ASTM Additive Manufacturing Center of Excellence

Research to Standardization

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ASTM International

Overview

- **Refresher**
  - ASTM F42
  - ASTM AM Center of Excellence

- **Research to Standardization**

- **AM Data Initiatives**

- **E&WD**

- **Q&A**
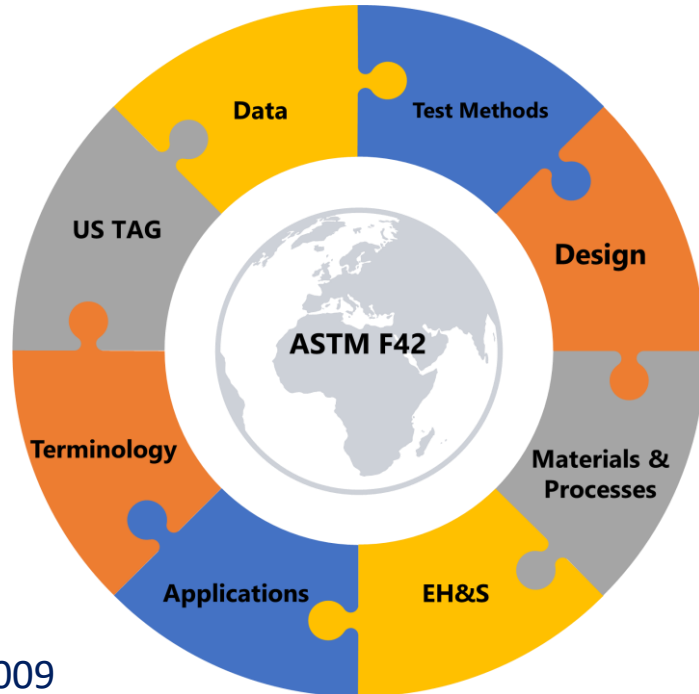
ASTM AM Footprint

Diagram: ASTM F42 (center) surrounded by puzzle pieces: Data, Test Methods, Design, Materials & Processes, EH&S, Applications, Terminology, US TAG

F42 Additive Manufacturing

Feedstock — A01 Steels, B09 Powders, D20 Plastics, D30 Composites

Test Methods — E07 NDT, E08 — Fracture & Fatigue, E28 — Mechanical Testing, E37 — Thermal Measurement, E57 3D Imaging

Applications — F07, F37, F38, F44, F47 — Aerospace; F04, E55 — Medical Devices, Pharmaceuticals; G01 Corrosion; F25 Ship and Marine

- **Formed:** 2009

- **Current Membership:** 1000+ members (Over 30% outside the US)

- **Standards:** 30+ approved, 45+ in development (Jointly with ISO)

- **Global Representation:** 28+ countries
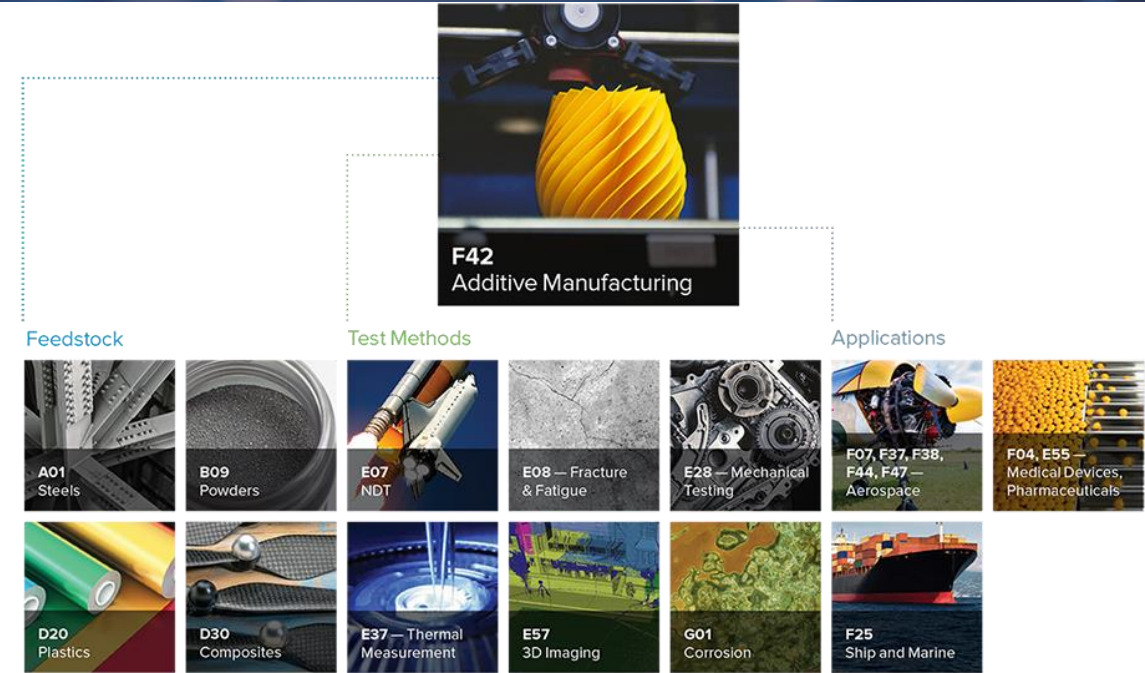
- **Collaboration:**
  - PSDO – ISO TC261 (CEN TC438)
  - MOU & Membership – America Makes
  - Strategic Relationships – NIST, NASA, FAA, FDA, DOD, MMPDS, CMH17 ….

ASTM AM CoE – Research to Standard

- **ASTM formed Additive Manufacturing Center of Excellence (AM CoE) in 2018**

Mission

The Center bridges standards development with R&D to better enable efficient development of:
- Standards
- Education and Workforce Development
- Certification and proficiency testing programs

Vision

The Center facilitates collaboration and coordination among government, academia, and industry to:
- Advance AM standardization
- Expand ASTM International's and our partners' capabilities.

AM CoE R&D: High Priority Areas

AM CoE R&D Themes

CoE R&D Areas

Topics are crosslinked to create synergy!

F42.07 Applications

CoE R&D Areas:
- Design, Data, and Modeling
- Feedstock materials (Testing, Reuse)
- AM processes/ Post Process
- AM Testing
- Qualification (NDT, etc.)

F42 Applications:
- F42.01 Test Methods
- F42.04 Design
- F42.05 Materials and Processes
- F42.06 Environment, Health, and Safety
- F42.07 Applications
- F42.08 Data
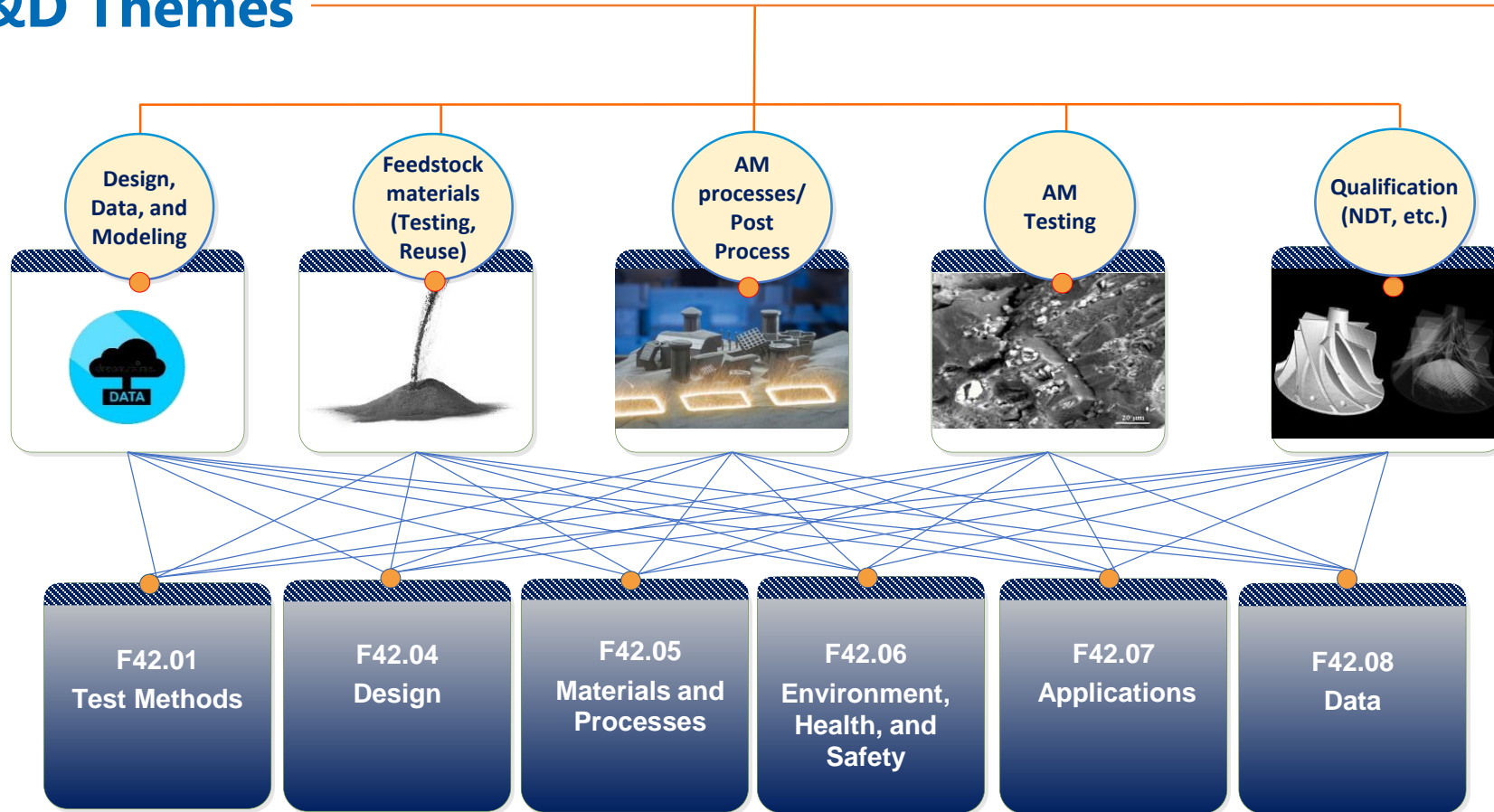
1. Defined based on the input of the CoE R&D team
2. Short-term
3. Highly-focused
4. High-priority (linked to AMSC roadmap and Committee F42)
5. Aligned with America Makes projects
6. Coordination/collaboration with Government agencies (e.g. FAA, NASA, NIST, AFRL, ...)

R&D Projects Overview

CENTER of EXCELLENCE Research to Standards ADDITIVE MANUFACTURING

- The AM CoE has supported a total of 14 R&D projects during two previous rounds of projects

- Each project is designed to address one or more AM standardization gaps listed in the Additive Manufacturing Standardization Collaborative (AMSC) roadmap

NOTE: Some standards and standards gaps were impacted by multiple projects, so the total shown here is less than the sum of the table.

R&D Projects

Round 1: 2018-2019 (5 projects)

EWI Post Processing (Surface finishing and Characterization)	**NASA / AUBURN**	LB-PBF Process Qualification
mtc Feedstock (Powder quality guide)	**NIAR**	Polymer AM Test Specimen Design
AUBURN Mechanical Testing of Metal AM		

Round 2: 2019-2020 (9 projects)

EWI Standardization of Data Pedigree	**NASA / AUBURN**	LB-PBF Process Qualification – Phase II
mtc Design Guide for Post-Processing	**NIAR**	Polymer AM Design Value Tests
mtc Powder Spreadability	**NIAR**	Dynamic Testing of Polymer AM
AUBURN Rapid Quality Inspection Specimen (RQIS)	**NAMIC**	In-process Monitoring
	NAMIC	Design Guides for AM Processes

LAUNCHED **14** Total Research Projects

ADDRESSING **25** Total Standards Gaps

IMPACTING **53** Total Standards

Research to Standardization

PROJECT LEAD	FUNDING YEAR	PROJECT	STANDARD WORK ITEM	STATUS 1	2	3	4
AU	2018	1801: Metal AM Testing	WK49229	Completed	Completed	Completed	In process
AU	2019	1901: Rapid Quality Inspection Specimen	WK71395	Completed	Completed	In process	Upcoming
EWI	2018	1802: AM Post Processing	WK66682	Completed	In process	Upcoming	Upcoming
EWI	2019	1902: Data Pedigree	WK72172	Completed	Completed	Completed	In process
mtc	2018	1803: AM Feedstock Evaluation	WK66030	Completed	Completed	In process	Upcoming
mtc	2019	1903: AM Powder Spreadability	WK71393	Completed	Completed	In process	Upcoming
mtc	2019	1904: Design for Post Processing	WK73444	Completed	Completed	Completed	In process
NAMiC	2019	1905: Design Guides for AM Processes	WK62867	Completed	In process	Upcoming	Upcoming
			F3413-19 (WK62946)	Completed	Completed	Completed	Completed
NAMiC	2019	1906: In-process Monitoring	WK74390	Completed	In process	Upcoming	Upcoming
NASA / AU	2018/2019	1804/1907: LB-PBF Process Qualification	WK65937	Completed	Completed	Completed	In process
			WK65929	Completed	In process	Upcoming	Upcoming
NIAR	2018	1805: Polymer AM Testing	WK66029	Completed	Completed	Completed	In process
NIAR	2018	1805: Polymer AM Testing	WK71391	Completed	In process	Upcoming	Upcoming
NIAR	2019	1908: Polymer AM Design Value Tests	TBD	In process	Upcoming	Upcoming	Upcoming
NIAR	2019	1909: Dynamic Testing of Polymer AM	WK73340	Completed	In process	Upcoming	Upcoming

Legend:
- Completed
- In process
- Upcoming

Status Key:
1. Work item scoping and registration
2. Draft under development
3. Editorial Support and Pre-Ballot
4. Undergoing Balloting and Final approval as a standard

3rd Round of Projects
Selected Project Topics

Lead	Project Title	Material	Topic
Auburn	Specimen Design for Compression Testing of Metallic Lattice Structures	Metal	Testing
EWI	Common Data Exchange Format for Powder Characterization	Metal	Design, Data, & Modeling
mtc	Metal Powder Feedstock Recycling and Sampling Strategies	Metal	Feedstock
mtc	Recycling and Re-Use of Polymer Powders	Polymer	Feedstock
NAMIC	Miniature Tensile Specimens for Additive Manufacturing	Metal	Testing
NAMIC	Volume-Traceability (VT) Development in Porosity Characterization with XCT for Integrity and Quality Assurance of AM Parts	Metal	Testing
NAMIC	Development of Specification for Maraging Steel	Metal	Feedstock
NASA / Auburn	Thermal Tolerance Test for LB-PBF Process Parameters	Metal	Processes & Post-Processes
NIAR	Continuation of AM Polymer Projects (Design Value and Dynamic Testing)*	Polymer	Testing
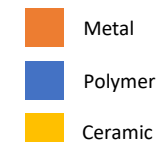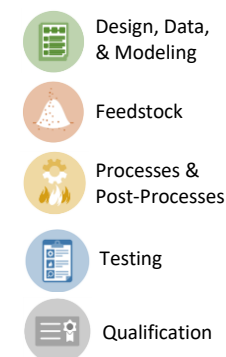
* Continuation of projects initiated in 2019

Material
- Metal (orange)
- Polymer (blue)
- Ceramic (yellow)

Topic
- Design, Data, & Modeling
- Feedstock
- Processes & Post-Processes
- Testing
- Qualification

New Funding Mechanism

New Call for Projects (CFP) mechanism allowing <u>non-AM CoE partners to receive support to conduct targeted R&D projects</u>

- **Objectives**

  - Allow the wider AM community to participate in Research to Standardization initiative

  - Evaluate the possibility of bringing on additional partners to the AM CoE team, to further accelerate standard development in AM

PROPOSAL DUE	NOVEMBER 24, 2020
SELECTION ANNOUNCEMENT	JANUARY 29, 2021
ANTICIPATED START DATE	MARCH 1, 2021

2020 Call for Projects

Submit Your Proposal!

Funding Opportunities for Research Organizations

Informational Webinar:
November 2, 2020

Proposal Deadline:
November 24, 2020

- Collaborative workshop with America Makes

- Two-day event: 20 technical talks, panel, roadmapping session

- Objective:
  - Identify challenges, gaps, and pain points
  - Discuss solutions
  - Build a momentum

Data - Highest Rated Gaps

Data Acquisition

37 Gaps

- Potential for manual data entry to lead to human error

Data Security

- Data traceability/integrity/provenance
- Protection of intellectual property (IP) during data sharing

Data Practices

- Minimum viable data packages
- Common terms and semantics for data definition

Data Management

- The need for unique, unified data identifiers (e.g., bar codes, alphanumeric tags, etc.) for AM data

Data Use

- Correlating data to part performance
- Format or presentation mode of data

- **ASTM WK72172:** New Practice for Additive manufacturing -- General principles -- Overview of data pedigree
  - The standard identifies classes of AM data (buckets), important terms for data that fit within those buckets, and relationships that exist between the buckets.
  - Balloting completed, negative comments are being addressed (Tech contact: Yan Lu, NIST)

- **Common Data Exchange Format (CDEF)**
  - Facilitates data sharing among data management systems, Will be registered in Nov. 2020 (Lead org: EWI)

- **ASTM WK73978:** New Specification for Additive Manufacturing - Data Registration
  - This standard practice comprises actions that users need take to register datasets and store them in a repository.

- Several other data related activities at F42 ISO/ASTM joint groups such as JG64, JG67, JG70, JG7

Strategic Guide

- Based on inputs from participants

- Summarized gaps and challenges with respect to Data in AM, and provided solutions and action plans

Download at: https://amcoe.org/rd-publications
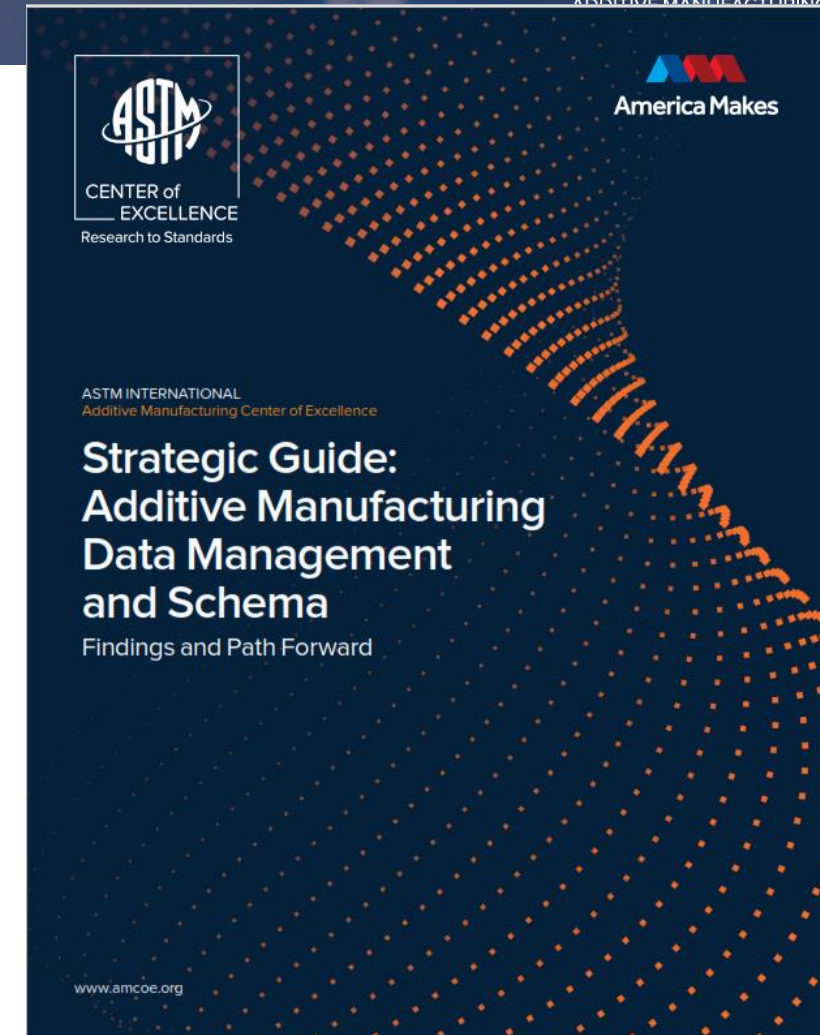
Data Initiatives/Activities
Formation of F42.08

Data Pedigree Project
2nd round of R&D projects

AM Data Subcommittee
Recommended during the road-mapping session discussions

CDD Work Item
"Overview of Data Pedigree"
Post-Balloting stage

CDEF Work Item
"Common Data Exchange Format"
Scoping and Registration

| Oct. 2019 | Dec. 2019 | Feb. 2020 | Jul. 2020 | Aug. 2020 | Jul. 2020 | Nov. 2020 |

AM Data Workshop
ASTM Int. & America Makes

Strategic Guide
based on inputs from the workshop participants

AM CoE R&D Team update
Addition of two AM Data Experts
Mr. Matthew Jacobsen
Mr. Chuck Browne

F42.08 Officers

Formation of F42.08:

- Based on input from the AM Data Workshop

- A dedicated forum for AM Data experts to identify gaps and develop standards

- Approved by the ASTM Committee F42 Executive Team on Feb. 2020

Chair
Alex Kitt,
EWI

Vice-Chair
Yan Lu,
NIST
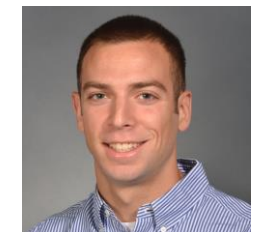
Secretary
Peter Coutts,
Penn State
ARL

Data Initiatives/Activities
In-Process Monitoring Project

- **Assessment of State-of-the-Art of In-Process Control and In-Situ Monitoring for Additive Manufacturing**

  - Conducted literature review of available monitoring technique

  - Evaluated TRL/MRL level

  - Conducted survey (20+ experts in North America and Europe)

  - Report to be published for public before end of the year

- **Data structure a primary concern**

  - High spatial resolution sensor data produces very large volumes of data

  - Real time data processing is challenging and expensive

  - Parameterization reduces data volume for analysis and storage, but loses fidelity

  - Variation between companies constrains development of universal acceptance criteria

  - Standardization of data simplification will be necessary for allowance in certification/qualification

61% North America
29% Europe
8% Asia
1% Middle East & Africa
1% South America

ASTM INTERNATIONAL
Additive Manufacturing Center of Excellence

Assessment of State-of-the-Art of In-Process Control and *In Situ* Monitoring for Additive Manufacturing

July 31, 2020

www.amcoe.org
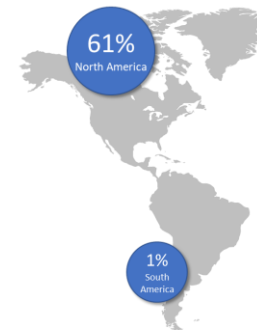
Data Initiatives/Activities
NASA-ASTM Cooperative Agreement

- This cooperative agreement will be the basis to expand the AM CoE and NASA's evolving partnership

  - Three-year contract

  - Formalize collaboration aimed at supporting projects identified by NASA for the AM CoE execution

- First project

  - Qualification framework for laser beam powder bed fusion (LB-PBF) AM processes

    - One of the largest impediments to the growing implementation of AM into many applications.

    - Need to standardize process qualification that ultimately contribute to robust data generation, collection and specification

Data Initiatives/Activities
Cyber Security Training Award

- America Makes Open Project Call

  - ASTM and Auburn University: AM Cyber security training

  - Need to create cyber security standards

General AM Personnel Certificate Programs

AM General Personnel Certificate Course

- **8 modules** that covers all the general concepts of the AM process chain
- **Globally recognized instructors:** 17 instructors hand-picked with specialty in key topics.
- **Flexibility:** Two modules will be covered every week to complete the entire course in one month
- **Open to** individuals from government agencies, industry, and academia with any level of AM experience, including those with no prior experience at all.

Upcoming AM CoE Annual Flagship Event – ICAM 2020

- 10 panel discussions
- 220+ organizations
- 300+ presentations
- 400+ attendees
- Award ceremony

Q&A