Robotic Welding Fills Skills Gap with Quality Production

Robotic controllers are easier to program and use today than finding qualified welders

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Senior Editor

The decision to adopt robotic automation for welding cells is getting easier every day. There are any number of manufacturing considerations influencing that decision, including quality, productivity, and consistency of the weld. Today, however, the key driver is the lack of skilled welders available to fill the requirements of shops both large and small. Though at first glance shops may be put off by their cost and the idea that robots are difficult to program, they soon learn that robotic controls are easier than ever to program and that in the long run it’s easier to train someone to operate the robot than it is to find qualified welders and support their very human health, safety, and employment costs.

“Companies typically invest in welding automation to expedite the welding process, gain more consistent weld quality and/or to reduce costs,” said Tom Whitter, technical support specialist, Tre-gaskiss, division of ITW Welding. The process can also set companies apart from the competition by allowing for faster completion and delivery of products. For companies with high-volume
demands and low-variation parts, robotic welding can become an important part of their production plans. Smaller companies with lower-volume, high-variety parts can also benefit, but they may require more flexible tooling and more programming time to accommodate for several types of products.”

**Diverse Challenges Are Met By Robotic Welding**

“We’re starting to see a lot more interest from general industry in automating their welding, primarily due to the lack of skilled welders available, not to mention the significant benefits to quality and productivity,” said Jimmy Howell, robotic automation product manager, ESAB Welding and Cutting Products (Florence, SC). Interest in robotic welding, especially from smaller shops where justification of the cost of automation may be more of a sticking point, is ramping up because of the challenging metals that shops are being asked to weld.
“Materials are changing—whether for the automobile industry to lighten cars or to meet more stringent rules for rust prevention. Alloys are getting thinner and harder to weld with coatings like galvanneal and hot-dipped galvanized that complicate the welding process,” said Howell. “In addition, customer expectations are for welds that are free of spatter, cleaner, and more uniform.”

Today, the key driver in turning to robotic welding cells is the lack of skilled welders available to fill the requirements of shops both large and small.

For welding thinner, harder metals, ESAB’s Swift Arc Transfer (SAT) high-feed wire process produces deep weld penetration with uniform wide bead profile. “Our travel speeds are so high that we’re actually reducing the heat input and, in turn, producing better parts with less weld distortion and less spatter due to heat,” said Howell. To meet the increasing demand for welding aluminum and thin exotic alloys, ESAB’s dual-process Super Pulse is designed to provide “a really flexible solution to controlling the arc by modifying parameters on the foreground and background for welding thin exotic metals,” said Howell. “We can set up a duration of time for foreground and background and then we can control whether it’s pulse-pulse, pulse-short arc, pulse-spray arc, short arc-short arc, short arc-spray arc, and vary the duration of time for each process,” said Howell.

To develop procedures and programming for its customer’s robot cells, ESAB works closely with its robotic partner in North America, KUKA Robotics Corp. (Shelby Township, MI). “We partnered with KUKA because of the simplicity of the KUKA KRC4 fourth-generation controller,” said Howell. “Anybody can program a robot if you make it easy enough and KUKA has done just that with their KRC4 controller. Teaching somebody to weld is a lot harder than teaching...
them to run a robot. With the KUKA robot control, the user can take welders and make them into robot programmers, creating a higher technical capability job and giving them a path for growth in the company. Welders are embracing it and management loves the better productivity, quality, and of course, the ROI," said Howell.

Programming a robot involves teach and play back by physically driving the robot from point to point, using either plus or minus keys or a joystick in the case of the KRC4 controller, making selections from drop-down boxes and entering commands at each point. “The operator doesn’t have to memorize any code and our welder can hold 255 programs that can be recalled to consistently weld a wide mix of parts,” said Howell. The KUKA robot with the ESAB Aristo welding machine also has the ability to make a data set where all of the welding information including travel speed and weaving parameters are all in the same file. This means that cloning one good weld to another on a part or to another part or to another plant is easy with the ESAB/KUKA combination.

One thing to remember, however, said Howell, “Robot consistency is both a good thing and potentially a bad thing. If you program wrong, it’ll run every part wrong, producing bad parts. If programmed right to weld specifications, you’re going to have consistently good quality every time. KUKA publishes data on path accuracy which is the most important consideration in arc welding to ensure getting the optimum weld width every time and avoiding wasting wire.”

A new kind of welding system that solves quality and productivity problems related to automated and mechanized welding is being developed at Loppenranta University of Technology (LUT; Finland).

The system is self-adjusting, flexible, and adaptable such that it can be integrated as part of different robotic systems and different manufacturer’s power suppliers. Its self-adjusting properties are based on a new kind of sensor system which is controlled by a neural network program.

Most often in welding a monitoring sensor is used which tracks the bevel angle, an essential part of the welding process. In the system being developed by LUT, there are also monitoring sensors for the thermal profile (the weld pool's heat values) and the weld form. Data are transferred from sensors to the neural network which is able to deduce and react to simultaneous changes in multiple variables. “When a mistake is detected, the system is able both to correct it during the welding process and also calculate what other faults may arise. Thus the final product is flawless.

“The problem with welding automation systems is that certain values are set for the work, based on which the whole weld is carried out, and only then is it checked whether the result is good. Now the welding is monitored throughout the whole process,” said Project Manager Markku Pirinen. “In the gas-shielded arc welding process, factors affecting outcome quality include the welding current, the arc voltage, the wire feeding and transporting speeds, and the position of the welding gun. With the help of the neural network, a regulating window can be set for these system variables, and they can then be controlled so that they remain within certain limits, which ensures that final product is as required.”

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The positive impact of welding automation on large and especially on small shops in today’s advanced manufacturing environment could not be timelier, particularly because of the lack of skilled welders available, according to Kevin Summers, automation sales specialist, Miller Electric Mfg. Co. (Appleton, WI).

“The promise of putting a robot in place is typically a 3 to 1 improvement in productivity, or in a worst case scenario 2 to 1— with a definite uptick in quality as long as you are presenting repeatable parts to this highly repeatable process,” said Summers.

“Robotic welding frees key, highly skilled shop personnel to do other more difficult operations. Lower skilled workers can handle loading, unloading, tacking, and fitting. Business owners, especially of small shops, can build their business, hire new people, add new manufacturing equipment and pursue new business opportunities because of the consistency and increased volume of their throughput with robotic welding.”

Miller offers the Panasonic robot, which, Summers said, was developed specifically as a welding robot and is aptly named: The Arc Welding Robotic System, or TAWERS. “TAWERS gives us the ability to provide positional data on the robot with waveform control from the welder. The welding power supply and the robot brain have been combined into a single unit so there’s no lag time in communication and the robot can share positional data with the welder. What that means is when I’m making a weld of a thin member to a thick member, I can adjust the waveform instantaneously as the robot weaves between the thin and the thick piece.”

Programming for the Panasonic robot is done with the familiar Windows-based language. “If the operator has some welding background, he simply has to consider how he...
would make the weld manually. How would I position my torch? What would my gun angle look like? What would tip-to-workpiece distance need to be? He simply moves the robot arm into that orientation from point to point. The unique features of our robot allow him to digitally see the work angle, the torch angle, the push angle, or pull angle—all visually displayed. It takes the guesswork out of programming,” said Summers. “Using the Weld Navigator function allows inputting variables about what kind of weld, material thickness is required, and the robot will automatically calculate what travel speeds, voltage, and amperage are required based on material thickness and joint size.”

Summers said that welding thinner metals and metals coated for corrosion resistance is a challenge to controlling feed input, while fit up is always a challenge. “If the joint isn’t in the same spot each time results will not be consistent. For welding thinner metals, our Active Wire Process technology, for example, uses a combination of mechanical feeding forward and backward of the welding wire, which is moving in and out like a sewing machine needle. We combine that motion with waveform control to weld thinner and thinner materials with absolutely no spatter.”

Supplier Goes All-In With Its Turnkey Solutions

“We have a diverse customer group that includes, automotive, light and heavy industrial, and oil and gas, and aluminum applications which happens to be our specialty for robotic welding,” said Todd Griffieth, Technical Operations Manager, OTC DAIHEN (Tipp City, OH).

“As a turnkey solutions provider, we propose a solution that fits the cus-
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“Demand for customized and pre-engineered solutions is high and customers like the idea of a single source and a single supplier responsible for robotic welding applications ranging from thin gage steel to heavy plate. Aluminum is one of the most challenging applications because the expectation is that appearance implies quality of the weld so we minimize rework, and provide spatter-free or reduced spatter welding, and the need for secondary processes like grinding and wire brush clean-up are minimized or completely eliminated,” said Griffieth.

OTC DAIHEN offers seven main classes of robotic equipment that is differentiated by the investment and sophistication required by the customer’s applications. All the platforms tend to work in the cell configurations beginning with the ECO-ARC 200 for the first-time customer with a minimum investment, but with all the safeguards and stationary table and automation. “We build from there in modular fashion substituting tables, headstocks, and positioners as required. We engineer around all the possible solutions and allow the parts be presented to the operator rather than the operator moving to the parts. Our DT-ARC 500 dual trunnion unit is a highly flexible robotic cell with a variety of footprints including a two-station setup that can grow as big as you need. This isn’t a box cell like some systems. It’s independently floor-mounted and requires a safety

ROBOTIC WELDING CELLS

tomer’s requirement and are responsible for its total performance because everything in the system has our name on it. Our equipment covers every aspect of welding automation and automation technology, including robot manipulator and controller, positioners, power sources, torches, wire feeders and sensors,” said Griffieth.
fence. The DT-ARC is highly configurable and can handle up to three stations,” said Griffieth.

Commitment to Support Welding Cells Needed

Because robotic welding systems represent a large investment in the equipment, they require careful attention to performance of all aspects of the cell. No two cells are the same, but each is selected to fit the particular requirements of parts. “The important consideration for both high- and low-volume production is to ensure that the parts to be welded lend themselves appropriately to an automated welding process. Robotic welding systems rely on consistent parts to provide consistent results. Companies that have or are planning to implement a robotic welding system need to be certain that parts are simple and repeatable. The presence of gaps, poor fit-up, or poor joint access can have an extremely negative impact on the high quality sought with robotic welding systems,” said Tregaskiss’ Tom Whitter.

Production rates will change with implementation of robotic systems which are welded so much faster, requiring faster delivery to the cell and exiting from the cell. “Companies have to assess each activity leading up to the part entering the cell, making sure that the supply of parts matches the robot’s cycle time, and also assess the steps for handling the part after it leaves. In some cases, it may be necessary to change how the parts are fabricated upstream and completed downstream (e.g., finishing, painting, etc.) to establish good workflow. Companies should also look to eliminate non-value-added activities, including excessive lifting or handling of parts, and avoid multiple trips to stack products or other similar activities,” said Whitter.

Robotic welding systems add another favorable element in view of the difficulty of finding qualified welders. They can tolerate much harsher work environments. “Automated welding systems,” said Whitter, “typically operate at higher amperages and longer duty cycles than semiautomatic welding operations—the robots can withstand the greater arc-on time and heat compared to a human operator. ➔

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