



EWI PARTNERS WITH ESAB TO ACCELERATE
**WELDING PROCESS
AND APPLICATION
DEVELOPMENT**

Arc DED Additive Manufacturing

Waveform manipulation and custom wire formulations open new applications, such as replacing castings with arc DED and cutting lead time in half.

**ICE Technology for Submerged
Arc Welding (SAW)**

Increased deposition rates of up to 100lbs/hr at reduced heat inputs that preserve mechanical and metallurgical properties.

SITUATION:

EWI, based in Columbus, Ohio, provides a comprehensive suite of advanced engineering solutions to manufacturers and suppliers across the industry with research and development to push technology in a way that will be most applicable. Always on the cutting edge of welding technology and applying new alloys, EWI accelerates entry into new marketplaces while mitigating risk and helping lower costs.

CHALLENGE:

For additive manufacturing (AM) applications, EWI wanted to experiment with using new alloys and pulsed MIG waveforms for the arc directed energy deposition (arc DED) process. AM requires good deposit fusion between layers but does not need the deep penetration associated with waveforms developed for welding.

For SAW, EWI wanted to explore the Integrated Cold Electrode (ICE™) multi-wire process that offers very high deposition rates (up to 100lbs/hr.) at reduced heat inputs.

SOLUTION:

EWI reached out to ESAB to leverage its innovative technologies. After a discussion of goals for AM, ESAB initially supplied an Aristo® U5000i 500A power source, U82 control and custom filler metals for arc DED. The power source subsequently been replaced with ESAB's new Warrior® EDGE 500 DX, which uses a next-generation power current control module.

For SAW, ESAB supplied a complete ICE system featuring two Aristo 1000 AC/DC 1000A inverter power sources, PEK process controllers, gantry, welding head, flux hopper and consumables.

ESAB supplied the systems under the auspices of Future Fabricators program, developed for aspiring welders and fabricators and to promote welding innovations and new technologies. In addition to EWI member companies and clients, others with access to the ESAB systems include students performing research as part of advanced degrees in the welding engineering program at The Ohio State University, also co-located beside EWI in the Edison Joining Technology Center, Columbus, Ohio.

RESULTS:

EWI and ESAB have collaborated and worked well together to create new solutions for more than 15 years, and this new collaboration continued that success.

“We recently collaborated on projects for the National Shipbuilding and Research Program to produce large-scale additive parts, as well as on other projects for the U.S. Department of Defense. ESAB has been highly responsive with its ability to develop and produce custom filler metal formulations for these projects. Combined with new innovative equipment and process knowledge, it has enabled us to expand our capabilities into unique alloys and alloys that are not typically welded,” says Michael Carney, Senior Engineer at EWI.



“We know there’s going to be a lot of metallurgical challenges as we explore SAW solutions, but we are kind of excited at the opportunity,” says EWI’s Jim Hansen.

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ICE SAW solutions will benefit offshore wind and shipbuilding industries, for example, where high deposition rates and controlled heat inputs are needed to meet high strength steel property requirements while improving affordability.

“If customers want to investigate the potentials of the ESAB ICE system, they can come to EWI to initiate a project that focuses on procedure development and qualification for their application,” says Jim Hansen, a project engineer in the Arc Welding and Directed Energy Deposition Processes Group at EWI. “Working with a trusted third party like EWI lowers their cost barrier to entry. EWI can help them determine if the technology is a fit for their application without making a capital investment.”



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BENEFIT # 1 ADVANCED WAVEFORM CONTROL

The Warrior Edge uses a field programmable gate array (FPGA) current control module. The FPGA:

- Controls the arc more quickly than the microprocessor controls used on other pulsed welding equipment. The Warrior Edge can detect and clear a short circuit or manage current transients 10 to 20 times faster. As a result, the system creates a stable, more controllable weld pool and minimizes weld spatter.
- The new Edge platform gives engineers much greater flexibility to develop and optimize waveforms.

“On the previous generation of pulsed MIG systems, you really only have four waveform data points to manipulate, and you don’t have full control over those data points to generate the synergic lines,” says Carney. “On new systems, you can have 6, 8 or 10 different points, and you can go in and modify each of those points to have a lot more control.”

Carney says that if traditional synergic don’t work well (such as for an uncommon material or a specific joint configuration, “industry can engage with us and EWI can tailor a waveform to your specific application.”

BENEFIT # 2 ADVANCING ADDITIVE MANUFACTURING APPLICATIONS

Using CAD to path software, arc DED uses filler wires and commercial welding power sources to add features onto an existing part or to create a new part. It is faster than other methods of additive manufacturing, extremely accurate, and can fabricate large-scale parts. In addition, arc DED can be implemented with less risk since it leverages decades of proven arc welding technology and standards.

“Compared to welding, arc DED application must ensure good deposit fusion, but we don’t need the deep penetration associated with welding,” adds Carney. “These applications demand deposition procedures and synergic spatter-free metal transfer that provide smooth

builds and edges that minimize post-process finishing.” By working with ESAB systems that have waveform development tools and hundreds of synergic lines, we can download the waveform and tailor it to a wide range of arc DED feature-material-process applications.”

High growth areas for arc DED include replacing castings as part of insourcing efforts. Traditionally, users may wait six months to a year for a casting where now arc DED can directly replace the casting and reduce the lead time by more than half.

BENEFIT #3

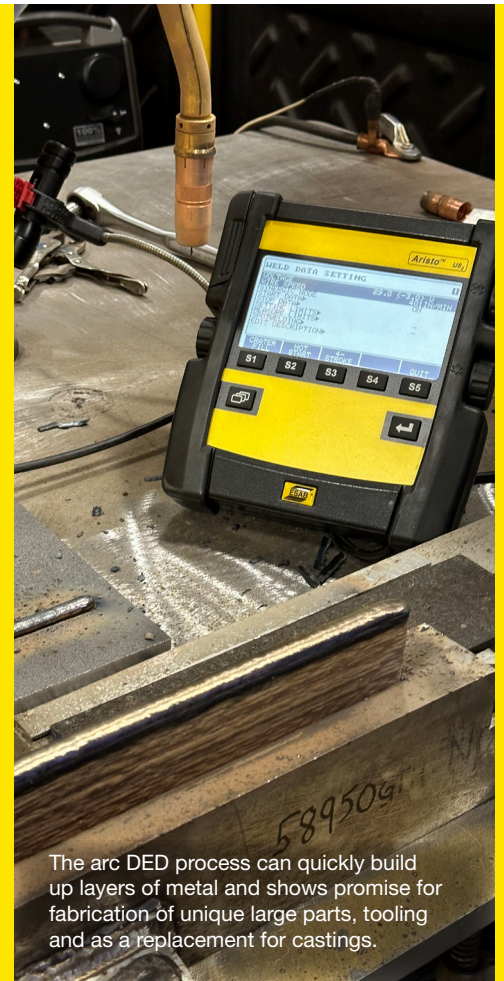
CUSTOM FILLER METAL FORMULATIONS

In 2023, Carney visited ESAB's filler metal and power source research facilities in Gothenburg, Sweden.

"I was able to see some of the waveform development tools that aren't readily available to normal users outside of very specific customers or research and development labs like us. I also got to see first-hand how quickly ESAB can create custom wires. It was an impressive operation."

Ravi Menon, PhD, ESAB Filler Metals R&D, notes that "ESAB and EWI have expanded our collaboration into metal AM and digital manufacturing applications that leverage our fusion welding and consumable technologies. ESAB's ability to customize and formulate high-strength wires, along with EWI's capability of producing 3D-printed structures, is leading to rapid prototyping of the components desired by industry. Other AM areas include stainless steel wires that can operate at very low levels of gas and slag coverage."

Hansen says that "In the next couple of years, I see us focusing on functionally gradient materials by manipulating the dilution rate throughout an AM part build. We can start with one-alloy-specific component features and move to something completely different at the other end or side of a metal additive part to achieve longer service. Gradient solutions are needed in applications such as heat exchangers or chemical vessels that have extreme service conditions and may suffer from thermal fatigue, corrosion or oxidation and/or combination thereof."



The arc DED process can quickly build up layers of metal and shows promise for fabrication of unique large parts, tooling and as a replacement for castings.



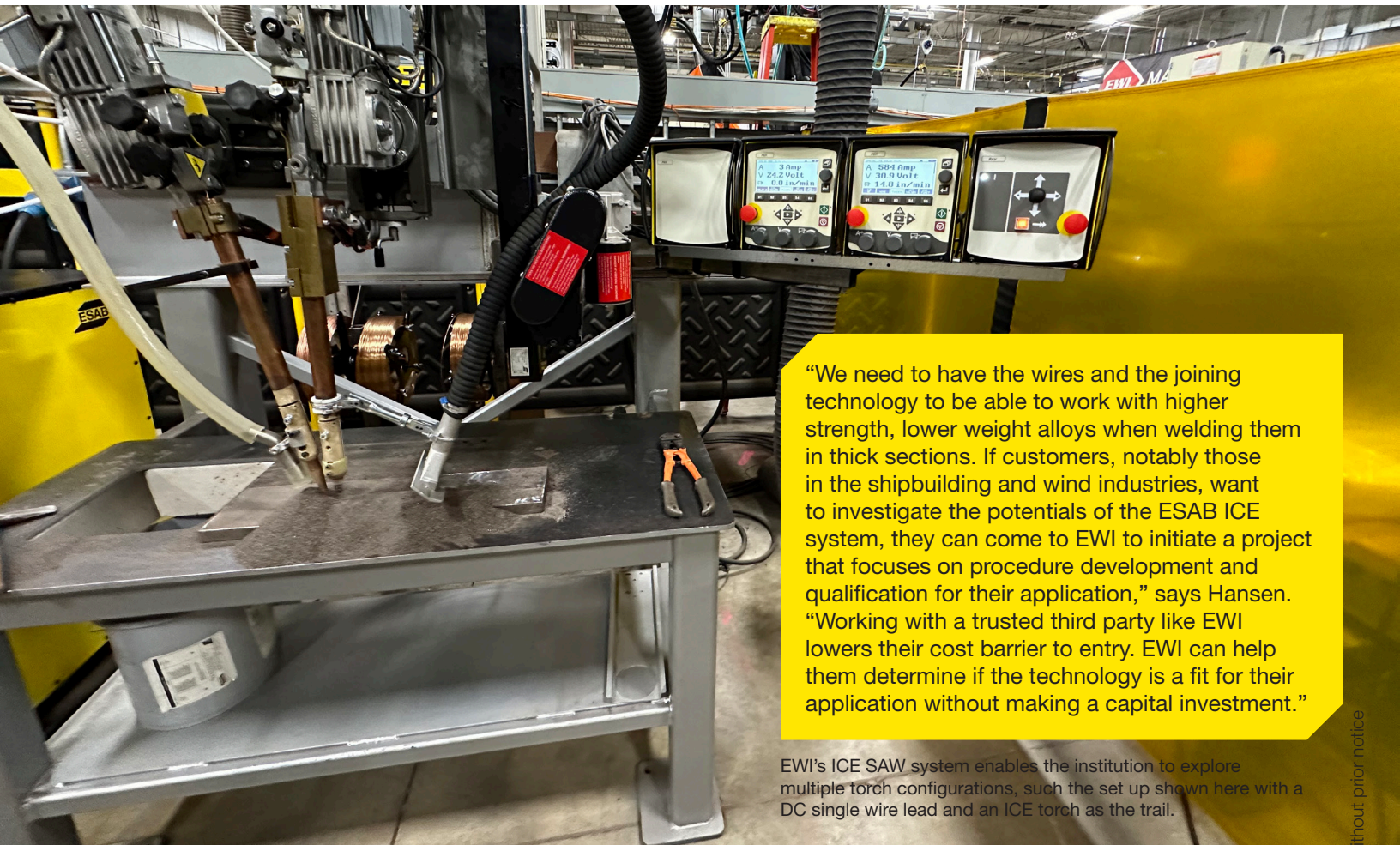
BENEFIT #4

SAW WITH FASTER TRAVEL, GREATER DEPOSITION AND LESS HEAT

Because of the ability to adjust more variables, as well as create different torch configurations, the ICE process can be tailored to emphasize travel speed, deposition rate, heat input, bead profile and a combination of these variables. The ability of the Aristo 1000 AC/DC to manipulate the AC wave form creates many possibilities for industry to explore.

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ESAB's patented ICE process introduces a non-energized ("cold"), electrically insulated electrode into the molten weld pool created by a twin-wire SAW process.



“We need to have the wires and the joining technology to be able to work with higher strength, lower weight alloys when welding them in thick sections. If customers, notably those in the shipbuilding and wind industries, want to investigate the potentials of the ESAB ICE system, they can come to EWI to initiate a project that focuses on procedure development and qualification for their application,” says Hansen. “Working with a trusted third party like EWI lowers their cost barrier to entry. EWI can help them determine if the technology is a fit for their application without making a capital investment.”

EWI’s ICE SAW system enables the institution to explore multiple torch configurations, such the set up shown here with a DC single wire lead and an ICE torch as the trail.

BENEFIT #5 FUNCTIONALLY GRADIENT MATERIALS

“Another thing that we’re really excited about with these multi-wire SAW processes is the ability to mix wire compositions as we’re welding,” continues Hansen. “It gives us a possibility to look at different wire formulations without really formulating those wires by feeding two separate wires into the arc.

“By feeding multiple wires into a weld puddle, the ICE system can potentially “get us close to space of functionally gradient materials. We could gradually change our weld deposit chemistry by adjusting the feed rate and the type of welding wires that we’re using. This is something that has not been looked at in the submerged arc industry.”

CONTINUED COLLABORATION AND SUCCESS

EWI is an unbiased, third-party, brand-neutral partner with a dedication to service for its customers and their respective industries.

“EWI serves as a place where our customers can come and flesh out new technology before they utilize it in their industry, whether that be through robotics, power supplies or new experimental alloys,” says Hansen. “We’re able to compare systems and give customers a high level of confidence that they will have a welding or additive manufacturing process that is robust and will ultimately improve their bottom line.”



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