, a CNC controller unit and specialized software and a complete educational curriculum. Students will use the system's professional CAD/CAM software to design and draw parts from blueprints and then learn to set up and operate the CNC system. The students will create designed parts, inspect them and troubleshoot any issues that may arise.



## Welding Booths

The project will use Lincoln Electric Welding Booths which are ideal for stationary production welding applications, education and vocational facilities and training centers. Those units will be used for training on SMAW, GTAW, GMAW, FCAW-G, FCAW-S and Submerged Arc applications. The booths will be configured with shelving, brackets, hooks, lighting, air and gas connections to meet the needs of welding students. Source extraction weld fume control will also be integrated into the booths with an extraction arm and connection to a Central System.

Welding Booths feature a rugged steel construction that endures the rigors of a training environment or production welding operations and is easily installed. Each standard booth is 5 ft. x 5 ft. or 6 ft. x 6 ft. and meets AWS guidelines for booth width and depth. ACC will add the following options for each booth: a worktable and adjustable overhead welding brackets; welding curtain (to help protect other students and workers from arc flash and sparks); tool shelves with torch holders (which will keep the booth neat and well organized); and an optional locker box which will provide convenient storage space for a welding hood, jacket, gloves and other related items.

In addition, the new booths will also include an optional telescopic arm with 360° rotatable hood, that allows maximum extension and compression. This spring-balanced mechanism will provide easy movement and ensure that the hood stays where it is positioned. The telescopic arm will be ideal for pipe welding as the arm length can extend from 40 to 80 in.

### Helpful Hints:

*If you are interested in looking at programming at a model community college that offers a multi-faceted program like the one referenced above, you should look at Wallace State College in Hanceville, Alabama. Wallace State broke ground on a new building in 2018 and students began taking classes in the new Center for Welding Technology and Innovation Center in October 2022. The 30,000 square foot facility is the largest welding training facility in the Southeast. It includes four robotic welding stations, with three additional stations expected soon; nine virtual welding simulators; 81 welding booths; 20 grinding booths; a fabrication area with two welders; a plasma CNC table and pipe welding equipment; and three state-of-the-art classrooms with built in cameras, microphones and speakers to allow hosting online classes.*

*Wallace State's Welding program offers associate degrees in Welding and Robotic Welding. The Robotic Welding degree is the first of its kind in the State of Alabama. The program also offers various welding certificates and has three AWS Certified Welding Inspectors on its staff at its campuses in Hanceville and Oneonta.*







**AIDS FOR COMPLETING  
COMMON SECTIONS**

# Grant Writing Aids

In this section of the Guide, items in red italicized typeface are explanations for the topic and are followed by an example that can be modified and inserted in a grant application. Remember to always customize the verbiage to make it specific to your institution while responding to the requirements of the agency or foundation seeking grant applications.



**Project or Executive Summary**



**Need Statement**



**Target Populations**



**Project Training Plan**



**How the Training Plan Directly Addresses Problems / Needs of the Industry**



**Alternative Training Plans**



**Partner Roles**



**Project Outcomes**



**Project Budget**



**Project Evaluation**



**Evidenced-Based Design**

## Project or Executive Summary

When applying for a grant, it is essential to include an executive summary or summary statement about the project, typically included on a cover sheet.

This summary serves as a written "elevator speech" that must be concise and effectively communicate the project's story in a few paragraphs. It is crucial to avoid any unnecessary information or "fluff" as it takes up valuable space. Reviewers often begin by reading the summary. The summary should include information about the proposed program's length, targeted populations, employer engagement (including the targeted industries or sectors and the expected outcomes). The following example contains the type of information that can be included in the summary.

This grant proposal seeks to expand and upgrade the welding program at Anywhere Community College (ACC) increasing skilled welders in our region and robotic welding operators. Adding a suite of Lincoln Electric Educational Products to our welding program, we can increase class sizes, enhance the quality of training, expedite the training process and provide the workforce needed to support the growth of Industry 4.0 in local companies. A bundle of five VRTEX 360 Compact virtual reality arc welding trainers; a Booth Assist unit for the traditional welding lab that will enable the welding instructors to monitor student progress in the welding booths; a ClassMate Cobot robotic welding system to prepare students to enter into more automated manufacturing environments that utilize robotic welding cells; a Torchmate 4 x 4 4400 CNC System to upgrade the existing cutting system in the lab and 10 Voyage Arc Virtual Reality Welding Headsets that will be used for career exploration purposes. These pieces of equipment will enable ACC to add state-of-the-art virtual reality training to their existing welding curriculum, better monitor student progress and prepare a generation of workers to work for employers that utilize automated welding cells.

These upgrades will enhance the quality of training, enhance the overall training capacity, and provide services to incumbent workers using the new units. In our region, the demand for skilled welders is growing, however, companies have reported a

shortage of skilled welders in the talent pipeline, impeding their ability to secure contracts and maximize production. To overcome part of this challenge, companies are turning to Industry 4.0 and investing in robotic welding cells. However, this presents another issue of needing trained robotic welding operators to run the machines. The need for robotic welding is on the rise. According to Robotics Tomorrow, the value of the robotics welding market was \$5,450.5 million in 2018 and is expected to increase to \$10,784.4 million by 2026. The market, during that time, will grow at a "Compound Annual Growth Rate (CAGR) or 8.7% highlighting the growing influence of robotics on welding applications." <sup>1</sup>

Using the VRTEX 360 Dual Systems as a virtual reality arc welding trainer, we can double the training capacity of the lab from 10 to 20 students at a time. We will use the virtual reality training as a prerequisite for students to become adept at welding, by providing a safe introduction to the field. The VRTEX units have been shown to expedite the training process and prepare students to advance and quickly skill up through hands-on welding in the college's existing 10 fully equipped welding booths. This results in training time reductions and increased certification rates on industry welding tests. A study by Iowa State found that students who trained with at least a fifty percent mix of virtual reality using the VRTEX 360 virtual reality arc welding trainer and a fifty percent mix of traditional welding completed 41.6 percent more AWS certifications than a comparable group that used only a traditional welding lab.

The project will also target veterans and recently discharged military personnel and family members, based on the college's proximity to an Army Base, a Marine Reserve facility, and a Coast Guard Base. ACC will also target unemployed workers impacted by economic downturns and job loss due to the pandemic. Spouses of active-duty military personnel and veterans will also be recruited. Due to the critical shortage of skilled welders with more advanced skills, we will also develop and implement a strategy to upgrade the skills of incumbent welding personnel to enable them to move into higher-level positions.



We will also help those companies to backfill the jobs of upskilled incumbent workers with graduates who are completing our enhanced welding program. This incumbent worker training strategy will include the use of robotic welding equipment. In addition, we will recruit youth, juvenile offenders and previously incarcerated individuals for the program by using the Voyage Arc Virtual Reality Headsets as part of a career exploration/recruiting strategy. ACC will recruit XX students, enroll XX students with XX students completing the welding training during the XX-

month period of the grant. Each student will practice virtual welding before moving to live welding in the lab. ACC will also train XX incumbent workers to advance their welding skills within their respective workplaces. The project will be led by a highly skilled welding faculty member who worked XX years as a welder in a manufacturing company. It is our intent to assist XX students who complete training to enter employment in a welding occupation with local businesses that employ welding personnel, including XYW Manufacturing Inc. and XYZ Contractors, Inc.

## Need Statements

All grant applications typically require a statement of need that identifies an issue or problem that the proposed project will address. The following section describes the need for welders and enhanced welder training.

Be sure to add important local companies and/or industries that need welders. The examples below cover the need for welders, solderers, and brazers, as well as robotic welding. Depending on the funding that is being sought some of the information may be highly relevant. Customize responses based on the national needs (as shown in the examples) and then compare that to the specific needs in your area.

### General Welding Need Statement

Durable goods manufacturing industries, in which welding is a critical enabling technology, account for 90% of the total production value of U.S. durable goods. It is an industry that is continuously evolving in terms of technology, processes and materials. The industry requires ongoing training for its practitioners and those who teach welding at all levels. Industries in which welding is a critical enabling technology account for 59% of the total value of production by all Manufacturing, Construction and Mining industries.<sup>2</sup>

Welders, cutters, solderers, and brazers use hand-held or remotely controlled equipment to join or cut metal parts. They also fill holes, indentations, or seams in metal products.

### Welders, cutters, solderers, and brazers typically do the following:

- » Study blueprints, sketches or specifications
- » Calculate the dimensions of parts to be welded
- » Inspect structures or materials to be welded
- » Ignite torches or start power supplies
- » Monitor the welding process to avoid overheating
- » Maintain equipment and machinery

Welding is the most common way of permanently joining metal parts. In this process, heat is applied

to metal pieces, melting and fusing them to form a permanent bond. Welding is used to join steel beams in the construction of buildings, bridges and other structures and to join pipes in pipelines, power plants and refineries. Because of its strength, welding is used in shipbuilding, automobile manufacturing and repair, aerospace applications and thousands of other manufacturing activities.

Welders work in a wide variety of industries, from car racing to manufacturing. The work that welders do and their equipment vary by industry. Arc welding, the most common type of welding, uses electrical currents to create heat and bond metals together, but a welder can use more than 100 different processes. The type of weld is based on the types of metals being joined and the welding conditions. Cutters use heat to cut and trim metal objects to specific dimensions. Their work is closely related to that of welders. However, instead of joining metals, cutters use the heat from an electric arc, a stream of ionized gas called plasma or burning gases to cut and trim metal objects to specific dimensions. Cutters also dismantle large objects, such as ships, railroad cars, automobiles, buildings and aircraft. Some operate and monitor cutting machines like those used by welding machine operators.

Solderers and brazers also use heat to join two or more metal objects. Soldering and brazing are similar, except that the temperature used to melt the filler metal is lower in soldering. Soldering uses metals with a melting point below 840 degrees Fahrenheit. Brazing uses metals with a higher melting point.

Soldering and brazing workers use molten metal to join two pieces of metal. However, the metal added during the soldering or brazing process has a lower melting point than the piece, so only the added metal is melted, not the piece. Therefore, these processes typically do not create distortions or weaknesses, as can occur with welding. Soldering is commonly used to make electrical and electronic circuit boards, such as computer chips. Soldering workers tend to work with small pieces that must be positioned precisely. Brazing is often used to connect cast iron and thinner metals that higher welding temperatures would

warp. Brazing can also be used to apply coatings to parts to reduce wear and protect against corrosion.

In 2022, there were 431,800 jobs for SOC Code 51-4121 - Welders, Cutters, Solderers and Brazers, with a projected 438,000 jobs in 2032. This represents a 1% increase in jobs between 2022 – 2032. During those ten years, there will be a total of 426,000 job openings (an annualized rate of 42,600 openings). Despite limited employment growth, about 42,600 openings for welders, solderers and brazers are projected each year on average, over the decade. Most of those openings are expected to result from the need to replace workers who transfer to other occupations or exit the labor force for reasons such as retirement.<sup>3</sup>

For SOC Code 51-4122 Welding, Soldering and Brazing Machine Setters, Operators and Tenders in 2022 there were 1,048,200 jobs with a projected decrease of 67,200 total jobs in 2032. Despite declining employment, about 90,800 openings for metal and plastic machine workers are projected for each year, on average for the next decade. All of these openings are expected to result from the need to replace workers who transfer to other occupations or exit the workforce for reasons such as retirement.<sup>4</sup>

Overall job prospects vary with the worker's skill level. Job prospects are good for welders trained in the latest technologies. Welders who do not have up-to-date training may face strong competition for jobs. For all welders, job prospects are better for those willing to relocate. The nation's aging infrastructure requires the expertise of welders, cutters, solderers and brazers to help rebuild bridges, highways and buildings. The median annual wage for welders, cutters, solderers and brazers was \$47,540 in 2022. The lowest 10 percent earned less than \$35,380 and the highest 10 percent earned more than \$68,750.<sup>5</sup>

Most welders, cutters, solderers and brazers work full time and overtime is common. Many manufacturing firms have two or three 8-to 12-hour shifts each day, allowing the firm to continue production around the clock if needed. As a result, welders, cutters, solderers and brazers may work evenings and weekends.<sup>6</sup>

For SOC Code 17-3024.00 Electro-mechanical and

Mechatronics Technologists and Technicians in 2022 there were 15,200 jobs with a projected decline of 400 total jobs by 2032. Despite declining employment, about 1,300 openings for electro-mechanical and mechatronics technologists and technicians are projected each year, on average, over the decade. All of these openings are expected to result from the need to replace workers who transfer to other occupations or exit the labor force for reasons such as retirement.

Automation in manufacturing could affect this occupation in both positive and negative ways. While automation may replace certain responsibilities, electro-mechanical and mechatronics technologists and technicians will still be needed to operate and maintain the robotic equipment. Included within the statistics for SOC Code 17-3024.00 is another SOC Code 17-3024.01, Robotic Technicians which may align more with the need for Robotic Technicians who are specific to welding automation.

Note - As of this time SOC 17-3024.01 is a new and emerging job title that is being developed by BLS and currently there is no further information available.

The median annual wage for electro-mechanical and mechatronics technologists and technicians was \$60,570 in 2022. The lowest 10% earned less than \$40,300 and the highest 10% earned more than \$99,390. Most of these employees work full-time and some more than 40 hours per week.

The American Welding Society (AWS) declared, "The United States is in the midst of a welder shortage that is expected to intensify as baby boomers age and the need for skilled labor grows."<sup>7</sup> The same AWS report said more than half of all welders are nearing retirement age and further states.

"Compounding the problem is the fact that high schools, universities and vocational institutions across the country are struggling to recruit younger talent to meet the burgeoning demand for welders. The fact is welding is one of the oldest and thriving fields that plays a key role in the vast manufacturing sector. A career in welding can be extremely lucrative, exciting and can lead to high-level employment in various industries. In fact, for those who are involved in the welding industry, there is a strong conviction



that a large part of the U.S. economy is dependent on welding and that continued advances in the field are necessary to increase productivity and strengthen the nation's financial stability."

In addition to jobs classified strictly as welders by the BLS, many other occupations require welding skills as part of the employee's job duties. Welders are employed in many industries, including manufacturing, where two out of three welding jobs are located. Significant sources of employment include the military, aircraft, aerospace, building construction, automotive, bridge and highway construction, shipbuilding, the medical industry, mining, robotics and computer engineering, farming equipment manufacturers, job shops and consumer electronics.<sup>8</sup> Welding careers can progress in many directions, including specialty welding jobs, inspection, management, entrepreneurship, welding education, engineering and research.

Another key demographic issue that was known by the welding industry and its talent development pipeline providers was that the ability to recruit young workers into the occupation has been difficult at best. The manufacturing industry has had difficulty attracting youth and the welding industry has fared no better in its efforts. This is partly caused by the misperception that manufacturing and welding are dying industries and that there is no future if you choose to work in those fields. There is also the perception from parents, some educators and students that manufacturing and welding jobs often take place outside or can occur in less than desirable environments.

The welding trade is "upskilling" to meet demands across industries. There is increased emphasis on certifications to ensure that welders can perform to industry standards with each type of weld. Advanced manufacturing technologies create more uses for welding. Some welders need computer skills to program robots, lasers and other welding systems. Welding new materials requires more educated and innovative welders. Welding automation requires skilled machine operators.<sup>9</sup>

### Needs Statement for Robotic Welding

"Robotic welding trends in 2022"<sup>10</sup> showed that several outcomes of moving toward automated robotic welding need to also be part of the focus in upgrading our welding training capability and capacity. Those trends include:

#### Improved speed and precision with robotic welding:

There are numerous benefits of robotic welding, from improved efficiency and deployment of skills to creating considerably safer and more realistic training environments. Robotic welding can enhance precision and the consistency of workmanship (even across complex applications), while simultaneously increasing output and the number of parts welded every hour. This is underpinned by a concept referred to as "adaptive control." Based on cutting-edge technology and the principles of machine learning, adaptive control draws on welding data from different robots. This is then logged and subsequently analyzed to identify ways in which processes can be enhanced going forward. Adaptive control can leverage some granular datasets, such as the voltage of the machine and the level of resistance incurred during welding. Other factors such as temperature are also considered, with a view to creating adaptive robots that continually operate in optimal conditions. Typically, individual adjustments save robotic welding controls milliseconds, but adopting this approach across the board can deliver significant gains in speed, accuracy and efficiency over time.

#### Ushering in the Age of Industry 4.0:

The term Industry 4.0 refers to the Fourth Industrial Revolution, which conceptualizes the rapid pace of technological advancement and the wider impact of interconnectivity and smart automation across a broad range of industries. The global coronavirus pandemic accelerated the impact of Industry 4.0 as businesses sought to embrace digitization and create a more resilient "value chain" that safeguards against future disruptions to their operations. "Value chain" describes the various activities that contribute to a business' operation, which may include welding applications and key tasks that help to create specific products. Because of this, robotic and automated welding is thought to be front and center in enabling

Industry 4.0, as it has already begun to transform various applications and industries through the deployment of cobots (collaborative robots that work alongside humans in a shared space) and “plug and play” automation systems. In this respect, Industry 4.0 is already here, while advancements in robotic welding will continue to drive this revolution further by negating the need for complex industrial R&D and allowing businesses to focus on execution and delivering far greater efficiencies.

### **Bridging the Skill Gap Through Cobots in the Short-Term:**

While the demand for workers in the global welding industry continues to rise, there remains a widespread shortage of skilled welding personnel. In the U.S. alone, AWS has predicted a total deficit of 400,000 welders by 2024, with this triggered largely by an aging workforce and the distinct lack of younger welders making their way within the industry. Robotic welding is viewed as a potential solution to address the shortage of skilled workers in the welding industry. This is because it offers immersive training opportunities to the next generation of welders while also optimizing productivity. The fact remains that this technology is still in its infancy, and there is currently a shortage of skilled robotic welders as the industry continues to mature. The use of cobots may provide a more viable solution in the short term.

Cobots are collaborative robots that leverage artificial intelligence to work alongside humans. Conversely, robots are autonomous and intuitive machines that perform tasks without human control. Cobots typically have a lower payload capacity than traditional robots, but are more adaptable for various tasks, especially in welding applications where a lightweight welding gun is used. Their compact and lightweight design allows them to navigate seamlessly around the workplace, providing optimal coverage and enhancing productivity within a streamlined workforce. By boosting the efficiency of

human workers, Cobots offer an affordable solution to bridge the short-term gap created by a global welder shortage.

### **Needs Statement for CNC Machine Technology – Relates to Torchmate Products Line**

A comprehensive Career and Technical Education program in machine technology includes everything from design to production. To meet industry standards<sup>11</sup>, students, need to understand and be able to interpret planning and lay out operations used in machining, follow blueprints, perform calculations and use computer tools appropriately to plan, lay out and produce parts or finished products. They should understand the qualities of various raw and industrial materials and how those materials can be processed and used in manufacturing. Students need to be able to:

- » Select and use the proper tools for cutting, milling, drilling, turning, shaping and forming.
- » Understand machining and forming processes.
- » Understand inspection and quality control systems.
- » Troubleshoot design, set-up and production problems.

All told, they should be able to select and operate the machines best suited for prototype and production work. Meeting these needs requires a broad variety of industrial equipment so students can have a wide range of experiences to prepare them for a wide range of jobs in machine technology.

The Torchmate system can be used to prepare students for CNC and CNC-related occupations. The table below depicts Standard Occupational Classification (SOC) Codes for those occupations along with a corresponding Occupational Title, choose the titles that apply for your project and then the same descriptions from the next table below.

SOC Code	Occupational Title
51-4011.00	<a href="#">Computer-Controlled Machine Tool Operators, Metal and Plastic</a>
17-3023.01	<a href="#">Electronics Engineering Technicians</a>
47-2111.00	<a href="#">Electricians</a>
47-2211.00	<a href="#">Sheet Metal Workers</a>
51-1011.00	<a href="#">First-Line Supervisors of Production and Operating Workers</a>
51-2031.00	<a href="#">Engine and Other Machine Assemblers</a>
51-2041.00	<a href="#">Structural Metal Fabricators and Fitters</a>
51-4012.00	<a href="#">Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic</a>
51-4031.00	<a href="#">Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic</a>
51-4041.00	<a href="#">Machinists</a>
51-4061.00	<a href="#">Model Makers, Metal and Plastic</a>
51-4062.00	<a href="#">Patternmakers, Metal and Plastic</a>
51-4081.00	<a href="#">Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic</a>

Table 1. Standard Occupational Classification (SOC) Codes



## Target Population

Typically, the RFP or FOA will indicate what population the grant's funding is seeking to target. Review your project and determine if the population your project seeks to serve aligns with the grant's targeted population. In this section, you should try to identify the number of people in your community or region that meet the definition of that targeted population. Some of that data can be collected by going to the American Community Survey conducted through the U.S. Census Bureau at <https://data.census.gov/profile>. Depending on the data you are looking for, you may also want to explore topics at that location for specific population demographics including age, gender, race and ethnicity and income data.

### Several target populations that may fall under the parameters of the funding source are:

- » **Customers of American Job Centers:** Previously referred to as One Stop Centers for adults, dislocated workers, as well as the underemployed.
- » **Local High School Welding Programs:** Students enrolled, completing or in a dual enrollment program.
- » **Veterans:** Including recently discharged military personnel, as well as military family members.
- » **Dislocated workers:** Especially from manufacturing jobs
- » **Public/Subsidized Housed Individuals:** Who are considered low-income and underemployed.
- » **Incumbent Workers:** Typically, underemployed or as part of an upskilling strategy
- » **Unemployed Graduates:** Two and four-year college graduates who are unemployed and desire in-demand technical skills.
- » **Ex-offenders:** (adults and juveniles)
- » **Incarcerated individuals:** At correctional facilities, pre-release facilities or in post-release halfway housing.
- » **The Long-Term Unemployed**
- » **High School Dropouts**
- » **High School Students at Risk of Dropping Out**

An example of a targeted population description for veterans and recently discharged military personnel follows:

The proposed welding training program at Anywhere Community College will target active-duty military personnel who are transitioning out of the service, members of the Coast Guard or National Guard and Reservists who are currently unemployed or underemployed, military spouses and veterans.

From 2013 to 2018, the U.S. military was downsized, resulting in thousands of active-duty personnel and their families transitioning into the civilian workforce. This downsizing challenged the communities that service members were returning to or the area they were relocating to. To fully understand the magnitude of the issue, it was essential to understand the ramifications of budget cuts on the military. During that time, Secretary of Defense, Chuck Hagel, indicated that budget proposals called for the U.S. Army to downsize from 522,000 active-duty personnel, the Marine Corps was to reduce its overall force to 175,000, the Air Force was to shrink below 327,000 and the Navy reduced its force below 323,000 service members.

As was the case during 2013-2018 (as well as now), some of the active-duty personnel who left the service came with skills that rapidly enabled them to assimilate into the workforce, while others needed to access the local workforce system or return to school to re-enter the civilian workforce. Those who could not immediately find employment typically ended up receiving unemployment benefits in the state where they resided post-discharge.

Many of these veterans and their spouses were adversely impacted by employers downsizing or closing due to the COVID-19 pandemic. "According to the Bureau of Labor Statistics the unemployment rate among veterans fell to 7.9 percent in July 2020. That figure translated to about 700,000 veterans looking for work. In June, that number was 8.6 percent. In April, the first full month of the coronavirus pandemic in the United States, the number was 11.7 percent, the highest monthly rate

recorded by the agency in at least the last 20 years. More than 1 million veterans reported being jobless in April as the national unemployment rate rose to 14.7 percent. Post pandemic, that rate has dropped considerably and in August 2023 the following rates were reported. Many of these employed individuals were more than likely employed in industries other than the ones they entered post-discharge.<sup>12</sup>

Unemployment Rates by Gender and Veteran Status for September 2022 – August 2023 Averaged*		
Women	Veterans	2.8%
	Nonveterans	3.4%
Male	Veterans	2.7%
	Nonveterans	3.6%

\*12-month moving average generated using unpublished data tables obtained from the U.S. Bureau of Labor Statistics: Table 1. Employment status of persons by veteran status, age, race, Hispanic or Latino ethnicity, and sex, not seasonally adjusted.

Source: bls.gov (Current Population Survey)

**The recruitment processes included in the applications vary depending on the targeted population. A few common processes include meeting with or contacting:**

- » American Job Centers (previously referred to as One Stop Centers) staff to create awareness about the program and the needs of the welding industry and to establish recruitment and referral processes.
- » High school counselors to establish a recruitment and referral process and arrange to speak with students and parents to create awareness about the program and the needs of the welding industry. This would also include the use of the Voyage Arc System and possibly VRTEX units to promote careers in Welding.
- » Personnel from juvenile and adult correction facilities where students can begin the process of training pre-release and then continue in training at the college post-release. This could include the use of Voyage Arc and VRTEX units.
- » Veterans’ groups to create awareness about the program, the needs of the welding industry and to establish a recruitment and referral process.
- » Military base leadership to identify individuals who will be transitioning out of the service

pre-discharge to speed up their efforts to become gainfully employed in the local community. Recruitment could target individuals who have a Military Occupational Classification that aligns with welding, welding automation and robotics.

- » Military base leadership to identify military spouses who are unemployed and are interested in pursuing a career in welding or automation.
- » Community-based organizations, including United Way, to create awareness about the program to the needs of the welding industry and to establish a recruitment and referral process.
- » Chambers of Commerce or local associations of manufacturers to create awareness about the program, the needs of the welding industry and to establish a recruitment and referral process.

**For recruiting purposes, minimum qualifications for acceptance into a welding training program will vary based on the program and the equipment that is used in training. Entry requirements for robotic welding will be different than those for entry into welding training using the traditional lab and/or the VRTEX systems:**

Welding, soldering and brazing workers need with good math, problem-solving and communication skills. They should be able to concentrate on detailed work for long periods and be able to bend, stoop and work in awkward positions.<sup>13</sup>

**Screening participants for admission into a training program will vary based on local circumstances. One possible method is as follows:**

Once potential participants are recruited, they will be screened using the VRTEX 360 System virtual reality arc welding trainers. Two-hour intake sessions will be scheduled for up to 10 participants at a time. Individuals who do not attend their scheduled session will be dropped from the project. At the start of each session, project staff will describe the training program and the VRTEX virtual reality arc welding trainers. Each potential trainee will be allowed to create four to six virtual welds on the equipment.

The VRTEX 360 System virtual reality arc welding trainers will be used to “screen-in” and “screen-

out” potential participants. Giving each potential participant the ability to experience welding using this virtual reality training tool which can promote interest in applicants with no welding experience to enroll in the proposed training project. It can also help potential participants with little or no aptitude for welding to screen themselves out of the program. Following the virtual reality experience, project staff will interview each trainee to determine interest and aptitude for the welding program. Project staff will make the final decision regarding which applicants to admit/enroll in the training program.

**The following is an alternate screening statement for an incumbent worker training program:**

Employees will be assessed for their current (baseline) welding skills using the VRTEX 360 System virtual reality arc welding trainers. Each employee will be assigned six welds to complete. The VRTEX System virtual reality arc welding scores on the six welds will determine the employee’s welding strengths and weaknesses and form the basis for an individual training plan for that employee. The system produces unbiased, objective data that will be used to focus training on the specific types of welds and welding techniques that the employee needs. The system also permits students to avoid spending time on welds and techniques on which they are already proficient.

**The following is an alternate screening statement for incumbent workers who are interested in robotic welding training:**

The college will work with local employers to design an assessment that will be used to determine the potential for an incumbent worker to enter the robotic welding training program. The assessment will include prior welding experience, prior experience in working with automation in the manufacturing

industry and knowledge and set-up of automated machinery. This assessment will also require proof from the applicants or their employers regarding welding certifications that the individual holds. Potential students will be tested using the ClassMate Cobot Automated Welding System.

**The following statement is related to the recruiting and screening of youth and incarcerated populations:**

Youth will be recruited for the program using the Voyage Arc Virtual Reality Headsets. Using gaming related situations, potential youth applicants will learn about the welding industry and welding. Individuals expressing an interest in entering the welding field will also be given the opportunity to try the VRTEX 360 System as part of the interview process. The youth will also be interviewed by faculty from the welding program. Incarcerated populations will be interviewed by faculty regarding entering the program. These individuals must be within 4-6 months of release into the community or in a halfway house situation. Only non-violent offenders will be considered for the program. Individuals who are interested in the program will be provided with the opportunity to use the Voyage Arc headsets in a supervised setting. An internet connection is not required for either product, making it suitable for correctional facilities. Those who remain interested will have the opportunity to try using the VRTEX 360 System under the supervision of a faculty member. Once accepted into the program the individuals will only receive VRTEX or VR welding training while incarcerated, with hands-on training in the college’s traditional welding lab post-release. The traditional welding lab setting will enable faculty to continually supervise all trainees in the welding booths using the Boost Assist unit that is being acquired as part of this grant.

## Project Training Plan: Robotic Welding Automation, Virtual Reality and Traditional Welding Lab Technology

This section can be used in an application for equipment purchase. The section below is written for robotic welding and for welding applications that use virtual reality as part of a curriculum integrated with traditional welding. Summaries of alternate plans to use the system in standalone training (for example, in career exploration, as part of a community or technical college program or a four-year university metal program or in a corrections institution) can also be found in the guide. This section can be used in an application for equipment purchase. The section below is written for robotic welding and for welding applications that use virtual reality as part of a curriculum integrated with traditional welding. Summaries of alternate plans to use the system in stand-alone training (for example, in career exploration, as part of a community or technical college program or a four-year university metals programs or in a corrections institution) can also be found in the guide.

### Robotic Welding

Robotic welding is undergoing a technical revolution. Once relegated to large-scale operations, today's robotic welding machines are more agile and flexible, which makes the benefits of robotic welding – increased productivity, consistent weld quality, flexibility and safety – more manageable and cost-effective for smaller to medium-sized operations. More than 20 percent of commercial welding in the United States is performed by robotics – a trend that is expected to continue to grow as operations look to find alternatives to streamline production. As a result, the demand for trained robotic welding technicians is on the rise – and Lincoln Electric Robotic Training Systems are leading the charge for knowledge and training in this growing field.

**The proposed project will prepare the students to work in an environment with robotic welding equipment.**

The Lincoln Electric ClassMate Cobot is designed to help welding educators meet the need for advanced manufacturing training. The robotic welding training system is a pre-engineered mobile system, allowing

for teaching in both classroom and welding lab settings. The collaborative robotic welding cell is a single-zone, small-footprint system where welders learn to advance their programming and welding skills. The ClassMate Cobot includes the Lincoln Electric Cooper App™ which offers a range of abilities allowing for entry level training to more advanced course concepts.

**Other key components of the ClassMate Cobot include everything that faculty will need to teach classes safely and productively, including:**

- » Integrated safety measures in system and software
- » Transformational welding capabilities and processes
- » Slender, lightweight cart design allowing mobility for any classroom or lab
- » Smart torch technology for at-the-torch programming
- » Industry preparation: Realistic, on-the-job training

**The ClassMate Cobot System that will be used for training includes the following:**

- » Industrial Educational System
- » Collaborative Robot Arm and Controller
- » Power Wave® R450 Robotic Power Source
- » AutoDrive® 4R100 Wire Drive

**Training highlights include:**

- » Details needed to safely operate, maintain and program the Lincoln Electric Automation system for maximum output.
- » Student-to-robot ratio is 1:1 or 2:1 to maximize trainee experience.
- » All students will receive reference materials, documents and contact information for Lincoln Electric Automation personnel.



### Virtual Reality Welding and Traditional Welding Integration:

This project will integrate virtual reality welding into Anywhere Community College's traditional welding curriculum to help enhance the quality, quantity, and efficiency of training for welders; increase the number of trained welders entering the field; and increase their skill levels and industry certifications from the American Welding Society. This project will use the VRTEX 360 virtual reality welding trainers which simulate hands-on welding training for two students at a time on one machine. These Virtual Reality Arc Welding trainers will be used in addition to classroom training and "live" welding training in a traditional welding booth. This computer-based training system is an educational tool designed to allow students to practice their welding skills and technique in a simulated environment. It promotes the efficient transfer of welding skills to the welding booth while reducing material waste and energy consumption associated with traditional welding training.

#### The VRTEX 360 provides a life-like welding environment that uses:

- » Realistic puddle and actual welding sounds to help welders respond and adjust welding technique.
- » Simulates sparks, slag, grinding and weld cooling.
- » Welding discontinuities that appear when improper welding technique is used.
- » Virtual bend tests provide results instantly and reveal what causes a weld to pass or fail.

#### Reinforcement for students is based on:

- » Demos of successful welds.
- » Replication of proper machine set-up using a Welding Procedure Specification. Students must select gas type, process, gas flow, amperage/voltage, and wire-feed speed in the system; and,
- » Tracks and scores key weld parameters including work angle, travel angle, travel speed, distance, and position.

The VRTEX 360 virtual reality arc welding trainer

supports four welding processes: shielded metal arc welding (SMAW), gas metal arc welding (GMAW), flux cored arc welding – gas-and self-shielded (FCAW-G/S) and gas tungsten arc welding (GTAW). The VRTEX virtual reality arc welding trainer systems promote the efficient transfer of quality welding skills and body positioning to the welding booth while reducing material waste associated with traditional welding training. Descriptions of the primary components to the VRTEX 360 virtual reality arc welding trainer follow.

#### These descriptors can be used in part or in whole based on grant requirements and page limitations:

360 Compact features include (if a college opts to use VRTEX 360 Compact – use this language):

- » Retractable SMAW stick stinger, GMAW/FCAW gun and GTAW TIG torch, filler metal and adaptive foot pedal devices that realistically simulate the look, feel and action of actual guns and torches.
- » Practice flat, horizontal, vertical and overhead 5G and 6G on mild steel, aluminum and stainless steel.
- » Extremely realistic weld puddle is visually and audibly responsive to operator behavior, helping welders learn when to adjust welding technique. Welding discontinuities appear when improper technique is used.
- » Tracks and scores key weld parameters including work angle, travel angle, travel speed, distance and position.
- » Virtual bend test provides results instantly and reveals what causes a weld to pass or fail.
- » Demo, Replay & Lesson Mode helps instructors and welders identify what went wrong or well.
- » Simulates sparks, slag, grinding and weld cooling.
- » 4 different welding environments.

The student logs in and uses this machine to set up and use the welding simulation. The power button on the front of the machine turns the system on, and the touchscreen interface navigates the simulation software through multiple menus to perform various functions, such as the selection of welding processes, material, positions, current, polarity, amperage, wire feed speed and voltage settings. settings. A USB port

is used to upload software and download data for each logged-in user. Three welding devices including one for GMAW and FCAW, one for SMAW and one for GTAW are included in the system. The virtual reality GMAW/FCAW gun has a trigger that is used during the simulation of these processes to initiate and maintain the simulated welding arc. The virtual reality SMAW stinger has a rod representing the electrode. When the virtual arc is struck, this rod retracts to simulate the electrode burning off during the welding process. To strike an arc with the SMAW device, students strike or tap the tip of the rod on the virtual reality coupon that has been set up in the system. The angle of the rod can be changed between 90 and 45 degrees, by squeezing the clamp of the VR SMAW device. The virtual reality GTAW torch can be used with the virtual filler or autogenously. The Foot Amptrol™ is used with the torch to strike the arc and control the current flow.

The VRTEX virtual reality arc welding trainer stand is modeled after an actual welding booth. The stand holds one of the seven VRTEX virtual reality arc welding trainer welding coupons in the flat, horizontal, vertical or overhead welding positions to simulate real welding applications. The table is used to teach students proper body positioning.

The virtual welding coupons represent the various workpieces the students will practice welding. During the virtual welding process, they provide physical feedback to the student.

There are seven VRTEX coupons:

- » Flat Plate
- » T-Joint
- » Lap Joint
- » 3/8 in. Groove Joint with Backing Bar
- » 2 in. Diameter XXS Pipe (Open root)
- » 6 in. Diameter Schedule 40 Pipe (Open root)
- » Pipe on Plate

### How the Virtual Reality Technology Works

Before starting a virtual weld, the student logs in to the system, selects the welding processes, coupons, positions, current, polarity, amperage, wire feed speed, voltage and trim setting on the VRTEX machine, just as they would before starting an actual weld. The student then selects the appropriate

coupon, attaches it to the welding stand and puts on the headset.

Using the virtual welding device and the coupon on the stand, the student strikes a virtual arc and begins to weld. The student sees the virtual arc melt metal on the coupon and form a bead of molten metal and then sees the weld form as they move the device across the coupon. The instructor and class can see while the user is welding and the instructor and class can also see what the student welder sees.

Once the virtual weld is complete, the VRTEX 360 virtual reality arc welding trainer scores the weld. The system measures the position of the weld relative to the joint, the contact tip to work distance, work angle, the angle of the electrode to the direction of travel and the speed the welder moves the electrode along the coupon. The virtual reality system translates these measurements of the welder's technique into highly accurate predictions of discontinuities in the weld that may cause weld failure. For instance, if the arc length is too long, it will cause porosity. AWS industry-standard weld defects are measured and listed on the screen.

The welding instructor can show the view from inside the welding headgear on the VRTEX monitor to a small group or on a larger external monitor to show to an entire classroom. The instructor can rotate, zoom in and out and pan along the joint to view the welded piece. This feature is also used to inspect the weld after welding has been completed. It gives the student, the instructor and other students the ability to visually inspect the surface, shape and profile of the bead, including leg length and any discontinuities that may be present. Using these external views, users can forgo the use of the headgear altogether if desired due to any concerns for health, safety or personal preference.

Visual cues are graphical overlays that aid students in correcting their welding technique. They guide students toward appropriate travel speed, contact tip to work distance, travel angle, work angle and aim. The visual cues turn green when the student is welding within tolerance and close to optimal. They turn yellow when the student is welding close to the tolerances but not in the optimal range, and they turn red when students are welding outside of

tolerances. The cues show the student exactly which techniques need correcting and help the instructor guide the student to corrective action.

The Theory feature provides an easy and immediate way to gain technical welding knowledge within the VRTEX 360 system. Pressing the yellow theory icon on the touchscreen opens a menu that lists the

welding terms present on that screen along with definitions and supporting images. This feature engages students and provides continued access to welding terms and definitions using the VRTEX 360 virtual reality arc welding trainer. The Theory feature also reinforces standard American Welding Society terminology.

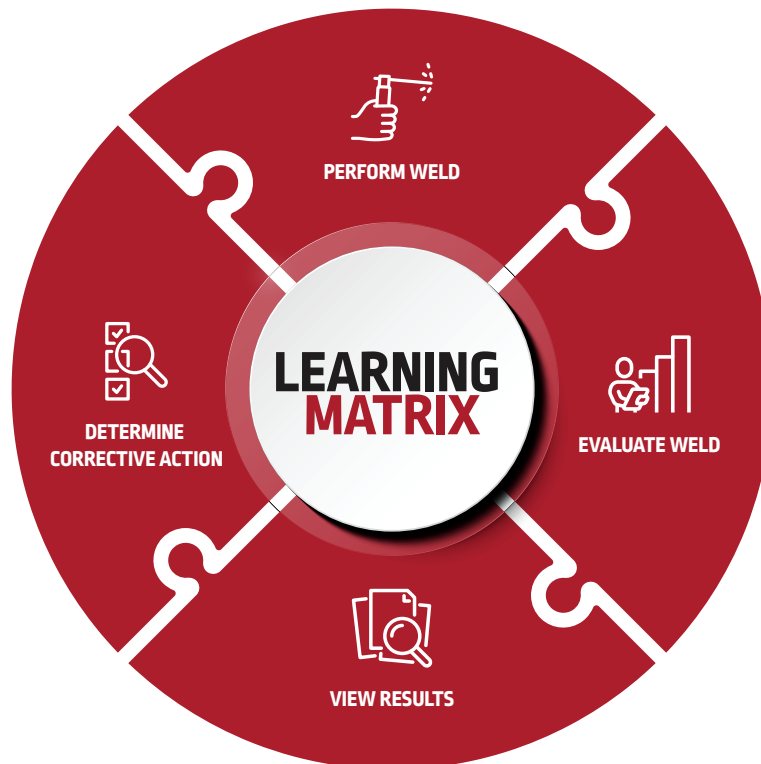
## Project Training Plan : Integrating Virtual Reality into a Comprehensive Curriculum

The VRTEX 360 Compact units can be used in various ways within a comprehensive welding curriculum. The following section describes recommended use of the system by the Lincoln Welding Technology and Training Center.

The sample curriculum outline that follows is used by the Lincoln Electric Welding Technology and Training Center. When applying for a grant, you should substitute your own curriculum outline.

### WELDING CURRICULUM OUTLINE<sup>15</sup>

- |   |   |
|---|---|
| » Safe Practices in Welding   | » Safe Practices in Welding Types and Positions of Welded Joints  |
| » Welding Symbols   | » Welding Symbols Principles of Welding   |
| » Principles of Shielded Metal Arc Welding (SMAW)   | » Process of Gas Metal Arc Welding (GMAW) Principles of GMAW  |
| » Uses and Characteristics of SMAW Electrodes   | » Modes of Metal Transfer   |
| » SMAW Electrode Identification and Operating Characteristics   | » GMAW Equipment and Accessories  |
| » Choosing the Proper Current   | » Electrodes Used to Weld Carbon and Low Alloy Steels in GMAW   |
| » Welding Heat Input  | » GMAW Shielding Gases  |
| » Welding Discontinuities and Visual Inspection   | » Principles of FCAW  |
| » Arc Blow and Welding with AC and DC Current   | » Electrodes Used to Weld Carbon and Low Alloy Steels in FCAW Welding Discontinuities and Visual Inspection |
| » Striking and Establishing an Arc  | » Running a Stringer Bead with a Whipping Motion  |
| » Running a Bead on a Plate in the Flat Position  | » Welding Heat Input  |
| » Restarting a Bead and Filling Craters   | » GMAW Bead on Plate  |
| » Running a Bead with a Weaving Motion  | » GMAW Pad  |
| » Running a Stringer Bead with a Whipping Motion  | » GMAW 2F Fillet  |
| » Building a Pad  | » GMAW 3F Fillet (Welding Down)   |
| » Effects of Polarity   | » GMAW 3F Fillet (Welding Up)   |
| » Fillet Weld on a Lap Joint in the Horizontal Position (2F)  | » GMAW 4F Fillet  |
| » 3-Pass Fillet Weld on a T-Joint in the Horizontal Position (2F) with Fast Freeze and Fill-Freeze Electrodes | » GMAW 2F Lap   |
| » 3-Pass Fillet Weld on a T-Joint in the Horizontal Position (2F) with Low-Hydrogen Electrodes                | » GMAW 3F Lap   |
| » 3-Pass Fillet Weld on a T-Joint in the Horizontal Position (2F) with Low-Hydrogen, Fast-Fill Electrodes     | » GMAW 1G Groove  |
| » Fillet Weld on a T-Joint in the Horizontal (2F) and Flat (1F) Position with Fast-Fill Electrodes            | » GMAW 2G Groove  |
| » Fillet Weld on a T-Joint in the Vertical Position (3F)  | » GMAW 3G Groove  |
| » Welding Down Double Square Weld on a Butt Joint in the Vertical Position (3G)                               | » GMAW 4G Groove  |
| » Welding Down Fillet Weld on a Lap Joint in the Vertical Position (3F)                                       | » GMAW Axial Spray 2F Fillet  |
| » Welding Down Fillet Weld on a Lap Joint in the Overhead Position (4F)                                       | » GMAW Axial Spray 1G Groove  |
| » 3-Pass Fillet Weld on a T-Joint in the Vertical Position (3F)   | » FCAW-G 2F Fillet  |
| » Welding Up 3-Pass Fillet Weld on a T-Joint in the Overhead Position (4F)                                    | » FCAW-G 3F Fillet  |
| » Single V-Groove Weld with a Backing Bar in the Flat Position (1G)   | » FCAW-G 4F Fillet  |
| » Single V-Groove Weld with a Backing Bar in the Horizontal Position (2G)                                     | » FCAW-G 1G Fillet  |
| » Single V-Groove Weld with a Backing Bar in the Vertical Position (3G)                                       | » FCAW-G 2G Fillet  |
| » Welding Up Single V-Groove Weld with a Backing Bar in the Overhead Position (4G)                            | » FCAW-G 3G Fillet  |
|   | » FCAW-G 4G Fillet  |
|   | » FCAW-S Pad  |
|   | » FCAW-S 2F Fillet  |
|   | » FCAW-S 3F Fillet  |
|   | » FCAW-S 4F Fillet  |
|   | » FCAW-S 1G Groove  |
|   | » FCAW-S 2G Groove  |
|   | » FCAW-S 3G Groove  |



The training plan includes three modes of instruction:

- » Classroom instruction on safety, theory of welding, proper techniques, and the types of welds
- » Virtual reality instruction on each type of weld and
- » Practice in a traditional welding lab with real-world equipment. Students are divided into pairs and assigned to work together on the VRTEX 360 Compact virtual reality arc welding trainer. One student puts on the virtual reality welding headgear and welds while the second student watches the weld on the monitor and coaches the welder. Then they reverse roles. Learning together is an effective pedagogical model, increasing teamwork and speeding learning<sup>14</sup>. In many cases, the student in the coaching role learns from the welder's mistakes and enables them to master a weld faster when it is their turn to weld.

Another benefit of virtual reality is that students can learn by repetition with both efficiency and cost-effectiveness. In a traditional setting, students must complete each weld or waste a welding coupon. With virtual welding, the student can start a weld over. As many times as they need to master a particular

technique. Instructors can set a score threshold for each parameter of the weld and students can work on each one until all parameters reach a passing score and comprise an ideal weld.

After the student completes three virtual welds with a score of 80 points or better, the student goes into an actual welding booth to perform the same weld. After completing satisfactory welds, the student returns to the virtual reality system to learn a new weld or a new position, which is practiced until it is mastered and the welder is ready to move to the actual welding booth again. This procedure is repeated for each weld and welding position. Following completed training, students should be able to take the American Welding Society certification test for each type of weld learned.

Lincoln Electric's VRTEX 360 series of products have been implemented and proven successful in a wide range of programs and environments. To learn more about customer success stories, visit <https://education.lincolnelectric.com/arced-onlineresources/resources/education-resource-center/casestudies>.



## How the Training Plan Directly Addresses Problems/Needs of the Industry

### Training With Torchmate CNC Plasma Tables

Lincoln Electric has made the Torchmate CNC plasma tables a top-tier product in the world of plasma automation that is both affordable and high quality.

Lincoln Electric engineers have designed the 4000 Series CNC machine to change the way you can make small parts at home, at school or in the shop. The ACCUMOVE® 2 motion controller, included with each machine, uses technology developed for the most advanced motion control systems. The Torchmate 4000 Series is available as a 4x4, 5x5, 4x8 and 5x10 cutting system. The entire 4000 Series line comes standard as a waterbed to reduce plasma dust without the use of an expensive and dirty downdraft system. The power source for the Torchmate Tables is the FlexCut Plasma power supply, which is made for CNC. Lincoln Electric also offers the Tomahawk as a handheld power source.

Torchmate markets their affordable automated plasma cutting machinery to shop classes in schools throughout the country, giving teachers a real-world manufacturing tool to teach CAD software and CNC operations to the next generation. The machine that students will use in the classroom is no different than the machine they will see in the real world. Student investment in learning the technology in the classroom will likely save time in training with their employer after graduation.

Each machine has the most advanced technological features; such as a touch-friendly user interface, integration with CAD and CAM software, Ethernet connectivity and digital torch height control. The Torchmate machine allows students to grasp CAD and CAM design, as well as see the completion of their design in a final product. Finished parts from a Torchmate machine can be welded and finished, allowing students to get the full educational experience in hands-on manufacturing. Students can put multiple skills together using a Torchmate machine, allowing them to leave school not as an entry-level worker, but as a skilled CNC machine operator.

**Educational programs using the standard Torchmate software can now upgrade to the EDU package. This will provide faculty with the ability to give their students the full CAD/CAM experience. With the Torchmate CAD EDU software, educational institutions no longer need to purchase multiple dongles/drives for their students or require costly yearly software subscriptions.**

**The Torchmate 4000 series that will be used for training includes the following:**

- » A complete drawing package for the creation of parts that can be used independent of any other design software or in conjunction with other CAD programs. The most critical component in CNC operation is the design of the parts to be cut. There are many software packages in the industry that are capable of designing parts. Torchmate is no exception; Torchmate's CAD/CAM allows users to conceive a part, design the part and optimize the part for machining. With Torchmate's CAD/CAM, no additional software is needed to create parts on a CNC system. On the other hand, there is such a diverse range of software packages in the CNC industry that some users may have extensive experience using an existing CAD/CAM software package other than those that are provided by Torchmate. Torchmate's CAD/CAM software is designed with the same industry standards as other software packages and may use drawings created in another software and convert them to a cuttable file.
- » The system can import shapes from other CAD programs and scan any bitmap, jpg, gif or other image formats. In the industrial and graphic design industries, multiple file formats exist for conveying a design or piece of artwork. Torchmate's CAD/CAM program can accept some of the most popular formats (i.e. DXF, JPG, PNG and more) for images, clipart and drawings. This allows a user to utilize multiple sources to complete the designs they want. The ability to scan drawings directly into Torchmate CAD/CAM creates another avenue of design by allowing hand-drawn elements to be incorporated using a scanner.

- » **The system provides the ability to convert drawn shapes for cutting.** In the CNC industry there are two groups of software, Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM). Some software packages like Torchmate CAD/CAM span the two groups. In other cases, these two important functions may be accomplished with two separate software packages, often developed by two companies. By combining both functions into one software package, Torchmate CAD/ CAM seamlessly transitions the files from a design environment to a manufacturing environment. This synchronicity also decreases the time from part conception to reality and reduces the possibility for errors introduced between one software package and another.
- » **The system can import any vector file or pictures from a digital camera and scale shapes to any desired size.** Similar to the ability to scan an image, a picture may be taken of an object or drawing. This image may then be opened using Torchmate's CAD/CAM software. The image may be scaled and manipulated the same as any other part. This allows small representations to be sized to the finished product's size or adjustments to different dimensions. This feature simply adds another method of incorporating various elements into a finished design.
- » **The system can duplicate shapes in any number & pattern.** Torchmate software allows for the custom arrangement of your shapes into patterns for unlimited possibilities and creativity.
- » **The system is capable of automatic nesting, including rotation, multiple sheet fill, variable spacing and flipping.** Automatic nesting is an industrial standard for reducing wasted material and increasing the number of parts cut per sheet of material. The software will automatically take a group of parts and fit them together as tightly as possible by rotating and flipping the parts. This automatic nesting results in minimal material being cut, reducing cost per part and scrap metal.
- » **The system provides automatic insertion of lead-ins and lead-outs.** Torchmate software allows for the custom arrangement of your shapes into patterns for unlimited possibilities and creativity.
- » **The system provides automatic kerf (width of cut) compensation.** In any cutting process, a certain amount of material is removed to define a shape. The width of material removed is called the kerf. When designing a part in the CAD portion of Torchmate's CAD/CAM software, the part is drawn to the size of the finished dimension of the part. When the CAM aspect is incorporated, the actual motion of the machine is adjusted to account for the physical material that was removed during the cutting process. The resulting machine path produces a part that is the same size as it was drawn.
- » **The system provides a custom material library.** In thermal cutting applications, like plasma and oxy-fuel cutting, there are different machine settings required for different types and thicknesses of materials. Torchmate's CAD/CAM software allows these different settings to be saved and used for future parts of the same material.
- » **The system provides automatic control of torch travel direction.** When a plasma arc is created there is a swirl of shielding gas that stabilizes the process. This swirl causes one direction of cutting to be of a higher quality than another. Torchmate's CAD/CAM system enables the user to specify which direction, clockwise or counterclockwise, to use for a specific process.
- » **The system provides control of cut order (sequence).** Often, the order in which parts are cut may not be important. However, in specific cases, this feature can be advantageous. Torchmate's CAD/CAM software allows users to determine the sequence in which multiple parts are cut. This can be helpful when utilizing a high heat process and needing to control the heat applied to a specific area.
- » **The system can export finished shape patterns as DXF files.** Drawing Exchange Format (DXF) is the industrial standard file format for design. The Torchmate CAD/CAM software can read and create DXF format files to exchange between software packages.
- » **Torchmate System provides support for other processes such as plate marking.** Why buy a CNC machine just for plasma cutting?

Torchmate's automated plate marking attachment is a fully pneumatic tool that marks designs onto your metal plate and is available for any Torchmate table. This tool is designed to handle uneven plates. Adding part numbers, break lines, logos and more to your designs adds an extra element of customization that will give all your metal pieces a unique look.

- » **The Torchmate System also allows you to cut round tubes and pipes with the 4000 TC.** The 4000 TC is an attachment you can add on to your any 4000 Series plasma cutting tables. You will be able to cut schedule 40, round pipe and tube from 1.5in. to 6in. in diameter and up to 7ft. long. When cutting weld coupons, the automated bevel head will be able to cut a bevel up to 45 degrees on both sides of the coupon. The plug-and-play interface makes the 4000 TC easy to install and operate.

### **Best Practice Justification: Virtual Welding Research – Iowa State University Studies**

The use of virtual reality welding as part of a comprehensive training program that includes traditional welding instruction as well as instruction on cutting produces more welders who have been trained in a consistent, fact-based manner, up to industry standards and with documentation of competencies that they have achieved.

The integrated use of a virtual reality system enables more welders that can be trained in a shorter period of time. Researchers at Iowa State found an overall reduction in training time and a corresponding reduction in welding lab times of over 50 percent for benchmark welds<sup>16</sup>. One benchmark for achievement was a visual test by a certified welding inspector on 2F and 3F welds and visuals and actual bend tests by the inspector on 1G and 3G welds. The results showed an overall reduction in training time and a corresponding reduction in welding lab times of over 50 percent for all welds (2F, 3F, 1G and 3G).

Training time was reduced and rates on industry welding tests increased. The Iowa State study found that students trained with a mix of virtual reality and traditional welding completed 41.6 percent more AWS certifications than a comparable group that used only a traditional welding lab.

Several observations helped to explain this finding. First, the students spent more “arc time” using virtual reality on a given day because they did not have to prepare weld coupons, run for more consumables, clean their welds and many other time-consuming but necessary tasks associated with traditional welding training. The system also substantially reduced the costs of training materials, including expensive weld coupons. Reductions in consumable expenses of 50 percent are expected compared with costs of operating a traditional welding lab when the virtual reality equipment is in use.

Virtual reality also permits consistent standards in training and evaluation that do not vary from instructor to instructor or day to day. The VRTEX 360 series of virtual reality welding simulators use a data-based scoring system that accurately and consistently tracks, scores and records the five operator variables that affect the weld. At any time during the training course, a student’s abilities can be easily assessed in an objective and non-biased way by viewing the numerical and graphical results of a weld. In addition, the screen displays AWS weld discontinuities created from improper virtual welding techniques. This display alerts the student to the consequences of poor technique.

By studying those consequences and referring back to the movements that caused those defects, the student develops an understanding of how to correct their technique. The instructor can then subject the virtual weld to a virtual bend test (similar to what takes place in an actual lab) to test the weld. A welding instructor can quickly identify the developmental needs of each student and then have the student practice on identified areas of weakness.

The VRTEX 360 series of virtual reality welding simulators are also effective because they provide continuous feedback to the student performing the virtual weld, observers and instructor. The feedback includes a live display of the five operator-controlled electrode/gun movements, a graph that shows whether the welds are being made within the tolerances selected by the instructor, a visual of the weld as it is being made, a real-time display of industry-standard AWS weld discontinuities and an overall score for each weld. In addition, students can track their movements against cues from the

headset. After each pass, the screen will display a numerical score for the last weld and automatically send the screen information to a USB drive for storage and later review. The instructor can use this data to track progress and determine what corrective action each student needs. The instructor has two other features that provide immediate feedback; the ability for the instructor to move about in space to view the virtual reality weld as it is being made and the ability to view the weld in real time “through the eyes of the student.” In contrast, in a traditional welding lab, feedback for the student welder usually comes only from their own or the instructor’s visual inspection of a completed weld. The student may have to leave the welding booth to find the instructor or wait for the instructor to finish working with other students to obtain any feedback.

**All of These Factors are Part of The Justification for the Integration of Virtual Welding with the Traditional Welding Booth at Your College or Training Institution. Virtual Reality Training Leads to Industry Credentials.**

The VRTEX 360 series of virtual reality simulators are built around American Welding Society standards and certifications for welders. AWS has established standards for each weld type and welding position. The system is specifically designed to prepare students for the AWS D1.1 bend tests, the most recognized industry qualification for welders. The virtual reality weld tolerances can be changed, enabling the instructor to set very tight tolerances—making it harder to pass a virtual reality test plate and ensuring that virtual reality skills transfer to the welding booth. The VRTEX 360 series of virtual

reality arc welding trainers can also be used to test virtual welds per AWS guidelines. Once a test plate is welded virtually, it can be prepared and bent to determine if it passes, just as an actual weld is tested. The virtual bend test uses virtual discontinuities in the weld specimen to predict how the bend specimen should behave. Once a student learns to pass a virtual bend test, they will better understand how actual bend tests are done and how to pass real ones.

Many welding industry employers require the American Welding Society certifications before a welder can begin work on a particular project. They are well-recognized, standard tests that help ensure that the welder has the skill to perform a specific job. The certifications help ensure quality welding on a job site. In many cases, job specifications require the employment of certified welders. The proposed ACC project provides training to meet these specific industry standards.

Virtual reality certifications are also available for foundational welding knowledge in several areas, including principles of welding, welding safety, shielded metal arc welding (SMAW), gas metal arc welding (GMAW), flux-cored arc welding (FCAW), and gas tungsten arc welding (GTAW). These certifications can be completed solely on the VRTEX 360 series of virtual reality welding simulators with no live welding component involved.

## Alternate Training Plan

### VRTEX 360 Compact

The following information is designed for use in a grant application in which the VRTEX 360 series of welding simulators are NOT used in combination with a traditional welding lab. As described below, such uses include career exploration, a community or technical college program, a four-year university metals program or a program in a correctional facility. Programs that are only using VRTEX units should also acquire Voyage Arc Headsets for use in career exploration and recruitment of students, including incarcerated populations.

For this project, Anywhere Community College will use the VRTEX 360 Compact virtual reality arc welding trainer to provide students with a realistic welding experience as part of a career exploration program. This will also include the use of the Voyage Arc Headsets as part of the recruitment process.

Welding is often perceived as a “dirty,” unattractive job that today’s young people are not interested in, despite good job prospects and good wages. The result is both a short-and long-term shortage of skilled welders to fill employers’ vacancies in our region that are the result of new jobs and typical business churn including turnover and retirements. ACC will strive to increase participation in the welding talent development pipeline by doing career exploration visits at middle schools and high schools in the college’s service delivery area, using the Voyager Arc units. Once a student expresses interest after exposure to the Voyager Arc unit experience, we will bring those middle school and high school students into the virtual reality welding lab for xx hours. These sessions will begin with a lecture/demonstration by a welding instructor using the

VRTEX 360 Compact virtual reality arc welding trainer. The instructor will give an overview of welding and welding career opportunities and demonstrate welds on the VRTEX 360 Compact virtual reality arc welding trainer. Then each student will complete at least two virtual welds. All the welds will be projected onto a screen for the entire class to learn from observation of the student’s efforts. Using virtual reality, students will get a realistic introduction to advanced welding technology at a lower cost than if the school were required to purchase a complete advanced welding lab. We anticipate that this exposure to virtual reality welding will lead to XX students enrolling in the ACC welding program on a dual enrollment basis during high school or after high school graduation (or the successful completion of a GED).

If you are considering a correctional institution proposal, a more in-depth description will be required and you will more than likely not be able to propose the VRTEX 360 Compact virtual reality arc welding trainers combined with training in a traditional welding lab due to security considerations that accompany the use of coupons and other consumable supplies. Inmates can participate in a more comprehensive VRTEX 360 Compact virtual reality arc welding training curriculum during their incarceration that will prepare them for a short-term, hands-on training program using actual welding equipment upon their release at your institution. In this scenario the institution should also acquire the Voyager Arc Headsets for career exploration as well as an introduction to virtual welding prior to the inmate using the VRTEX units. It is important to note that neither VR product requires an internet connection, making it ideal for correctional institutions.



## Project Work Plan

Grant applications often require a work plan that specifies dates and numerical program goals for each phase of the work plan. The requirements vary and the example below depicts a plan for an 18-month project. Depending upon the entity that is soliciting

the proposal, they may also require additional information such as who will work on each element of the plan and the desired outcome for each element.

Project Work Plan Example:

Work Plan	Duration
Hire Project Staff and Convene Administrative Work Group	Month 1
Perform Project Administration Activities	Month 1-18
Convene Employer Advisory Group	Month 1, 4, 8, 12, 15, 18
Procure and Set Up Virtual Reality System	Month 1
Recruit Potential Participants	Month 2-12
Screen Participants for Interest and Aptitude	Month 2-12
Enroll Participants in Training	Month 3-13
Conduct Training	Month 3-17
Issue AWS Certifications	Month 3-17
Place Trainees in Jobs	Month 4-17
Perform Program Evaluation	Month 17-18
Complete Final Report	Month 18

## Partner Roles

Many funders ask applicants to partner with other entities and agencies to leverage outside resources and expertise. Potential partners are listed below, along with a statement regarding their possible role in a grant application.

**Workforce Development Boards (WDBs) and their One-Stop Career Centers/American Job Centers** - will recruit potential trainees from among target groups, assist in screening and provide wrap-around supportive services, including transportation and childcare vouchers, protective clothing for welding students and payments for training materials. The WDB may also help with ongoing employer engagement activities to ensure that the training meets employer needs and that any changes in the local welding industry are reflected in the training program offered. This will be especially important if your entity is moving into robotic automation, including robotic welding. (Name specific target groups for recruitment such as unemployed, veterans, specific disadvantaged groups, etc.)

**Community-based organizations** (Funders often ask for names of specific organizations) - will assist in recruiting potential trainees, including non-traditional trainees such as women and disabled individuals.

**Employers** (Funders often ask for names of specific employers and the role that each employer will play related to the project and training) - participating in this project have agreed to interview and consider hiring qualified program graduates as openings occur. Employers also agree to participate in an employer advisory council that will meet quarterly to assess the training program, review its progress and make recommendations to the training organization to improve its program. Several of the employers are also committed to providing Subject Matter Experts (SMEs) to assist ACC in revising curriculum or creating new welding or automation certificate and degree programs.

## Project Outcomes

Examples of potential project goals that you can establish are listed below. Specific training outcomes may vary by funding source and local economic circumstances.

Goal	Number
Number of Potential Trainees Recruited for Screening	XXX
Number of Students Who are Enrolled Following Recruitment and Screening	XXX
Number of Students Completing Training	XXX
Number of Students Who Receive One or More AWS Certifications	XXX
Number of Students Placed into Employment	XXX
Average Wage at Time of Placement into Employment	XX.XX
Number Of Students Retained in Employment After 6 Months	XXX
Average Wage Two Quarters After Placement Occur	XX.XX
Number of Instructors Trained in Virtual Reality	XXX

## Project Budget

The price for any of the Lincoln Electric Products including the ClassMate Cobot, VRTEX 360 Compact virtual reality arc welding trainers, the Torchmate cutting tables, the Voyage Arc units, welding lab booths and Personal Protective Equipment (PPEs) can be quoted through the local Lincoln Electric Sales Representative or your local Distributor. For most of the lab equipment, the price includes instructor training (days specified by-product), service and support, with plenty of flexibility in the type of training, the content and the number of attendees.

A grant can cover the full cost of the equipment, or it may cover a portion of the total cost based on the equipment's useful life and the duration of the grant period. Alternatively, the grant may cover the actual or equivalent cost of leasing the equipment for the project period. Circumstances vary, and grant writers should consult the details within the Request for Proposal (RFP) or grant guideline. When developing the Budget Narrative that supports the budget document, you should rely on the specifications for each of the products that can be found in the attachment section of the guide. Those specifications will help in justifying the acquisition of equipment for your project.

- » Cost of premises (classroom and lab space)
- » Utility costs (either direct or as part of an indirect cost calculation)
- » Training books and supplies, for example:
- » VRTEX 360 series of virtual reality arc welding trainers Project Based Lessons
- » SMAW VRAW VRTEX Welding Training Curriculum
- » GMAW/FCAW VRAW VRTEX Welding Training Curriculum
- » Personal welding equipment (PPEs) for students including helmets, gloves, coats, etc.
- » Consumable supplies are used in the traditional welding lab.
- » Personnel costs for administration (there may be limitations on this item)

- » Personnel costs for trainers, training assistants and laboratory support personnel.
- » Taxes and employee benefits for administrative and training personnel.

The VRTEX 360 series of virtual reality arc welding systems from the Lincoln Electric Company are Stand-alone systems that use virtual reality technology to simulate the welding processes for training purposes. The VRTEX 360 welding simulator is a proprietary product that combines physical props with virtual reality to create a one-of-a-kind experience that includes tactile, visual and auditory cues in an easy-to-use format. The VRTEX 360 welding simulator is the only multi-process focused piece of equipment with various joint configurations, including pipe and flat plate. The simulator is also unique in that it covers multiple welding positions while providing an augmented reality experience including tactile, visual and audio feedback. The VRTEX 360 Compact virtual reality arc welding trainers combine proprietary hardware with proprietary physics modeling to create a welding experience that looks, sounds and feels real. Further, the VRTEX 360 series of virtual reality arc welding trainers provide various instructor tools that allow the instructor to customize the system to match welding curricula. This includes an "instructor view" feature which provides real-time visual inspection of the weld and the student's technique while the student is welding and afterward for inspection. These instructor tools allow the instructor to use the simulator to teach mission-critical techniques and processes. The VRTEX 360 virtual reality arc welding trainer is designed to easily fit into an existing training curriculum.

## Project Evaluation

The following are possible project evaluation criteria. Depending upon the funding source, you may be required to identify a third-party external evaluator to design and conduct the evaluation. Potential third-party external evaluators include the National Coalition of Advanced Technology Centers (NCATC) and the Rutgers Education and Employment Research Center. More information on those two resources can be found later in the guide.

- » Student evaluations of training experience (using surveys or online products such as Survey Monkey).
- » Instructor evaluations of training experience (using surveys or online products such as Survey Monkey).
- » Number of AWS welding certifications issued.
- » Employer evaluation of hires from program graduates (using surveys or online products such as Survey Monkey or employer interviews).
- » Partnerships with the workforce system – one-stop centers).
- » Higher percentage completion rate.

- » Other project outcomes to be evaluated would include those listed in the project outcomes section.

### Virtual Reality Builds School Capacity

In addition to the immediate benefits to people during the initial training period, the VRTEX 360 series of welding simulators increase the capacity of Anywhere Community College to provide training long-term. The training equipment will be integrated into the current curriculum, which will enable ACC to provide a higher quality training experience in less time than traditional welding training alone. These efficiencies will continue after the grant period is completed. It will also allow a more significant number of students to enroll in and complete the welding program. In addition, the “wow factor” of the virtual reality simulator will help recruit more students and more non-traditional students to welding training.



## Evidence-Based Design: Independent Research Validates the Performance of Virtual Reality

Three independent studies by researchers at Iowa State University support the use of the VRTEX 360 virtual reality arc welding trainer as a quality training tool. Following are the abstracts of the three studies.

### “Physical and Cognitive Effects of VRIT” by Richard T. Stone, Kristopher Watts, Peihan Zhong and Chen-Shuang Wei. Following is the abstract from this study.

- » **Objective:** The objective of this study was to evaluate the cognitive and physical impact of virtual reality (VR) integrated training vs. traditional training methods in the domain of weld training. Background: Weld training is very important in various industries and represents a complex skillset appropriate for advanced training intervention. As such, there has been a long search for the most successful and most cost-effective method for training new welders.
- » **Methods:** Participants in this study were randomly assigned to one of two separate training courses taught by sanctioned AWS (American Welding Society) CWIs (certified welding instructors); the duration of each course was two weeks. Upon completing the training for a specific weld type, participants were given the opportunity to test for the corresponding certification. Participants were evaluated in terms of their cognitive and physical parameters, total training time exposure and welding certification awards earned. Each of the four weld types taught in this study represented distinctively different levels of difficulty and required the development of specialized knowledge and skills.
- » **Results:** This study demonstrated that participants in the virtual reality integrated training group (VR50) performed as well as and in some cases significantly outperformed, the traditional welding training group (TW). The VR50 group was found to have a 41.6% increase in overall

certifications earned over the TW group

- » **Conclusion:** Virtual reality technology is a valuable tool for the production of skilled welders in a shorter period of time and often with more highly developed skills than their traditionally trained counterparts
- » **Application:** These findings strongly support the use of VR integrated training in the welding industry.

### “Virtual Reality Integrated Weld Training: A scientific evaluation of training potential, cost effectiveness and implication for effective team training” by Richard t. Stone, Kristopher Watts, Peihan Zhong. Following is the abstract from this study.

Training in the welding industry is a critical and often costly endeavor; this study examines the training potential, team learning, material consumption and cost implications of using integrated virtual reality technology as a major part of weld training. In this study, 22 participants were trained using one of two separate methods (traditional training (TT) and virtual reality integrated training (VRI)). The results demonstrated that students trained using 50% virtual reality (VRI) had training outcomes that surpassed those of traditionally trained (TT) students across four distinctive weld qualifications (2F, 1G, 3F, 3G). In addition, the VRI group demonstrated significantly higher levels of team interaction which led to increased team-based learning. Lastly, the material cost impact of the VRI group was significantly less than that of the TT group even though both schools operated over a full two-week period.

### “Full Virtual Reality Training vs. Integrated. Virtual Reality Training: A comparison of performance, feature usage, cognitive and physiological development” by Richard T. Stone, Eleasc J. McLaurin, Peihan Zhong and Kristopher Watts. Following is the abstract from this study.

This study compared the impact of a full virtual training program vs. a mixed virtual reality and real-world training program on participants' pass-fail skill completion rate, physical and cognitive development. Additionally, this study explored how the presence of a visual, real-time feedback feature in a VR simulator training environment impacts participant performance.

- » **Background:** Two types of training programs have been developed for virtual reality simulators: full virtual training programs and mixed virtual reality and real-world training programs. There is a need to compare the programs in terms of their training effectiveness.
- » **Methods:** Participants completed welding training either in a full or mixed virtual reality training program. Four weld types were taught which represented different levels of difficulty and required the development of specialized knowledge and skills. Upon completing the training for a specific weld type, participants were given the opportunity to test for the corresponding certification. Participants were evaluated in terms of their cognitive and physical parameters and welding certification awards earned.
- » **Results:** The two training programs were comparable in terms of performance for the simple tasks. For the more complex tasks, the mixed training program had better performance.
- » **Conclusion:** Full virtual training is effective for learning simple techniques while more complex techniques require some real world training. VR simulator feedback features

can greatly improve performance, but their use must be balanced with respect to the amount of available attention.

- » **Application:** The findings expand understanding of the impact of levels of VR training and the impact of feedback features.

### **Virtual Reality Training Sparks Savings!**

By embracing virtual reality in welding, we can significantly cut down on electricity consumption typically associated with traditional welding processes. This not only saves energy but also reduces costs. Virtual reality training also cuts base metal usage, scrap and waste and reduces the cost of capturing and filtering welding fumes and gases.

### **Virtual Reality Training Is Accessible to Persons with Disabilities**

The controls on the VRTEX 360 Compact virtual reality welding tables and the arm that holds the coupons are all readily accessible to those with disabilities, including wheelchair users. Virtual reality can help those with disabilities to qualify for many welding jobs, depending on individual capabilities and industry requirements for specific jobs.

### **Virtual Reality Can Be Part of a Manufacturing and/or STEM Curriculum**

Secondary and even primary students can benefit from the VRTEX 360 Compact as part of a broader manufacturing and STEM curricula. The VRTEX 360 includes lesson books covering various welding techniques and pre-welding lessons on safety, math, machine set-up and more.





# WELD FUME CONTROL AND LAB BOOTHS



# Weld Fume Control

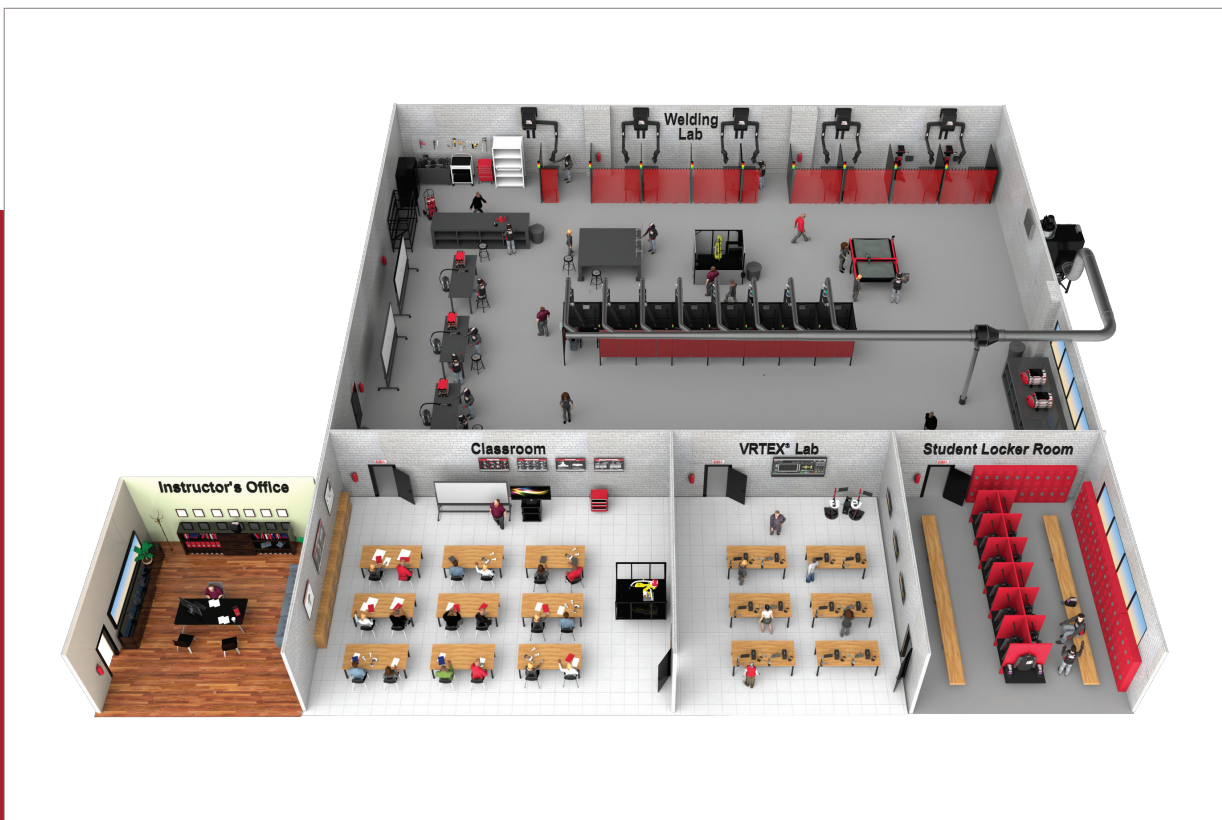


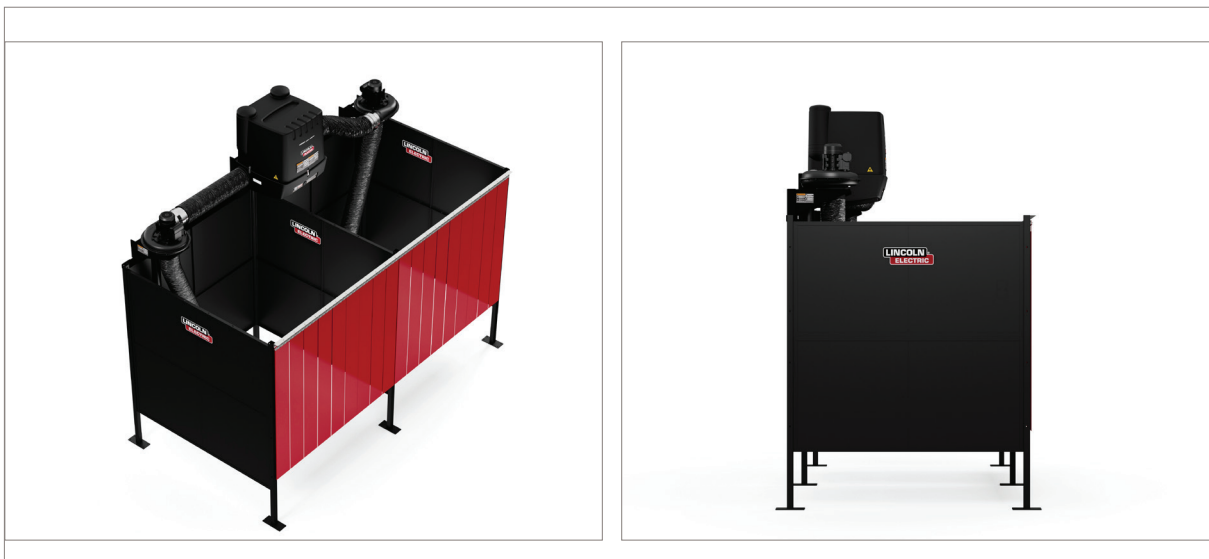
Illustration of A Weld School Layout

Weld Fume Control is a critical component of the welding process. Our weld fume control product portfolio includes a broad range of equipment for the capture, extraction and filtration of welding fumes and particulates. Lincoln Electric offers a complete line of portable, stationary and configured-to-application solutions. By asking a few simple questions, our dedicated staff of environmental specialists can help you find the weld fume equipment your organization needs.

- » What welding processes and positions are you teaching?
- » If available, can you obtain a print of the layout of the school?
- » What power capabilities does the school have?
- » How many booths do you expect to have?
- » What size booths are required?
- » Do you want to filter air, recirculate the air or exhaust it?
- » Is it preferred to have the fan and filter inside or outside the facility?
- » If the fan and filter are outside, will they be covered or uncovered?
- » Are there laws and building codes set by the State that need to be considered?

## Fume Extraction Systems and Weld Fume Control Features

- » **Configurable:** A complete line of portable, stationary, and engineered solutions for welding fume control. Available in 4-24 bank models.
- » **Affordable:** Several models are available to assist with budget planning, units have low operating costs and are designed to provide long filter life.
- » **Easy to Install and Use:** Smart Connect™ technology allows for quick and seamless wire connectivity and an easy-to-use HMI screen for preventative maintenance.
- » **Quiet and Efficient:** The silencer on the exhaust fan drastically reduces airflow noise, variable speed drive regulates fan speed based on filter loading to maximize fume extraction, intelligent fan control technology, and automatic filter cleaning.
- » **Extraction Arms:** Several models to select from to assist with booth design. Constructed with a balance system for stability and ensuring the hood stays where it is positioned.



Weld booth configuration example

The layout contains the following items:

- » 8 – 5 x 5 booths with Strip Curtain Kits
- » 8 – K5248-1 Welding Table with Adjustable Bar
- » 8 – K1655-14 Prism Wall -Mount 5-8ft telescopic counterweight extraction arm-all position welding
- » Prism Filter Bank with Automatic Filter Cleaning



## Welding Booths



Lincoln Electric Welding Booths are ideal for use in stationary production welding applications, education and vocational facilities, as well as training centers. Specifically, they can be used for SMAW, GMAW, GTAW, FCAW-S, FCAW-G and Submerged Arc Welding (SAW) applications. The booths can be configured with shelving, brackets, hooks, lighting and air/gas connections to meet the needs of welding students or welding operators. Source extraction weld fume control can be easily integrated into the booths with an extraction arm and connection to a central system. Lincoln Electric will meet with you and your team to create a customized solution to meet your needs.

- » **Rugged Steel Construction:** Endures the rigors of a training environment or production welding operation.
- » **Easy Installation:** This helps minimize start-up costs.
- » **Generously Sized:** With plenty of room to maneuver within the training or workspace. Standard booth sizes of 5 ft. x 5 ft. and 6 ft. x 6 ft. meet AWS guidelines for booth width and depth.
- » **Optional Worktable with Adjustable Overhead Welding Bracket:** Allows operators or students to be as comfortable as possible while welding.
- » **Optional Welding Curtain:** Helps protect other students and workers from arc flash and sparks.
- » **Optional Tool Shelves with Torch Holders:** Keeps the booth neat and well organized.
- » **Optional Locker Box:** Provide convenient storage space for a welding hood, jacket, gloves, and other related items.

### Booth Assist – Monitors Students in the Weld Booth



Lincoln Electric's Booth Assist is a control panel located inside any weld booth that is paired with a visual monitoring system that easily permits the instructor to monitor the activity of the entire class at a glance. The stacked red, amber and green light bars indicate if a booth is occupied, if active welding is taking place or whether a student needs individual support.

## Booth Assist – Monitors Students in the Weld Booth



- » **Easy installation:** Included with the Booth Assist is a variety of mounting brackets and hardware.
- » **Low voltage operation:** LED lights and low voltage power.
- » **Compatible with any Welding Process:** The main control panel is connected to each booth and monitors the activities inside the booth.
- » **Compatible with any Welding Equipment:** Works independently of the equipment inside the booth.

## Protective Apparel for Students and Instructors – Welding Gloves, Jackets and Caps

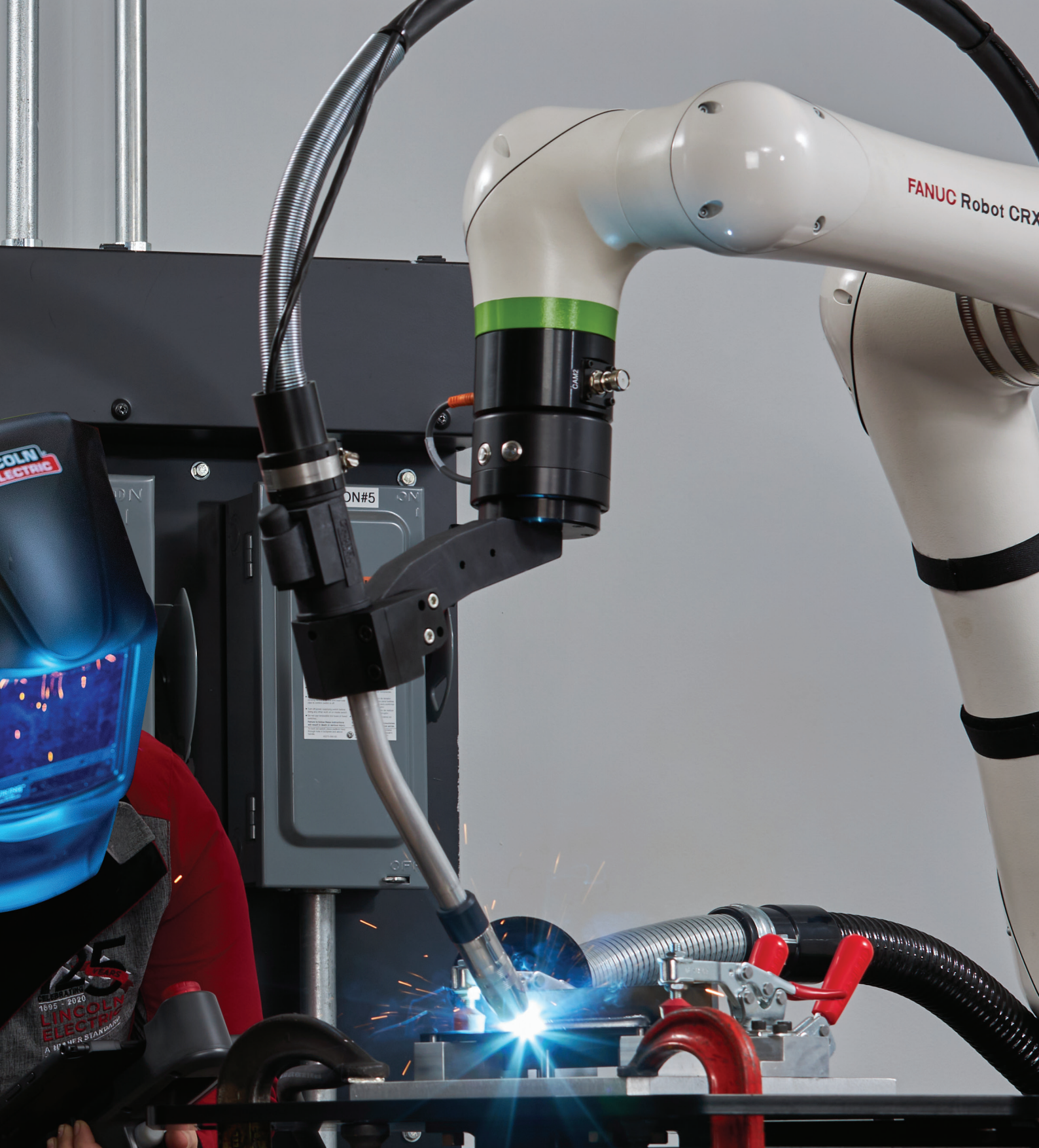
Arc welding is a safe process when proper operating practices are followed, and sufficient measures are taken to protect the welder from potential hazards. Exposure to welding fumes and gases, arc rays, fire, explosion and electric shock are among the major hazards that welders can encounter. Welders must wear proper clothing to protect them from being burned. Lincoln Electric offers a personal protective equipment line that includes a variety of jackets, caps, sleeves and gloves.

- » **Selecting Welding Gloves:** The first area to consider when selecting gloves for your lab is what the primary welding process will be used: SMAW, GMAW, GTAW, FCAW-S, FCAW-G or Submerged Arc. Next, consider the amperage range that will be used on the equipment and lastly, rank the benefits: Heat resistance, comfort, dexterity, durability and price. These factors will help you select the glove that will handle any job or welding process.
- » **Red Line Jackets:** This gear effectively protects the arms and upper body. The flame-retardant cloth panel helps to keep the welder cool, and heavy-duty leather panels in high spatter exposure and high wear areas. Customers can choose from flame-retardant cloth, heavy-duty leather or hybrid cloth/leather jackets.
- » **Doo Rags, Beanies and Caps:** For wearing under the welding helmet, Lincoln Electric offers doorags beanies and caps that stylishly and effectively help to protect the top of the head. They are comfortable, include athletic mesh lining for fast sweat evaporation and are machine washable.

## Eye Protection for Students and Instructors – Welding Safety Glasses and Helmets

- » **Welding Safety Glasses:** Students and instructors should always wear safety glasses with side shields or goggles to protect their eyes in the manufacturing and fabrication environment. Lincoln Electric offers a full line of protective, stylish safety glasses. All eyewear meets the ANSI Z87.1+ and CSA Z94.3 standards and offers 99.9% UV-A, UV-B and UV-C protection. Indoor or outdoor, clear or mirrored styles are available.
- » **VIKING Auto-Darkening Welding Helmets:** are lightweight, comfortable and full of features for every application. Just select the feature set that your students or instructors will need as there is a perfect VIKING Helmet that is right for your educational environment and the applications you are teaching.
- » **Welding Gear Ready-Paks®:** There is a variety of ready-paks available filled with a curated mix of welding gear and tools needed based on the level of program offered. You can purchase the ready-paks for students in your welding training programs through the MyLincoln Education Portal. The two most popular ready-paks are:
  - **Standard Welding Gear Ready-Pak®:** Industrial duffle bag, Viking Black 1740 Auto-Darkening Helmet, Traditional Flame-Retardant Cotton Jacket, Traditional Leather Welding Gloves for GTAW, GMAW and SMAW, Traditional Lincoln Clear Safety Glasses, Welding Face Shield, Essential Tools for SMAW, GMAW and FCAW welding processes.
  - **Intermediate Welding Gear Ready-Pak®:** Welders All-in-one Backpack, Viking Black 1440 Auto Darkening Helmet, Traditional Split-Leather Sleeved Jacket, DynaMIG HD Professional GMAW Welding Gloves, Leather GTAW Welding Gloves, Traditional Lincoln Clear Safety Glasses, Welding Face Shield, Complete Tool Set and a Lincoln Electric Flame-Retardant Welding Doo Rag.





# CLASSMATE ROBOTIC WELDING AND LASER EQUIPMENT

# ClassMate Robotic Welding Laser Equipment



One of the many core competencies of Lincoln Electric is providing complete welding, training, assistance and support to the customer. The ClassMate Robotic Trainers are a family of unique robotic educational cells that help improve quality, lower costs and help educators enhance their training environments. Through design, integration, world-class customer service and unparalleled welding expertise, Lincoln Electric is the industry leader in automated arc welding and tooling solutions. Lincoln Electric has served industries such as automotive, aerospace, transportation, shipbuilding, petrochemical and heavy fabrication.

The ClassMate Robotic Trainers portfolio is uniquely designed for educational facilities to train the next generation of welders with the latest technologies industries need to bridge the skills gap.

## Lincoln Electric's Robotic Welding Equipment Advantage:

- » **Lincoln Electric - FANUC:** Lincoln Electric is the #1 FANUC Welding Integrator with over 30 years of collaboration.
- » **Customer Support and Training:** 24/7/365 support with installation, startup support, on-site technical support and training, programming assistance, preventative maintenance and repairs.
- » **Curriculum Courses:** Course offerings include Basic, Intermediate, Advanced Robotic Programming, Robotic Service Training and WeldPRO™ Training.

## Lincoln Electric's Robotic Welding Equipment Advantage:

- » **Affordable:** Complete educational software/assets at an affordable price.
- » **Inclusive:** Everything you need to teach safely and productively.
- » **Versatile:** Suite of products designed to meet current training needs in welding/laser/Cobot production.
- » **Timely:** Advanced manufacturing and technology capabilities.



## ClassMate M



ClassMate M

The ClassMate M cell is a complete robotic training solution designed to meet the need for advanced manufacturing training. Instructors can teach robotic concepts in the classroom and quickly move to the lab for welding practice. Students can perform offline programming and then test their skills at a manufacturing-ready robotic cell.

As businesses of all sizes now compete on a global stage, manufacturing companies are challenged to increase productivity, improve quality and reduce costs. These challenges, coupled with the critical skilled labor shortage, drive many manufacturers to implement automated welding fabrication. Employers everywhere are demanding that prospective employees be trained in robotic fabrication technologies. Educators are rapidly moving to respond. The ClassMate M Robotic Trainer provides the education community with a complete advanced manufacturing solution for robotic welding training.

### ClassMate M Key Features Include:

- » **All-in-One System:** Power Wave R450 Robotic Power Source, Autodrive 4R100 Wire Drive, Magnum® Pro Air Cooled Torch, 3-1- Welding Fixture, Fume Extraction, 10 PPE Hand Shields.
- » **Small Footprint:** Designed to fit through 36-inch doors to easily teach in classroom settings.
- » **Mobile:** Cart allows freedom to move from classroom to weld lab.
- » **Affordable:** Best economic solution for robotic welders.
- » **Curriculum:** FANUC Educational Software Bundle, Robotic Training Course & Project Based Lesson Plan Booklet and 2 instructor seats in our automation courses are included.
- » **Optional Upgrades:** Expand your classroom's capabilities with the Education Startup Package, Educational WeldPRO Package, or Gripper Package.



Classmate M teaching pendant training

### Optional Upgrades:

- » **Education Startup Package:** On-site application technician startup assistance. 1-on-1 training and support for instructors, two Welding Gear Ready Pak®, Welding coupons.
- » **Educational WeldPRO Package:** Digital Teach Pendant, 15 PC WeldPRO licenses, WeldPRO 3D model, and introduction to offline programming.
- » **Gripper Package:** Ideal for dual-purpose curriculum, package includes a manual tool changer and WeldPRO CAD.

## ClassMate Cobot



ClassMate CRX Welding Cobot



ClassMate GoFa Welding Cobot

The ClassMate Cobot is an easily programmable robot in the collaborative robot family designed for students in the robotic welding industry. The ClassMate Cobot can be equipped with either a Fanuc® or ABB® collaborative robot arm, which are commonly used in industry. Finding qualified and reliable welders continues to be a challenge in industrial and manufacturing sectors. For many manufacturers, the idea of implementing automation can be overwhelming, especially with the initial training required for staff to use the new system. The ClassMate Cobot helps solve this problem in the manufacturing industry by bringing a robotic trainer version to educators and their students.

Equipped with the Lincoln Electric Cooper app, instructors and students will have everything they need to learn how to operate the ClassMate Cobot. This new and improved automated solution enables your classroom to automate even the highest mix of different products. The solution has been proven to be easily implemented by non-welders, due to simplified programming processes such as being able to teach the cobot arm, literally at the torch. Simply move the cobot's arm with your hand, to the start and finish weld points and the cobot does the rest. Simply move the cobot's arm with your hand to the start and finish weld points, and the cobot does the rest. Simply move the cobot's arm with your hand to the start and finish weld points, and the cobot does the rest. The ClassMate® Cobot robotic welding system is built to educate and prepare students for the industrial space and has access to Lincoln's highest productivity weld programs, allowing your students to learn how to increase manufacturing productivity.



Teaching made easy with ClassMate Cobot

### Classmate Cobot Key Features Include:

- » **Comprehensive System:** Power Wave® R450, AutoDrive® 4R100, Air-cooled Smart Torch, Lincoln Electric Cooper App, Mobile Cart with Modular Table, PPE Hand Shields (10) with choice of Fanuc or ABB Collaborative Robotic Arm-Fanuc Robot Collaborative Robot® CRX-10iA with R30iB Mini+ Controller or ABB CRB 15000 GoFa 5™ Collaborative Arm with OmniCore C30 Controller.
- » **Small Footprint:** Slender, lightweight design offers flexibility and mobility for classrooms and labs; the standard tooling tabletop makes it easy to set up parts.
- » **Simplified Programming:** The Cooper App provides an easy and intuitive interface that gets operators performing welds quickly. It accommodates personal preference and customization of specific welds.
- » **Weld by Numbers®:** Offers preset weld settings. Dozens of parameters are preset in these numbers, which correlate to the material thickness to help optimize weld performance and quality.
- » **Curriculum:** Teach at the Torch-Designed for an operator at any level of experience with robotics, ergonomic grip allows users to move the collaborative robotic arm.
- » **Optional Upgrades:** Traditional Pendant & Thick Plate Software (FANUC only), Educational WeldPRO Package (FANUC only), Cobot Education Startup Package, Fume Extraction, Clamp Kif for Modular Table.

## ClassMate Pro



ClassMate Pro

The ClassMate Pro is designed to help welding educators meet the need for advanced manufacturing training. The robotic welding training system is a pre-configured, self-contained cell constructed for quick and easy installation. The industrial-size robotic welding cell is a single-zone, small footprint system where welders learn to advance their programming and welding skills while replicating a true production environment. The ClassMate Pro has the option to be equipped with a single axis positioner, allowing for more advanced training to prepare students for the workforce.



Teaching made easy with ClassMate Pro

### Classmate Pro Key Features Include:

- » **Comprehensive System:** FANUC 100id/12 Robot with R30iB+ Controller, Power Wave R450 Robotic Power Source, Autodrive 4R100 Wire Drive, Magnum Pro Air-Cooled Torch, 3-in-1 Welding Fixture, 10 PPE Hand Shields, Fume Hood.
- » **Larger System:** Industrial-sized robotic welding cell is a single-zone, small-footprint system perfect for larger work zones and projects.
- » **Advanced Programming:** Optional upgrade to a single-axis headstock for part manipulation.
- » **Arc Flash Protection:** Fully enclosed cell with a sliding hinge door.
- » **Industry Preparation:** Realistic, on-the-job training.
- » **Curriculum:** 2 instructor seats to our automation courses and FANUC Educational Software Bundle included.
- » **Optional Upgrades:** Educational Startup Package, Educational WeldPRO Package, Prism® Compact Fume Extraction.



## ClassMate Laser



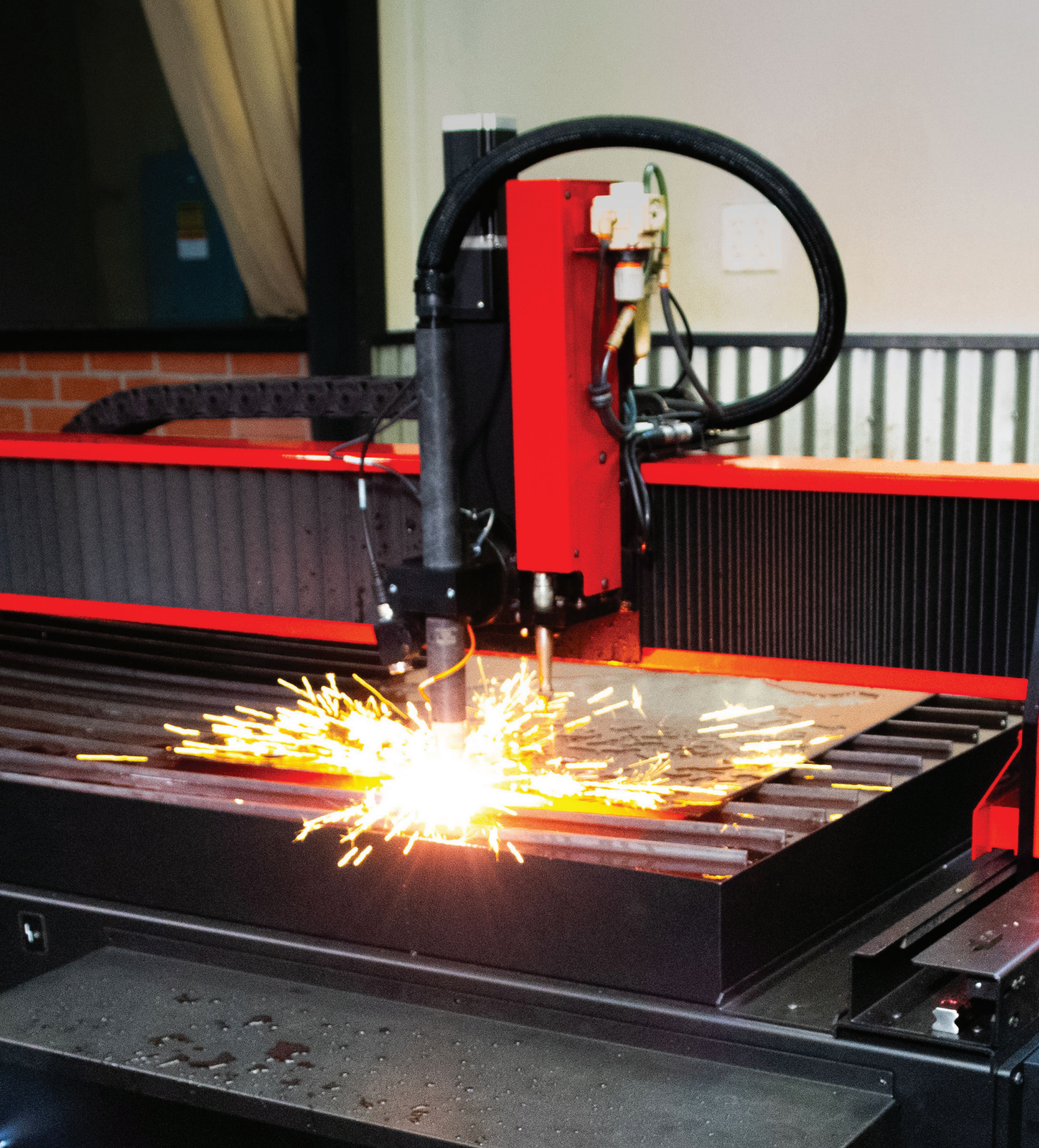
Lighting the way for the next generation of welders. Meet the ClassMate Laser! A complete, all-in-one laser welding cell designed for training students in advanced laser welding technologies. Utilizing both a laser system and robotic arm, the laser welding process is programmable and integrated via the teach pendant. A laser welding cell complete with everything each student needs including fume extraction, laser optics and a water chiller—all in one cart.

With the ClassMate Laser robotic trainer, we provide industry-level laser welding training that improves quality, lowers costs and helps educators enhance their teaching environments. Through design, integration, world-class customer service and unparalleled welding expertise, we are the industry leader in automated laser welding and tooling solutions. We have served industries as diverse as automotive, aerospace, transportation, shipbuilding, petrochemical and heavy industry.

### Classmate Pro Key Features Include:

- » **Comprehensive System:** FANUC 100id/12 Robot with R30iB+ Controller, Power Wave R450 Robotic Power Source, Autodrive 4R100 Wire Drive, Magnum Pro Air-Cooled Torch, 3-in-1 Welding Fixture, (10) PPE Hand Shields, Fume Hood.
- » **Advanced Manufacturing and Technology:** Autogenous laser welding.
- » **All-in-One System:** All equipment required for operation, including fume extraction.
- » **Laser Safety:** CDRH Class 1 Laser Safe Enclosure; door with interlock.
- » **Small footprint:** Fits through a standard 36" doorway.
- » **Curriculum:** 2 seats in basic robot programming and laser course.
- » **Optional Upgrades:** Education Startup Package, Educational WeldPRO Package, Cutting Package and Cold Wire Feed Package.





# TORCHMATE CUTTING TABLES AND PLASMA CUTTERS



## Torchmate Cutting Tables



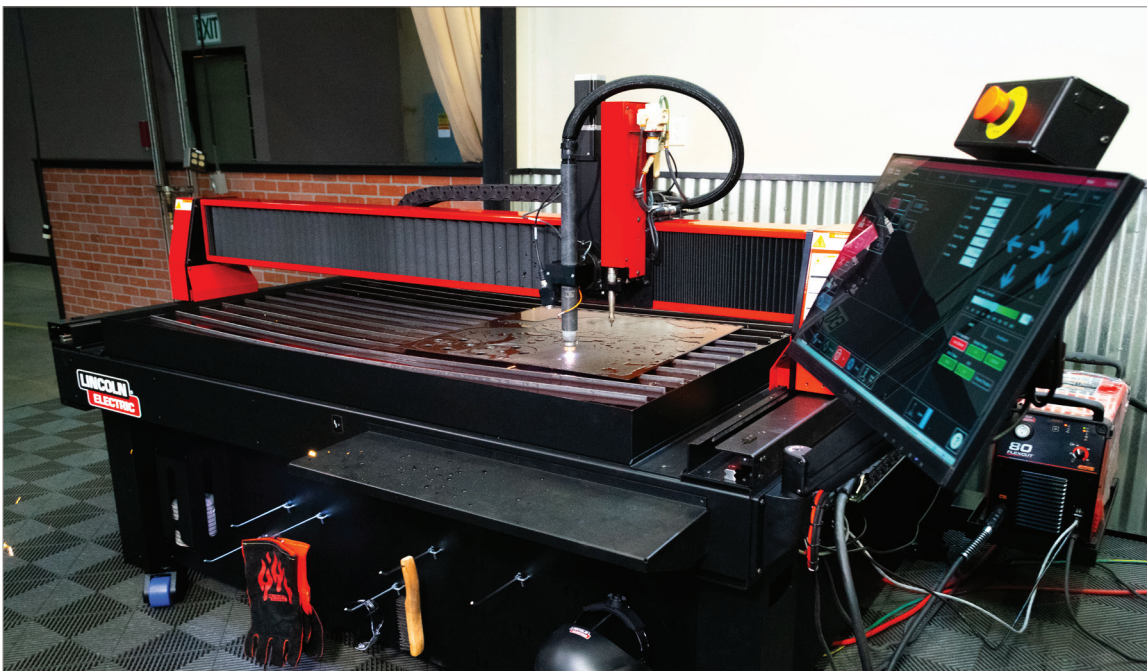
The Torchmate product line of automated plasma cutting tables encompasses a broad scope of machines: from entry-level CNC machines—the 4000 Series, to industrial plasma cutting tables—the 5100 and everything in between. Any of the four options in the 4000 series lineup will give teachers a real-world manufacturing tool, used in a variety of industries across the country, to teach CAD software and CNC operations to the next generation. The machine your students will use in the classroom is no different than the machine they will see in the real world. Our company is the industry leader in CNC plasma cutting technology and has sold more machines than any other competitor on the market. Student investment in learning the technology in the classroom will save time in training with their employer after graduation.

The utility of the plasma table goes beyond the normal scope of what customers classify as a fabrication machine. From engraving to metal cutting processes like plasma and oxy-fuel options, the Torchmate table can easily adjust to any project your students come up with. Torchmate has been making affordable cutting tables since 1979 and has accelerated its technological advances in motion control, height control and manufacturing as a result of its acquisition by Lincoln Electric in 2011. Lincoln Electric has made this international brand of CNC plasma tables a top-tier product in the world of plasma automation and will continue to offer the affordability and quality that made Torchmate a household name in the fabrication industry.

One of the largest benefits of purchasing a Torchmate CNC plasma cutting table is when your students have gone through the curriculum, they can apply that knowledge directly to any other existing Lincoln Electric Torchmate cutting table. These machines are used in almost any metal fabrication industry you can think of, from fab shops to heavy construction and Oil and Gas to farming, giving your students a step up and making them a sought-after resource with real-world skills.



Our fully assembled machines are ideal for the small or mid size shop looking to add their first piece of automated machinery to their business.



The Torchmate 4400, 4800, 4510 and 4505 (5x5) are the clear choice for all Educators, with complete educational packages designed specifically for the classroom and backed by the nationwide support of Lincoln Electric.



## FlexCut Plasma Systems



FlexCut 80 Air Plasma Cutting System

All Torchmate CNC plasma cutting tables come standard with Lincoln Electric's own highly regarded air plasma cutters. The FlexCut 80 and optional FlexCut 125 are robust plasma cutters, giving you top-notch cut quality along with some of the best consumable life in the industry. FlexCut air plasma systems offer impressive pierce thicknesses and high-duty cycles. The only thing required is power and an air compressor to be able to pierce  $\frac{3}{4}$  or 1 inch mild steel material with exceptional cut quality.

### FlexCut Key Features Include:

- » **Performance:** Whether piercing up to  $\frac{3}{4}$  in [19mm] mild steel material in a mechanized cutting application or cutting expanded metal, you can expect less edge bevel and superior edge quality.
- » **Durable:** Rugged enough for outdoor and indoor use.
- » **Flexible:** Choose 1-phase or 3-phase, 200 to 575 volt input power for cutting, gouging and grid-cutting tasks.
- » **Ease of Use:** Controls are simple which makes set up easy and get consistent and reliable arc without needing to rely on high-frequency start systems.

# Lincoln Electric Torchmate 4000 TC – Round Pipe and Tube Cutting Machine

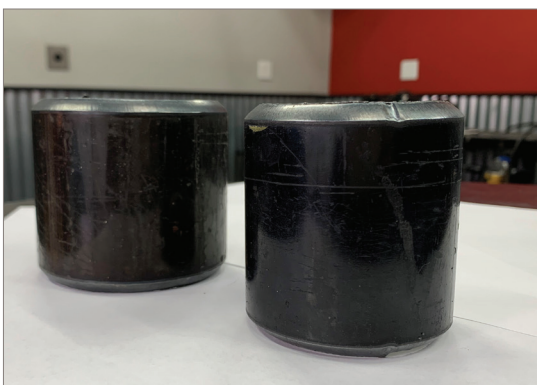


Torchmate 4505 with 4000TC

The Torchmate 4000 TC is your entry into pipe and tube cutting. Designed to work as an attachment to the Torchmate 4000 series CNC plasma tables, this machine is plug-and-play and interfaces seamlessly with your existing machine. This machine can cut 1.5 in to 6 in schedule 40 pipe, and can handle a maximum pipe length of 7 ft. The head is capable of cutting pipe with a bevel angle up to 45 degrees.

This machine is designed to allow for simple swapping between the operation of your 4000 Series plasma table and your 4000 TC. Simply swap the plasma torch connection on your plasma cutter and choose which machine to control, all from the same touchscreen and you're ready to go! The best part is you can use the same plasma cutter, computer and one motion controller as your 4000 Series table - a significant amount of savings to you over purchasing an additional stand-alone machine!

The Torchmate 4000 TC is perfect for welding programs that have a pipe welding course. The 4000 TC can cut pipe coupons with any specified bevel up to 45 degrees on both sides. It can even cut a whole stick of material at once, saving you time and material.



Torchmate 4000 TC tube cutting samples







## VRTEX 360 Compact



VRTEX 360 Compact



Student practices welding techniques virtually

The VRTEX 360 virtual reality arc welding trainers are serious, high-fidelity training tools that attract computer-savvy students because they utilize fully immersive VR technology to prepare them with realistic, high-quality weld training for well-paying careers in welding. The arc welding trainer provides students with the opportunity to learn and practice welding in a safer, simulated environment. They consist of a computer enclosed in the realistic body of an arc welding machine; advanced virtual reality software; a virtual retractable stinger/electrode holder for stick welding (SMAW); a virtual gas metal arc torch for gas metal arc welding (GMAW) and flux-cored welding (FCAW-G and FCAW-S); a gas tungsten arc torch, filler and Foot Amptrol™ for gas tungsten arc welding (GTAW); an all-position stand modeled after a traditional welding booth that holds welding coupons and headgear that immerses the student in the sight, sound and touch of actual welding.

Students can practice welding virtually before, during and after welding lab work to practice new techniques and refine their skill set. Students watch and listen with the latest VR headset technology as they strike an arc, guide the electrode and create a welding puddle of molten metal. The device scores each weld and gives immediate feedback to the student welder. Other students can watch welds displayed on a large screen while the instructor teaches welding techniques and theory.

The VRTEX virtual reality arc welding trainer can also be used in distance and hybrid learning in a variety of ways. Educators can set up the machine to coordinate with virtual instructor-led training (VILT), video conferencing or live streaming; and additional cameras can be configured to display multiple angles for demonstration purposes. This solution allows students to begin learning with live demonstrations before stepping into a physical classroom or lab.

**VRTEX 360 Virtual Welding Trainer Key Features:**

- » **Attract and Engage Students:** Interactive fun way to learn the fundamentals of welding.
- » **Measure and Record Real-Time Results:** Instant Feedback enables instructors to view the competency of learners, see the decisions they make and how they react to the consequences.
- » **Reduce Energy Consumption, Waste and Scrap:** More hands-on practice while saving expensive material and training resources and can complete more welds within a fixed amount of time.
- » **Replicate Proper Machine Setup:** Requires students to enter the proper material type, process, gas flow and amperage/voltage/wire-feed speed into the system.
- » **Support Collaborative Learning:** Allow instructors to connect a projector or large display to the VRTEX unit so an entire classroom can see what the welder is seeing underneath the headset.
- » **Promote Teamwork:** The learning process increases comprehension through student interaction.
- » **Provide Multiple Welding Views:** Show accurate, real-time measurement of key variables including contact tip to work distance, work angle, travel angle, travel speed and position.
- » **Promote Confidence:** Ability to move from the VRTEX virtual reality arc welding trainer into an actual welding training booth with confidence in their abilities to set up and perform welding procedures.
- » **Expand Training Options:** Virtual welding simulation provides the opportunity to learn introductory concepts before practicing complex welds traditionally involving expensive components.
- » **Emphasize Safety:** Learn new techniques or practice skills in a safer environment without real risk of personal injury.
- » **Enhance Recruiting:** Utilize virtual reality technology to provide students with hands-on experience in the field of welding.
- » **Support Mobile Training:** Machines have been developed for easy transport and set up which assist those looking to develop mobile training centers.
- » **Develop Skill Growth:** Simulated arc augments visualization with muscle memory and kinetic awareness, engaging users in interactive scenarios and reflecting real welding equipment, processes and procedures.
- » **Contribute To Distance Learning Resources:** Create live or recorded virtual demonstrations of machine setup, welding procedures and techniques.
- » **Include supporting materials:** VRTEX 360 Compact models include lesson books covering SMAW, GMAW and FCAW exercises and welding procedure specifications (WPS).
- » **Feature Removable VR Headgear:** An option for programs that restrict sharing VR headsets.
- » **Multilingual:** Languages included are English, French, German, Spanish, Turkish, Japanese, Chinese, Russian, Brazilian Portuguese, Korean, Polish, Finnish, Swedish and Italian.
- » **Career Exploration:** Offers six career-oriented environments: Ironworker, Power Plant, Welding Booth and Shipyard.
- » **ROI Calculator:** The Weldometer tracks material usage, providing an easy way to calculate return on investment. The user can alter tolerances and customize the WPS to fit better the needs and methods of the instructor/user.
- » **Compact:** Small footprint training tool allows for multiple machines in a classroom setting.
- » **Cost Savings:** Bundled discounts are offered in quantities of 5%, 10%, 15%, 20%.

## Add in optional items for VRTEX 360 Compact



The **VRTEX 360 Compact Travel Case Set** includes two heavy-duty Pelican™ brand carrying cases to house the VRTEX 360 Compact machine and all its accessories with ease, ensuring top-notch protection during travel. This is an essential add-in item if your school utilizes mobile classrooms or if you intend to engage with the community via recruitment events, career exploration events, etc.



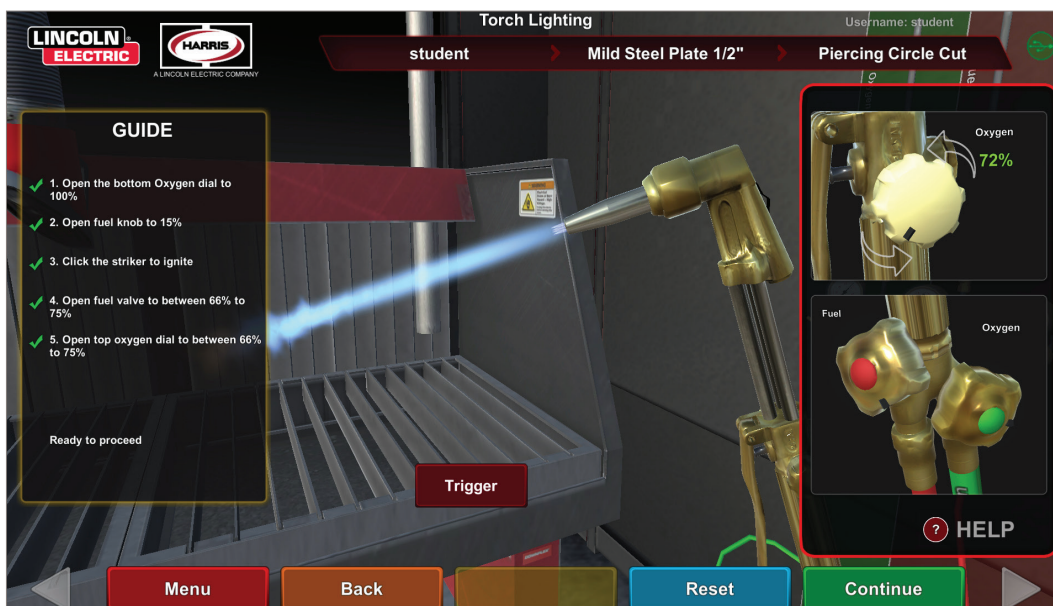
The **VRTEX 360 Welding Stand Kit** is meant to complement the VRTEX 360 Compact virtual reality trainer. The kit includes the monitor mount, welding table and arm, bracket, adjustable pole, saddle bag for holding coupons and weighted base. This add on item is a great addition if you intend to create a permanent VR lab experience in your school.

## VRTEX 360 Oxyfuel Cutting Upgrade Kit



The VRTEX 360 Oxyfuel Cutting Upgrade Kit

The **VRTEX 360 Oxyfuel Cutting Upgrade Kit** is essential for welding programs that include fabrication and cutting curriculum. Every aspect of the Oxyfuel Cutting feature is designed to address real-world cutting applications, from setting up the torch to executing the cut. Connect your fuel of choice, Propane or Acetylene and properly set fuel pressures in proper safety sequence. Learn the step-by-step torch lighting sequence, follow safety protocols and reinforce the importance of reading the flame. Instant feedback is provided on the scoring screen with each single line of data in the chart representing the performance parameter of individual technique.



Virtual reality welding environments





# VIRTUAL REALITY WELDING CAREER EXPLORATION TOOLS



## Voyage Arc



VRTEX 360 Compact



Students enjoyed exploring the VR Environment

The Voyage Arc Virtual Reality Welding Career Exploration Tool is an interactive and immersive classroom platform that introduces welding fundamentals to students. Developed to spark an interest in a career involving welding, it exposes the learner to career opportunities and promotes career exploration. It simulates real-world scenarios in an exciting, fun and profoundly engaging VR environment.

The Voyage Arc Virtual Reality Welding Career Exploration Tool transports students into a day-in-the-life adventure of the welding trade. Students navigate through practical welding applications at an amusement park and learn basic welding fundamentals, including the parts of a weld, what takes place to make a weld, what equipment is used and more. Ten bite-sized learning lessons are guided by continuous narration and on-screen cues.

## Why is Career Exploration Important? <sup>17</sup>

# 60%

of skilled manufacturing jobs go unfilled each year due to a skills gap

# 2 Million

unfilled jobs expected by 2025 due to the skills gap

# 30,000

new welders needed annually to offset retirement and keep up with growing demand

# 67%

of companies are experiencing a shortage of qualified workers

### Voyage Arc Key Features:

- » **Engaging and Immersive Student Experience:** Set in a virtual amusement park that provides a unique welding experience in a self-paced, bite-sized learning environment.
- » **Reliable, Cutting-Edge Technology:** Multi-sensory, engaging experience in a safe and controlled environment that is easy to implement and monitor.
- » **Versatile:** Inclusive and supportive learning platform is accessible to every student.
- » **Complete Classroom Solution:** The standalone exploration tool is a classroom-ready device that can supplement existing curricula or become the foundation for career exploration programs.
- » **Trusted Education Expertise & Support:** Supported by Lincoln Electric's decades of trusted experience, support and dedication to the art and science of welding.
- » **Immersive Welding Lessons:** Students are introduced to safety, elements of PPE, common joints and GMAW and SMAW welding techniques.
- » **Rewarding Engagement:** Students earn "spark" points as they progress through the lessons and perfect their welds. Points are used to customize their virtual welding helmet along with earning a virtual ride in the park!
- » **Simple Deployment and Monitoring:** Students can easily save their progress and quickly pick up where they left off. Lessons can be individually selected or repeated as needed. Teachers can access headsets to view students' scores, skill comprehension and completed lessons.
- » **Cost Savings:** Bundled discounts are offered in quantities of 10 or 20 and come with the LAN system.
- » **LAN System:** A local area network (LAN) provides the instructor with the ability to connect an entire classroom and gather user analytics for classroom leaderboards, class progress, or individual tracking. The LAN system can be used with two or more headsets.





# U/LINC AND LEEPS

## U/LINC



U/LINC™ is a comprehensive welding curriculum developed by Lincoln Electric's Education Team. It connects welding theory, practice and knowledge through the Tooling U-SME learning management system. U/LINC promotes learning and student engagement while giving the instructors maximum control over their programming. The U/LINC curriculum provides options for faculty to deliver instruction using several modalities including classroom, lab and eLearning curriculum materials. Instructors can select a pre-built curriculum or customize their own with more than 18,000 pages of materials, from lesson plans and student handouts to lab activities and PowerPoint presentations and videos.

- » **Flexibility:** eLearning materials may provide options for distance, hybrid, and face-to-face instruction in the classroom and lab.
- » **Accessibility:** Available 24/7 from a computer with internet connectivity. U/LINC gives students the ability to complete assignments at their own pace/own time.
- » **Customizable:** select a pre-built curriculum or create your own competencies, curriculum sequence, and performance dashboards.
- » **User-friendly:** Students and teachers can easily search, download and print out lesson plans, class assignments, student handouts, presentations and lab activities and get immediate feedback.
- » **Inclusive:** Students have access to a curriculum that includes different instruction deliverables including audio voice-over.
- » **Expert Support:** In-depth direction, tips and teaching strategies are created from Lincoln Electric's more than 100 years of experience.
- » **Robust Curriculum:** 17 subject areas.
- » **Administrative Ease:** Ability to set permissions to manage learning, administer comprehensive testing, automated grade and tracking of pre-tests and final exams, display students' time spent in class and tests, create custom class bundles for multi-level of students and reports available to track knowledge gained.



## U/LINC Offers a Curriculum Comprising of 17 Essential Subject Areas



U/LINC AND LEEPS

### List of 17 Essential Subject Areas:

- » Safety
- » Principles of Welding
- » GMAW
- » SMAW
- » SAW
- » Pipe Engineering
- » FCAW
- » GTAW
- » Careers
- » Blueprint Reading
- » Thermal Cutting
- » Robotics
- » CNC Plasma Cutting 1
- » CNC Plasma Cutting 2
- » Manufacturing and Engineering
- » Fabrication
- » Mathematics in Welding

# LEEPS



## LEEPS Key Features:

- » **Flexibility:** eLearning materials may provide options for distance, hybrid and face-to-face instruction in the classroom and lab.
- » **Accessibility:** Available to students 24/7 from a computer with Internet connectivity gives them the ability to complete assignments at their own pace/own time.
- » **Customizable:** Select a pre-built curriculum or create your own competencies, curriculum sequence, and performance dashboards.
- » **User-friendly:** Students and teachers can easily search, download, and print out lesson plans, class assignments, student handouts, presentations, and lab activities, students get immediate feedback
- » **Inclusive:** Students have access to curriculum that includes different instruction deliverables including audio voice-over.
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- » **Robust Curriculum:** 17 subject areas
- » **Administrative Ease:** Ability to set permissions to manage learning, administer comprehensive testing, automated grade and tracking of pre-tests and final exams, display students' time spent in class and tests, create custom class bundles for multi-level of students and reports available to track knowledge gained.

The Lincoln Electric Education Partner Schools (LEEPS) Welding Certification Program, in partnership with the National Coalition of Certification Centers (NC3), provides a comprehensive suite of portable, stackable welding certifications that are recognized by the industry. LEEPS offers welding schools and training programs across the country the most comprehensive and relevant welding education tools and resources available to advance skill levels and prepare students for success. NC3 is a network of education providers and industry leaders who share a passion for innovative career and technical education models and strive to produce a sustainable, highly skilled workforce. NC3 was established to address the needs of today's and tomorrow's industries by fostering effective training, elevating skilled careers and creating employment opportunities through synergistic partnerships between employers and educational institutions. To achieve its mission, NC3 builds deep industry-educational partnerships and develops, implements and sustains industry-recognized portable certifications based on national skills standards. NC3 envisions an industrial labor market where all workers have the jobs they need to thrive, and all companies have well-trained employees they need to operate and grow.

## Additional Teaching Resources



The Teaching Aid Toolbox is a comprehensive collection of tools and accessories from various welding and cutting processes. It is fully supported with Lincoln Electric U/LINC curriculum lesson plans and is designed to bring actual welding and cutting tools into the classroom to better illustrate the principles of each process. This toolbox helps to enhance learning by illustrating joints, cuts, equipment and related techniques, taking the understanding of welding to the next level. The toolbox includes weld sample coupons, which allow instructors to demonstrate various welding joints and typical beads used in welding. Additionally, a set of discontinuity flashcards is included, which allows instructors to show and discuss common weld flaws.

### What's Included:

- » Cutaway Harris® gas regulator and oxyfuel torch
- » SMAW equipment including electrode holder, clamps and rods.
- » GTAW equipment includes torches, collects and nozzles.
- » GMAW/FCAW Magnum Pro Mig gun, drive roll, wire, diffusers, nozzles and more
- » Cutting - Tomahawk plasma cutting torch assembly, electrode, nozzle, oxyfuel cutaway torch and regulator.
- » Weld samples - common joint plates and discontinuities flash cards.

# FURTHER INFORMATION

For questions about the Lincoln Electric Suite of Products:

Visit our site at [www.lincolnelectric.com/education](http://www.lincolnelectric.com/education) or email at [educationsales@lincolnelectric.com](mailto:educationsales@lincolnelectric.com)

## Possible Resources to Strengthen Your Proposal

### National Coalition of Advanced Technology Centers (NCATC).

If you are interested in gaining a better perspective on Industry 4.0, Advanced Manufacturing, Robotic Welding and related subjects, the author strongly suggests that you connect with the National Coalition of Advanced Technology Centers (NCATC). NCATC is an Affiliated Council of the American Association of Community Colleges (AACC) that is catalyzing a network of higher education and industry-led Strategic Partner resources that advocates, advises and promotes the use of advanced technology applications to enhance economic and workforce development programs and services. With over 160 members from community and technical colleges, universities, CTE high schools, adult education organizations and the corporate community, NCATC provides great networking opportunities at both their Summer Workshop and Fall Conference every year.

NCATC also provides third-party external evaluation services and consults on program designs.

The core goals of NCATC include:

- » Developing and facilitating the exchange of workforce development programs.
- » Providing a forum to discuss new and emerging technologies to keep members on the cutting edge of technology applications.
- » Providing a conduit for member centers to network with one another in advancing workforce and economic development in their communities; and,

- » Increasing national awareness of Advanced Technology Centers and their positive impact on America's competitiveness and economic growth.

NCATC provides great networking opportunities at both their Summer Workshop and Fall Conference every year. NCATC also provides third-party external evaluation services and consults on program designs.

For more information about NCATC go to:

<https://ncatc.org/>

### Third-party Research External Evaluator

If you are interested in finding a third-party research external evaluator (other than NCATC), contact the Rutgers University Center for Education and Employment Research.

The Education and Employment Research Center (EERC) is a nonprofit research group based in Rutgers University's School of Management and Labor Relations. EERC provides research, evaluation and analysis relating to linkages between education and the workplace. The center strives to be a catalyst for evidence-based study of learning and skills development informing the future of work. EERC promotes quality and equity in education and training for students and workers, the institutions that serve them and the broader economy.

EERC areas of focus includes Community College Innovation; Educational Pathways; Education and Labor Market Linkages; Non-degree Credentials & Noncredit Education; STEM and Technician Education; Evaluation of Policy and Practice; Equity and Access; and the Future of Work.

For contact information go to:

<https://smlr.rutgers.edu/eerc>



**Additional Questions**

For additional questions about grants or grant-writing, contact Bob Visdos at [rvisdos@workforceinstitute.com](mailto:rvisdos@workforceinstitute.com).

Robert Visdos-The author of this grant writing aid is Robert Visdos, President and Owner of the Workforce Institute, Inc. in Portland, OR. He can be reached at 571-214-5239 or via the email address.

**Contact Summary**

Information	Contact Information/Website
Lincoln Electric Suite of Products	Website: <a href="http://www.lincolnelectric.com/education">www.lincolnelectric.com/education</a> Email: <a href="mailto:educationalsales@lincolnelectric.com">educationalsales@lincolnelectric.com</a>
NCATC	Website: <a href="https://ncatc.org/">https://ncatc.org/</a>
EERC	Website: <a href="http://smlr.rutgers.edu/eerc">http://smlr.rutgers.edu/eerc</a>
Grant Writing Guide	Bob Visdos: <a href="mailto:rvisdos@workforceinstitute.com">rvisdos@workforceinstitute.com</a> .
Grant Writing Aids	Phone: 571-214-5239

FURTHER INFORMATION

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- <sup>15</sup> Richard T. Stone, Kristopher Watts, Peihan Zhong, and Chen-Shuang Wei. 2010 Virtual Reality Integrated Weld Training; A scientific evaluation of training potential, cost effectiveness and implications for effective team learning. Independent white paper, Iowa State University. ISU Study 2.
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