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EASA AM Producer – Knowledge Transfer – Training Meeting Group 3B

Rachael Andrulonis, Wichita State University - NIAR

Sara Gobbi, ASTM International

Mohsen Seifi, ASTM International

Ian Simpson, Performance Review Institute (PRI) Europe

Hannah Godfrey, Performance Review Institute (PRI) Europe



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Question

- **What knowledge* and training* does each group believe that it needs from the other groups (including the regulators) in order to function more efficiently and better meet its safety (and commercial) objectives?**
 - * themes, level of detail, theoretical and practical training aspects, duration, base level qualifications and experience etc.



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Inputs by Category

1. Information/knowledge we need from other groups
2. Information/knowledge we think that other groups probably need from us
3. Ideas on how information and knowledge could be shared
4. Information on other activities/organizations that are involved or should be involved in this general area
5. Any other information/comments

1. Information/knowledge we need from other groups

Group	Information/Knowledge Needed
ALL	ALL: Information on training requirements: - what are the knowledge, skills and experience expectations for additive manufacturing operators, planners, owners
ALL	Practical Training: Is a practical element to assessment required/desirable?
ALL	Should qualification be required: To what degree should qualifications be 'required' - as a minimum to perform the process such as with Welding operators and NDT inspectors or as a desired?
ALL	Lessons learned from lack of training: Useful to understand the specific manufacturing consequences of poorly trained and unqualified personnel performing this process.
Machine Producers	Machine Producers need to define key elements that operators must have intimate knowledge of (e.g. file controls / traceability; preventative maintenance that they can perform and those that require a service agent; calibration; limitations of environment- i.e. humidity, temperature, magnetic field etc.)
Machine Producers	Machine Producers: in addition to providing definition to key elements, need to have a min level of training - how can this be achieved?
TCH/Spec Bodies	TCH / specification bodies: should define the requirements they have for the Process Owner / Subject Matter Expert. While at this time there is no equivalent to a Welding Coordinator or NDT Level III, perhaps we should consider how we get a SME to a specified level in order to run an AM facility
ALL	Process Control Parameters: How do we get on an agree for minimum set of process control parameters across one AM modality? This has implications on the standards that can specifically be designed around a modality such as PBF or DED, etc.
Machine Producers	Machine Producers - qual. requirements: Once equivalency requirements are set up, machine producers need to be involved with setting up qualification requirements



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2. Information/knowledge we think that other groups probably need from us



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SDO	Information/Knowledge Needed
eQualified	eQualified Process: Understanding of how eQualified and other qualification systems have been implemented in other manufacturing areas such as Composite Repair, Heat Treating, Welding etc.
ALL SDOs	Qualification Process: Proposed process flow to show how a qualification system could be rolled out across the industry
NCAMP/Other	Equivalency Process: Information on how an equivalency approach would work
ALL SDOs	How can SDOs help: Information on how the different standardization groups work together (or don't work together) and how each of the SDOs may be applicable to different types of technology/applications
ALL SDOs	How can SDOs help: Information on how a consensus based standardization process is applicable to different types of deliverables (e.g. method, guide, spec, report, etc.) regardless of a industry type.

3. Ideas on how information and knowledge could be shared

- A document which brings together information from all the groups and includes a future vision of the AM qualification landscape and a gap analysis of where we are now to where we need to get to
- Private access online site where slides/other information from each group can be housed for future reference
- Potential to use a private LinkedIn group for regular information sharing between Members and encourage communication across the group



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4. Information on other activities/organizations that are involved or should be involved in this general area



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Other Groups	Information/Knowledge Needed
Training Providers	Training Provider: Potential training providers such as Advanced Manufacturing Training Centre https://training.the-amtc.co.uk/mod/page/view.php?id=211
Supply Chain	Do we enough of the supply chain (non-TCH) representation in this effort?
Training Providers	Training Collaboration: Collaboration on training opportunities internationally
Training Provider/Other SDOs	Training/SDO Collaboration: Collaboration with SDOs and AM centers internationally
ASTM CoE	ASTM CoE Support: Information on recently established ASTM AM COE to support and accelerate standardization, developing focused training programs, etc. Partners involved: The MTC, EWI, NASA, Auburn, ASTM (<i>see related slides</i>)



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5. Any other information/comments

Category	Information/Knowledge Needed
Training and Qualification	Training and Qualification - existing: Require a clear picture of existing range of additive manufacturing training and qualifications - develop a matrix to show qualification types, levels, providers
Training	Training Matrix: A training matrix that identifies the key items and the skill level achieved of the individuals (e.g. in training, competent, able to train other) would be beneficial
Training	Personnel requiring training: Besides operators of the actual machines, we need to consider other personnel who may be involved and require training, e.g. maintenance, inspectors
Training	Periodic Training: Need to establish if there is a need for periodic refresher training (or requalification). What common training can be utilized for different machines and what additional training is needed when machines change
Regulatory Bodies	Involvement of other regulatory bodies (FDA): Global consideration - are FDA also going to follow recommendation of this initiative. Having a unified global approach to qualification would be beneficial for the industry as a whole
Universities	Qualification applicability to universities: Is there a qualification system for new entrants in to manufacturing, e.g. school/university leaders? Do we need to 'grandfather' in those currently working in the process but without any qualifications?

5. Any other information/comments

Category	Information/Knowledge Needed
Specifications	Level of detail and requirements in specs: To be included in a Nadcap checklist, there must be a requirement in a standard / customer specification. Without specifics, the only option is for a generic question that asks the Supplier for a procedure on how they control (training in this case) and then compliance that they meet this procedure. At this time AMS 7003 only appears to recommend training guidance, rather than requiring it. Not sure of the approach of other Industry specification bodies, but if they take a similar approach, it is hard to enforce specific requirements.
Qualification	Qualification Process: While the focus appears to be on training, does this need to go to the next level and require qualification? This could take many different levels; qualification in the theoretical aspects of AM; qualification on how to practically apply the process; qualification in the use of a specific machine / machine type
Machine Producer Responsibilities	Responsibility by Machine Producer: There are many critical items that are needed to control the process effectively that may not be flowed down by machine producers (e.g. powder control). How do we ensure Suppliers have the required knowledge to control these items and don't assume they can simply purchase a machine and start manufacturing without considering these factors? Perhaps some inherent responsibility on the Machine producer to provide this type of information when selling a machine.
ASTM	ASTM Testing Program: How does ASTM A2LA certified proficiency testing program support accreditation programs? <i>See related slides</i>
EWf/Others	Other organizations: Are all global organizations considering developing or currently developing qualifications in AM included within the workshop: example EWf: European Welding Federation: <i>see related slide</i>

EWF Metal AM Qualifications

- EWF is currently developing seven new Qualifications in Metal AM.
 - Three are Metal AM Operators
- One is generic Metal AM Engineer qualification, which provides an overarching knowledge about Metal AM, and that after completion then allows the trainee to attend a specialisation in a specific Metal AM process

Directed Energy
Deposition (Wire
plus Arc) Operator

Directed Energy
Deposition (Laser)
Operator

Laser Powder Bed
Fusion Operator

Metal AM Engineer

Directed Energy
Deposition (Wire
plus Arc) Engineer

Directed Energy
Deposition (Laser)
Engineer

Laser Powder Bed
Fusion Engineer

ASTM AM Center of Excellence



Bridges standards development with R&D and Innovation Community to better enable efficient **development of standards**, education and training, certification, and proficiency testing programs to **support commercialization and adoption**.



CoE founding partners

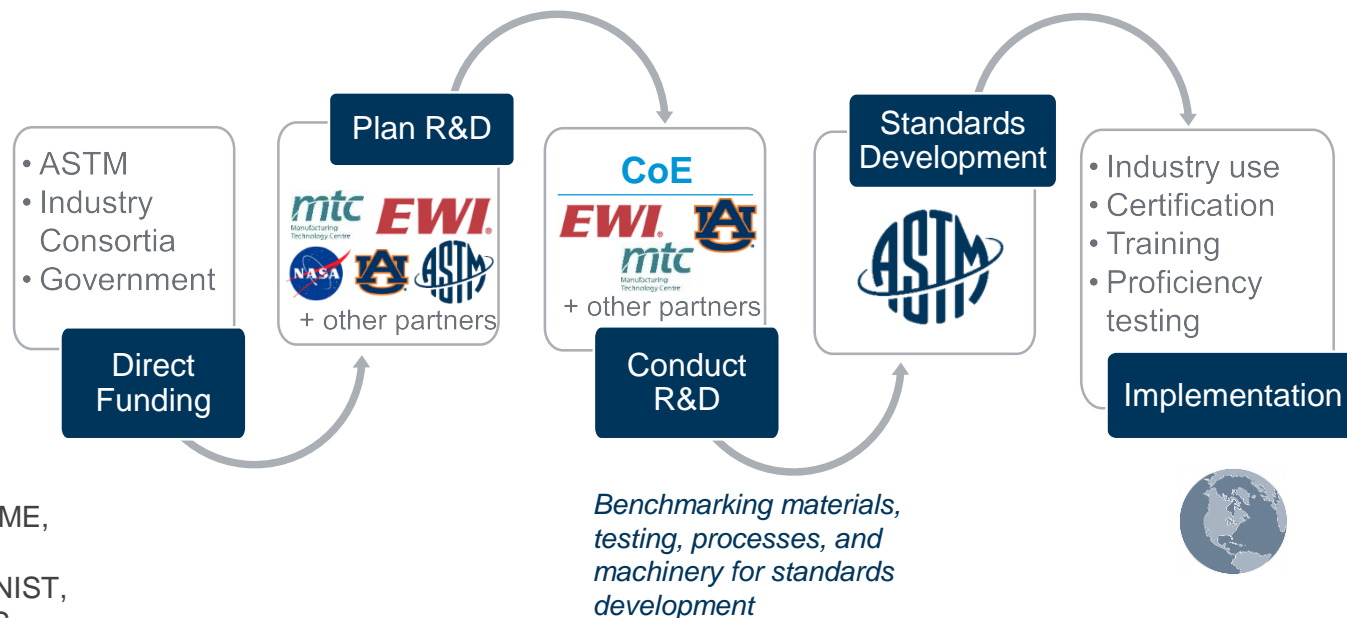


- ASTM International Selects EWI and Auburn University/NASA for New Additive Manufacturing Center of Excellence
- ASTM International Selects UK-based Manufacturing Technology Centre (MTC) as New Additive Manufacturing Center of Excellence Partner



ASTM INTERNATIONAL
Helping our world work better

How it works



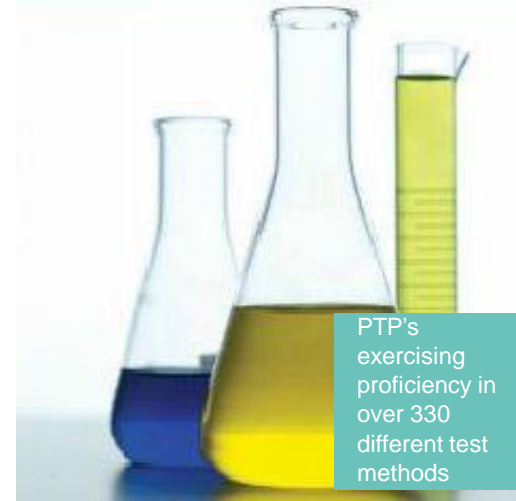
ASTM Collaborations

- PSDO – ISO TC261 (CEN TC438)
- MOU – America Makes, SME, 3MF
- Strategic Relationships – NIST, FAA, FDA, EASA, MMPDS, EPMA, CECIMO, ...

What is the ASTM Proficiency Testing Program



- A program designed as a statistical quality control tool enabling participating laboratories to assess their performance in conducting ASTM or other committee approved test methods, such as ISO, IP, EN, UOP, AATCC, etc.
- We provide management and the administrative support:
 - Program registration, contract negotiations for sample preparation and distribution, data collection and generation of statistical summary reports
- Coordinate the preparation and distribution of test samples
 - Test samples are prepared by outside contractors
- Our program provides reporting instructions, lab test worksheets and electronic data report forms for submitting lab data, all accessible on the ASTM PTP website portal



New ASTM Proficiency Testing Program for Metal Powders

Powder Characterization/Test Method (12 standards at this time)

B215 — Practices for Sampling Metal Powders

B212 — Test Method for Apparent Density of Free-Flowing Metal Powders Using the Hall Flowmeter Funnel

B213 — Test Methods for Flow Rate of Metal Powders Using the Hall Flowmeter Funnel

B214 — Test Method for Sieve Analysis of Metal Powders

B329 — Test Method for Apparent Density of Metal Powders and Compounds Using the Scott Volumeter

B417 — Test Method for Apparent Density of Non-Free-Flowing Metal Powders Using the Carney Funnel

B527 — Test Method for Determination of Tap Density of Metallic Powders and Compounds

B703 — Test Method for Apparent Density of Metal Powders and Related Compounds Using the Arnold Meter

B822 — Test Method for Particle Size Distribution of Metal Powders and Related Compounds by Light Scattering

B855 — Test Method for Volumetric Flow Rate of Metal Powders Using the Arnold Meter and Hall Flowmeter Funnel

B923 — Test Method for Metal Powder Skeletal Density by Helium or Nitrogen Pycnometry

B964 — Test Methods for Flow Rate of Metal Powders Using the Carney Funnel

Outcome:

- Data will be made available to all participants but confidential
- Identify sensitivity of tests methods to alloy
- Insight on the relevance of current standards
- Create more relevant powder characterization methods tailored to AM powders

Short summary of a survey to launch this PTP by the numbers:

- 265 companies responded
- 115 companies responded yes/maybe for participation
- 18 – 49 labs would provide results, depending on the test method

Technical Reviewers:

Selected F42 and
B09 executive members



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Resources

- Conferences
- Documents
- Standards/Specifications
- Organizations



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Resources - Conferences

- FAA Workshop 2017 - <http://www.tc.faa.gov/its/worldpac/techrpt/tc18-3.pdf>
- ASTM F42 meetings – every 6 months, next meeting September in Singapore
- SAE meetings - every 6 months, most recent April 2018 – Norway (operator qualification discussion)
- ASTM AM meetings - November 2018 - ASTM Symposium on Structural Integrity of Additive Manufactured Parts (see next slide) (https://www.astm.org/SYMPOSIA/filtrexx40.cgi?+-P+EVENT_ID+3548+callforpapers.frm)

3rd Symposium on Structural Integrity of Additive Manufactured Materials and Components (E08, F42, E07)



Topics to be addressed include:

- Applicability of existing fatigue and fracture test methods to AM materials
- Development of new fatigue and fracture test methods for AM materials
- Fatigue and fracture behavior of components fabricated using AM
- Residual stress effects
- Effects of process and design parameters on fatigue and fracture behavior
- Process optimization to improve fatigue performance of AM materials
- Nondestructive evaluation of components fabricated using AM
- High-speed, low-cost nondestructive evaluation techniques for AM

Dates

November 2018

Location

Washington, DC

Sponsored by

NASA, NIST, ESIS





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Resources - Documents

- AMSC Roadmap – Phase 1 and 2
- NADCAP Checklist



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Resources – Standards/Specifications

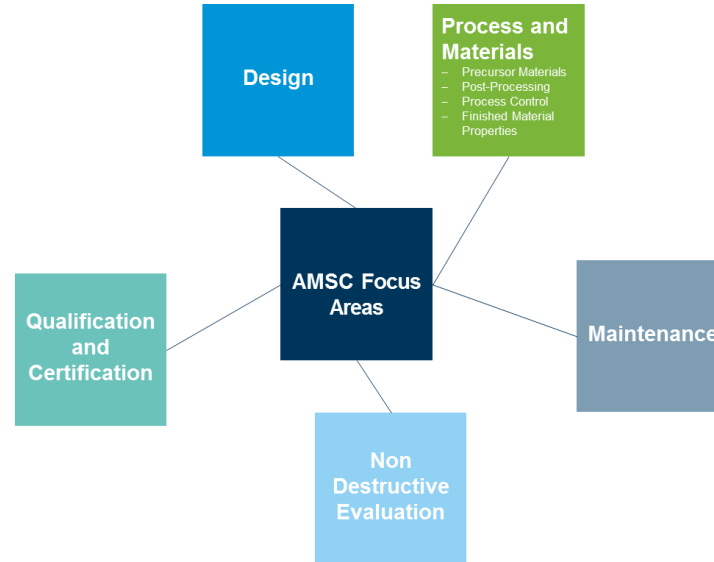
- ASTM F42 guidance documents, standards and specifications (joint with ISO)
- SAE specifications

One major example: AMSC Roadmap V 2.0



Of that total 93 gaps:

- 19 gaps/recommendations have been identified as **high priority**,
- 50 as **medium priority**,
- 24 as **low priority**.
- ASTM is already positioned to address 82 gaps in conjunction with ISO.
- **64 gaps require R&D!**





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Resources - Organizations

- ASTM/ISO
- PRI
- SAE
- NCAMP
- EWG