Additive Manufacturing Consortium
Operated by EWI

Additive Manufacturing Consortium

Mark Barfoot
Director, AM Programs
mbarfoot@ewi.org
716.710.5597

Additive Manufacturing Consortium
Operated by EWI

EWI OVERVIEW

- **History**
  - Founded in 1984, EWI's comprehensive engineering services help companies identify, develop and implement the best options for their specific applications.
- **Our Mission**
  - Break through our customers' technical barriers, solve their manufacturing challenges, and further their success.
- **Expertise**
  - Industry experts in materials joining, forming, testing, modeling and additive manufacturing
- **Locations**
  - Headquartered in Columbus Ohio with technology centers in Buffalo, NY and Loveland, CO.

EWI - AM Capabilities

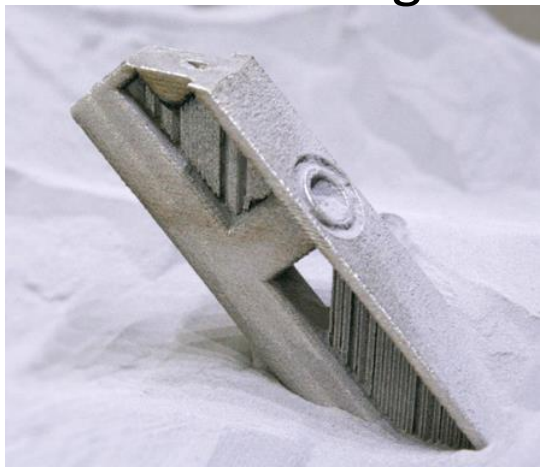
- EWI leads way in AM by evaluating new processes, developing material property data, and helping our clients adopt and implement state-of-the-art technology to build their products.
  - Recognized expertise in metal AM
  - All 7 ASTM Additive technologies in house
  - Extensive laboratory and testing capabilities
  - Non profit
  - Technology and vendor agnostic neutral party
- Founded Additive Manufacturing Consortium (AMC) in 2009

Additive Manufacturing Consortium
Operated by EWI

Additive Manufacturing Consortium

Mission: Accelerate and advance the manufacturing readiness of additive manufacturing technologies

- Goals:
  - Platform for ***collaboration*** across global industry, academia and government entities.
  - Execute group sponsored projects focused on addressing ***pre-competitive*** AM challenges
  - ***Partner*** on government funding opportunities
  - ***Forum*** for discussion/shaping AM roadmaps



Additive Manufacturing Consortium
Operated by EWI

“Direct Quotes” from our members

“We can’t do this alone”

“Leveraging membership fees and time to develop low TRL (Technology Readiness Level)”

“Technical Interchange with like minded AM professionals”

“Keep our company updated in terms of challenging solutions for metal AM issues”

“Sharing of R&D Costs “

Additive Manufacturing Consortium
Operated by EWI

Industries & Organizations & Partners

Aerospace

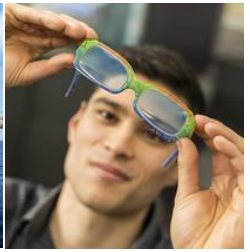
Defense

Ship Building

Automotive

Medical

Oil & Gas



Consumer Products

Government

Universities

Powder/Material Mfg

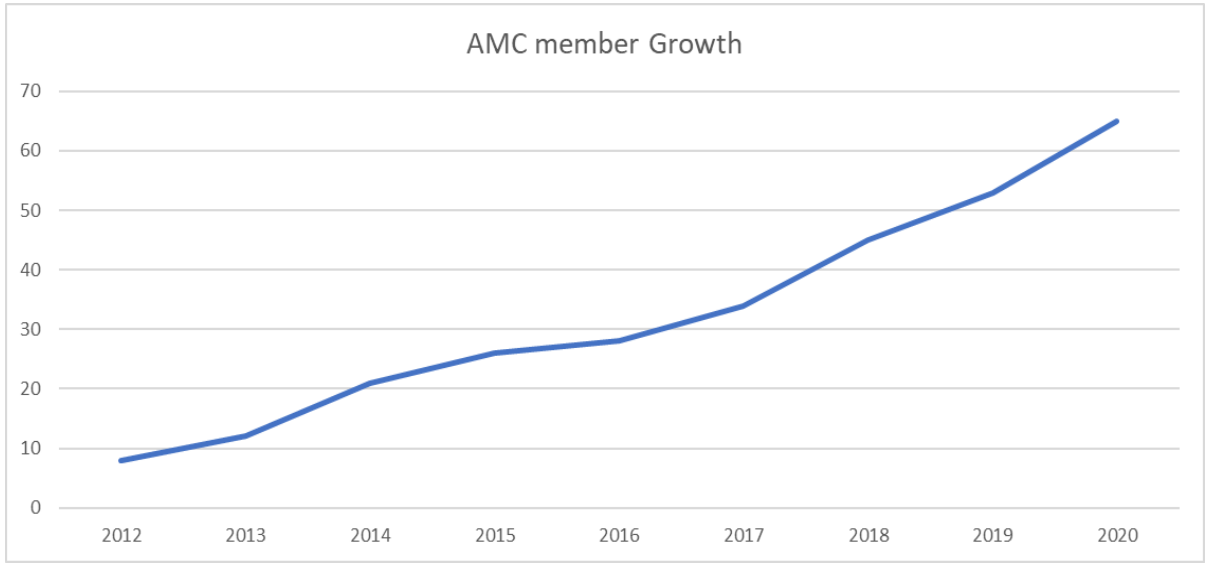
Service Bureau's

OEM's

Software

Additive Manufacturing Consortium
Operated by EWI

Growth of AMC Members



Increasing membership…

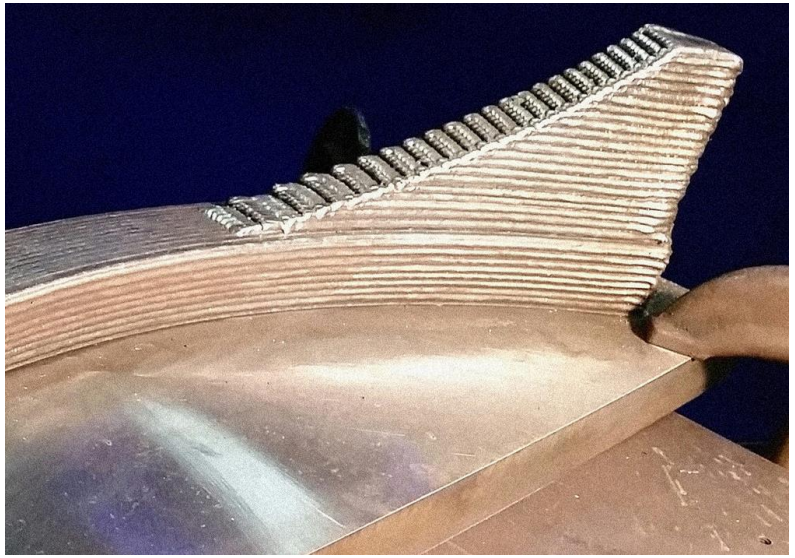
- 65 Total Members
- Increasing by 5-8 full members/year.
- 90% + retention rate

Additive Manufacturing Consortium
Operated by EWI

AMC Project Portfolio

Total current project portfolio is:

- +$4.5M in past project work
- Over $2M cash/in-kind per year of project work
- Currently 6 -8 projects/year



Additive Manufacturing Consortium
Operated by EWI

Benefits Summary

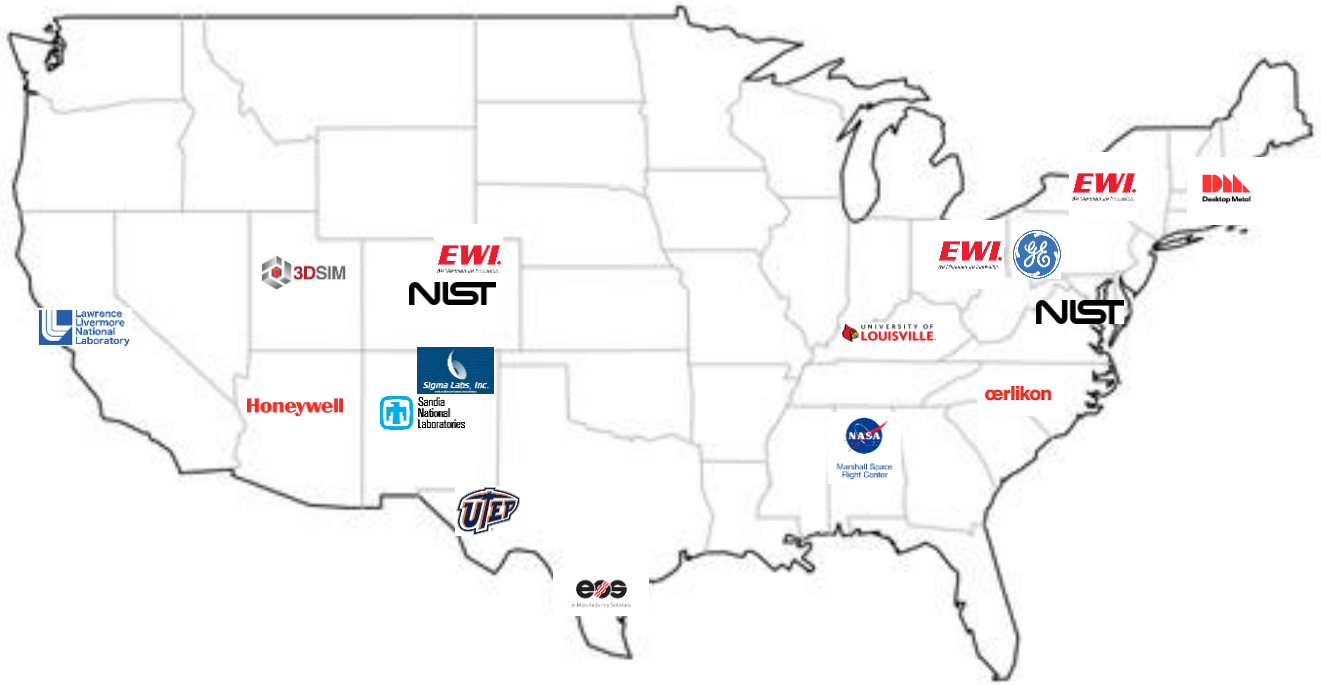
- **Network** with **like minded** additive professionals
- **Technical discussions** on latest AM work
- Leverage your membership fees for **combined project work**
- Allowances for foreground IP and confidentiality *
- Ongoing Technical Communication
  - Biweekly project teleconferences
  - Quarterly technical meetings including tours of AM facilities

**per membership and sponsorship agreement terms*

Additive Manufacturing Consortium
Operated by EWI

Quarterly Meetings

- AMC holds Quarterly Meetings at partner sites



- Average attendance is 80-140 people
  - Includes AMC members and invited guests.*

Typical Quarterly Meetings & Tours

Desktop Metal™

OERLIKON

Joe Gibbs Racing

NASA Marshall Space Flight Center

Honeywell

Typical Quarterly Meeting Agenda

- **Day 1 – Members only meeting**
  - Update on current AMC projects

- **Day 2 – General Session – latest AM news**
  - Evaluation of Laser Powder Bed Fusion AM to Produce replacement legacy aircraft components
  - Additive Manufacturing – A User's Perspective
  - Advanced Finishing Methods in Additive Processes
  - High Speed Thermography results on EOS M270
  - High throughput Testing reveals rare, catastrophic defects

LOCKHEED MARTIN

SSL

EXTRUDE HONE AFM

NIST National Institute of Standards and Technology U.S. Department of Commerce

Additive Manufacturing Consortium Operated by EWI

AMC 2021 Down Selected Projects

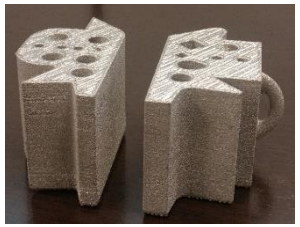
To be voted on Feb 3-4,2020

- Materials
  - Continue Testing for IN625 & 718
  - Phase 2 – Material Characterization for high strength AL alloys
  - Microstructure evaluation of joint interfaces between additive & convention methods
- AM Machines & Tests
  - Continuation of NEW AM Technologies
  - Assessment of new metal AM technologies – Hybrid Systems
  - Materials Testing in AM – Does your coupon size, shape & surface condition matter?
  - Phase 2 – Evaluate correlation between powder analysis techniques in relation to the printed part quality (surface roughness, mechanical properties and dimensional accuracy)
  - Deeper dive into Velo System including distortion in support free geometries
  - Phase 2 – Factors affecting as build surface finish
- Technology Advancement
  - AM for tooling study
  - Continuation of Investigation into multi-laser systems
  - Deeper Dive into LPBF Process restarts – what's really happening at microstructure level, and are we allowed to do process restarts?
- Post Processing & Finishing
  - Post Processing of AM Parts
- Simulation
  - AM Process simulation for parameter development

AMC 2020 Projects

- Phase 6 - Continuation of IN625/IN718 – Effect of thickness on microstructure
- Phase 4 - Material Characterization & Testing for high strength aluminum alloys (7075)
- Phase 2a – Continuation of evaluating new AM technologies
- Factors affecting AS built surfaces (vertical, upskin, downskin)
- How to qualify machine performance across various manufacturers
- Investigation into multi-laser systems
- Phase 3 – Evaluation of NDE techniques

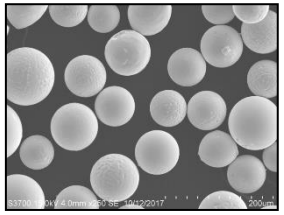
2019 AMC Projects



- **Phase II: Evaluation of Post Process Techniques for AM**
  - Processing a part using 8 post process techniques and comparing results. This year looking at the effect of post processing on fatigue results
- **Phase III: In-Process Monitoring**
  - Evaluating the commercially available in-process monitoring systems for L-PBF and comparing their results.
- **Phase V: Continuing Further Testing on Current Projects IN 625 and IN 718 and Relating Microstructure to AM Properties – Fatigue & Creep**
  - Studying the fatigue and creep resistance of AM printed parts

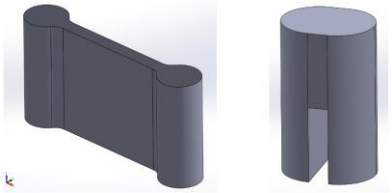
Additive Manufacturing Consortium
Operated by EWI

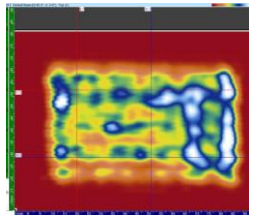
2019 AMC Projects



Desktop Metal SPEE3D XACT METAL

MELD MANUFACTURING Markforged FORMALLOY





- **Evaluation and compare powder measurement techniques**
  - Evaluation of available powder measurement techniques to determine what system works best for specific types of powder
- **Assessment of new AM metal AM technologies**
  - Reviewing the “new” metal AM technologies and then comparing the properties of parts printed using those technologies
- **Feature wise Parameter development for L-PBF**
  - Looking at how parameters should be varied for specific types of geometries (ie: bridges or thin walls)
- **Phase II: Evaluation of NDE techniques for complex AM parts**
  - Determining the best NDE techniques to analyze a complex AM part

Additive Manufacturing Consortium
Operated by EWI

How do I Join?

- Complete Membership agreement
  - Current term is 2018-2021
  - Dues payable annually
- Contact Mark Barfoot, Director of AM Programs
  - Email at mbarfoot@ewi.org
  - Phone at 716.710.5597

Additive Manufacturing Consortium
Operated by EWI

Next Meeting

Feb 3-4th, 2020 – VIRTUAL

- tours and topics TBA shortly

Contact me if you are interested in coming as a guest

WHY JOIN AMC

"Develop strategic relationships/networks and advance AM technology in a pre-competitive, collective manner that could provide value to our company and accelerate the introduction of AM-built parts into aerospace applications"

Additive Manufacturing Consortium
Operated by EWI

Appendix: Past AMC Projects

2015 AMC Projects

- **Nickel Alloy 625**
  - Heat treatment and mechanical property development for L-PBF
- **Nickel Alloy 718**
  - Heat treatment and mechanical property database development for L-PBF and EB-PBF
- **Monel 400 Process Development for L-PBF: Phase 1**
- **High Strength Aluminum Alloy Process Development for L-PBF: Phase 1**
  - Large literature review and feasibility study aimed at processing an aluminum alloy with similar properties to 6xxx and 7xxx series alloys.

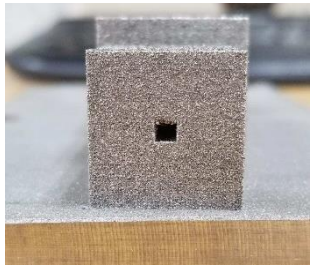
2016 AMC Projects

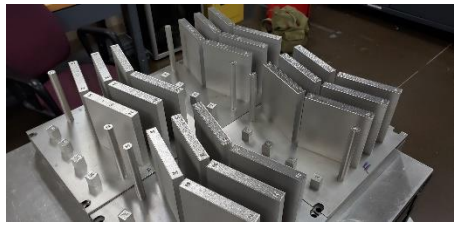
- **Nickel Alloy 625: Phase 3**
  - Comparison of multiple L-PBF platforms on the metallurgical and mechanical properties of deposited Nickel Alloy 625
- **Nickel Alloy 718: Phase 3**
  - Powder recycling study including powder characterization, UT inspection of coupons, and Fatigue testing
- **High Strength Aluminum Alloys for L-PBF: Phase 2**
  - Investigation of multiple process and chemistry alterations targeted to deposit an aluminum alloy with properties at the level of the 7xxx series
- **Monel 400 Heat Treatment Optimization: Phase 2**
  - Study to determine heat treatment, tensile properties, corrosion properties, and impact toughness for Monel 400 deposited using L-PBF

2017 AMC Projects

- **In-Process Monitoring of Defects in L-PBF: Phase 1**
  - In-process monitoring and defect rectification study utilizing multiple sensors
- **High Strength Aluminum Alloys for L-PBF: Phase 3**
  - Heat treatment optimization through metallurgical and mechanical property evaluation for two high strength aluminum alloys
- **AM Powder Recycling and Reconditioning for L-PBF: Phase 1**
  - Investigation of powder recycling and reconditioning through mixing and plasma spheroidization
- **Nondestructive Post-Process Evaluation of AM Components: Phase 1**
  - Evaluation of NDE techniques and their applicability to multiple types of L-PBF defects

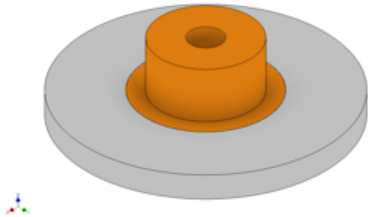
2018 AMC Projects

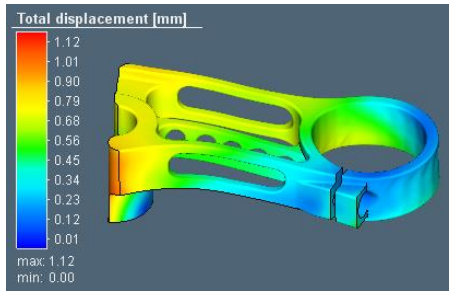


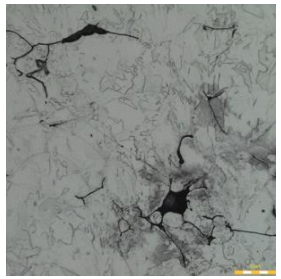


- **Evaluation of Post Process Techniques for AM**
  - Processing a part using 8 post process techniques and comparing results
- **Phase II: In-Process Monitoring & Defect Rectification**
  - Evaluate performance of different repair strategies over varying L-PBF defect modes and levels
- **Continuing Further Testing on Current Projects IN 625 and IN 718 and Relating Microstructure to AM Properties**
  - Effective of chemistry changes from different powder suppliers on microstructure and material properties

2018 AMC Projects







- **DED Multi-material/ Repair**
  - Review of QuesTek Innovations for CALPHAD simulation and then produce a Swagelok component using DED
- **Comparison of Commercially Available AM Simulation Tool**
  - Evaluate software simulation capabilities and performance comparisons. Build a part and compare prediction to actuals
- **Stainless Steel Multi-Process AM**
  - Evaluating microstructure and results of stainless steel parts printed using L-PBF and DED process

Additive Manufacturing Consortium
Operated by EWI

EWI

We Manufacture Innovation

EWI is the leading engineering and technology organization in North America dedicated to developing, testing, and implementing advanced manufacturing technologies for industry. Since 1984, EWI has offered applied research, manufacturing support, and strategic services to leaders in the aerospace, automotive, consumer electronic, medical, energy, government and defense, and heavy manufacturing sectors. By matching our expertise to the needs of forward-thinking manufacturers, our technology team serves as a valuable extension of our clients' innovation and R&D teams to provide premium, game-changing solutions that deliver a competitive advantage in the global marketplace.

ewi.org • 614.688.5000

EWI FACILITIES AND LABS

Columbus, Ohio
EWI (Headquarters)
1250 Arthur E. Adams Drive
Columbus, OH 43221
614.688.5000
info@ewi.org

Buffalo, New York
Buffalo Manufacturing Works
847 Main Street
Buffalo, NY 14203
716.710.5500
drose@ewi.org

Loveland, Colorado
EWI Colorado
815 14th Street SW
Loveland, CO 80537
970.635.5100
mwillard@ewi.org

Additive Manufacturing Consortium
Operated by EWI