WELDING JOURNAL

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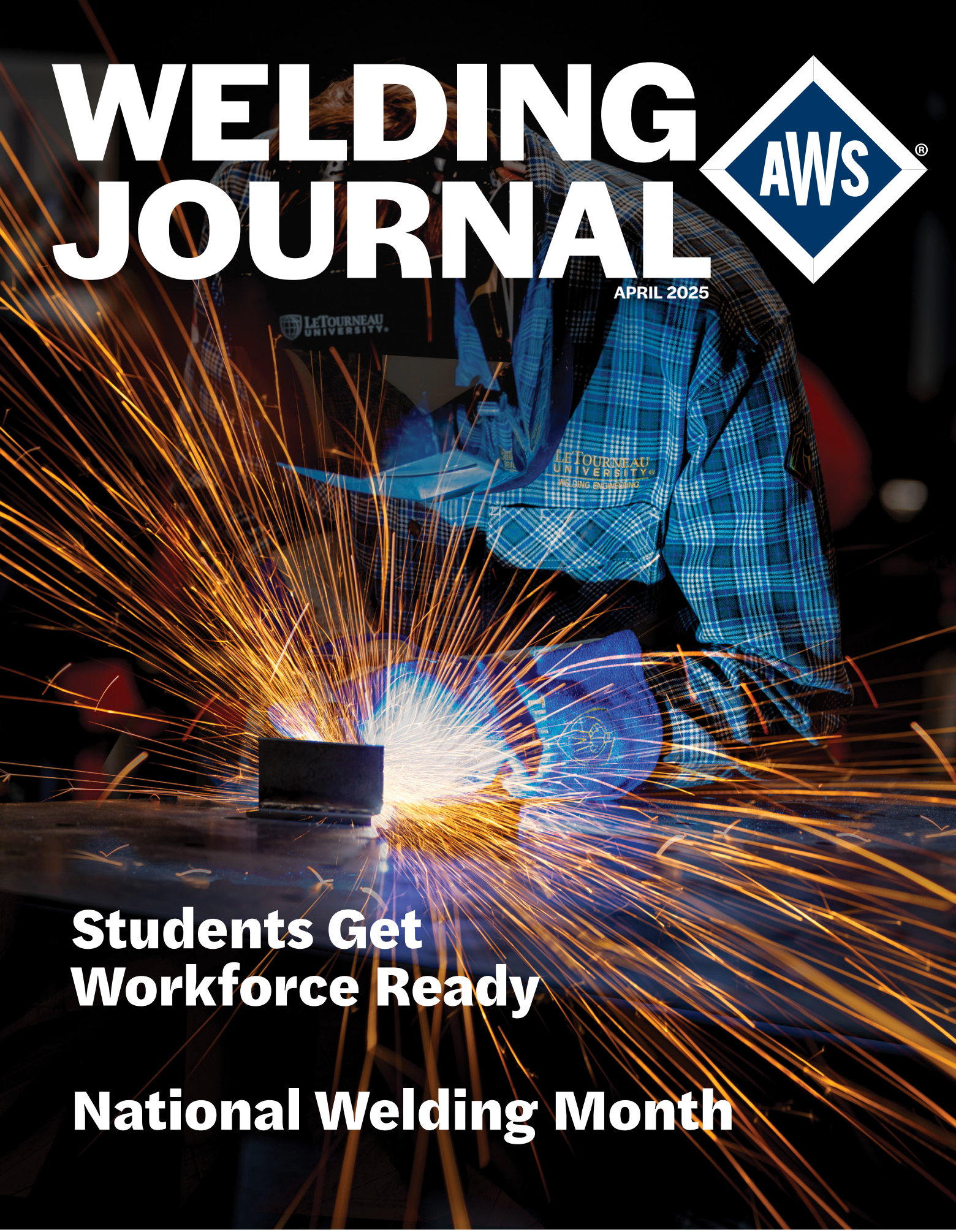

Students Get Workforce Ready

National Welding Month

IN THIS ISSUE: THE IMPACT OF AWS FOUNDATION GRANTS ■ NEW AWS FUTURE LEADERS ■ SCHOOL PROFILES

April 2025 | Volume 104 | Number 4

CONTENTS

INTERNATIONAL UPDATE

14 Showcasing the First AWS SENSE Institution in Africa
The DTI-AWS partnership highlights how international collaboration can significantly elevate technical training
S. T. Snyder

POINT OF VIEW

20 Meaningful Work Matters to the Welding Engineering Workforce
Learn about engineering education and current gaps, the state of the welding engineering profession, and a lower-case "t"-shaped model
M. J. McGinnis and M. Green



On the cover: Jaden Moughon, a welding engineering student, performs gas metal arc welding on steel. (Photography by Karen Sanchez, LeTourneau University, Longview, Tex.)

FEATURES

28 In-Space Laser Welding Technology Takes Flight*
A recent collaboration led by NASA Marshall Space Flight Center and OSU is pioneering experiments and talent development to push boundaries for in-space manufacturing
J. W. Sowards et al.

34 AWS Foundation Grants Empower the Workforce
The AWS Foundation has doubled its Welding Workforce Grant to support the demand for skilled welders
J Jones and J. Douglass

38 Cobots Help Bridge the Welding Skills Gap
This technology allows students to receive training that aligns with the needs of modern employers
S. Kobayashi

42 Reflecting on National Welding Month
AWS District directors offer their perspectives on this month-long event
C. Weihl

DEPARTMENTS

5 Editorial
8 News of the Industry
17 Education 411
18 Brazing Q&A
24 Product & Print Spotlight
45 Coming Events
46 Standards Action
47 Society News
50 Tech Topics
56 Section News
66 Guide to AWS Services
67 Seminar Schedule
68 Personnel
70 **School Profiles**
78 Classifieds
78 Advertiser Index

CONTENTS

April 2025 | Volume 104 | Number 4

WELDING RESEARCH SUPPLEMENT

107-s **Bond Characteristic-Dependent Viscosity Variations in CaF_2-SiO_2-Al_2O_3-MgO Welding Fluxes**
Structure-viscosity correlations are revealed by employing molecular dynamics calculations coupled with viscosity measurements
H. Yuan et al.

119-s **Liquid Metal Embrittlement Elimination in RSW of Galvannealed AHSS DP980**
This study aims to design an MPEA system to preferentially accommodate Zn in a solid solution and inhibit elemental Zn as an LME agent while avoiding brittle phase formation as it interacts with an AHSS substrate during RSW
A. Abdelmotagaly et al.

131-s **The Effect of CWTSAW on the Toughness of Heavy-Gauge X70 — Part II: Correlating Microstructure with Charpy Toughness**
The work presented in this paper aims to establish the quantitative effect of MA morphology and PAG size, altered by cold wire feed rate, on the Charpy impact energy and crack path of heavy-gauge (19.1 mm thick) X70 CWTSAW welds
T. Ren et al.

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AWS Mission Statement

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The World of Welding Education



Charles House
Program chair of welding technology and assistant professor at Ivy Tech Community College

When I entered welding education, I had only taught a semester of gas metal arc welding classes part-time. A full-time faculty position opened up at Ivy Tech Community College in Indianapolis, Ind., and I applied with some hesitation. Coming directly from the field and unfamiliar with a college setting, I had little idea of the journey I was about to embark on.

As much as I would love to brag about my students, the fantastic equipment, and the program's growth, I think it is important to share a side of welding education that doesn't often get enough attention: the amazing things happening behind the scenes in most programs and the different tools we use to conduct these feats. My experience comes from a large statewide community college with 190,744 total students, 32,115 of whom are on our campus alone (unfortunately, not all are welding students). Currently, we have 109 students in the welding program and are running 19 sections this semester.

In most schools, the first challenge for new instructors is navigating the learning management system (LMS), where students can locate the syllabus, course outline, and other tools. Usually, an LMS is aligned with a curriculum provider and contains homework, tests, quizzes, required reading, and safety-related materials. At first, I was a bit skeptical of the LMS, but students coming to class already familiar with welding terms and understanding safety hazards has huge benefits. And it saves me from giving them a long lecture about why I'm missing part of a finger.

We also have a curriculum committee consisting of 17 welding professionals from different campuses across Indiana. We meet at least twice a year to make changes to our curriculum or our course outline. While each campus can add to the curriculum to better align with local industry, all campuses must follow the statewide curriculum. Being a part of a large organization has its benefits and challenges, but I have come to rely on this group to build better coursework for students and to help build a stronger program for our state. Normally, before our committee meets, we hold an advisory board meeting made up of industry professionals who are invested in our program and contribute to the discussions, bringing knowledge and foresight from their experience in the skilled trades. This helps us maintain rigor that aligns with industry standards and guides us when asking for grants to improve labs and welding equipment. I have found that if you give industry employers a voice and show them they matter, they will fight to help improve things for prospective employees.

This is just scratching the surface of things we do daily that have little to do with student-facing outcomes but lead to better student engagement and a healthier learning environment. When I started this journey, my only goal was being in the classroom. But now, I am the program chair. We have two full-time faculty members and two adjuncts. We work as a team to get things done in a timely and efficient manner. Our students are our priority, no matter what. As long as the team keeps this focus, we can't fail.

Now, let's talk about those fancy welding labs a little bit. We like to think of our lab as an independent shop, but what we ultimately produce is scrap. It's hard to conduct a true business model when the end product cannot be sold. Instead, we focus on engagement and how we can capture that through a structured lesson plan to meet a learning objective that will align with a specific outcome.

All of this must be done while trying to increase enrollment and staying within a structured budget. Most know that welding is not cheap, and welding education, done right, can't focus solely on finances. However, the instructor usually takes on the challenge of trying to keep expenses within a specific boundary. We reach out to our advisory board for help with materials for certain things, and our community is a great resource.

At the end of the day, I am grateful that I have had wonderful mentors to help develop my skills. Though I earned my position, I didn't get here alone. I was supported — and sometimes dragged along — through learning everything from email etiquette (don't "reply all" on a campus-wide email) to building course schedules and utilizing purchasing software. I continue to stay grateful for those lessons. Now, I have the opportunity to give others a chance to teach and test the waters in the world of welding education. WJ

"As much as I would love to brag about my students, the fantastic equipment, and the program's growth, I think it is important to share a side of welding education that doesn't often get enough attention: the amazing things happening behind the scenes in most programs and the different tools we use to conduct these feats."

IN-SPACE

Laser Welding Technology Takes Flight

A NASA-OSU partnership conducts a welding experiment held in reduced-gravity conditions

BY JEFFREY W. SOWARDS, ANDREW O'CONNOR, BOYD PANTON, AND ANTONIO J. RAMIREZ

Imagine a future where space is no longer a destination for a select few astronauts but a thriving industry hub where manufacturing beyond Earth's atmosphere is routine. This is a future where factories orbit the planet, power stations generate life-giving energy for outposts on the surface of the Moon, and autonomous robots mine deep into asteroids to extract precious resources. Cutting-edge welding and manufacturing technologies will shape how structures are built, and a new workforce will emerge, bringing this future to life. Engineers skilled in developing welding technologies for harsh space conditions, as well as technicians and welders — the new-collar space workforce — will be trained to apply these advancements.

This vision is closer to reality as newly formed partnerships advance in-space welding technology and workforce readiness. A recent collaboration led by NASA Marshall Space Flight Center (MSFC), Huntsville, Ala., and The Ohio State University (OSU), Columbus, Ohio, is pioneering experiments and talent development to push boundaries for in-space manufacturing. Here is how this collaboration is transforming laser welding technology to enable space exploration and the emerging in-space industrial base.

Start Small but Think Large Scale

Welding processes are a critical and enabling technology in aerospace manufacturing. Practical welding and joining methods and allied processes, including additive manufacturing, will be required to develop the in-space economy. These processes will repurpose and repair critical space infrastructure and build structures too large to fit current launch payload volumes. Large habitats in low Earth orbit, spacecraft structures that keep astronauts safe on future space exploration missions, future space observatories, gigantic solar-energy farms, and towers for enhanced lunar communication and solar power collection that enable long-term lunar sustainment would greatly benefit from in-space welding (Ref. 1).

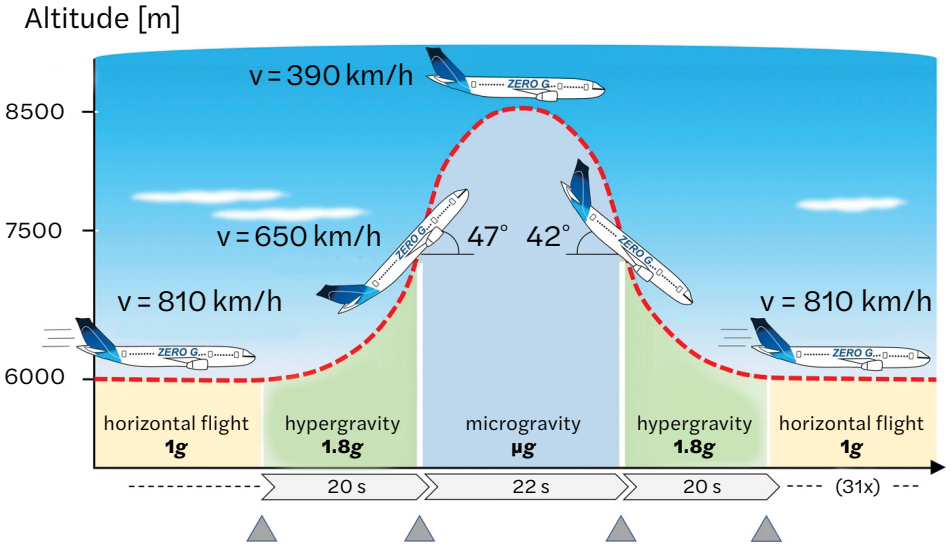

Fig. 1 — Schematic of a parabolic flight trajectory to simulate reduced-gravity conditions. (Licensed under creativecommons.org/licenses/by/4.0 *from Ref. 2.)*



Fig. 2 — The flight team performs laser beam welding in microgravity conditions.

Fig. 3 — Close-up of the welding configuration in a vacuum chamber for the parabolic flight.

Laser Beam Welding Flies High

In late August 2024, over two days, a joint team from OSU's welding engineering and multidisciplinary capstone programs and the MSFC Materials and Processes Laboratory performed high-powered fiber laser beam welding aboard a commercial aircraft that can simulate reduced gravity. The Boeing 727 performed parabolic flight maneuvers that began in level flight, pulled up to add 8000 ft in altitude, and pushed over at the top of a parabolic arc, resulting in approximately 20 seconds of reduced gravity to the passengers and experiments, as shown in Fig. 1 (Ref. 2). While floating in this nearly weightless environment, the team members (Fig. 2) performed laser beam welding experiments under vacuum in both low Earth orbit and lunar gravity and collected data from a network of sensors. This data, combined with advanced analysis of the welds, will progress our understanding of the unique effects of these space environments on the welding process and welded material. In-person observation and recordings have already revealed that weld spatter flew in straight lines in all directions rather than arcing downward as it does on Earth.

"During the flights, we successfully completed 69 out of 70 welds in microgravity and lunar gravity conditions, realizing a fully successful flight campaign," said Will McAuley, OSU welding engineering student.

Hard Work and Planning = Huge Dividends

This success was made possible by extensive collaborative work spanning over two years, involving two cohorts of OSU undergraduate capstone students, multiple graduate students and professors, and engineers across OSU and several NASA centers (see Acknowledgments).

NASA MSFC personnel trained alongside the OSU team, learning how to operate the flight hardware and sharing valuable lessons from previous parabolic flight experiments. NASA's Langley Research Center developed a portable vacuum chamber, which the OSU team modified for laser beam welding, integrating high-dynamic-range and thermal imaging cameras, thermocouples, advanced positioning control, data acquisition, and developed flexible control software. A laser beam weld at reduced



Fig. 4 — Core team members stand on the tarmac on the first flight day.

gravity is shown in Fig. 3. The team is now analyzing the data and conducting a nondestructive examination and metallography to determine how the combined effects of reduced gravity and pressure influenced the welding process and microstructure. These findings will contribute to advancing in-space laser beam welding technology and computational modeling efforts.

Partnering Makes a Positive Difference

Long-term partnerships between federal agencies and universities have historically been crucial in driving innovation and developing a highly skilled workforce. This collaboration focused on continuously advancing technologies, primarily laser welding for in-space manufacturing, while simultaneously preparing future generations to sustain that momentum. NASA has leveraged OSU's expertise and talent to develop welding processes and instrumentation, research experimental design, advance materials science critical to in-space manufacturing, and train students who will soon contribute to the space industry.

"This experience deeply inspired me by showcasing the potential of in-space welding to revolutionize how we build and repair structures in space," said Eugene Choi, OSU welding engineering graduate student. "The idea of contributing to advancements in space exploration motivated me to pursue graduate school."

Another key benefit of these partnerships is universities' access to state-of-the-art academic research. Educational institutions are home to expertise in specialized fields and are at the forefront of technology innovation. Government-academia partnerships effectively tap into this knowledge for national initiatives, such as in-space welding for the burgeoning space economy. This allows federal agencies to harness academic talent to address complex, real-world challenges, driving both technological progress and the training of future professionals. For example, the OSU team has brought its expertise and experience in building scientific instrumentation involving lasers, high vacuum, electronics, sensing, and control, enabling the good performance of the experimental setup used for the welding under space conditions performed during parabolic flight. OSU's advanced characterization facilities facilitate the investigation of the differences in welded materials on Earth and space-like conditions. Additionally, the multiple computational tools that the welding engineering program at OSU has been developing for decades enable the prediction of the thermomechanical history associated with the joining processes, extending to their effect on the material microstructure and, finally, on the material and component performance.

The OSU and NASA teams are jointly improving and validating their analytical and computational models to accurately account for space's unique conditions. Core team members are shown on the first flight day in Fig. 4.

In addition to the NASA partnership that started the project and was critical to its success, the Ohio Federal Research Network and the Air Force Research



Fig. 5 — The NASA TRL scale is shown (Ref. 3).

Laboratory's (AFRL) Midwest hub provided further funding and support. This funding enabled the update and modification of the experimental system and the hiring of engineers and graduate students. It also brought critical support from other government and industry partners, including The Lincoln Electric Co., Voyager Space, EWI, and Xiris.

Maturing Technology Matters

Resource alignment between agencies and universities offers a strategic advantage for the mature Technology Readiness Level (TRL). This system, proposed at NASA in the early 1970s, has been widely adopted by the defense and aerospace communities. The scale, shown in Fig. 5, describes the evolution of technology from theoretical to flight-proven systems. NASA has identified in-space welding as a technological challenge ripe for maturation. Thus, it dovetails readily with cutting-edge research tools and pools of intellectual talent at the university level. In this case, NASA has gained access to significant resources and the experience of at least seven faculty members at OSU. These partnerships not only bridge a valley that often stunts technological progress in the mid-TRL range but also help mitigate risk by fostering diverse perspectives and reducing reliance on insular approaches to problem solving. A case in point: This partnering has allowed the maturation of high-power fiber laser welding to a TRL approaching 5, and it's well on its way to the much-coveted TRL 9.

Developing a Workforce to Support Aerospace Welding

Finally, workforce development is one of the most significant outcomes of these partnerships. Universities play a central role in educating and training the aerospace community's next generation of engineers and researchers. While completing their education and research projects, students benefit from hands-on experience solving critical national problems, gaining exposure to practical challenges, and learning to turn theoretical knowledge into durable skills that prepare them for impactful careers. Looking to the past, we see evidence of this impact, with at least 27 Ohio State welding engineers having worked or interned across NASA at five or more centers since the early 1980s (Ref. 4). Looking at the current collaboration and development of this program, at least 21 undergraduate, one master of science, and two PhD students, in addition to one postdoctoral researcher and three engineers at OSU and Central State University, have gained insight and been trained with durable skills that address the needs of NASA and the space industry.

"Space welders will have to have a passion for welding and space as well as a true desire to see this pictured future come to fruition," said Aaron Brimmer, OSU welding engineering graduate student. "Fortunately for us, I believe these people already exist and are just waiting for the technology to mature."

Looking Ahead

Using the strong partnerships built and the scientific and technical achievements during the development and utilization of the instrumentation flown, a continued investigation will further show the effects of microgravity, vacuum, and extreme temperatures — all typical of space — on welding process behavior, material responses, and joint performance. Ongoing and upcoming work will quantify changes in laser interaction with the evaporated metal, heat transfer, buoyancy, surface tension, and other characteristics of the liquid metal within the weld pool. Such work will also assess differences in alloy solidification and its potential effect on microstructure and performance. Careful evaluation of these phenomena will resolve space's impact on laser welding, advancing the technology's maturity for reliable in-space manufacturing and assembly. WJ

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Acknowledgments

The assembled multidisciplinary team, which includes welding, mechanical, electrical, and computer engineers and students, as well as materials and physics scientists, is enabling a fundamental understanding of how welding processes will perform in space and identifying future opportunities to build robust and production-ready physical and computational tools for in-space laser welding.

The Ohio State University. Welding engineering program: Professor Antonio Ramirez, project principal investigator, Ma²JIC director, instrumentation development, materials analysis, and modeling; Assistant Professor Boyd Panton, coprincipal investigator, laser and electron beam processes; Dr. Kaue Riffel, process modeling and mechanical design; and Eugene Choi, Aaron Brimmer, and Will McAuley (graduate students). StarLab-George Washington Carver Science Park: Professor John Horack, director, and Professor David Williams, director of global university research and industry partnerships. Integrated Systems Engineering: Ali Nassiri, coprincipal investigator, welding processes modeling. Engineering education: Professor Bob Rhoads, director of the multidisciplinary capstone program. Center for Design and Manufacturing Excellence: Nate Ames, director, engineering support. Capstone students: Eugene Choi, Carlos H. Gelada, Martina Monocolova, Evan Sichel, Diya Adengada, Will McAuley, Sarah Huetter, Aafreen Shajahan, Regan Morton, Grant Smith, Kristina May, Parker Vaughan, Vika Vorona, Nathan Holty, and Spencer Reardon.

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Guidelines for Submitting a *Welding Journal* Feature Article

Have you ever thought about writing a feature article for consideration in the *Welding Journal*? If so, our staff stays on the lookout for original, noncommercial, practical, and hands-on stories. Potential ideas to focus on could include a case study, a recent company project, and tips for handling a particular process.

Here's an easy breakdown of our guidelines:

- The text of the articles should be about 1000 words and provided in a Word document.
- Line drawings, graphs, and photos should be high-resolution JPG or TIFF files with a resolution of 300 or more dots per inch.
- Plan on about one figure for every 500 words and provide captions for every image. Also, if a nice lead photo is available, please include it for review.
- The authors' names, along with the companies they work for and their positions, should be listed.

If you'd like to discuss a particular idea or email a submission for evaluation, please contact Managing Editor Kristin Campbell at *kcampbell@aws.org*.

BY CINDY WEIHL

Reflecting on NATIONAL WELDING MONTH

AWS District directors share insights on this April celebration

National Welding Month, celebrated every April, is an important time to recognize the vital role welding plays in modern society. The month-long observance shines a spotlight on the contributions of welders and the skills and expertise required in this critical trade. The *Welding Journal* asked several AWS District directors what National Welding Month means to them and what their Sections are doing to celebrate.



"Our Sections typically hold meetings and tours during the month of April to recognize National Welding Month. Since 2023, District 1 has tried to schedule our Annual District 1 Conference in April to coincide with National Welding Month celebrations. This has been the case for the past two years (and will be close this year, right at the beginning of May/end of April). Also, last year, the welding program department staff at White Mountain Community College in Berlin, N.H., planned and hosted a Welding Instructor Professional Development Day event in April specifically to coincide with National Welding Month. This event will be held at the college again this year, and I will be there representing AWS once again."

— Tim Kinnaman, District 1 director



"National Welding Month, to me, is celebrating the past and current enhancements to our daily lives. Without welding, much of what we do as humans today would not be possible. Every facet of our lives is impacted by welding at some point, and because of this, welding as a whole should be celebrated for making our daily lives better throughout the world. Outside of the normal Section meetings, our Sections celebrate the month by holding student welding competitions and reflecting on the advancements and continual desire to improve the industry and how it is viewed by those who do not understand welding."

— Bradley Brandmeir, District 3 director



"To me, National Welding Month is an opportunity to promote the trade that has had the biggest impact on my career. As a trades advocate, I like to watch students' (or their parents') expressions change when their curiosity about welding wakes up and they start thinking about the part they can play in our welding community. This is my first year as a District director during National Welding Month, and I look forward to visiting a fabricator or shipyard during an April Section meeting."

— Justin Mixon, District 2 director



"National Welding Month is a time that I like to use to interact with my Sections and see what is happening in their areas and brainstorm ideas on how to better promote AWS and gain new members and supporting companies. In the past, I have visited my state representative and had them write up a declaration stating that Pennsylvania acknowledges that April is National Welding Month. Some of my Sections also hold their social meetings in April so members will bring their significant other or friends to the event."

— Thomas Kostreba, District 10 director



"National Welding Month is an opportunity to highlight welding activities and the impact welding has on industry and the skilled trades in the United States. This year, the Detroit and Saginaw Valley Sections will be assisting AWS President Dick Holdren when he visits Mott Community College and Genesee Career Institute in Flint, Mich., to give presentations about AWS."
— Wesley Doneth, District 11 director



"National Welding Month is a time for us to reflect on the important strides generations have made in welding and modernization. It's about reflecting on our journey and career paths, connecting with others, knowledge transfer, and camaraderie. We recognize the significant people who have influenced us, just as we have influenced them, in the creation and stability of the United States. This month, several of our Sections are hosting technical meetings, touring college welding programs, participating in SkillsUSA, and holding a tour at one of the local fabrication shops."
— Nicholas Martinez, District 21 director



"After being directly involved in welding for the past 40-plus years, I am thrilled to see that the majority of our community is recognizing that welding and welding-related trades are fascinating careers. The 'College for All' movement has finally embraced the idea that education comes in many forms, not just through traditional college pathways. Being part of our senior welding community, I find National Welding Month to be an emotional validation of my many years of work. It was also extra rewarding to be able to work as a welding educator for many years while I was also an active tradesman. This hybrid career has been an excellent success and allowed me to bring the educational and industrial worlds together. National Welding Month is a great time to reflect and look forward to a more productive future for all who engage in welding. Our Sections have many community college and high school partners who host welding events and contests during the month of April, and our most important outreach will be during the various contests throughout the District."
— Randy Emery, District 22 director

Conclusion

National Welding Month serves as an annual reminder of the vital role welding plays in our world. It highlights the incredible skill, innovation, and importance of welders in every industry, from manufacturing and infrastructure to technology and safety. Welding not only drives economic growth and advances in technology but also ensures the safety and sustainability of the structures and products we rely on. By recognizing and celebrating the contributions of welders, National Welding Month fosters a greater appreciation for their work and encourages the next generation to pursue this rewarding and vital profession. WJ

CINDY WEIHL (*cweihl@aws.org*) is senior editor of the *Welding Journal*.

Celebrate National Welding Month with AWS

This year, under the theme "Connected by Welding: Bridging Communities and Industries," AWS honors how welding unites people, strengthens industries, and builds the infrastructure that brings us together. Here's how to connect, win, and save with AWS during National Welding Month.

Connect with AWS throughout April

- **Join the conversation** all month long on social media by using the hashtag #NWM2025.

- **Show your welding pride** by downloading the National Welding Month logo. Digital banners and other resources are also available for download and can be used to post and share online or on social media on our National Welding Month page at *weld.ng/nwm2025*.

- **My Welding Story on AWS's Instagram** will spotlight stories from across the welding community, showcasing how welding has shaped careers, lives, and industries. Among those featured will be AWS President Richard L. Holdren and AWS CEO Carey Chen, who have recorded their welding journeys. Want to share your story? Make sure you're following *@americanweldingsociety* on Instagram and check back for details on how you can be featured in our stories. One new story will be shared each weekday on Instagram stories.

- **Listen to the Weld Wednesday Podcast** for a special National Welding Month episode airing on Wednesday, April 2. Listen to the episode at *weld.ng/podcast* and join host Jason Becker and his special guest AWS President Richard L. Holdren as they discuss "The State of the Welding Industry: 2025 Insights and Predictions."

Continued on page 44

Continued from NATIONAL WELDING MONTH

Save and Win with AWS

Take advantage of exclusive membership promotions and giveaways for Individual, Early Career, and Student Members by visiting *weld.ng/nwm2025.*

- **Save on an AWS membership** by using promo code NWM2025. When you join as an Individual Member using the promo code, you'll receive three extra months of membership for free. That means 15 months of exclusive access to industry-leading resources, networking opportunities, and discounts that help you stay ahead in your career.
- **Existing member promotions** during April are offered to the following:
  - Early Career Members: Enter to win $75 in AWS merchandise store credit.
  - Student Members: Enter to win one of five exclusive hats.
  - Corporate Members: Receive 25% off membership pricing for job postings at *jobsinwelding.com*. Active AWS Corporate Members can receive the 25% coupon by emailing the AWS Membership Operations team at *membership@aws.org*.
- **Members save at the AWS Bookstore** during April with a 35% discount off list and member prices for hard copies of the *Welding Handbook*. Shipping is excluded from the discount.
- **AWS education discounts** on self-paced online courses will be offered at a 15% discount throughout April.
- **Pledge and receive a gift** when you donate to the AWS Foundation this month. By becoming an AWS Workforce Torchbearer, you support scholarships, education, and workforce development programs that inspire the next generation of welders. Pledge $5 per month and receive an exclusive AWS Foundation-branded shirt. Pledge $10 per month and receive the AWS Foundation-branded shirt and a hat.
- **Enter to win a custom helmet** by visiting the National Welding Month site.



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