National Additive Manufacturing Innovation Institute (NAMII)

NASEO
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OUTLINE

- **Chronology: Announcement to BAA to proposal submission**
- **NAMII organization, partners, operations**
- **Contract announcement and ribbon cutting**
- **Next steps**
- **Energy opportunities for AM**
- **Lessons from previous technology development**

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National Network for Manufacturing Innovation

On March 9, 2012, President Obama announced a new proposal for a National Network for Manufacturing Innovation (NNMI) to establish up to fifteen Institutes for Manufacturing Innovation around the country.

Objectives of NNMI:

- accelerate innovation and transition industrially-relevant manufacturing technologies
- bring together large and small companies, academia, federal agencies, and the states
- bridge the gap between basic research and product technology transition (TRL 4 – 7)
- provide shared assets to help companies access cutting-edge capabilities and equipment
- create an environment to educate and train students and workers

National Additive Manufacturing Innovation Institute (NAMII)

Technology Focus Area: Additive manufacturing is of strong interest to the DoD, DOE, and other participating civilian agencies, and is ripe with potential for technology transition.

Pilot Institute: Awarded to National Center for Defense Manufacturing and Machining on August 16, 2012

NAMII Sequence of events

NMII announced March 9, 2012

Political support – Join PA, OH, WV resources (manufacturing heredity, AM activity, swing states)

Contact potential partners – prime contractors, SMEs, universities, community colleges

Solicit letters of support – provide model letter, include cash and in-kind contributions

Develop proposed organizational structure

- **NCDMM prime (non-profit, administrative infrastructure in place, reached sustainability)**
- **NAMII organized as subset of NCDMM**
- **Technical Advisory Panel, Governance Board, Executive Committee**
- **Technology hub to support startups**

Develop proposed mode of operation

- **Project development, research scope, roadmap**
- **Digital thread – integrated supply chain, open architecture**
- **Sustainability thread – environmental soundness**
- **Education and training thread**
- **Shared resources (equipment in technology hub)**
- **Focus on sustainable business**

NAMII Sequence of events (continued)

BAA on May 15, 2012

Proposal planning – meet requirements of BAA

- **35 pages (12 pt., double spaced) + 3 example projects + resumes + cost proposal**
- **Business Plan – Business sustainability, IP, Innovation strategy, Management structure, Partners and relationships, Recruitment, Education and training, Technology dissemination**
- **Technical Plan – Process development, Materials research, Open architecture development Personnel, Schedule, Statement of Work**
- **3 Example projects**

Proposal writing – assemble players, assign writing tasks, meet in war room in YBI

Proposal delivered June 14, 2012

Rapid review process; 12 proposals received

NCDMM informed of selection July 15; Response to Negotiation issues

Announcement on August 16, 2012 at M-7 Technologies in Youngstown OH

Refurbishment of abandoned furniture warehouse in Youngstown for NAMII Headquarters

Ribbon cutting on September 15, 2012

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National Additive Manufacturing Innovation Institute

- Development of open architecture additive manufacturing processes that have flexibility in starting raw materials, *in-situ* metrology, and process controls for quality;
- Fabrication of novel hybrid materials at relevant scale with multifunctional properties such as tailored stiffness, electrical conductivity, and cooling passages, including the potential use of direct write and deposition processes;
- Improved deposition rates, surface finish, manufacturing throughput and process reliability, and lower energy density;
- Advanced Manufacturing Enterprise methodologies for enabling rapid design and functional fabrication of current and future DoD platforms through integration of digital designs with reverse engineering techniques using computational tools and mechanisms;
- Advanced methods to rapidly and affordably qualify additive manufacturing processes.

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Education Sector
Research universities
Community colleges
Secondary schools

Private Sector
"Voice of the Customer"
Large Industry
Small Businesses
Entrepreneurs

Public Sector
Federal agencies
National labs
States

NAMII

Innovators:
- Full time applied researchers
- Faculty/students in residence
- Engineers
- Entrepreneurs

Shared Infrastructure:
- Additive Mfg Equipment
- Design & Simulation
- Part Testing
- Demonstration

Links:
- Manufacturing Extension Partnerships
- Other Mfg Innovation Institutes
- International community

Greater Economic Competitiveness

- Innovative and better products and manufacturing technologies
- Spin-off Companies
- Highly Skilled Workforce

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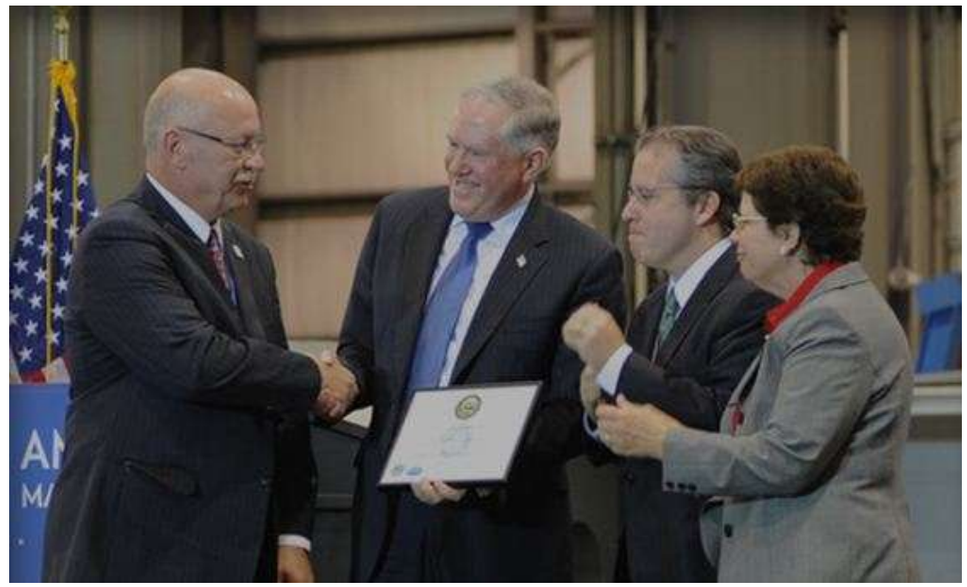
Announcement: Aug 16, 2012

Prime Awardee: National Center for Defense Mfg. & Machining (NCDMM)

- Providing ~$40M cost share
  - ~ $20M from industry
  - ~ $48M available for projects
- Strong leveraging of equipment and existing resources
- Strong business development
- Ties to many organic facilities
- Tiered membership-based model



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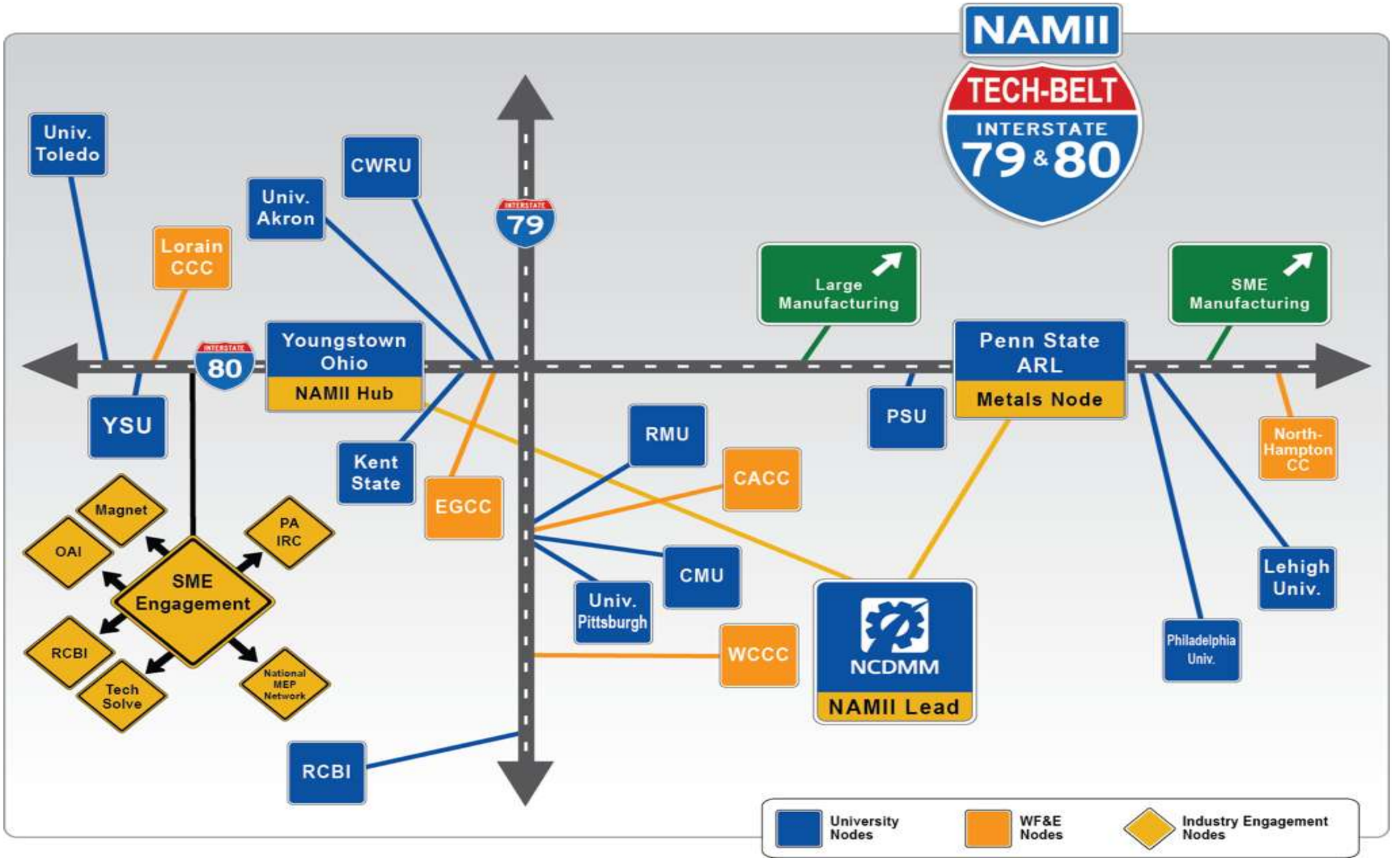
A REGIONAL Center of Excellence, with a vision for NATIONAL PRESENCE



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NAMII Initial Partners

Industry

AM Materials
Allegheny Technologies
FMW Composite Systems
Lubrizol
Oxford Performance Materials
Plextronix
RTI
Touchstone

AM Equipment
ExOne
Laser Technology Associates
MicroFab Technologies
nScrypt
Optomec
POM
Sciaky
Stratasys

AM Manufacturing
AlphaMicron
FMW Composite Systems
Kent Displays
Morris Technologies
Paramount Industries

Platform Systems
Boeing
GE Transportation
General Dynamics
Goodyear
Honeywell
Johnson Controls
Kennametal
Lockheed-Martin
Northrop Grumman
OSRAM Sylvania
Parker Hannifin
Timken
Westinghouse Nuclear

Inspection
M-7 Technologies
Stratonics

Software
AST2
Autodesk
IBM

Manufacturing Support

Manufacturing Extension Partners
PA MEP Network (IRCs)
OH MEP Network

Industry Organizations/TBEDs
BFTP
EIO
JumpStart
OAI
Nortech
Wohlers Associates

Workforce Training

North Eastern Ohio
Eastern Gateway CC
Lorain CCC
Youngstown State Univ.

Western Pennsylvania
CC of Allegheny C
Robert Morris Univ.
Westmoreland CCC

Eastern Pennsylvania
Northampton CC
Penn College of Technology
Penn State University

West Virginia
RCBI @ Marshall Univ.

NAMII Hub
Northeast Ohio Facility

National Center for Defense Manufacturing and Machining

Research Universities*

Carnegie Mellon University (Automation)

Case Western Reserve University (Micro/Nano)

Kent State University (Sensors)

Lehigh University (Composites)

Penn State University, ARL (Metal SLS, E-beam)

University of Akron (Polymer/Ceramic LOM)

University of Pittsburgh (Medical)

Government

Army ARDEC
ECDC
ManTech
NETL
NUWC

Manufacturing & Standards Organizations

AMT
MTConnect Institute
NDMEC
NIST
SME

*Proposed thrust lead area in parentheses

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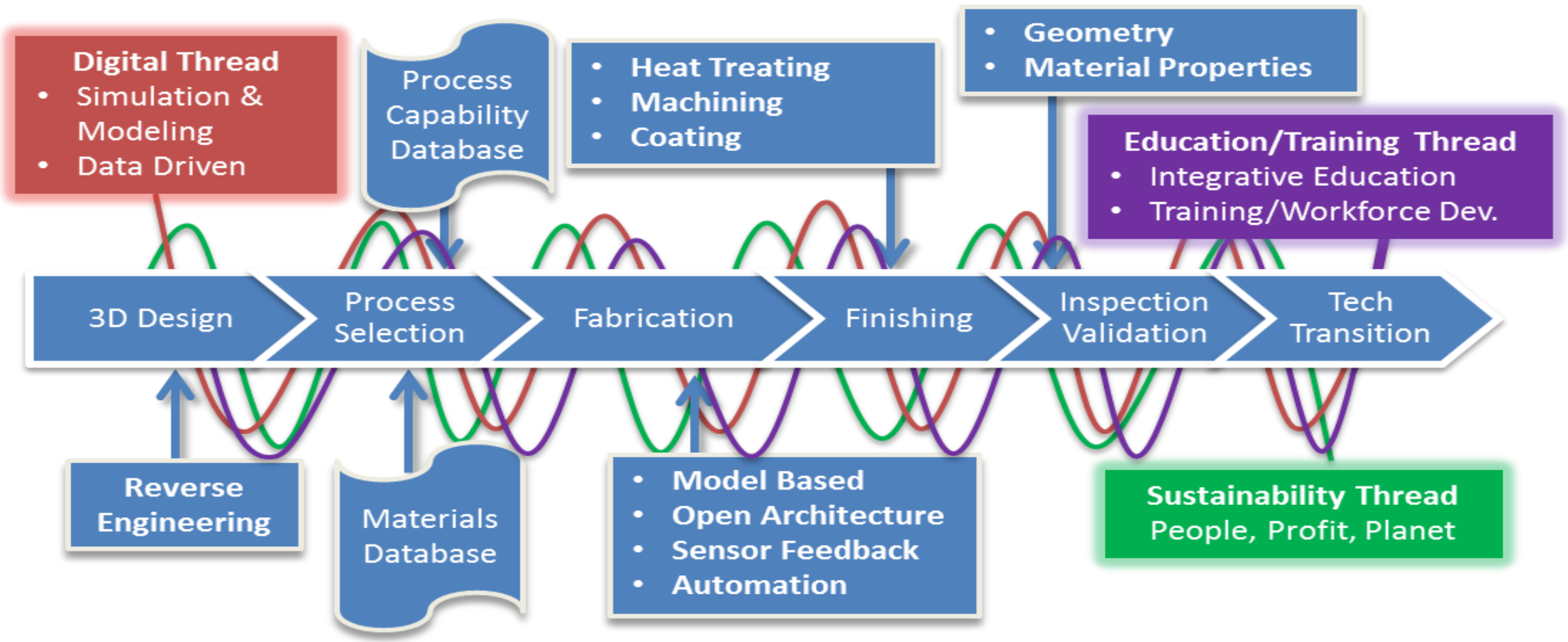
Strong, Holistic, Integrated Technology Plan



- Process development: metals, polymers, ceramics, electronics, hybrid materials
- Digital thread / AME
- Specialized, portable AM systems
- Open Architecture
- Process planning

- Process Control
- Material Development
- Component Design

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NAMII Governance – *Shared Leadership*

Governance Board*
Technical strategy, program operating guidance

Executive Committee**
"Champions" - Vision, Policy and Long-term Strategy and Planning

NCDMM BOD

NCDMM Pres/Exec Director

NAMII Director

OSD ManTech
(Mfg and Ind. Base Policy)
Gov't Co-op Agreement
Program Manager

Technical Advisory Board
(12 gov't members)
Link to Gov't Agencies, Technical Strategy, Program Operating Guidance

Deputy Director:
Technology Development
- Facility Management
- Project Management
- IP Management

Deputy Director:
Technology Transition
- Outreach & Engagement
- Technology Dissemination
- Conferences & Events

Deputy Director:
Advanced Manufacturing Enterprise
- SME Coordination
- Incubation/Commercialization
- Supply chain and design modeling
- Digital Thread
- Sustainability Thread

Deputy Director:
Workforce/Educational Outreach
- Education Outreach
- STEM activities
- Workforce Training
- Integrated Education thread

= Direct Oversight/Responsibility
= Guidance/Direction

***Governance Board:** All 1st and 2nd Tier Members, small business members, MEPs & Econ Development Groups, States Ex-officio

****Executive Committee** : Elected by Governance Board & Tech Advisory Board, 1 year rotating positions

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Technology Incubation Hub (9/27 Ribbon Cutting)
Youngstown Business Incubator Annex Building

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NAMII Technology Incubation Hub

Youngstown OH – Heart of America's Manufacturing

- Youngstown Business Incubator
- Downtown Youngstown - vibrant, revitalized location
  - Rich history of manufacturing and incumbent labor pool with manufacturing background
- Geographic center of manufacturing activity stretching from Northern Ohio through Pittsburgh to Eastern Pennsylvania
  - Roughly 50% of the U.S. population lives within 500 miles
- Region is well-poised for economic rebirth
  - Steel industry is being reborn (2010 V&M Star plant expansion)
  - High technology, advanced manufacturing
  - Focal point for entrepreneurs

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AM Equipment Entrusted To Date

Equipment	Manufacturer	Model
Fused Deposition Modeling	Stratasys	Fortus 400MC
Selective Laser Melting	Renishaw	AM 250
Bonded Plaster	Z-Corp	Z-Printer 310
Selective Laser Sintering	3D Systems	SLS sPro 60
Wax Depositon	3D Systems	Thermojet
Bonded Metals & Ceramics	ExOne	M-Lab
Material Extrusion (3D Printer)	3D Systems	Cube
Direct Metal Deposition	POM	Synergy 5
Material Extrusion (3D Printer)	3DCAD Printer	Hyrel
Plunge / "Dry" EDM	Sodick (w/ POM Upgrades)	AQ55L

Ancillary/support equipment: CNC milling machine, ovens, chillers, etc.

Next Steps

November 2013

- Initial project call

January 2012

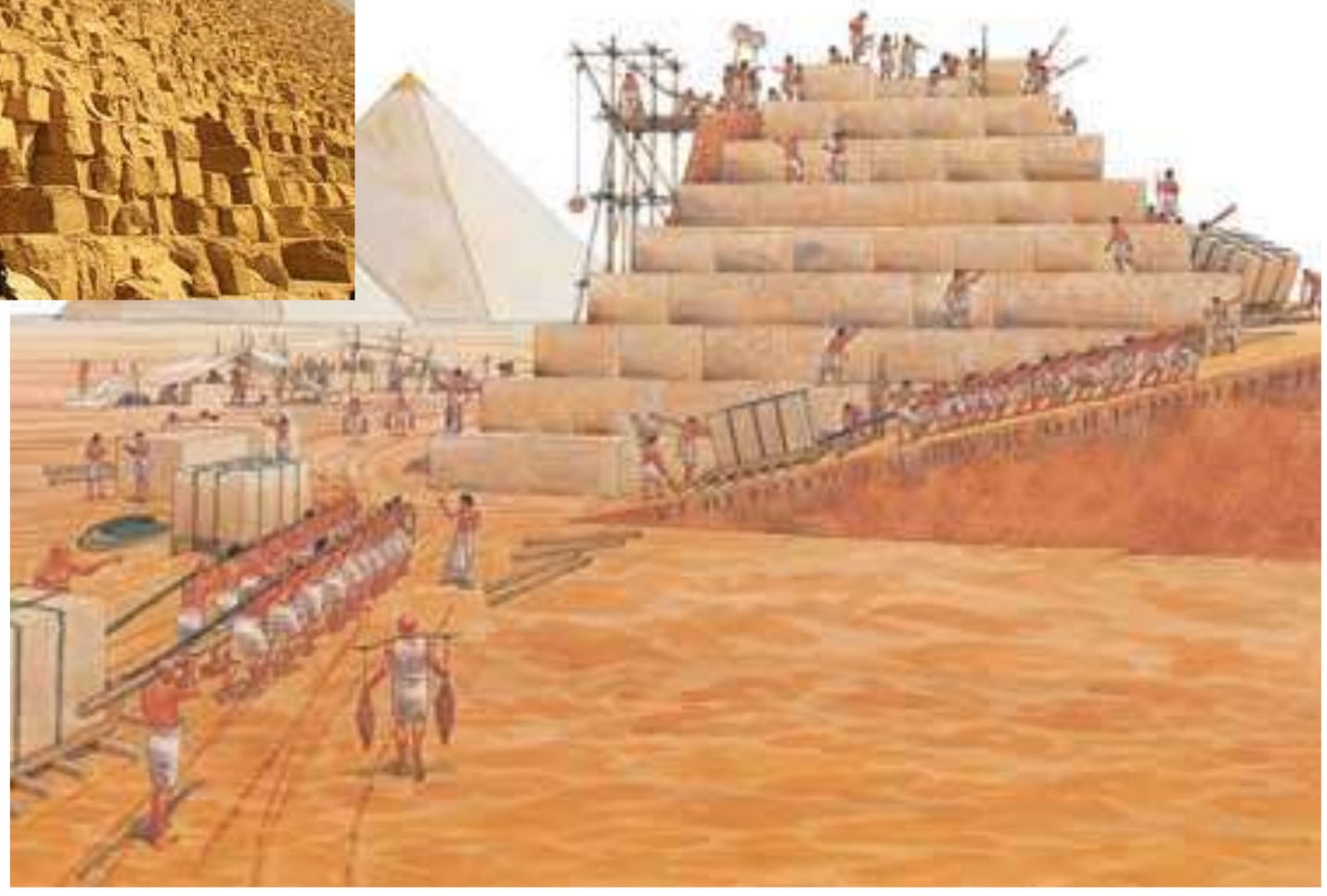
- Complete Strawman National AM Roadmap and project call criteria
- Initial project proposals received

February 2013

- Projects selected

March 2013

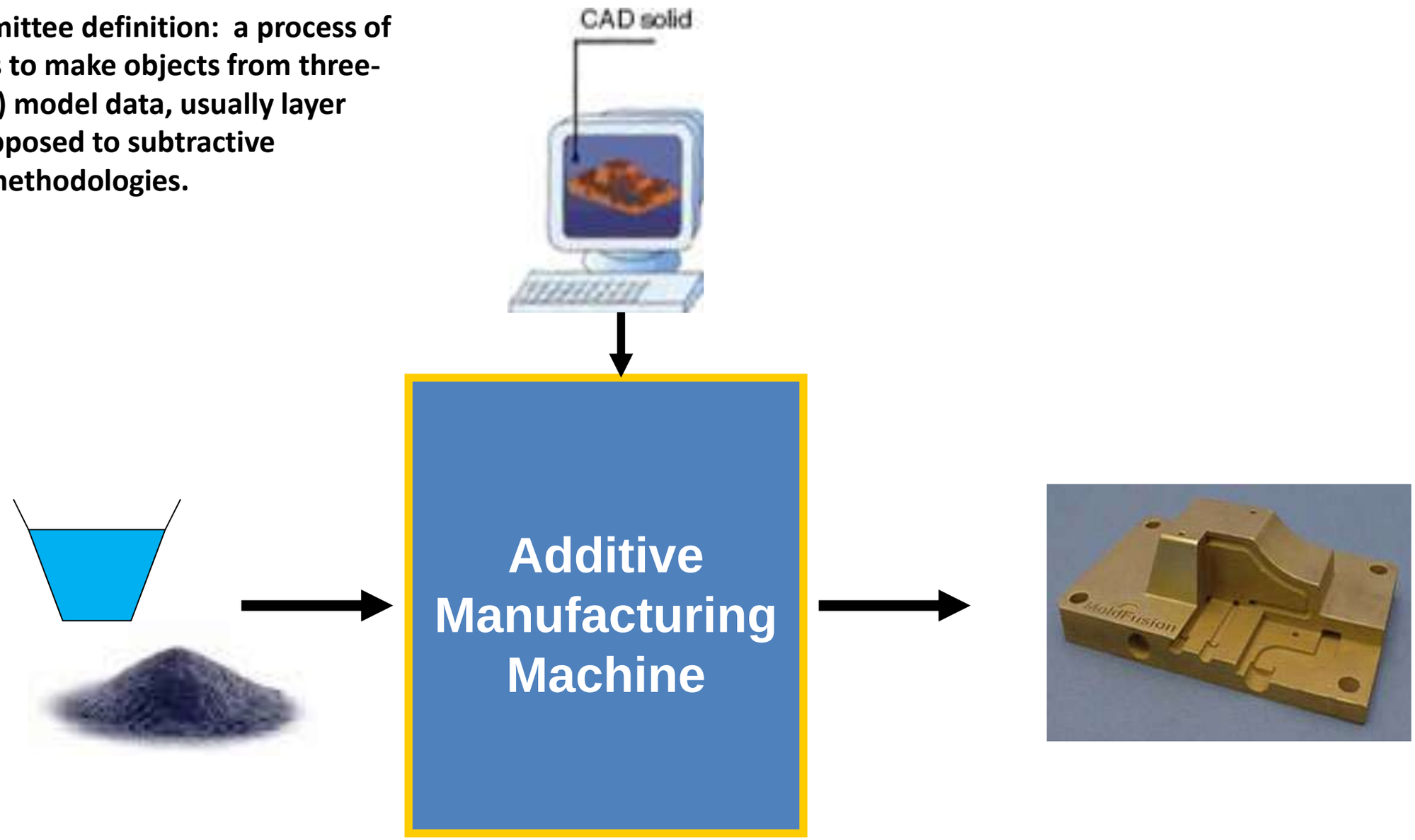
- Project announcements and kick-off



Additive manufacturing is as old as the pyramids

Additive Manufacturing

ASTM F-42 committee definition: a process of joining materials to make objects from three-dimensional (3D) model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.



Selective transformation of material having no form (liquid or powder)

into a

solid form prescribed by a CAD solid model

ASTM F-42 Classification of AM Processes

Metal Powder

- **Powder Bed Fusion** → **Powder Bed**
  - ***Laser Processes***
    - ***Selective Laser Melting (SLM)***
    - ***Selective Laser Sintering (SLS)***
    - ***Selective Mask Sintering (SMS)***
  - ***Electron Beam Melting (EBM)***
- **Binder Jetting**
  - ***3DPrinting***
- **Directed Energy Deposition**
  - ***Powder Feed (LENS)***
  - ***Wire Feed***

Polymer

- **Polymerization**
  - ***Stereolithography (SLA)***
  - ***Flash Curing***
  - ***Film Transfer Imaging (FTI)***
- **Extrusion**
  - ***Fused Deposition Modeling (FDM)***
- **Material Jetting**
  - ***Drop-on-Demand (DoD)***
  - ***Multijet Modeling***
- **Lamination**
  - ***Solidica***
  - ***Ultrasonic Consolidation (UC)***

Energy Opportunities in AM

Drill Heads
(with internal fluid channels)

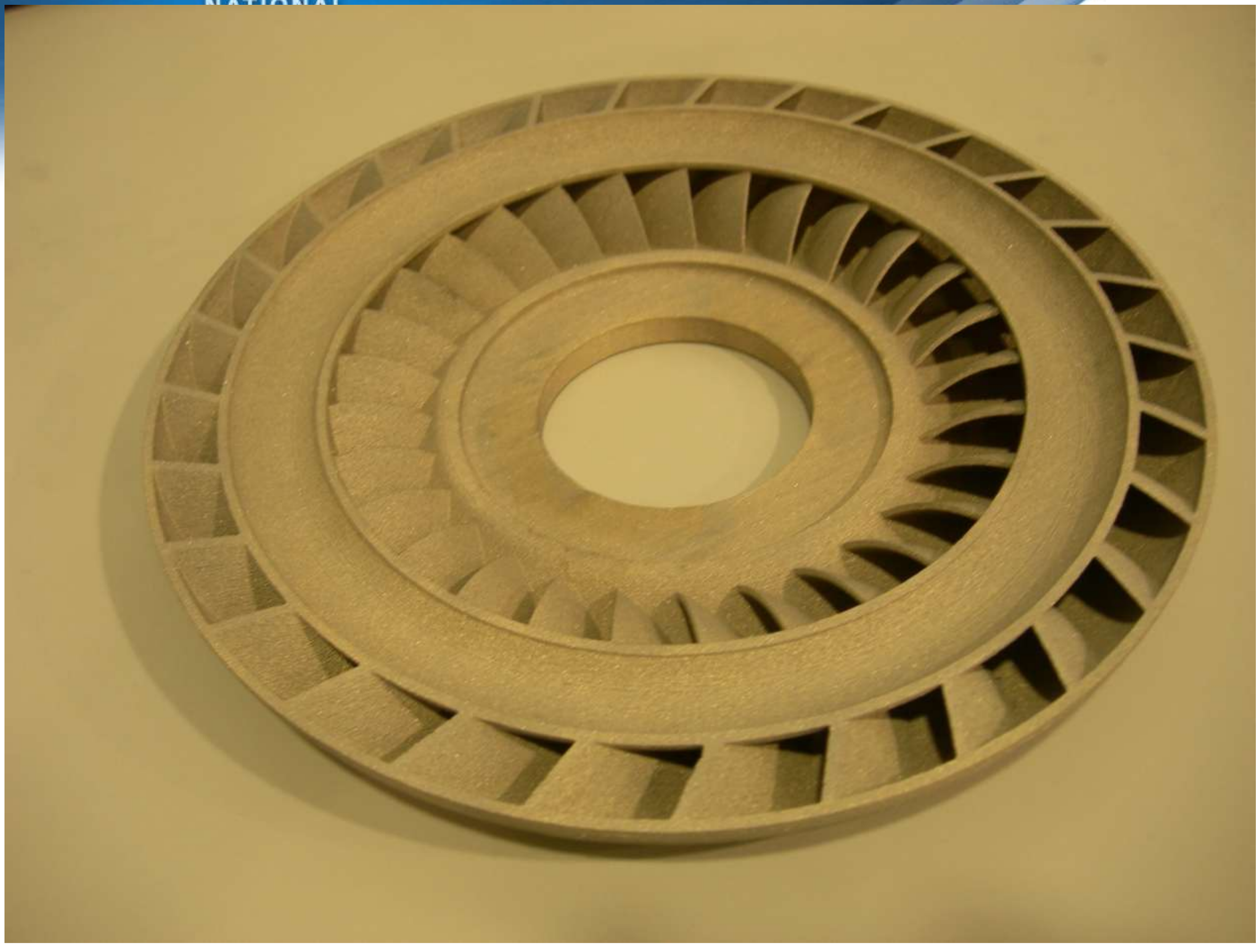
Complement mass production processes
(low-volume, functional prototypes)

Large parts without tooling
(complement to forging, HIP, CIP)

Complex 3D parts
(beyond capabilities of conventional processes)

Multi-functional parts

Functionally gradient parts



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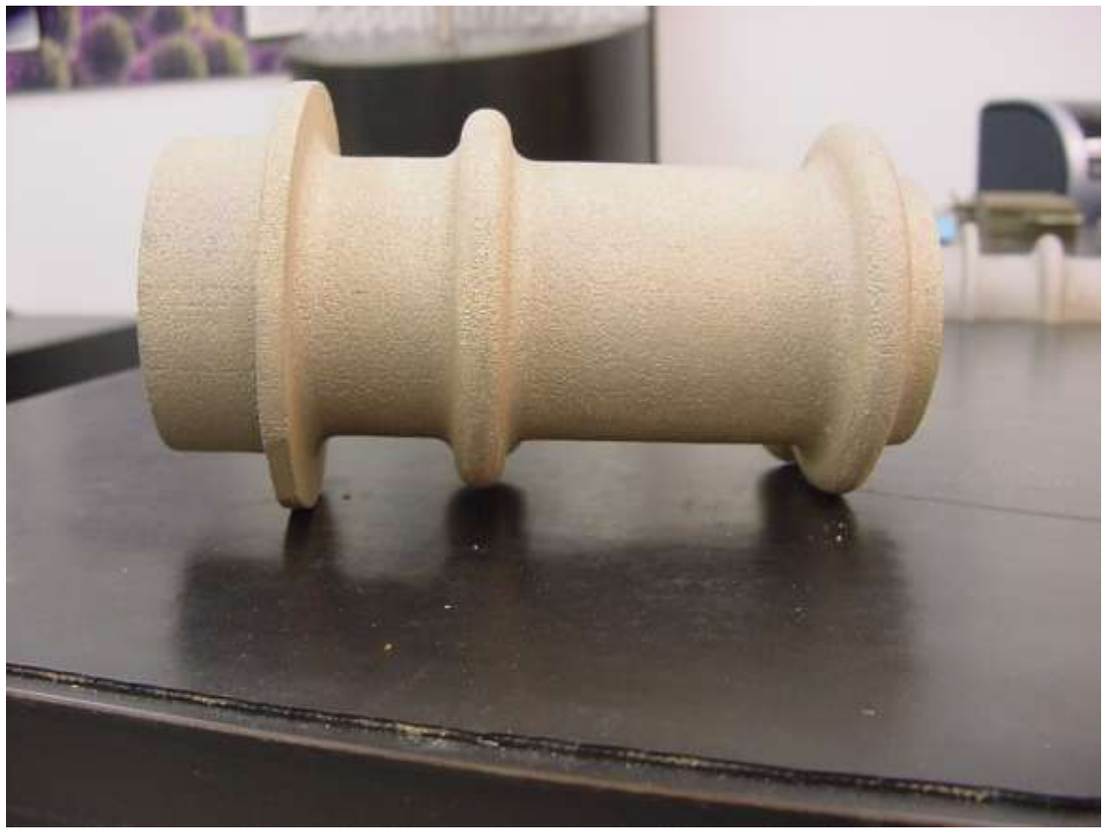
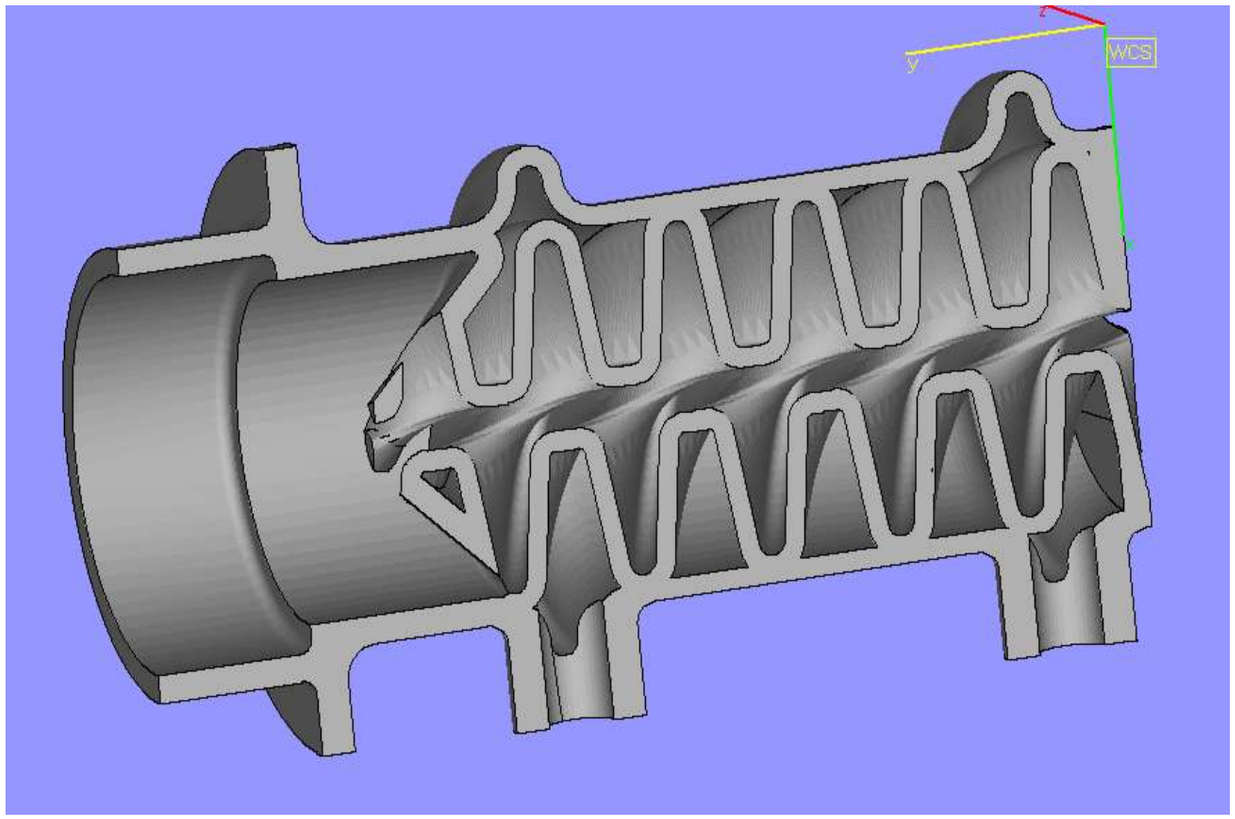
Functional Prototypes





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Patterns for investment casting

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Challenges for AM

Reduce build times

Improve reproducibility

Develop specifications

Generate material property data

Improve surface finish

Manage residual stress and distortion

Eliminate porosity

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Lessons Learned from Powder Forging for AM as an Emerging Technology

Basic research required

Blend mechanics and metallurgy

Accelerated by Federal funding

Was not the elixir for all PM ills

Economic applications evolved

Closed solutions not embraced