America Makes – The National Additive Manufacturing Innovation Institute Update

The National Accelerator for Additive Manufacturing

Ed Morris
NCDMM Vice President and America Makes Director
330-301-7963
Ed.Morris@NCDMM.org

MBE Summit 2016

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# ASTM Definitions of Seven Main Categories of Additive Manufacturing Processes

<table>
<thead>
<tr>
<th>Process Type</th>
<th>Method</th>
<th>Materials</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Powder Bed Fusion</strong></td>
<td>Thermal energy (laser or electron beam) selectively fuses regions of a powder bed</td>
<td>Metals, Polymers</td>
<td>Manufacturing, Prototyping</td>
</tr>
<tr>
<td><strong>Directed Energy Deposition</strong></td>
<td>Focused thermal energy (laser or electron beam) is used to fuse materials as deposited</td>
<td>Metals</td>
<td>Manufacturing, Repair</td>
</tr>
<tr>
<td><strong>Material Extrusion</strong></td>
<td>Material is selectively dispensed through a nozzle and material laid down in layers</td>
<td>Polymers, food</td>
<td>Manufacturing, Prototyping</td>
</tr>
<tr>
<td><strong>Vat Photopolymerization</strong></td>
<td>Liquid photopolymer in a vat is selectively cured by light-activated polymerization</td>
<td>Photopolymers</td>
<td>Prototyping</td>
</tr>
<tr>
<td><strong>Binder Jetting</strong></td>
<td>Liquid bonding agent is selectively deposited to join powder materials</td>
<td>Polymers, Sand, Metals, Ceramics, Polymers (electronics)</td>
<td>Prototyping, Casting Molds, Manufacturing</td>
</tr>
<tr>
<td><strong>Material Jetting</strong></td>
<td>Droplets of build material are selectively deposited, “ink-jet printer” like</td>
<td>Polymers, Waxes, tissue, metals (electronics)</td>
<td>Prototyping, Casting Patterns</td>
</tr>
<tr>
<td><strong>Sheet Lamination</strong></td>
<td>Sheets of material are bonded to form an object</td>
<td>Paper, Metals</td>
<td>Prototyping, Manufacturing</td>
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</table>
Why, How, What

AMERICA MAKES

WHY
The U.S. is not doing well in the Global Economy, and needs a reinvigorated Manufacturing Sector that includes a strong Defense Industrial Base.

HOW
Transform manufacturing in the U.S. through innovative, coordinated Additive Manufacturing Technology Development, Technology Transition, and Workforce & Educational Outreach.

WHAT
Accelerated adoption of additive manufacturing technologies in the U.S. manufacturing sector that yield innovative products and increased domestic manufacturing competitiveness.
Who We Are

America Makes is a public/private partnership with substantial federal, private industry, and academic investment.

The partnership is a multi-agency collaboration between industry, government and universities, led by the Defense-wide Manufacturing S&T team.

We have an innovation facility in Youngstown, Ohio.

We have 171 members and continue to grow.

We are operated by the National Center for Defense Manufacturing & Machining (NCDMM).
Membership Growth

171 America Makes Members as of 4/12/16

- 20 Platinum Members
- 51 Gold Members
- 100 Silver Members

15 New Member Requests Being Processed

- 108 Industry Partners
  (61 Are Small Businesses)
- 37 Academic Partners
- 13 Government Partners
- 10 Non-Profit Organizations
- 3 Manufacturing Extension Partnerships (MEPs)

42% Average Annual Membership Growth Rate in 2014 & 2015
Delivering Value

- Robust Additive Manufacturing Roadmapping
- Opportunity to Participate in Funded Projects
  - Consortium-driven Project Calls
  - Agency-driven Projects
  - Member-driven Projects
  - Client-driven Projects
  - Competitively-awarded Projects
  - Crowd-sourced Projects
- Access to Consortium Developed IP
- Use of the America Makes Innovation Factory

With our March 2016 Project Call, America Makes will have a portfolio of more than $96 million in public and private funds invested in advancing the state-of-the-art in AM in the United States.
# America Makes Technology Roadmap – Level 1

<table>
<thead>
<tr>
<th>AM Genome</th>
<th>Value Chain</th>
<th>Process</th>
<th>Material</th>
<th>Design</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Next-Gen Machines</td>
<td>Multi-Material Delivery &amp; Deposition Systems</td>
<td>“Non Ad-Hoc” Additive Manufacturing Tech Data Packages</td>
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<tr>
<td></td>
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<td>Cost &amp; Energy Driver Analysis/Modeling</td>
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</tbody>
</table>

- **Standards/Schemas/Protocols**
  - Advanced Sensing and Detection Methods
  - Rapid Inspection Technologies
- **Repair Technologies**
  - Intelligent Machine Control Methods
- **Digital Thread Integration**
  - Benchmark Validation Use Cases
  - Physics-Based Modeling & Simulation
  - Model Assisted Property Prediction
Developing Topology Optimization Tools that Enable Efficient Design of Additive Manufactured Cellular Structures

**Objectives:**
- Develop experimentally-validated micromechanics models, topology optimization, and reconstruction algorithms for different cellular structures.
- Demonstrate and validate capability of design and optimization tools on design of a realistic structural component.

**Goals & Benefits:**
- Enable efficient design of cellular structures in load-bearing parts for Defense Wide applications.
- ANSYS infrastructure already in place to commercialize the optimization technology.

**Performers:** University of Pittsburgh, Acute Precision Machining, Alcoa, ANSYS, ExOne.
Integrated Design Tool Development for High Potential Additive Manufacturing Applications

Objective: Develop an integrated design suite with built-in design aids for various AM manufacturability requirements and new topology optimization capabilities for high potential additive manufacturing applications

Goals & Benefits:
- Integrated design suite will help minimize time of the design phase, lower manufacturing cost, and reduce time to market for new AM product development
- ANSYS will implement this technology into the Topo Opt module and SpaceClaim module of its software

Performers: University of Pittsburgh, ANSYS, UTRC, Honeywell, Material Science Corp., Aerotech, ExOne, EOS, RTI International Metals, AMRDEC
Multidisciplinary Design Analysis for Seamless AM Design, Analysis, Build, and Redesign Workflows

**Objective:** Deliver demonstration models, training, rule sets and design flows

**Goals & Benefits:**
- Development of design for manufacturing rule sets to exploit Additive Manufacturing benefits and improve design to build flow
- Exploit market reach of team participants to transition design rules and improve multi-platform results
- Pervasive impact to industry and membership
  - Improve design to build cycle time
  - Integration of multi materials/properties
  - Simultaneous trades for performance

**Performers:** Raytheon, GE, University of Wisconsin, University of Massachusetts Lowell Research Institute, Netfabb, ANSYS, Altair, Autodesk, Materialise

Move from a serial process of islands of sub-optimization…

…to an integrated rule-based environment
Digital Threading of Additive Manufacturing

**Objective:** Demonstrate how modification of STL information will reduce material consumption, processing time, and post process finishing time, resulting in shorter cycle times and reduced lifecycle cost (material, time, and energy)

**Goals and Benefits:**
- Enable an art-to-part integrated process, tools, and digital thread to reduce cost, cycle time, and time to market by minimizing material deposition, component finishing processes and the application of automation between process step.
- ITI and Stratonics will provide the results of this project as part of standard product and service offerings.

**Performers:** Boeing, ITI, Stratonics, Aerojet, Raytheon, U. of Tennessee
Automatic Finishing of Metal Additive Manufactured Parts to Achieve Required Tolerances and Surface Finishes

**Objective:** Develop an integrated software solution that will create an automatic hybrid system that can deliver direct metal parts with required tolerances and surface finish

**Goals and Benefits:** Reduction of cost for use of additively manufactured parts for maintenance and sustainment efforts

**Performers:** North Carolina State U., CalRAM, Advanced Machining, FineLine Prototyping, Iowa State U., John Deere, Kennametal, Productivity Inc.
America Makes Advisory Group and Working Groups for Additive Manufacturing Standards, Specs, and Schemas Coordination

Additive Manufacturing Standards, Specs, and Schemas Advisory Group

- **Purpose:** Coordinate, prioritize, and accelerate the development and availability of additive manufacturing standards, specs, and data schemas
- **Membership:** Cross-section of America Makes Members and Government stakeholders

America Makes & ANSI Additive Manufacturing Standardization Collaborative

- **Purpose:** Coordinate and accelerate the development of government and industry-wide additive manufacturing standards and specifications
- **Membership:** America Makes Members and Non-Member Stakeholders

Additive Manufacturing Data Schemas Coordination Working Group

- **Purpose:** Establish industry-wide data schemas and templates for additive manufacturing and accelerate their use
- **Membership:** America Makes Members and Non-Member Stakeholders
**Purpose:**
The Purpose of the Additive Manufacturing Standards, Specs, and Schemas Advisory Group (AM3S AG) is to lead America Makes’ efforts to coordinate, accelerate, and prioritize the development and availability of additive manufacturing standards, specs, and data schemas for use by government and industry in the United States.

**Objectives:**
- Provide advice to America Makes leadership and members regarding the coordination of standards, specs, and data schemas that meet the needs of the additive manufacturing community
- Develop and implement sound technical approaches to accelerate the development and availability of additive manufacturing standards, specs, and data schemas for the user community

**Advisory Group Members:**
- Todd Rockstroh – Industry
- Kevin Jurrens – NIST
- Greg Saunders – DoD
- Blake Marshall – DoE
- Doug Wells – NASA
- Michael Gorelik – FAA
- LT James Coburn - FDA
- Rich Martukanitz – Academia
- Jim McCabe – ANSI
- Jim Williams – Working Group Chair
- Jesse Boyer – Working Group Chair
- Kevin Creehan – America Makes
ANSI Panels/Collaboratives & Workshops

- Provide a neutral forum to address topical issues of national importance
- Convene all materially affected and interested parties in an environment that respects the principles of openness, balance and consensus
- Prioritize needs in relation to standards and conformity assessment programs
- Identify and catalog existing standards and standards under development
- Define gaps
- Develop recommendations for work to be undertaken by standards developers
- Other activities as needed, e.g., topical workshops
America Makes & ANSI Additive Manufacturing Standardization Collaborative (AMSC) Working Groups (WGs) and Co-Chairs

- **Design WG Co-chairs:** John Schmelzle (NAVAIR) and TBD

- **Process and Materials WG Co-chairs:** Todd Rockstroh (GE Aviation) and Art Kracke (AAK Consulting LLC)
  - 4 Subgroups (SG): Precursor Materials, Process Control, Post-Processing, Finished Materials

- **Qualification & Certification (Q&C) Co-chairs:** Armen Kurdian (U.S. Navy) and TBD

- **Maintenance WG Co-chairs:** David Coyle (NAVSUP WSS) and Michele Hanna (Lockheed Martin)
Additive Manufacturing for Maintenance and Sustainment Advisory Group (AG)

- America Makes Additive Manufacturing for Maintenance and Sustainment Advisory Group (AM Members Only)
- Technology Roadmap AG
- Specs, Standards, and Schemas AG
- Commercial Industry Working Group
- AM Solutions for MICAP Parts Working Group
- AM for Sustainment Business Model Wargame Working Group
- OSD Additive Manufacturing Maintenance Operations (AMMO) Working Group
Additive Manufacturing (AM) Business Model Wargame

Understanding the Commercial Considerations

Dates: 9-10 May 2016
Location: Lockheed Martin Corporation – Center for Innovation
8000 Harbor View Blvd, Suffolk Virginia 23435

The Simulation at a Glance: The intent of the wargame is to illuminate the required business transactions when the DoD requires critical and non-critical parts be additively manufactured at a DoD depot location or at a 3rd party location in support of an immediate readiness goal. The wargame will also include assessing commercial gaps and challenges that may be discovered during this simulation in order to begin developing the necessary environment to support the continued adoption of Additive Manufacturing (AM) capabilities.

Outcomes: The wargame exercise will identify issue sets, frame up potential solutions, test government and industry readiness to exercise solutions, and provide next steps for further consideration.
# Game Move One: RFP Release and Reaction

<table>
<thead>
<tr>
<th>Time</th>
<th>Government Team</th>
<th>Industry Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 to 1:00</td>
<td>Lunch/Networking and Game Kick Off</td>
<td></td>
</tr>
</tbody>
</table>
| 1:00 to 3:00 | **Government Team:** Formulate Requirements, Draft and release RFP  
**Industry Teams:** Formulate Questions and Proposal Strategy |                                         |
| 3:00 to 5:00 | **Government Team:** Holds Individual Meetings, Develop Evaluation Criteria  
**Industry Teams:** Develop proposal briefings, including pricing |                                         |
| 5:00 to 5:30 | Move One Closing Comments               |                                         |
| 5:30 to 6:30 | Networking Reception                    |                                         |
| 7:00 to ?    | Game Facilitators Prep for Day Two      |                                         |

**Government Team**  
This team will run the scenario with both Industry teams working both RFPs. This will identify contracting and procurement issues on the Government side in both RFP scenarios.

**Industry Team 1**  
This team will run the scenario reacting to RFP 1. This will illuminate the issues, risks, and solutions around the Government procuring IP for organic or 3rd party AM.

**Industry Team 2**  
Will run the scenario Reacting to RFP 2. This will address the problem sets surrounding a Government ask for the OEM, direct competitors, or AM focused 3rd parties to maintain control of the IP in a critical need situation.
# Game Move Two: RFP Release and Reaction

<table>
<thead>
<tr>
<th>Time</th>
<th>Government Team</th>
<th>Industry Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 to 10:00</td>
<td>Government Team: Reviews Proposals</td>
<td>Industry Teams: Brief proposals and then consider negotiating strategies</td>
</tr>
<tr>
<td></td>
<td>Industry Teams: Evaluate and Conduct second meeting as necessary</td>
<td></td>
</tr>
<tr>
<td>10:00 to 12:00</td>
<td>Government Team: Evaluate and Conduct second meeting as necessary</td>
<td>Industry Team: Revise proposals as required</td>
</tr>
<tr>
<td>12:00 to 1:00</td>
<td>Move Two Closing Comments, Lunch, &amp; Networking</td>
<td></td>
</tr>
</tbody>
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**Government Team**

This team will run the scenario with both Industry teams working both RFPs. This will identify contracting and procurement issues on the Government side in both RFP scenarios.

**Industry Team 1**

This team will run the scenario reacting to RFP 1. This will illuminate the issues, risks, and solutions around the Government procuring IP for organic or 3rd party AM.

**Industry Team 2**

Will run the scenario Reacting to RFP 2. This will address the problem sets surrounding a Government ask for the OEM, direct competitors, or AM focused 3rd parties to maintain control of the IP in a critical need situation.
# Roles – Who We Need and Why

<table>
<thead>
<tr>
<th>Function</th>
<th>What do they do?</th>
<th>Why should we include them?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement &amp; Contracting</td>
<td>• Evaluate responses to RFPs and structure contracts</td>
<td>• Provide insight into the procurement of specific technology and equipment</td>
</tr>
<tr>
<td>Budgeting &amp; Finance</td>
<td>• Provide funding for contracts that maintain the supply chain</td>
<td>• Provide insight into government budgetary constraints and regulation</td>
</tr>
<tr>
<td>Mission Support</td>
<td>• Plan for and acquire parts for mission critical maintenance</td>
<td>• Possess on-the-ground experience interacting with mission critical supply chain</td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>• Manage the sourcing and procurement of mission critical parts</td>
<td>• Understand the procedures around last-minute requests for mission critical parts</td>
</tr>
<tr>
<td>Policy Officer</td>
<td>• Assigns responsibilities, and provides procedures governing DoD policy</td>
<td>• Provide expertise as it pertains to oversight, compliance, and DoD policies</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales &amp; Contracts Management</td>
<td>• Manage responses to RFPs and maintain existing contracts</td>
<td>• Provide insight into what incentivizes industry partners to respond to government RFPs</td>
</tr>
<tr>
<td>Intellectual Property &amp; Legal</td>
<td>• Manage intellectual property rights and patents for the company</td>
<td>• Demonstrate the legal implications of sharing IP with government or 3rd parties</td>
</tr>
<tr>
<td>Supply Chain &amp; Manufacturing Ops</td>
<td>• Manage demand planning and manufacturing of mission critical parts</td>
<td>• Determine the approach for manufacturing and stocking ideal quantities of parts</td>
</tr>
</tbody>
</table>
When America Makes America Works

America Makes

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