American Welding Society®

2022 WELDING TRACK

November 8 – 10

aws.org

TUESDAY, NOVEMBER 8

2022 AWS/WELD-ED FABTECH EDUCATORS CONFERENCE AGENDA: ROBOTS AND AUTOMATION IN WELDING EDUCATION

Since the early 1980s, robots have been used for a wide variety of applications. Resistance welding and arc welding are Among the most popular applications. Robot and automation programs have educated and trained operators, technicians, and engineers for the welding industry. Currently, with the shortage of manufacturing employees, robot sales are at record levels. In addition, the introduction of cobots has further increased industry interest in robots and automation. This education session will provide an overview of robot education and training strategies for use in classrooms and laboratories. The session will provide specifics to improve robot and automation education.

8:30 AM – 8:45 AM
WELCOME / INTRODUCTIONS
Rick Polanin, *AWS President & Co-Principal Investigator, Weld-Ed*

8:45 AM – 9:15 AM
TEACHING WELDING STUDENTS ABOUT ROBOTS
Rick Polanin, *AWS President & Co-Principal Investigator, Weld-Ed*

9:15 AM – 10:00 AM
PLUMMER LECTURE
THE WRITTEN PROJECT PORTFOLIO: BENEFITS TO PRACTICAL WELDING TRAINING
Jeff Carney, *Professor, Ferris State University*

10:00 AM – 10:15 AM
BREAK

10:15 AM – 11:00 AM
ROBOT EDUCATION AT COC
Tim Baber, *Professor, College of the Canyons*

11:00 AM – 11:45 AM
ROBOT SYSTEMS EDUCATION
Joel Johnson, *Professor, North Dakota College of Science and Technology*

11:45 AM – 12:15 PM
LUNCH
Sponsored by Hypertherm Inc. – Betsy Van Duyne, *Hypertherm*

12:15 PM – 1:00 PM
HYPERTHERM AUTOMATION
Hypertherm Inc.

TUESDAY, NOVEMBER 8

1:00 PM – 1:45 PM
ENGAGING STUDENTS WITH ROBOTS
Lincoln Electric Inc.

1:45 PM – 2:00 PM
BREAK

2:00 PM – 2:45 PM
ROBOT EDUCATION AT MILLER ELECTRIC
Miller Electric Inc.

2:45 PM – 3:15 PM
AWS FOUNDATION SCHOLARSHIP OPPORTUNITIES
Monica Pfarr, *AWS Foundation Executive Director*

3:15 PM – 3:30 PM
VENDOR PRESENTATIONS

3:30 PM
WRAP-UP, EVALUATIONS

TUESDAY, NOVEMBER 8

WELDING PRODUCTIVITY TRACKS

9:00 AM – 9:15 AM
WELCOME INTRODUCTION
Steve Snyder, *Staff Welding Specialist, American Welding Society*

9:15 AM – 10:15 AM
COBOTS INCREASING WELDING & CUTTING PRODUCTIVITY
Josh Pawley, *VP of Business Development, Vectis Automation*

In this track, you'll learn more about collaborative robots in welding applications, hear case stories of cobots boosting productivity in fab shops of all types and sizes, and learn the keys to successful implementation.

10:30 AM – 11:30 AM
ROBOTIC WELDING AUTOMATION: WELD A LOT OF PARTS FAST WITH CONSISTENT RESULTS
Mike Monnin, *General Manager – Sales& Marketing, OTC Daihen, Inc.*

Robotic welding systems have grown over the last 40+ years to be a consistent, reliable solution for automating arc-welding production within metal fabrication operations. FAQs for those considering robotic welding will be addressed and return-on-investment analysis will be used to justify the expense. The high-mix / low-volume challenge facing contract fabricators will be quantified and solutions that address their unique requirements will be presented.

11:30 AM – 12:45 PM
LUNCH BREAK

12:45 PM – 4:00 PM
WELDING PRODUCTIVITY FOR WELDING ENTHUSIAST
Rob Tessier, *Airgas and* Steve Snyder, *Staff Welding Specialist, American Welding Society*

Understanding welding economics, productivity limitations and how to overcome them.

4:00 PM – 4:30 PM
Q&A PANEL DISCUSSION

TUESDAY, NOVEMBER 8

DIVERSE ROLES AND NEEDS WITHIN THE WELDING INDUSTRY TRACKS

8:00 AM – 9:00 AM

WELDING FOR SANITARY APPLICATIONS

William Roth, *President, Welding Engineering Consultants, LLC and* Richard Howard, *Director of Quality, Traylor Industrial*

This presentation covers basic reasons why sanitary design differs from ordinary fluid designs. It will include some weld joint design principles for sanitary applications as well as acceptance criteria for welded connections per AWS D18.

10:00 AM – 11:00 AM

HIGH PURITY ORBITAL WELDING

Richard Howard, *Director of Quality, Traylor Industrial and*
Richard Campbell, *Bechtel Fellow & Welding Technical Specialist, Bechtel*

High Purity Orbital Welding, this presentation will describe and explain the importance of qualified practices and procedures, with an emphasis on daily production welding. In the high purity world there isn't any time for rework and rejection, it can adversely affect the schedule and cost of the project. That's why proven qualified welding procedures and practices are so important to this industry.

11:00 AM – 12:00 PM

SEMICONDUCTOR HIGH-PURITY WELDING

Richard Campbell, *Bechtel Fellow & Welding Technical Specialist, Bechtel and*
Richard Howard, *Director of Quality, Traylor Industrial*

This presentation will describe and explain the importance of qualified practices and procedures, with an emphasis on daily production welding. In the high purity world there isn't any time for rework and rejection, it can adversely affect the schedule and cost of the project. That's why proven qualified welding procedures and practices are so important to this industry.

1:00 PM – 2:00 PM

DESIGN ENGINEERS & WELD ENGINEERS – HOW THEIR ROLES DIFFER AND HOW THEY CAN WORK TOGETHER

Joe Bailey, *Weld Engineering Manager, Vermeer*

Are you a manufacturing or weld engineer looking to be more effective in influencing and assisting your product design teAMs? Or, are you a product designer wanting to learn how understanding welding principles can help you improve your design? This talk is for you. Using D14 standards as a basis, this talk will consider the unique qualifications and responsibilities of design engineers and weld engineers and ultimately explore how these two roles can and should work together to make a robust product design and manufacturing process.

2:30 PM - 3:30 PM

D1.6 - PROPER PURGING OF STAINLESS STEEL AND OTHER STAINLESS STEEL PIPE WELDING

William F. Newell, Jr. *PE, Peng, IWE, Vice President, Engineering, Euroweld, Ltd.*

High integrity service usually requires purging the inside Diameter of stainless-steel piping and tubing with an inert gas to avoid the creation of deleterious oxides. Various purging and non-purging methods will be presented as well as advantages and disadvantages for each approach.

TUESDAY, NOVEMBER 8

2022 AWS PROFESSIONAL PROGRAM

ROOM: C208

SESSION 1: PLENARY SESSION

Chair: T.J. Lienert, *TJ Lienert Consulting*

8:00 AM

ADDRESSING MATERIALS CHALLENGES AND OTHER BARRIERS TO THE FUTURE OF ADDITIVE MANUFACTURING

Todd Palmer, Pennsylvania State University

9:00 AM

EVOLUTION OF ANALYTICAL MODELLING APPROACHES FOR RESISTANCE SPOT WELDING: A HISTORICAL PERSPECTIVE

Jerry Gould, *Edison Welding Institute*

Room: C208

SESSION 2: AMERICAN COUNCIL OF THE IIW

Chair: R. Shaw, *Steel Structures Technology Center*

10:00 AM

ROLE OF STANDARDS IN WELDING SAFETY

Bruce Cannon, *Weld Australia*

10:30 AM

KEEPING PACE WITH CHANGE
THOMAS MEDAL 2020, VINCENT VAN DER MEE

Vincent van der Mee, *European Welding Association*

11:00 AM

IIW COMMISSION I ACTIVITIES ON ADDITIVE MANUFACTURING

Doug Kautz, *Leidos, Inc.*

11:20 AM

THE INTERNATIONAL INSTITUTE OF WELDING: STRATEGIC DIRECTIONS FOR WELDING AND JOINING RESEARCH AND INDUSTRIAL APPLICATIONS

Robert Shaw, *Steel Structures Tech Ctr*

11:40 AM

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF ELECTRON BEAM ADDITIVELY MANUFACTURED TI-6AL-4V

Amber Black, Thomas Jungst, Samantha Lawrence, Michaela McKamey, Mary O'Brien, Robin Pacheco, Brett Preston, Nolan Regis, Mark Sandoval, *Los Alamos National Laboratory*

TUESDAY, NOVEMBER 8

ROOM: C209

SESSION 3: ARTIFICIAL INTELLIGENCE/MACHINE LEARNING

Chair: Zongyao Chen, *Air Liquide*

10:00 AM

AN AI-BASED VISION METHODOLOGY FOR SELF-GUIDED SEAM TRACKING IN GAS METAL ARC WELDING

Mahyar Asadi, Amin Ghasemazar, *Novarc Technologies*

10:20 AM

EVALUATION OF SPATTER PRODUCTION WITH DEEP LEARNING ALGORITHMS

Zongyao Chen, *Air Liquide*

10:40 AM

HOW TO ACCURATELY MONITOR THE WELD PENETRATION FROM DYNAMIC WELD POOL SERIAL IMAGES USING CNN-LSTM DEEP LEARNING MODEL?

Joseph Kershaw, Peng Wang, Rui Yu, YuMing Zhang, *University of Kentucky*

11:00 AM

MACHINE LEARNING-BASED PROCESS CHARACTERIZATION AND EFFICIENT ADAPTIVE CONTROL IN ROBOTIC ARC WELDING

Joseph Kershaw, Peng Wang, Rui Yu, YuMing Zhang, *University of Kentucky*

11:20 AM

PREDICTING OPERATION WINDOWS FOR HIGH-FREQUENCY INDUCTION ALUMINUM TUBE WELDING THROUGH MACHINE LEARNING

Shao-Wei Cheng, *National Tsing Hua University* | Hongyan Zhang, *University of Toledo*

TUESDAY, NOVEMBER 8

2022 AWS PROFESSIONAL PROGRAM

ROOM: C208

SESSION 4: AUTOMATION, SENSING & CONTROL

Chair: YuMing Zhang, *University of Kentucky*

2:00 PM

DEVELOPING AN AUTOMATED DEFECT DETECTION TIG WELDING ROBOT WITH A FUTURE ADAPTIVE IMPLEMENTATION

Shems-Eddine Belhout, John Codevilla, Devon Goodspeed, William Hamel, Bradley Jared, Dylan Lewis, *University of Tennessee* | Greg Frederick, David Hansen, John Tatman, *Electric Power Research Institute*

2:20 PM

HIGH SPEED VIDEO (HSV) AND SYNCHRONIZED DATA ACQUISITION (DAQ) TO OBSERVE WELDING PROCESS STABILITY

Michael Carney, Dennis Harwig, Jim Hansen, Nick Kaputska, James McNeil, *EWI*

2:40 PM

REAL-TIME RECOGNITION OF ARC WELD POOL USING IMAGE SEGMENTATION NETWORK

Joseph Kershaw, Peng Wang, Rui Yu, YuMing Zhang, *University of Kentucky*

3:00 PM

MICRO CROSS WELD TENSILE TESTING OF DISSIMILAR METAL WELDS USING DIGITAL IMAGE CORRELATION

Boian Alexandrov, William Siefert, *Edison Joining Technology Center (OSU Welding Engineering)*

3:20 PM

MECHANICAL DESIGN AND DEVELOPMENT OF A FIVE DEGREE-OF-FREEDOM TIG WELDING ROBOT

Shems Belhout, John Codevilla, Devon Goodspeed, William Hamel, Bradley Jared, Dylan Lewis, Josh Penney, Ethan Rummel, *University of Tennessee*

TUESDAY, NOVEMBER 8

ROOM: C209

SESSION 5: WELDING PROCESS STUDIES

Chair: Nick Kaputska, *EWI*

2:00 PM

APPLICATION OF POLARITY SWITCHING CAPACITOR DISCHARGE WELDING TO ALUMINUM SHEET STRUCTURES

Jerry Gould, Lindsey Lindamood, *EWI*
Patrick Lester, Julio Malpica, Dewei Zhu, *Novelis Global Research & Technology Center*

2:20 PM

BURIED ARC GMAW FOR SINGLE PASS SINGLE SIDED ERECTION JOINTS ONBOARD SHIPS

Paul Blomquist, Jim Hansen, Nick Kapustka, *EWI*

2:40 PM

IMPACT OF BEAM DEFLECTION ON POROSITY DURING KEYHOLE MODE LASER WELDING OF ALUMINUM ALLOYS

Tarasankar DebRoy, Todd Palmer, Abhirup Saha, *Penn State University*
Michael Maguire, Jeffrey Rodelas, *Sandia National Laboratories*

3:00 PM

MICRO GTAW APPLIED TO A BATTERY PACK FOR RACING APPLICATIONS

Faissal El Idrissi, Prashanth Ramesh, *Center for Automotive Research - Ohio State University*
Kaue Riffel, *Federal University of Santa Catarina* | Michael Johanni, *Venturi North America*
Antonio Ramirez, *Edison Joining Technology Center - Ohio State University*

3:20 PM

WELDVAC – A QUIET, CLEAN METAL REMOVAL SYSTEM

Paul Blomquist, Jason Rausch, *EWI*

WEDNESDAY, NOVEMBER 9

POSTER COMPETITION

8:00 AM – 4:00 PM
PRACTICAL WELDING METALLURGY
Ben Pletcher, *Chief Welding Technologist, Bechtel*

Introduction to basic metallurgy concepts with practical applications of material properties from time of manufacturing through to welding fabrication. We will discuss crystal structures, grain size, effects of welding and how these change the mechanical properties of our engineering alloys. By understanding fundamental physical metallurgy concepts, we will evaluate scenarios of how and why we use preheat, PWHT, or place limitations on heat input. Our emphasis on this course will be carbon and low-alloy steels but introduce stainless and non-ferrous alloys for future more specialized study.

8:00 AM – 4:00 PM
PRICING FOR PROFITABILITY OF WELDED STRUCTURES
Scott Helzer, *Technology Enabled Welding & Inspection- AWS: CWI, CWE, ASNT: PT, RT, VT*

Introduction to the Micro and Macro Economics of Welding Using Cost / Volume / Profit Relationships for the Best Practices in the Economics & Marketing of Welded Fabrications

10:00 AM – 12:00 PM
WELDING PERFORMANCE QUALIFICATIONS
Scott Witkowski, *Republic Testing Labs.*

What the attendee will learn is how to successfully create, weld, test, report, & write a successful PQR over multiple codes.

1:00 PM – 3:00 PM
SECRETS TO A SUCCESSFUL PQR
Scott Witkowski, *Republic Testing Labs.*

What the attendee will learn is how successfully perform, test, report, and write certs for welder qualification

WEDNESDAY, NOVEMBER 9

2022 AWS PROFESSIONAL PROGRAM

ROOM: C208

SESSION 6: MECHANICAL PROPERTIES

Chair: P.W. Hochanadel, *LANL*

9:00 AM

AN INVESTIGATION INTO THE EFFECTS OF STIR ZONE CHEMISTRY ON FRACTURE TOUGHNESS IN FRICTION STIR WELDED PIPELINE GRADE STEEL

Michael Eff, Jerry Gould, Hyeyun Song, Tim Stotler, *EWI*

9:20 AM

DEVELOPMENT OF A TEMPERATURE-DEPENDENT MATERIAL PROPERTY DATABASE FOR DH36 STEEL

Daniel Bechetti, Charles Fisher, Jennifer Semple, *Naval Surface Warfare Center, Carderock Division*
Wei Zhang, *Ohio State University*

9:40 AM

EVALUATING THE CARBIDE PRECIPITATION BEHAVIOR DURING SHORT TERM TEMPERING AND ITS INFLUENCE ON IMPACT TOUGHNESS

Boian Alexandrov, Eun Jang, *OSU Research*

10:00 AM

FATIGUE PROPERTIES OF DISSIMILAR ALUMINUM TO STEEL WELDS JOINED BY ULTRASONIC INTERLAYERED RESISTANCE SPOT WELDING PROCESS

Luke Walker, Wei Zhang, *Ohio State University* | Anoop Samant, Craig Vanderbilt2, *KTH Parts Industries*
Daniel Paolini, *Honda Development & Manufacturing of America*

10:20 AM

HARDNESS PREDICTION BY INCORPORATING HEAT TRANSFER AND MOLTEN POOL FLUID FLOW IN A MULTI-PASS, MULTI-LAYER WELD FOR ONSITE REPAIR OF CSEF GRADE 91 STEEL

Aryan Aryan, Desmond Bourgeois, Obinna Onwuama, Wei Zhang, *Ohio State University*

10:40 AM

USE OF LOW TRANSITION TEMPERATURE STEEL ALLOYS IN WELDED OVERLAYS FOR HIGH WEAR APPLICATIONS

Patricio Mendez, Carter Trautmann, *University of Alberta*

11:00 AM

META-ANALYSIS OF FATIGUE PROPERTIES IN ADDITIVELY MANUFACTURED 316L AUSTENITIC STAINLESS STEEL

David Driggers, Todd Palmer, Ian Wietecha-Reiman, Stephen Sabol, *Pennsylvania State University*

WEDNESDAY, NOVEMBER 9

2022 AWS PROFESSIONAL PROGRAM

ROOM: C209

SESSION 7: PROCESS MODELING AND SIMULATION

Chair: P.F. Mendez, *CCWJ University of Alberta*

9:00 AM

ANALYSIS OF TEMPERATURE AND VELOCITY FIELDS IN THE GTAW ARC FOR ARGON

Alfredo Delgado, Patricio Mendez, Marco Ramírez, Alberto Velazquez, *Universidad Nacional Autónoma de México*
Stefano Sacco, *University of Alberta*

9:20 AM

DROPLET TEMPERATURE IN GMAW

Patricio Mendez, Rishiekesh Ramgopal, *Canadian Centre for Welding and Joining*

9:40 AM

ENERGY BALANCE IN GAS METAL ARC WELDING

Patricio Mendez, Vicente Núñez Sánchez, *CCWJ*

10:00 AM

INTEGRATED MODELING OF DEFECT FORMATION DURING DEEP PENETRATION LASER WELDING OF CREEP RESISTANT NICKEL BASE ALLOYS

Tarasankar Debroy, Mingze Gao, Barnali Mondal, Todd Palmer, *Penn State University*

10:20 AM

SCALING ANALYSIS OF THERMAL AND MECHANICAL PROCESS IN FRICTION STIR WELDING

Xinrui Liu, Patricio Mendez, *University of Alberta*

10:40 AM

THE INFLUENCE OF DYNAMIC BEHAVIORS CHARACTERISTICS OF MOLTEN POOL ON THE WELD FORMATION DURING THE HIGH SPEED LASER WELDING

Yuewei Ai, *Central South University*

WEDNESDAY, NOVEMBER 9

ROOM: C208

SESSION 8: ADDITIVE MANUFACTURING

Chair: Michael Eff, *EWI*

2:00 PM

CARBONITRIDE DEVELOPMENT AND HEAT TREATMENT RESPONSE OF ADDITIVELY MANUFACTURED 17-4 PH STAINLESS STEEL WITH VARIATIONS IN COMPOSITION

Derek Shaffer, *Pennsylvania State University*

2:20 PM

CHARACTERIZATION OF DISSIMILAR MATERIALS 410 MARTENSITE STAINLESS STEEL AND MILD STEEL COMPONENT PRODUCED BY WIRE ARC ADDITIVE MANUFACTURING

Sudarsanam Babu, Michael Kirka, Chris Masuo, Luke Meyer, Peeyush Nandwana, Andrzej Nycz, Sougata Roy, Wei Tang, Derek Vaughan, Yukinori Yamamoto, *Oak Ridge National Laboratory* | Obed Acevedo, *University of Tennessee*

2:40 PM

DELETERIOUS PHASE AVOIDANCE IN ADDITIVELY MANUFACTURED FUNCTIONAL GRADIENTS THROUGH PATH PLANNING

Olga Eliseeva, *EWI*

3:00 PM

LARGE-SCALE HYBRID MANUFACTURING USING WIRE ARC ADDITIVE MANUFACTURING

Aaron Cornelius, William Hamel, Bradley Jared, Joshua Penney, Tiffany Quigley, Tony Schmitz, Ross Zameroski, *University of Tennessee*

3:20 PM

PROCESS-FEATURE-MICROSTRUCTURE-PROPERTY RELATIONSHIPS FOR A9628 DIRECTED ENERGY DEPOSITION ADDITIVE MANUFACTURED STEEL COMPONENTS

Boian Alexandrov, Dennis Harwig, Nikolas Vega Michalak, *Ohio State University*

3:40 PM

THE EFFECTS OF POST-WELD PROCESSING ON FRICTION STIR WELDED ADDITIVE MANUFACTURED ALSI10MG

Michael Eff, *EWI* | Harvey Hack, *Northrop Grumman*

4:00 PM

HYBRID MANUFACTURING: COMBINING ADDITIVE FRICTION STIR DEPOSITION, METROLOGY, AND MACHINING

Sudarsanam S (Suresh) Babu, Joshua Kincaid, Tony Schmitz, Ross Zameroski, *University of Tennessee*

4:20 PM

IN-SITU LIQUID NITROGEN CRYOGENIC COOLING FOR INTERPASS CONTROL IN HIGH-DUTY CYCLE WIRE ARC ADDITIVE MANUFACTURING OF LARGE COMPONENTS FOR NAVY APPLICATIONS

Carolin Fink, Dennis Harwig, Alexey Kuprienko, *Ohio State University* | Michael Carney, *EWI*

WEDNESDAY, NOVEMBER 9

2022 AWS PROFESSIONAL PROGRAM

ROOM: C209

SESSION 9: WELDABILITY/WELDING METALLURGY

Chair: Daniel Bechetti, *NSWC Carderock Division*

2:00 PM

INFLUENCE OF MICROSTRUCTURE ON THE MECHANISM OF HYDROGEN-ASSISTED CRACKING IN DISSIMILAR METAL WELDS FOR REFINERY APPLICATION

Boian Alexandrov, Abbas Mohammadi, *Ohio State University* | Jorge Penso, *Shell Global Solutions US Inc.*

2:20 PM

INVESTIGATION OF FE-10 WT.% NI STEEL WELD METAL HYDROGEN INDUCED CRACKING SUSCEPTIBILITY USING THE GAPPED BEAD ON PLATE (GBOP) TEST

Daniel Bechetti, Tyler Christ, *NSWC Carderock Division*

2:40 PM

MATERIAL CHARACTERIZATION OF GRADE 91 STEEL WELDS USING MICRO-RESOLUTION ULTRASONIC IMAGING SYSTEM

Aryan, Desmond Bourgeois, Obinna Onwuama, Wei Zhang, *Ohio State University, Dept of MSE*
Jeong Na, *Kellogg Brown & Root LLC*

3:00 PM

OPTIMIZING PRODUCTIVITY OF HYPER DUPLEX STAINLESS STEELS OVERLAY WHILE AVOIDING SIGMA PHASE FORMATION

Andres Acuna, Antonio Ramirez, *Ohio State University*

3:20 PM

PHASE TRANSFORMATION BEHAVIOR OF FE-10WT.% NI STEEL WELD METAL

Daniel Bechetti, Jennifer Semple, Matthew Sinfield, *Naval Surface Warfare Center, Carderock Division*

3:40 PM

THE INFLUENCE OF BORIDE PHASE TRANSFORMATIONS ON HEAT-AFFECTED ZONE LIQUATION CRACKING SUSCEPTIBILITY IN LASER WELDED 304L STAINLESS STEEL

Erin Barrick, Johnathon Brehm, Ryan DeMott, Peter Duran, Khalid Hattar, Jack Herrmann, James (Tony) Ohlhausen, Charlie Robino, Jeffrey Rodelas, Kathryn Small, *Sandia National Labs*

4:00 PM

WELDING INVESTIGATION OF WROUGHT FEMNAL STEEL

Tao Dai, *LeTourneau University* | Zhili Feng, *Oak Ridge National Laboratory*

THURSDAY, NOVEMBER 10

POSTER COMPETITION

8:00 AM – 4:00 PM

STAINLESS STEEL FABRICATIONS DO'S & DON'TS, AND WHY NOT(S)

Scott Helzer, *Technology Enabled Welding & Inspection- AWS: CWI, CWE, ASNT: PT, RT, VT*

Introduction to the properties of stainless steels: corrosion resistance, weldability, joint designs, base and electrode compatibility & the estimating of costs as compared to carbon steels.

The American Welding Society is the worldwide authority in the development of standards, certifications, and educational programming for the welding community. We are committed to connecting the welding industry to our extensive collection of resources, informing our members of technological advancements, and developing the next generation of welding professionals.