The Role of Engineering Education in the U.S. Advanced Manufacturing Partnership (AMP) 2.0

Mike Molnar
Advanced Manufacturing National Program Office
www.manufacturing.gov
1. The National Network for Manufacturing Innovation
2. Academic Participation in the NNMI
3. AMP 2.0 and Future Engineering Education
Interagency Advanced Manufacturing National Program Office (AMNPO)

Executive Office of the President

Advanced Manufacturing National Program Office (housed at DOC - NIST)
U.S. Trade Balance of Advanced Technology

Swung to historic deficit, lost 1/3rd of workforce

- 11% of U.S. GDP, 12 million U.S. jobs
- ~ half of U.S. Exports
- Nearly 20% of the world’s manufactured value added

Source: Census Bureau
Products invented here, now made elsewhere - not driven by labor cost
President’s Council of Advisors on Science and Technology
Advanced Manufacturing Partnership Steering Committee

18 Leaders from Industry and Academia

Steering Committee Co-Chairs

- Susan Hockfield, President Emerita, Massachusetts Institute of Technology
- Andrew Liveris, President, Chairman & CEO, Dow
- Bob McDonald, President, Procter & Gamble
- John Hennessy, President, Stanford University
- Wendell Weeks, CEO, Corning
- Paul Otellini, CEO, Intel
- Louis Chenevert, CEO, United Technologies
- G.P. “Bud” Peterson, President, Georgia Tech
- Richard Harshman, CEO, GE
- Alan Mulally, CEO, Ford
- William Weldon, CEO, Johnson & Johnson
- Bob McDonald, President, Procter & Gamble
- Bob McDonald, President, Procter & Gamble
- Bob McDonald, President, Procter & Gamble
- Curt Hartman, Interim CEO, VP & CFO, Stryker

Leaders from Industry and Academia

- Robert Birgeneau, Chancellor, University of California, Berkeley
- Jared Cohon, President, Carnegie Mellon University
- Mary Sue Coleman, President, University of Michigan
- Douglas Oberhelman, CEO, Caterpillar
- David Cote, CEO, Honeywell
- Robert Birgeneau, Chancellor, University of California, Berkeley
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AMP Mission and Results

AMP Mission:
- Encourage approaches that sustain and grow U.S. leadership in advanced manufacturing, making the U.S. a magnet for jobs and investment; fostering broad, long-term collaboration among industry, academia, and government partners to drive advances in U.S. innovation and workforce capabilities.

Inaugural AMP achievements:
- Issued 16 recommendations across:
  - Enabling innovation
  - Securing the talent pipeline
  - Improving the business climate
- Spurred critical national initiatives, including the National Network for Manufacturing Innovation (NNMI)
The “Scale-up” Gap or Missing Middle

Common terms
- The “valley of death”
- The “missing Bell Labs”
- The “industrial commons”

Basic R&D

Commercialization

Funding/Investment

High

Government and universities

Low

Manufacturing-innovation process

GAP

Private sector

Basic manufacturing research
Proof of concept
Production in laboratory
Capacity to produce prototype
Capability in production environment
Demonstration of production rates
The NNMI Story Today…

15 Institutes + Pilot

Full-size Institutes

Vision of 45 Institutes

6 x 2014 Institutes

March 2012

January 2013

January 2014

Congressional Authorization

Formation of Network and More New Institutes

Additive Mfg Pilot

Power Electronics

Digital Mfg & Design

Light-weight Metals

Public Comment

PCAST/AMP Call for NNMI

NNMI Framework

2014

2014

2014

2014
Designing, Building and Growing the NNMI
Presidental Initiative and Pilot

15 Institutes + Pilot

January 2013
Additive Mfg Pilot

January 2013
Power Electronics

January 2014
Digital Mfg & Design

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Vision of 45 Institutes

NNMI Framework

6 x 2014 Institutes

Public Comment

6 x 2014 Institutes
National Network for Manufacturing Innovation

“Sparking this network of innovation across the country, it will create jobs and will keep America leading in manufacturing...”
President Obama, March 9, 2012

- President asks Congress to authorize initial network of up to 15 Manufacturing Innovation Institutes
- President directs Agencies to work together on Pilot Institute, while designing Institutes with input from Industry and Academia
Additive Manufacturing Innovation Institute
Youngstown Ohio

Prime Awardee: National Center for Defense Manufacturing and Machining

- Initial $30M federal investment matched by $40M industry, state/local
- Strong leveraging of equipment, existing resources
- Strong business development
- Ties to many organic facilities
- Tiered membership-based model, low cost to small business and nonprofits
Why Additive Manufacturing?
High Potential for Transformative Impact

“20% of output of 3D printers is now final products, rather than prototypes. By 2020 it may be 50%.” – The Economist (2011)

Projected AM Sales (products and services)

Government agency investments and interest

Consumer Product Market
Designing, Building and Growing the NNMI
Public Input and the NNMI Design

- 15 Institutes + Pilot
- Full-size Institutes
- Vision of 45 Institutes
- 6 x 2014 Institutes

March 2012

Additive

January 2013

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NNMI Framework

Public Input and the NNMI Design
Public Engagement on Design
Workshops & Request for Information

Broad & Diverse Stakeholder Input
1,200 voices on the NNMI Design!

Industry 31%
Academia 31%
Research & non-profits 8%
Federal State & Local Gov’t 14%
Economic Development 6%
All Other 10%

Rensselaer Polytechnic Institute
Troy New York

Cuyahoga Community College
Cleveland Ohio

University of Colorado
Boulder, Colorado

National Academies Beckman Center
Irvine California

U.S. Space and Rocket Center
Huntsville, Alabama
The Institute Design
Creating the space for Industry & Academia to collaborate

White House Report
NNMI Framework Design
January 2013
Institute Activities
Not just Applied R&D – solutions, access & workforce

Applied Research & Demo projects for
• reducing cost/risk on commercializing new tech.
• Solving pre-competitive industrial problems

Tech Integration - Development of innovative methodologies and practices for supply chain integration

Small/Medium Enterprises
• Engagement with small and medium-sized manufacturing enterprises (SMEs).

Education, technical skills and Workforce development
Education and training at all levels for workforce development
So what does a Manufacturing Innovation Institute actually do?

How does an Industry-Academia Public-Private Partnership plan, develop and “de-risk” new technologies and materials?

How can these help Industry develop new products and processes for sustained competitiveness?
Why America Makes?

America Makes creates mechanisms for collaboration...

Pooling Resources / Pooling Risks

Cooperative Development of:
- Material Specs
- Process Specs
- Material Databases
- Design Rules
- Application Guides

Solving Problems Collaboratively

Public/Private Funded Projects
Crowd Funded Projects

Leveraging Community Knowledge

Knowledge Base, Online Collaboration Tools, Databases, Specifications, Application Guides, Curriculum
National Additive Manufacturing Innovation Institute

Cooperative Development & Maturation

Competitive Development & Delivery

Universities

National Labs

Manufacturing Demonstration Facilities

Value Added Providers

Industry End Users

TRL/MRL 1-3

TRL/MRL 4-7

TRL/MRL 8-10

America Makes
Governance Structure – Shared Leadership

- **Executive Committee (11):** Industry, for-profit organization (2), Non-profit association (2), Academic (2), Government (3), At-large (2)
- **Governance Board (35):** Lead and Full Members, states ex-officio

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**Deputy Director: Technology Development**
- Project Management
- IP Management
- Sustainability Thread

**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

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

Community
• Formalized community looking to leverage AM Technologies
• Leverage learning curves
• Cooperatively solve similar issues
• Direct future equipment, material, and software development
• Technical strategy input

Work Force Development
• Pre-K to grey training resources
• Immersive training/learning at America Makes facility

Projects
• Lead America Makes directed project calls
• Team with America Makes & members to win additional government project calls
• Use America Makes resources for targeted company projects

Enterprise Data
• Processing & Application data
• Material properties
• Supply chain
• Analysis
Project Call #2

- Eight *Priority Topics* Selected Based on Crowd-Sourced Roadmapping Process

- Solicitation Issued 8/29/13; Proposals Received 10/31/13
- Announced 15 Project Awards 1/21/14
- Awarding $9M of America Makes Funding with $10.3 million matching cost share from awarded project teams = $19.3M total funding
Designing, Building and Growing the NNMI
New Manufacturing Innovation Institutes

- 15 Institutes + Pilot
- Full-size Institutes
- Vision of 45 Institutes
- 6 x 2014 Institutes

March 2012

Additive Mfg Pilot
Power Electronics
Digital Mfg & Design
Light-weight Metals

Congressional Authorization
Formation of Network and More New Institutes

PCAST/AMP Call for NNMI
NNMI Framework

2014
2014
“In my State of the Union Address, I also asked Congress to build on a successful pilot program and create 15 manufacturing innovation institutes that connect businesses, universities, and federal agencies to turn communities left behind by global competition into global centers of high-tech jobs.

“Today, I’m asking Congress to build on the bipartisan support for this idea and triple that number to 45 – creating a network of these hubs and guaranteeing that the next revolution in manufacturing is Made in America.”

July 30, 2013

With Congressional Legislation

- Open competition on ANY topic proposed by Industry and Academia
- Selection of topics made on merit
  - let best proposals of greatest impact to US industry move ahead
- Institutes by Administrative Action limited to topics Federal agencies need
- Creates capability for enough institutes to form a value-added network
- Provides stable funding and certainty for consortia – path to sustainability
Next Generation Power Electronics Manufacturing Innovation Institute

$70M public investment, $70M match

Lead: North Carolina State University


**Mission:** Develop advanced manufacturing processes that will enable large-scale production of wide bandgap semiconductors, which allow power electronics components to be smaller, faster and more efficient than silicon.

Poised to revolutionize the energy efficiency of power control and conversion

President Obama
North Carolina State University, January 15, 2014
We also have the chance, right now, to beat other countries in the race for the next wave of high-tech manufacturing jobs. My administration has launched two hubs for high-tech manufacturing in Raleigh and Youngstown, where we’ve connected businesses to research universities that can help America lead the world in advanced technologies.

Tonight, I’m announcing we’ll launch six more this year. Bipartisan bills in both houses could double the number of these hubs and the jobs they create. So get those bills to my desk and put more Americans back to work.

President Barack Obama
January 28, 2014

Six full-scale manufacturing innovation institutes to be awarded in 2014
Designing, Building and Growing the NNMI

What was just announced?

15 Institutes + Pilot

Full-size Institutes

Vision of 45 Institutes

6 x 2014 Institutes

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Formation of Network and More New Institutes
“That’s what these new hubs are all about. They’re partnerships – they bring together companies and universities to develop cutting-edge technology, train workers to use that technology, and make sure research is turned into real-world products made by American workers.”
Lightweight and Modern Metals Manufacturing Innovation Institute

Mission: Provide the National focus on expanding US competitiveness and innovation, and facilitating the transition of these capabilities and new technologies to the industrial base for full-scale application.

Positioned to expand the US Industrial base for new products and technologies for commercial and USG demands that utilize new, lightweight high-performing metals.

$70M public investment, $70M match
Lead: EWI
Hub location: Canton, Michigan
Regional location: I-75 Corridor
• 34 Industry Partners
• 9 Universities and Labs
• 17 Other Organizations
Digital Manufacturing and Design Innovation Institute

$70M public investment, ~$240M match

Lead: UI Labs

Hub location: Chicago, Illinois

- 41 Companies
- 23 Universities and Labs
- 9 Other Organizations

Mission: Establish a state-of-the-art proving ground that links IT tools, standards, models, sensors, controls, practices and skills, and transition these tools to the U.S. design & manufacturing base for full-scale application

Over 3:1 Industry Cost Share
Funding Opportunity Announcement: Advanced Composites Manufacturing Innovation Institute

$70M public investment over five years

Objective
Develop and demonstrate innovative technologies that will, within 10 years, make advanced fiber-reinforced polymer composites at...

50% Lower Cost
Using 75% Less Energy

And reuse or recycle >95% of the material

<table>
<thead>
<tr>
<th>Application</th>
<th>Estimated Current CFC Cost</th>
<th>Institute CFC Cost Reduction Target (2018)</th>
<th>CFC Ultimate Cost Target (2024)</th>
<th>CFC Tensile Strength</th>
<th>CFC Stiffness</th>
<th>Production Volume Cycle Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles (Body Structures)</td>
<td>$26-33/kg</td>
<td>&gt;35%</td>
<td>&lt;$11/kg by 2025 ~60%</td>
<td>0.85GPa (123ksi)</td>
<td>96GPa (14Msi)</td>
<td>100,000 units/yr &lt;3min cycle time (carbon) &lt;5min cycle time (glass)</td>
</tr>
<tr>
<td>Wind (Blades)</td>
<td>$26/kg</td>
<td>&gt;25%</td>
<td>$17/kg ~35%</td>
<td>1.903 GPa (276ksi)</td>
<td>134GPa (19.4Msi)</td>
<td>10,000 units/yr (at &gt;60m length blades)</td>
</tr>
<tr>
<td>Compressed Gas Storage (700 bar – Type IV)</td>
<td>$20-25/kg</td>
<td>&gt;30%</td>
<td>$10-15/kg ~50%</td>
<td>2.55 GPa (370ksi)</td>
<td>135 GPa (20Msi)</td>
<td>500,000 units/yr (carbon fiber)</td>
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Designing, Building and Growing the NNMI

NNMI Next Steps

- 15 Institutes + Pilot
- Full-size Institutes
- Vision of 45 Institutes
- 6 x 2014 Institutes

- March 2012
- January 2013
- January 2014

- Additive Mfg Pilot
- Power Electronics
- Digital Mfg & Design
- Light-weight

- PCAST/AMP Call for NNMI
- NNMI Framework
- Congressional Authorization
  - Formation of Network and More New Institutes

- 2014
The Start of a Network...

Additive Manufacturing

Power Electronics

Digital Manufacturing

Lightweight Metals


2014 Solicitation TBA

2014 Solicitation TBA

2014 Solicitation TBA
NNMI Bipartisan/Bicameral Legislation

Revitalize American Manufacturing & Innovation Act of 2013

Lead Sponsors

Sen. Sherrod Brown
D Ohio

Sen. Roy Blunt
R Missouri

Rep. Tom Reed
R NY-23

Rep. Joe Kennedy
D MA-4

Joint press release: “Their landmark bill would establish a Network for Manufacturing Innovation to position the United States, once again, as the global leader in advanced manufacturing and ensure that the U.S. can out-innovate the rest of the world while creating thousands of high-paying, high-tech manufacturing jobs.”
Potential Future NNMI Topics

Public input identified 135 unique topics

Are you ready to propose your topic?

With congressional authorization will come open solicitation.
Agenda

1. The National Network for Manufacturing Innovation
2. Academic Participation in the NNMI
3. AMP 2.0 and Future Engineering Education
NNMI: Creating the Partnership Space for Academia and Industry

**Institute for Manufacturing Innovation**
- Applied Research
- Technology Development
- Prototype
- Labs/shops
- Mfg. Software Development
- Education and Workforce Development

**Shared Use Facility**
- Manufacturing Demonstrations
- Technology Workshops
- Mfg. Technology Services

**National Network of IMIs**

**Academia**
- Universities & National Labs
- Community Colleges

**Government**
- Federal Government
- State/Local Government
- Economic Development Organization

**Industry**
- Large Manufacturing Companies
- Small & Medium Enterprises
- Start-ups

**Partnership:** *Industry – Academia – Government*

Working better, together to create transformational technologies and build new products and industries
Addressing the Nation’s Advanced Manufacturing Needs – Academe Research linking to Applied/Scale-up R&D –

- **Research Spin-Offs?**
- **Linking Academe Research with TRL4 – TRL7 Needs?**
- **Challenges faced in moving from TRL4 to TRL7?**

**NNMI: New opportunities for Academia in expanded TRL 4-7 R&D**

Development challenges in TRL 4-7 gives rise to further TRL 1-3 research
Linked research to scale-up can open doors to new funding opportunities

New avenues for academe in leveraging funds up through innovation, product development to scale-up

- Leveraging Funding & Resources
  - Gov., VC funding?
  - University IP Commercialization Funds?
  - State Innovation & Capitalization funds?

Innovation hubs, Mfg Development Facilities, Incubators provide facilities to connect universities to enhance US supply chain
Addressing the Nation’s Advanced Manufacturing Needs

Industry Needs to Future Curriculum and Faculty Development

AMP: improved understanding of Industry needs/trends to future educational development

- Modifications to UG/Grad Curriculum?
- Onsite Class assignments in Industry?
- Entrepreneurs Workshops / Boot Camps?
- Professorial Internships?
- Industry Participation within the classroom?
Addressing the Nation’s Advanced Manufacturing Needs

Workforce Skills Standards to new Programs & Modules

Real need to establish standards that have meaning to employers

Growing trend in stackable, modular credentials
Agenda

1. The National Network for Manufacturing Innovation
2. Academic Participation in the NNMI
3. AMP 2.0 and Future Engineering Education
President’s Council of Advisors on Science and Technology
Advanced Manufacturing Partnership 2.0

**AMP Mission:** Encourage approaches that sustain and grow U.S. leadership in advanced manufacturing

AMP 1.0 – 16 Recommendations

**Pillar I:** Enabling Innovation
**Pillar II:** Securing the Talent Pipeline
**Pillar III:** Improving Business Climate

AMP 2.0 focused on Implementation

- Regional engagement and outreach
- Implementation on national initiatives
- Five active Working Teams to issue “letter-reports”

AMP 2.0 Working Teams
1. Transformative manufacturing technologies
2. Demand-driven workforce solutions
3. Supporting implementation of NNMI
4. Technology scale-up policy
5. Improving the Manufacturing image
Launching public-private initiatives to advance transformative manufacturing technologies:

- The AMP SC 2.0 will deploy small expert working teams against two to four of the technologies identified in the initial AMP SC report, with the goal of assessing actions and developing technology strategies for sustained U.S. leadership.

Scaling best-in-class demand-driven workforce solutions to develop technical skills:

- The AMP SC 2.0 will identify the characteristics of successful partnerships and mechanisms to rapidly scale demand-driven workforce solutions in areas of critical skills need; and identify private sector and federal resources to leverage behind these solutions.

Supporting implementation of the National Network for Manufacturing Innovation (NNMI): The AMP SC 2.0 provide tactical input on the implementation of the NNMI to ensure that the Institutes and the Network are appropriately geared towards industry needs and that core implementation issues are addressed.
AMP 2.0 - Working Teams (continued)

4) Scale-up Policy

Addressing core advanced manufacturing policy questions related to new technologies:

- Core manufacturing questions have been identified that currently lack clear solutions.
- The AMP SC 2.0 will task working teams to investigate potential solutions to one to two of these central questions, for example:
  - Solutions to unique barriers that inhibit young firms from scaling new technologies in the U.S.
  - Challenges to rapidly deploying new technologies and processes across the U.S. supply chain

5) Manufacturing Image

Driving excitement and engagement from the science and engineering community:

- Last year the AMP SC recognized the value of engaging this community through a series of specific recommendations.
- The AMP SC 2.0 will spearhead initiatives to implement these recommendations, which could include hosting a possible national advanced manufacturing innovation summit or public awareness campaign.
AMP 2.0 Implementation

- **AMP Steering Committee 2.0**
  - Holding 3 in-person AMP Steering Committee 2.0 meetings (December 3rd, March/April and May/June)

- **AMP 2.0 Outreach and Engagement**
  - Roundtables (focus groups)
    - Manufacturing Imaging
    - Capital Access – 3 video conferencing nodes: east-to-west
    - Financing Scale Up for Established SMEs
  - External Subject Matter Experts (Industry – Academia – Government)
  - State and National Government – Governors & Congress

- **AMP 2.0 Regional Meetings [Hosts]**
  - Atlanta, GA – February 3, 2014 [Georgia Institute of Technology]
  - Akron, OH – April 2, 2014 [University of Akron / United Steelworkers]
  - Troy, NY – April 24, 2014 [Rensselaer Polytechnic Institute / Global Foundries]
  - Cambridge, MA – May 16, 2014 [Massachusetts Institute of Technology]
  - Detroit, MI – June 9, 2014 [University of Michigan / Northrop Grumman Corporation]
Team 2: Demand-Driven Workforce Development

Led by Siemens and South Central College

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<th>GOALS</th>
<th>Scaling best-in-class demand-driven workforce solutions to develop technical skills</th>
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<th>SCOPE OF WORK</th>
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<tr>
<td>Increase <strong>career pathways and “dual credit” opportunities</strong> across education (K-12 schools, community colleges, and Universities) to increase number of qualified technical employees in advanced manufacturing.</td>
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<tr>
<td>Increase <strong>nationally portable, stackable credentialing systems</strong> through certifications and work-based learning elements.</td>
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<td>Establish <strong>internship/apprenticeship models</strong> with industry, trade unions, government and high schools or community colleges which can be implemented in regions across the US.</td>
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<tr>
<td>Develop practical competency based <strong>“bridging modules” for transitioning veterans</strong> focused on private sector manufacturing skills certifications and apprenticeships with DOL/GI Bill funding and support.</td>
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<th>REPORT OF PROGRESS</th>
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<td>The work team has divided into four subteams, one focused on each of the four priorities identified in the SOW.</td>
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<td>Important elements of the models include concepts such as: multiple entry and exit points along career pathways, modularized training programs, “regionality” of the effort and importance of partnerships between industry and academia with local “intermediaries”.</td>
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</table>
## Team 5: The Image of Manufacturing

**Led by Northrop-Grumman and The University of Michigan**

### GOALS
- Implement the recommendations included in the “Report of the Advanced Manufacturing Partnership Steering Committee Annex 5: Outreach Workstream”

### SCOPE OF WORK
- Develop a **new image for advanced manufacturing**
- Develop an **outreach program** for supporting the manufacturing image campaign
- Leverage **regional and national meetings**

### REPORT OF PROGRESS
- **Target Groups** have been identified and prioritized:
  - K-12 communities: parents, teachers and students
  - Technical communities: universities and community colleges
  - Local, State & Federal Policymakers: engaging the manufacturing community to help carry the campaign forward

- **Work has begun to define and focus** messages and outline the associated delivery tactics:
  - Messages include: “manufacturing is a career, not just a job” and is rewarding, exciting, creative and innovative, and new adjectives replacing “The Four D’s”
  - Media, social media, video, AD council, regional and national meetings etc.
  - Working with other stake-holders on manufacturing image

- **Building links** to the action plans that are being developed in the Workforce group
Thank you

For questions or comments, please contact the Advanced Manufacturing National Program Office

amnpo@nist.gov

www.manufacturing.gov

301-975-2830

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