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### In this issue...

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- Understanding stress relaxation cracking in austenitics

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Volume 37, August 2025

Energy & Renewables

**41 DUPLEX**

**Duplex World Conference & Expo Call for Papers**

Have your say at the world's premier duplex event! Time is running out to submit your abstract.



**46 DIGITALISATION/WELDING**

**Translating intuition into welding automation**

Interdisciplinary approaches and close, cross-generational communication are essential to effectively digitalise welding processes.



**49 ACOUSTIC EMISSION TESTING**

**Staying competitive with smart inspection**

Acoustic Emission Testing is a real-time solution for monitoring asset integrity, helping to streamline maintenance and extend inspection intervals.



**52 SUSTAINABLE NICKEL**

**Green nickel for sustainable electrification**

Scientists at the Max Planck Institute for Sustainable Materials have developed a carbon-free, energy-saving method to extract nickel.



**54 QUALITY CONTROL**

**The power trio behind superior SAM performance**

Selecting and integrating the right transducers, digitisers, and software drives superior Scanning Acoustic Microscopy quality control.



**6 Special Topic Update**

**57 Community Update**

**58 Industry Update**



**63 Buyers' Guide**

The Buyers' Guide and Application Guide are your essential reference tools for sourcing corrosion resistant alloys.



**ADVERTISERS' INDEX**

BIBUS METALS AG	51
Centravis Sales Germany GmbH	2
Hart b.v.	59
HW-Inox GmbH	56
Intoco Ltd.	72
MRC Global	45
Nippon Yakin Kogyo Co Ltd	12
P.A. Inc.	19
Scoda Tubes Ltd	21

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# Translating intuition into welding automation

Interdisciplinary approaches and close, cross-generational communication are essential to make the digitalisation of welding processes truly effective and to fully leverage the potential for higher process stability, resource efficiency, reproducibility and traceability.

By Matthias Schaffitz, Application Engineer, Wolfram Industrie

Industry 4.0 remains a hot topic: Systems are being digitalised, processes automated, and craftsmen increasingly replaced by programmers. Although welding technology already collects individual metrics such as current, voltage, and welding speed, process control and monitoring still rely heavily on the welder's expertise. The human ability to flexibly respond to tolerances in the welding joint through a combination of optical pattern recognition and acoustic perception still surpasses the potential of machine systems. The more automated a welding robot is intended to be, the more complex and precise the preparatory work must be. This means that the intuition developed by welders through years of experience must be translated into a logical language. Interdisciplinary approaches and close, cross-generational communication are essential for making the digitalisation of welding processes truly effective and fully leveraging the potential for higher process stability, resource efficiency, reproducibility and traceability.

## Industry 4.0 not yet complete

A 2024 study by BearingPoint, conducted in collaboration with Munich University of Applied Sciences, found that 100% of the surveyed companies in Germany were already engaged in implementing Industry 4.0<sup>1</sup>. However, none had fully completed the



Automated processes can reduce material waste as less reworking is required and high-quality results are easier to reproduce. Source: Gesellschaft für Wolfram Industrie mbH

transformation: On a scale from "not started" (0) to "fully implemented" (10), all responses ranged between 1 and 8. Given this background, it is unsurprising that 81% of companies plan to invest in Industry 4.0 in the coming years. The welding experts at Wolfram Industrie have already observed how challenging this transformation can be in practice. While their customers show great interest in the digitalisation of welding production processes, they also express significant uncertainty about its implementation. How can production lines be digitalised without replacing all existing machinery and personnel? How should the process chain be designed to remain simple and profitable in day-to-day operations, preventing welders from resorting to manual welding due to system complexity? Most importantly, how can digitalisation be implemented in a way that results in measurable resource savings and efficiency gains?

## No data hoarding, but meaningful monitoring

From a technical perspective, purchasing new Industry 4.0-ready systems is easier than retrofitting existing machinery, but such an investment rarely makes financial sense

for most companies. Fortunately, even older machine parks offer opportunities for data collection, such as monitoring current, voltage, coolant levels, or component movement. However, many sensors, according to common industry standards, lack the high resolution required for detailed monitoring of welding processes.

To track electrode wear, shielding gas effects, or gas turbulence, a resolution of more than 1,000 data points per second is necessary. Additionally, standard values such as current and voltage can be difficult to measure in tungsten inert gas (TIG) welding, as the high-voltage ignition used requires specially designed arc voltage measurement systems. Yet, even with the availability of high-resolution measuring devices, the key to Industry 4.0 implementation lies in balancing what is measured against how the data can be meaningfully analysed. So how can this balance be achieved?

## Resource efficiency and process reliability

Digital monitoring competes with a highly skilled counterpart: the experienced welder and their intuition. Due to their three-dimensional spatial

<sup>1</sup> <https://www.bearingpoint.com/de-de/publikationen-and-events/publikationen/industrie-40-die-unvollendete-revolution/> (called on 18.11.2024)



A resolution of more than 1,000 data points per second is required so that electrode wear, shielding gas influences or shielding gas turbulence can be recorded at all. Source: Gesellschaft für Wolfram Industrie mbH

awareness, humans can quickly recognise optical patterns and acoustic anomalies. This enables experienced welders to react flexibly, compensating for tolerances in the weld seam and making them less dependent on precise pre-processing. The more automated a welding process becomes, however, the more meticulous and precise the preparation must be. The increased setup time has led to the perception that digitalised welding processes are only worthwhile for high production volumes. However, time is not the only resource significantly impacted by welding digitalisation. Automated processes can



Matthias Schaffitz is an application engineer at the Wolfram Industrie GmbH research and production center in Winterthur, Switzerland. Source: Gesellschaft für Wolfram Industrie mbH

also reduce material waste, as fewer rework operations are needed, and a consistently high quality is easier to replicate. Given that metals are resource-intensive and costly materials, efficiency and process stability gains can become evident even in small-scale production. The prerequisite for this is correct machine settings and minimal production tolerances. In other words, the expertise and professional intuition of welders must be translated into a logical, programmable language.

### Linking Human Expertise with Digital Information Flow

At this point, two different information flows collide: that of craftsmen and that of programmers. This also raises a generational question, as traditional manual welders tend to belong to an older demographic, while operators are generally younger. To effectively merge the deep knowledge of traditional craftsmanship with the rapid data flow from real-time monitoring, the prevailing distrust between both groups must be overcome. Traditional welders would benefit from gaining an understanding of digital data processing and process control, while operators and programmers should strive to grasp the principles of the welding trade. The key to a successful digital transformation in welding technology

lies in communication and the methodological competence of both sides. To support its customers in this transition, Wolfram Industrie collaborates closely with research institutes, system manufacturers, and end users. The initial goal is to establish the necessary foundations for each production environment to assess the relevance of collected data in relation to realistic monitoring capabilities. Based on this, the effort required for pre- and post-processing of workpieces in automated welding processes can be optimised, setup times minimised, and resource consumption in daily operations reduced – ensuring that the vision of higher process stability, resource efficiency, and traceability promised by Industry 4.0 does not remain an empty promise.▲

### About the company

Wolfram Industrie is a global player developing and producing tungsten-based products. It delivers the technically intelligent solutions required to produce high-quality industrial goods. As the only manufacturer of tungsten electrodes in Germany and thoriated electrodes in Europe, expertise and regional ties are a top priority. With four generations of entrepreneurship to tap into, it remains an independent family business. For more information, visit: [wolfram-industrie.de](http://wolfram-industrie.de)