

WELDING JOURNAL



AUGUST 2026



AI in Industrial Applications and Weld Shops

Innovative Teaching Strategies



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**INSPECTION
TRENDS**

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Building Real Skills through Virtual Training

For years, I have told my students that learning to weld is not difficult, although it does take hours under the hood to master. Like any other hands-on skill, it takes guidance from subject-matter experts to help a student understand the correct speeds, angles, and distances to produce a high-quality weld. Students must also be provided with prompt feedback on their welds to not only ensure they perform them correctly but also understand what is wrong with the weld appearance and how to fix it. The implementation of augmented reality (AR) and virtual reality (VR) is still seen as a new methodology for teaching fundamental welding skills, yet these systems have been demonstrated to be beneficial for welding education for nearly two decades. When surveying other hands-on skill-training programs that use AR and VR systems, we find that many examples have been highly effective.

One of the industries that requires simulated, hands-on skills that comes to mind is airline transport, specifically pilot training. These students may be required to log as many as 100 hours learning to operate the aircraft and handle the vast amount of information they must track. Simulators have been used in pilot training for more than 75 years, with modern full AR/VR systems approved by the European Union Aviation Safety Agency (EASA) in 2021 and by the Federal Aviation Administration (FAA) in 2024.

Another field that requires hands-on skills and the ability to adjust in a high-stress environment is the U.S. armed forces. I am reminded of a conversation with a lifelong friend, a lieutenant colonel in the U.S. Army, during which we discussed how the U.S. government has been using simulations for more than a century, with modern immersive AR/VR technologies in use since the early 2000s.

A third profession comes to mind as a family member prepares for a heart valve replacement in the coming days: medicine, specifically surgeons. After speaking with another lifelong friend who is a radiologist, he mentioned that during residency, typically lasting five years for general surgery and often followed by an additional two-year fellowship, residents spend upward of 50 hours annually practicing and refining their skills before working under the guidance of an attending physician. Notably, modern VR systems have been in use for about 35 years.

As I compare the skills needed to fly a plane, perform surgery, or operate in a war zone with those we teach our welding students, it's difficult to imagine that they are any more demanding. One of the biggest critiques I have heard from welding instructors is that "students need to learn to weld for real." I could not agree more, and just as with pilots, doctors, and soldiers, AR/VR systems are designed to help students learn in a safe and controlled manner. The AR/VR systems we see in the welding training environment provide students with real-time, immediate feedback to help them learn and improve their basic muscle memory skills, such as aim, travel speed, work angle, travel angle, and arc length. The AR/VR system can support instructors when they can't be everywhere at once. Some students may need more one-on-one time to learn how to move across the weld, and these systems help by providing auditory, visual, and kinesthetic feedback. Additional research is needed to determine the optimal use of the systems across a variety of secondary agriculture and welding classrooms, post-secondary schools, and on-the-job training centers. Nevertheless, the research shows that AR/VR training systems are effective for developing hands-on skills, and we, as an industry, need to work to further their implementation. [WJ](#)



Travis Jumper, PhD

Dean of technical education,
Southwestern Illinois College;
AWS District 14 Director

“The implementation of augmented reality (AR) and virtual reality (VR) is still seen as a new methodology for teaching fundamental welding skills, yet these systems have been demonstrated to be beneficial for welding education for nearly two decades.”

PEOPLE OVER PAPER: THE REAL SOURCE OF LEARNING

How mentors and community shape education and careers



Jones is seen at the start of his welding career (left) and in the present day (right).

Education isn't a diploma; it's the people who teach you how to do the work right. From a backyard shop to college labs and AWS meetings, the mentors I've met over time have taught me more than techniques. They've taught judgment, pride, and how to keep learning. This article traces the lessons and leaders that made me a better welder, teacher, and member of our community.

My first teacher was my father. He ran a shop and expected my best work. As a kid, I thought I

was doing chores; in reality, I was learning craftsmanship, pride in a finished piece, and how to use tools to solve problems. Those afternoons customizing bikes and fixing small engines gave me confidence and a taste for making things that worked and looked right.

In junior high, I signed up for shop class and discovered competition and community. The hands-on work from my father's garage had primed me to learn faster and enjoy the process. I also joined the student council and learned people skills that don't show

up on a welding test but matter in every shop and boardroom.

High school metal shop was another step. My instructor, Mr. Mugg, cared about the program and his students. I joined the Industrial Arts Club, met other makers, and learned that welding could be more than a hobby — it could be a career. Welding paid cash for the work I did, and that practical reward reinforced the value of skill.

After high school, I enrolled in a respected college welding program. The director, Larry Jeffus, made it clear this was serious training: you had to study academics as well as practice. He taught me to understand the why behind the bead — metallurgy, joint design, procedure, and inspection. He also taught a lesson in accountability: if a weld failed, don't argue — show the code and make your case. That kind of tough, honest feedback was education in its purest form.

Jeffus also encouraged us to join AWS and attend Section meetings. I went, wrote a one-page report for extra credit, and found a community of professionals willing to talk to a student. That connection changed my life. AWS members donated their time and expertise to develop codes, standards, and educational tools. The North Texas Section encouraged me to apply for a scholarship and invested in my future long before I



Jones (far right) recently spent time with several of his industry mentors. Pictured with Jones are (from left) Larry Jeffus, Bryan Baker, and DeWayne Roy.

realized how valuable that support would be.

After college, I landed a job at Texas Instruments, where I worked with Jack White, a lead welder who became another teacher. Later, I took a high school teaching job with the Garland Independent School District (ISD). Teaching high school students taught me as much as I taught them. I learned how different audiences need different approaches. It also led me back to university to earn an education degree. Along the way, two friends and fellow educators, Sean Moran and Bryan Baker, showed me different paths from the classroom to industry and higher education.

While teaching, I met Ben Jezek, who opened my eyes to the gas equipment industry, distributors, and international perspectives. Jezek sent me to factories and customers, and those trips broadened my understanding of welding beyond the classroom. Experiencing other cultures and practices taught me that education isn't just facts; it's context and perspective.

AWS kept showing up in my life. I served on the North Texas Section board, attended the Leadership program, and eventually became Section chair. The Leadership program sharpened my skills and gave me friendships that matter. I met people like Dr. Richard Polanin and Ernest Levert, who mentored me through a run for District director. Serving as District director brought new responsibilities and new lessons in governance and service.

Two achievements from that period stand out. First, helping bring the Boy Scout Welding Merit Badge to AWS was a proud moment because it connected young people to our craft. Second, the Educators Scholarship grew from an idea into a funded program with help from past AWS leaders, such as Tom Lienert and Earl Lipphardt, who coached and guided the effort. I also currently serve on the Grants Committee and promote AWS's efforts to support projects that grow the profession of welding.

Colleagues and mentors encouraged me to run for AWS vice president. That vote of confidence

I'm grateful for the people who invested time in me — my father, teachers, shop leads, AWS volunteers, and colleagues.

is priceless. It pushed me to try new things and take on bigger challenges. Around the same time, I changed employers and joined Harris Products Group. New equipment, new procedures, and a supportive employer who backed my AWS role broadened my experience.

Experience matters as much as certification. While education and credentials are important, I would rather be described as experienced and qualified. You can earn degrees and certifications, but broad experience comes from, practice, mentorship, and service.

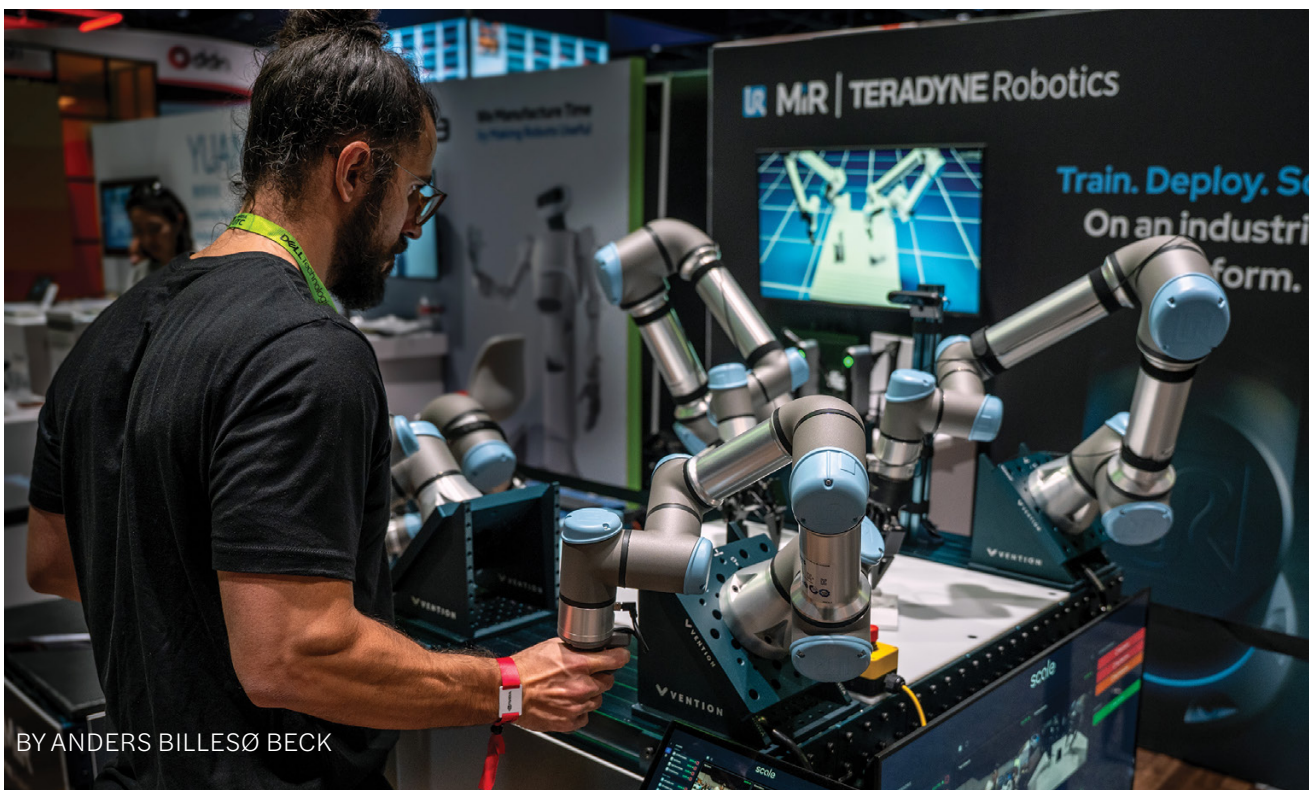
I'm grateful to my father, teachers, shop leads, AWS volunteers, and colleagues who invested in me. They corrected me, challenged me, and opened doors. My achievements are mine, but they were built with guidance from remarkable leaders who freely gave their time and wisdom. If there's one piece of advice I'd pass on, it's this: choose your teachers carefully, stay curious, and be willing to invest your time where it counts.

Welding education is more than classes and certificates; it's about the people who teach, mentor, and open doors. My path took me from my father's shop to college, industry, teaching, and AWS leadership. It showed me how mentorship, practical experience, and community shape a career. 

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PHYSICAL AI ENABLES ADAPTIVE WELDING AUTOMATION

A new approach helps robots handle fit-up variation, shifting parts, and real production conditions



BY ANDERS BILLESØ BECK

Industrial robots have traditionally been deployed on a simple premise: define the task, program the path, constrain the environment, and repeat. That model has delivered enormous value in stable, high-volume production, but it also explains why variable processes remain difficult to automate.

Manufacturers now face skilled labor shortages, rising productivity demands, shorter product cycles, more changeovers, less predictable

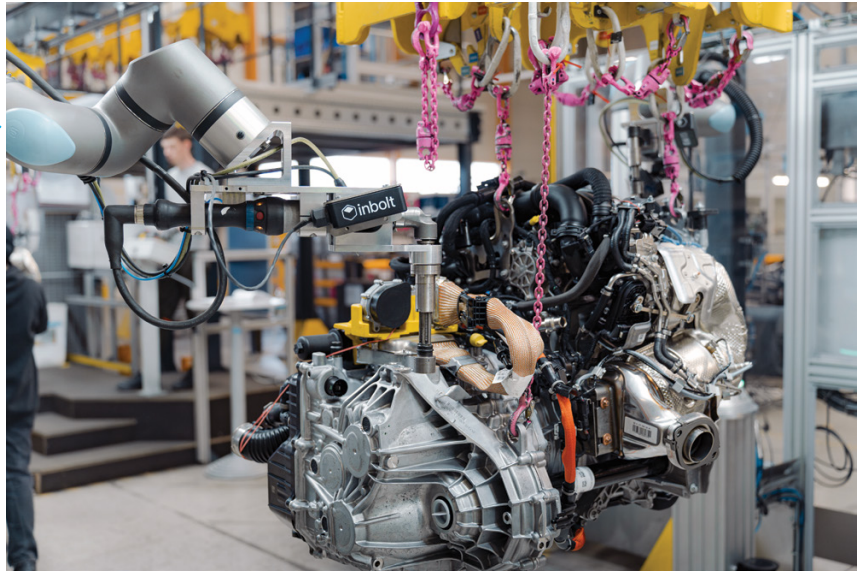
part presentation, and tighter quality requirements. In this environment, automation needs to perceive, learn, decide, and act in the complex conditions of real production.

What Physical Artificial Intelligence Means for Industrial Applications

During a recent conversation with experts from NVIDIA, Santa Clara,

Universal Robots's AI Trainer claims to be the first direct lab-to-factory solution for AI model training. Developed by Universal Robots and Scale AI, it utilizes the same hardware used in over 100,000 industrial deployments. Operators physically guide a "leader" robot through a task while a synchronized "follower robot" mirrors the motion in real time. (Credit: Universal Robots.)

Deploying a robot on a factory floor often takes weeks as engineers build digital twins of the production line, then spend the commissioning window touching up trajectories point by point. Using Inbolt's AI-assisted vision-enabled robot programming, the Universal Robots arm can locate the part on a moving surface and adjust its motion to execute the planned path. (Credit: Inbolt.)



Calif.; SICK, Bloomington, Minn.; Inbolt, Paris, France; and Universal Robots (UR), Odense, Denmark, the discussion turned to what physical artificial intelligence (AI) means in practical industrial terms. The clearest answer is not “robots that think” in some abstract sense. It is robots that can handle variation without requiring manufacturers to redesign the world around them. That means fewer fixtures, fittings, and manual workarounds.

Amit Goel, director of product management for autonomous machines at NVIDIA, described physical AI as the next wave after generative and agentic AI.

“This is where AI understands the data from the real world and takes actions to control and orchestrate things in the real world,” he said. “Robotics is at the heart of that evolution of AI.”

Physical AI is not simply digital AI placed on a robot. Industrial robots must interpret vision, force, torque, touch, position, speed, and sensor inputs, then act with low latency and predictable behavior. Unlike a chatbot, a robot’s output is physical motion, with consequences for people, equipment, and product quality.

Grounded in Reality

Physical AI must be grounded in real industrial systems, not only

research demonstrations. Simulation, synthetic data, and web video can help train models, but they cannot fully capture contact, friction, compliance, wear, or how a specific robot applies force. For contact-rich tasks, small variations in timing, torque, or part position can determine success.

As Goel noted, human video, web data, and simulation can support training and testing, but real robot data is needed to close the gap with the factory floor.

“The robots in the future are going to be driven by data,” he said. “We’re not going to be programming them anymore. They’re going to learn from the data.”

Physical AI can be framed around four core capabilities:

1. Perception and awareness
2. Planning and decision making
3. Adaptive execution
4. Learning and resilience

In factory terms, that means recognizing parts, replanning motion, adjusting force or speed, recovering from small errors, and improving task performance over time.

In welding, those capabilities are especially relevant because the process is sensitive to small changes in part fitup, joint location, torch angle, travel speed, and workpiece presentation. A fixed path may work on a perfectly fixtured part, but real production parts are rarely perfect.

Physical AI can help the robot smooth motion, adjust execution, and use sensor feedback to keep the process within an acceptable window.

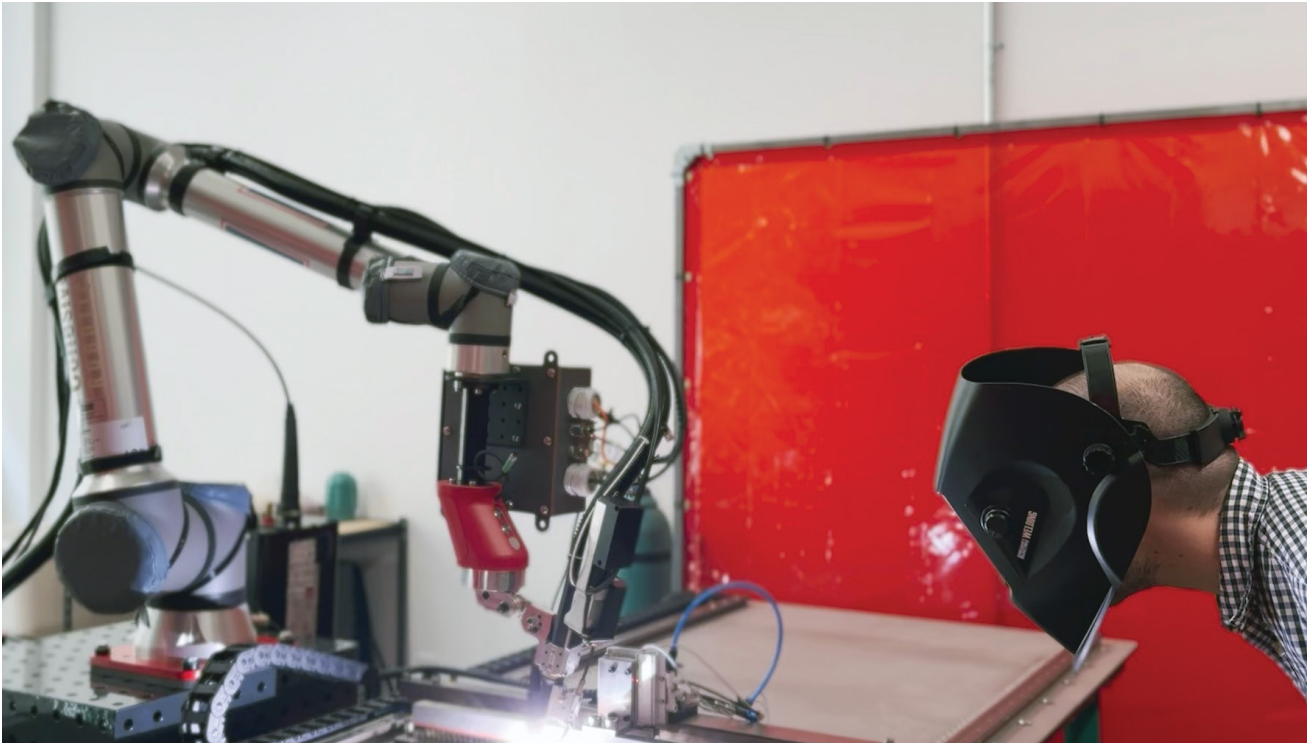
Sensing and Variability

Dominik Birkenmaier, global industry manager at SICK, highlighted AI-enabled robot guidance systems that combine image and depth data with pretrained neural networks. In variable applications such as depalletizing and bin picking, he noted that this can reduce setup, as “No training, CAD files, nor manual setup are required.”

Jan Jarvis, senior manager of visualization at SICK, added that realistic virtual sensors can help teams test systems early and explore rare scenarios safely. However, robustness is key. “AI can be extremely powerful, of course, but industrial systems must just work in the end, especially if it comes to safety,” Jarvis said.

For Inbolt’s Rudy Cohen, the same principle applies on the motion side. The manufacturer mounts a camera on a robot arm to estimate part pose in real time and update trajectories during execution. “Most robots in a factory floor are still essentially blind,” Cohen explained. “So they execute perfect trajectories in very imperfect worlds.”

That mismatch between perfect trajectories and imperfect worlds is the central problem physical AI



This AI-powered welding system from Cohesive Robotics is an example of how physical AI in robotics works in the weld shop. It's shown here mounted on a Universal Robot cobot, using a camera to gather millions of data points that it then analyzes to create the right program for welding tasks. (Credit: Cohesive Robotics.)

addresses. Cohen gave an example of parts loaded into racks that were never perfectly consistent because operators and forklifts introduced small shifts. Traditional automation would misalign or stall. But with real-time trajectory correction, the robot could continue working even when the part was offset or rotated.

The same issue appears in robotic welding on high-mix parts and large fabrications. Upstream cutting, forming, tacking, and clamping introduce variation before the robot starts. Physical AI does not remove the need for good workholding or process control. Still, it can reduce dependence on perfect presentation by helping the robot compare the intended weld path with the actual joint position and adjust accordingly.

For manufacturers, the value of physical AI lies in faster commissioning, fewer fixtures, less reteaching, reduced downtime, improved quality inspection, adaptive material handling, dynamic path planning,

and better performance in force-sensitive tasks.

Physical AI is most useful where variability is currently expensive, such as is welding operations that include high-mix parts, large fabrications, inconsistent fit-up, changing joint locations, and cells where excessive fixturing or reteaching has limited the business case for automation.

There are still limits. Fully end-to-end AI systems remain difficult to prove over long periods. Applications involving extreme accuracy or challenging physics are still active areas of development.

However, there is a practical path for companies considering physical AI: start with simple, bounded applications where AI can improve perception, localization, inspection, guidance, or contact behavior within a controlled safety envelope. And remember, the robot will be learning and improving every time it performs the task it has been assigned.

Conclusion

Physical AI is moving from concept to real-world production lines. But it is not replacing industrial robotics; it is extending it. Welding robots will still need good process control, safety, repeatability, and sound application engineering.

With the emergence of physical AI, they can begin to handle more of the variation that has traditionally made welding automation difficult. In that sense, physical AI is not about making robots magical. It is about making them more useful in the imperfect conditions where welding actually happens.

For more information, watch the on-demand webinar, "Discover How Physical AI is Transforming Industrial Automation" at urrobots.com/physicalAIwebinar. 

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