The Digital Manufacturing and Design Innovation Institute (DMDII)

Applying Digital Manufacturing Technologies to Solve Business Problems for Its Partners and the US Industrial Base

11 March, 2015

Prepared for: Manufacturing in America Symposium

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Director of R&D Programs
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Challenge: US losing leadership in manufacturing

ISSUE: Economy, Jobs, and future competitiveness
- When U.S. loses manufacturing base in advanced technology products, we lose ability to innovate on next generation of those products

U.S. Trade Balance for Advanced Technology Products

Source: Census Bureau
The “Scale-up” Gap or Missing Middle

The Need – Create the space for industry and academia to work on industry-relevant problems

- Government investment in private-sector led partnerships
- Addresses the market failure of industry underinvestment in “pre-competitive” applied R&D
- Focus on “de-risking” new technologies and materials to scale-up for U.S. manufacturers

Basic R&D

Commercialization
What forces are driving the digitization of manufacturing operations?

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Separation</strong> of designers and makers has slowed innovation</td>
<td><strong>Digital link</strong> between designers and makers</td>
</tr>
<tr>
<td><strong>Barriers</strong> for sharing data and information including: technology, skills, incentives, security, trust, IP, standards</td>
<td><strong>Digital connections</strong> to physical assets, machines, factories, and supply chains</td>
</tr>
<tr>
<td><strong>Increasing cost</strong> of labor globally, skills gap</td>
<td><strong>Decreasing cost</strong> due to data aggregation and analysis, do more with existing resources</td>
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Manufacturing already generates more data than any other sector

<table>
<thead>
<tr>
<th>Sector</th>
<th>Petabytes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturing</strong></td>
<td>1,812</td>
</tr>
<tr>
<td>Government</td>
<td>911</td>
</tr>
<tr>
<td>Banking</td>
<td>773</td>
</tr>
<tr>
<td>Communications and Media</td>
<td>776</td>
</tr>
<tr>
<td>Retail</td>
<td>424</td>
</tr>
<tr>
<td>Professional Services</td>
<td>397</td>
</tr>
<tr>
<td>Securities and Investment Services</td>
<td>336</td>
</tr>
<tr>
<td>Healthcare</td>
<td>375</td>
</tr>
<tr>
<td>Education</td>
<td>276</td>
</tr>
<tr>
<td>Insurance</td>
<td>273</td>
</tr>
<tr>
<td>Transportation</td>
<td>256</td>
</tr>
<tr>
<td>Wholesale</td>
<td>245</td>
</tr>
<tr>
<td>Utilities</td>
<td>207</td>
</tr>
<tr>
<td>Resource Industries</td>
<td>166</td>
</tr>
<tr>
<td>Consumer and Recreational Services</td>
<td>116</td>
</tr>
<tr>
<td>Construction</td>
<td>87</td>
</tr>
</tbody>
</table>

1 Discrete manufacturing constitutes 1072 petabytes; Process manufacturing 740 petabytes
SOURCE: IDC, McKinsey Global Institute analysis
Despite the recognition of importance most organizations feel they lack the necessary capabilities.

- **81%** of participants indicating digital ops is a critical driver of future competitiveness.
- **14%** of organizations with "high" digital capability today.

**SOURCE:** DMDII workshop, May 2014
A National Call to Action

- A series of reports to the President addressing Advanced Manufacturing are developed (2011 & 2012)
- National Science and Technology Council (NSTC) issues a preliminary design to establish a National Network for Manufacturing Innovation (2013)
- President launches the Advanced Manufacturing Partnership Steering Committee 2.0 (AMP 2.0 Report – Oct 2014)
- Revitalize American Manufacturing Act, Becomes Law (Dec 2014)
Revitalize American Manufacturing & Innovation Act

- September 15, 2014 – Passed House
  - 100 Cosponsors (51D, 49R)

- December 11, 2014 – Passed Senate
  - 18 Cosponsors (10D, 7R, 1I)

- December 16, 2014 – Signed By President Obama

Bipartisan Momentum Supporting NNMI Passage
Birth of the Institutes

National Network for Manufacturing Innovation - *Create a research-to-manufacturing infrastructure for U.S. industry and academia to collaborate and solve industry-relevant problems*

Five Institutes Established
- $335M public funding has catalyzed over $480M from consortia
- At launch, 349 companies and universities active partners from all across the country
- 4 more institutes under competition (photonics/flex/smart/tbd)

Digital Manufacturing and Design Innovation Institute (DMDII) is born on 25 February 2014

- Lightweight Innovations for Tomorrow (Detroit, MI)
- Additive Manufacturing (Youngstown, OH)
- PowerAmerica Institute for Advanced Composites Manufacturing Innovation (Raleigh, NC)
- Institute for Advanced Composites Manufacturing Innovation (Knoxville, TN)
- Wide Bandgap Semiconductors (Chicago, IL)
What is “Digital Manufacturing”?  

*Digital Manufacturing is an integrated suite of tools that work with product definition data to support tool design, manufacturing process design, visualization, modeling and simulation, data analytics, and other analyses necessary to optimize the manufacturing process” – CIMData (modified)*
What are the Institute’s Goals?

*Use the technology portfolio to:*

- Demonstrate and apply digital manufacturing technologies
- Accelerate these technologies to market
  - Digital links between design and fabrication
  - Connected machines, factories, and supply chains
  - Transparency into supplier factories
  - Data aggregation, analysis, and action across the product lifecycle
  - Leverage the power of data analytics and networks to do more with existing resources

*Increase the competitiveness of American manufacturing firms*
The DMDII Today

Working towards the completion of its new facility located on Goose Island in northwest Chicago, Illinois

- 96,000 ft² of Leased Space
- 41,800 ft² of Collaboration and Office Space
- 25,200 ft² of Manufacturing Space
- 29,000 ft² of Expansion Space

Mid April 2015 move-in plan is on track!

200 Mbps temp; 10 GHz dark fiber redundant transport w/ wireless BU
The New Facility

State of the Art Collaboration & Innovation Center

Auditorium
Venue & Lecture Room

Collaboration Area

UI LABS & DMDII Operational Area

Entrance

Manufacturing Cells
Advanced Manufacturing Cells

Cell #1 – Multi-Axis High End Machining
Cell #2 – Traditional/Legacy Standard Machining
Cell #3 – Additive
Cell #4 – Metrology Room
Cell #5 – Welding & Fabrication
Cell #6 – Micro Machining
Cell #7 – Electronics

Tool Crib – Auto Tool Pre-setter

POC: Dan Hartman - Director of Manufacturing Research and Development
dan.hartman@uilabs.org
The Essence of DMDII

An Agreement between the US ARMY Contracting Command – Redstone and UI LABS to:

1. Establish a **member driven** research institute
2. Manage the distribution of $70M of federal funds towards strengthening the capabilities of the US supply chain (requires 1:1 industry funding match)
3. Identify gaps in existing manufacturing technology and issue project calls to fulfill the needs
4. Distribute the Intellectual Property developed in the projects to the membership per the agreements
5. Engage small and medium enterprises
6. Conduct workforce development activities
Membership Types in DMDII

- **3 Industry Tiers**
- **4 Academic/Non-Profit Tiers**
- **State & Local Government Partner**
- **U.S. Government**
  - *Open to all U.S.-based companies, academic institutions, non-profits and other organizations*
  - *Membership not offered to individuals*
  - *Also open to affiliates and subsidiaries of foreign-based companies...IF the entity was incorporated under the laws of one of the 50 U.S. states*
  - *No specific technical qualifications or other obstacles to membership*
# Membership Obligations and Benefits

## Industry

<table>
<thead>
<tr>
<th>Tier</th>
<th>Obligations</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>• $2M membership dues over 5 years</td>
<td>• Seat on Exec. Committee &amp; TAC</td>
</tr>
<tr>
<td></td>
<td>• $3M “Cost Share” over 5 years (labor, mat’l, capacity)</td>
<td>• Royalty-free license to use ALL IP for internal R&amp;D and operations worldwide</td>
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<tr>
<td>Tier 2</td>
<td>• $1M membership dues over 5 years</td>
<td>• Vote on Exec. Committee rep.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Seat on TAC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Royalty-free license to use ALL IP for internal R&amp;D only</td>
</tr>
<tr>
<td>Tier 3</td>
<td>• $500 membership dues per year, over 5 years</td>
<td>• Vote on Exec. Committee rep.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Vote on TAC</td>
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<tr>
<td></td>
<td></td>
<td>• Project participation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Networking opportunities</td>
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<td></td>
<td></td>
<td>• Access to Digital Manufacturing Commons (DMC)</td>
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## Membership Obligations and Benefits

### ACADEMIC/ NON-PROFIT

<table>
<thead>
<tr>
<th>Tier</th>
<th>Obligations</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| Tier 1 | $5M “Cost Share” over 5 years (labor, mat’l, capacity) | Seat on Exec. Committee & TAC  
Royalty-free license to use ALL IP for internal R&D and operations |
| Tier 2 | $2M “Cost Share” over 5 years (labor, mat’l, capacity) | Vote on Exec. Committee rep.  
Seat on TAC  
Royalty-free license to use ALL IP for internal R&D only |
| Tier 3 | $1M “Cost Share” over 5 years (labor, mat’l, capacity) | Vote on Exec. Committee rep.  
Vote on TAC rep. |
| Tier 4 | $500 membership dues per year, over 5 years | Vote on TAC rep.  
Prohibited from Enterprise Projects focused on technology  
Eligible for workforce development, training and education programs |

*State and Local Governments can receive EC & TAC seats as well as IP rights for $5M commitment over 5 yrs*
## Benefits of Participation

| COLLABORATION AND RESEARCH DIRECTION SETTING | Access to cutting-edge, exclusive research to drive performance benefits  
| Networking and knowledge sharing with leading experts  
| Federal and partner matching funds to support research |
| COMPETITIVENESS ENHANCING PERFORMANCE IMPROVEMENTS | Lower design costs through better collaboration with suppliers  
| Lower manufacturing cost and capital requirements from better optimization of end-to-end product lifecycle  
| Reduced time to market due to more rapid iteration  
| Next-gen innovations first: digital design, digital factories, digital supply chains  
| New and legacy products |
| ACCESS TO INTELLECTUAL PROPERTY | Access to leading manufacturer partner base and technology companies  
| Internal R&D use and commercialization of IP  
| Ability to iterate on cutting-edge products and services in live demonstration facility to show effectiveness to partners |
| MORE ROBUST US MANUFACTURING ECOSYSTEM | Workforce development to strengthen the talent pool  
| Accelerating broad adoption of technologies, including a strengthened base of Small and Medium Enterprises able to use digital manufacturing  
| Spinoffs and licenses leading to innovative new technologies |
Create an Innovative Ecosystem

Increase the innovative capacity of OEMs and their suppliers through digital integration and strategic collaboration.

Commercialize Research

Move ideas from TRL 4-7 through a network of physical and virtual demonstration sites.

Strengthen the U.S. Economy

Offset the lower cost of labor used to compete for our jobs
Create open source tools for use by small businesses

A partnership of world-class companies including:

- GE
- Rolls Royce
- P&G
- Dow
- Siemens
- Lockheed Martin
- CAT
- Microsoft
- ITW
- Boing
- parc
- John Deere

Top universities and the world’s most powerful computer including:

- Iowa State University
- Northwestern University
- RIT
- Illinois University of
- University of Cincinnati
- University of Nebraska
- University of Louisville
- Arizona State University
- Purdue University
- Mississippi State University
- NCSA

Proven talent from a consortium of state, educational, and vocational institutions:

Source: McKinsey Global Institute and team analysis
DMDII Technology Portfolio Guiding Principles

**Problem Identification**  
*What should we work on?*
- **Business value creation** is at the center of our process
- **Driven by the technical advisory committee**, which brings an understanding of key business problems, technical problems, and an awareness of potential solutions
- **Problem statements are solution agnostic**, which creates the conditions for innovation

**Portfolio of Initiatives**  
*Technology projects conducted by the DMDII membership*
- Each project proposal must have a **compelling business case, technical case**, and potentially **scalable impact**
- **Competitive process** incentivizes innovation and rewards the best ideas
- **Diverse and unique project teams** form around specific project call opportunities; this brings together communities who would not otherwise interact

**Technical Products**  
*Specific outputs of the technology project portfolio*
- **Awareness** about manufacturing technologies that will become available over the next 2-5 years, which informs today’s decision making
- **Knowledge** about specific digital manufacturing technologies that have been demonstrated and de-risked, and understanding about how to take advantage thereof
- **Opportunities for commercialization** along multiple paths including internal implementation, licensing, and new ventures
TECHNOLOGY FOCUS AREAS

ADVANCED MANUFACTURING ENTERPRISE (AME)

Information systems integration throughout the product lifecycle.

Digital links between design and fabrication.

Smart factory and supply chain management.

INTELLIGENT MACHINING (IM)

Integration of smart sensors and controls to enable equipment to automatically sense and understand current production environment in order to conduct “self-aware manufacturing.”

ADVANCED ANALYSIS (AA)

Utilization of high performance computing to model materials, products and processes to enable “design with manufacturing in mind.”

OPEN SOURCE PLATFORM

DIGITAL MANUFACTURING COMMONS

An open source software platform that enables data aggregation, analysis, and action.

CYBER PHYSICAL SECURITY

Meet industry and national needs for security, trust, and IP protection within the manufacturing environment.
Project Calls to Date

- 3 project calls released
- 12 project subject areas addressed
- 25-51 projects anticipated from these efforts

<table>
<thead>
<tr>
<th>Category</th>
<th>Project Codes</th>
<th>Anticipated Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVM</td>
<td>DMDII-14-01, DMDII-14-02</td>
<td>2-8 projects</td>
</tr>
<tr>
<td>Core</td>
<td>DMDII-14-06, DMDII-14-07, DMDII-14-08</td>
<td>3-10 projects</td>
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**DMDII Internal Project**

*Digital Manufacturing Commons (online collaboration platform) 15Q1*

Quickly brings to life DMDII approach to value creation
## 2014 Project Calls

| **Advanced Manufacturing Enterprise** | **AVM DMDII14-01 and DMDII14-02**  
Transition of technologies from DARPA AVM program. Focus on improving a manufactured product or manufacturing process.  
**AME DMDII14-06**  
Model-based engineering principles and infrastructure. |
|--------------------------------------|----------------------------------|
| **Intelligent Machines**             | **IM DMDII14-07**  
Integration of smart sensors and controls to enable equipment to automatically sense and understand current production environment in order to conduct "self-aware manufacturing". |
| **Advanced Analysis**                | **AA DMDII14-08**  
Integrated design and manufacturing models with metrology. |

Digital links between design and fabrication.  
Smart factory and supply chain management.
2015 Strategic Investment Plan

Advanced Manufacturing Enterprise
- Information systems integration throughout the product lifecycle
- Digital links between design and fabrication
- Smart factory and supply chain management.

Intelligent Machines
- Integration of smart sensors and controls to enable equipment to automatically sense and understand current production environment in order to conduct “self-aware manufacturing”

Advanced Analysis
- Computing to model materials, products and processes to enable “design with manufacturing in mind”.

AME1 Systems design using the digital thread
AME2 Smart factory visibility and real-time optimization

IM1 Communication standards for intelligent machines
IM2 Operating system for cyber physical manufacturing

AA2 Virtually guided certification
AA3 Shop floor augmented reality and wearable computing

2015Q1 Project Call
Current Projects

DMDII 15-01
Factory Infrastructure Cybersecurity Assessment

**Key Idea:** Protecting the *operational systems of a manufacturing organization* presents a different set of challenges from protecting enterprise IT systems and networks.

This project has specific objectives:
- Identify minimum capabilities that satisfy DFARS requirements (252.204-7012) for incorporating information security measures in a typical industry setting
- Estimation of the costs to reach and maintain those DFARS-compliant capabilities
- Develop and test a vulnerability assessment tool
Current Projects

DMDII 15-02
Smart Factory Visibility and Real Time Optimization

Key Idea: Aggregate and analyze process data within a factory in order to make real-time decisions that improve factory operations, and to make this data available to factory operators and to other parts of the value chain.

DMDII 15-03
Communication Standards for Intelligent Machines

Key Idea: Apply standards and demonstrate plug-and-play digital integration that enables machine tool data collection, transfer and analysis. Significantly reduce the cost and complexity of machine tool digital integration. The ultimate goal is a smart factory that has full systems integration of hardware, software, and data.

DMDII 15-04
Shop Floor Augmented Reality

Key Idea: Integrate the manufacturing workforce with the digital thread. Capture product and process data. Capture and share manufacturing knowledge.
Current Projects

DMDII 15-05
Systems Design using the Digital Thread

Key Idea: Demonstrate technologies that can use data from across the product lifecycle and from across the value chain to improve product design and manufacturing.

DMDII 15-06
Operating System for Cyberphysical Manufacturing

Key Idea: Demonstrate an operating system for manufacturing that provides both horizontal and vertical resource management from the lowest hardware to the highest enterprise level.

DMDII 15-07
Virtually Guided Certification

Key Idea: Demonstrate technologies that use advanced computing, modeling and simulation, and data analysis to significantly reduce the time and cost of certifying a material, manufacturing process or design.
Project Funding Summary

Projected Project Funding (Cost Share + DMDII Funds) = $54,800,000
Project Call Status

AVM
- Proj. Call Released
- Eval. Board
- Req. Gov Approval
- Gov. Approved
- Projected Kick Offs

CORE
- Proj. Call Released
- Eval. Board
- Req. Gov Approval
- Gov. Approve
- Projected Kick Offs

Jan 2015 #1
- Proj. Call Released
- Eval. Board
- Workshop
- Eval. Board
- Cost Proposal
- Req. Gov Approval
- Projected Kick Offs

Jan 2015 #2
- Proj. Call Released
- Eval. Board
- Workshop
- Eval. Board
- Cost Proposal
- Req. Gov Approval
- Projected Kick Offs

Cyber Sec.
- Proj. Call Released
- Eval. Board
- Cost Proposal
- Req. Gov Approve
- Projected Kick Offs
Project Call Process Overview

Project Call → Workshop → White Paper → Evaluation Board

- Project Awarded
- Government Approval
- Cost Proposal

→ Project Kickoff
RFP Documents

- **Project Planning Document (PPD)**
  - Project Summary, Submission Information, Requirements, Background

- **Proposal Preparation Kit (PPK)**
  - Project Call Process Overview
  - White Paper & Cost Proposal Submittal, Evaluation, and Award
  - Instructions for White Paper and Cost Proposal Preparation
  - Resumes, Letters of Commitment (Stage 1)
  - SOW, Reps & Certs, IP Management Plan, Technical Data/IP Disclosure and Assertion Form (Stage 2)
Evaluation Process

- Participants selected from industry, academia and govt.
- Subject Matter Experts provide technical assessments
- Evaluators conduct individual assessments and submit resulting scores and comments
- Results aggregated, meeting convened, consensus established
- Recommendations pushed forward *(incl. request for clarifications)*
- Proposals selected for formal Cost Proposal submittal

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Points Available</th>
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<tbody>
<tr>
<td>Problem Statement and DMDII Relevance</td>
<td>0-15 Points</td>
</tr>
<tr>
<td>Methodology</td>
<td>0-25 Points</td>
</tr>
<tr>
<td>Innovation</td>
<td>0-10 Points</td>
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<tr>
<td>Program Management Plan</td>
<td>0-15 Points</td>
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<tr>
<td>Technology Transition and Impact to Industrial Base</td>
<td>0-10 Points</td>
</tr>
<tr>
<td>Workforce Development and Education</td>
<td>0-5 Points</td>
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<tr>
<td>Team Qualifications</td>
<td>0-10 Points</td>
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<tr>
<td>Cost Factors</td>
<td>0-10 Points</td>
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<tr>
<td><strong>Total Points Possible</strong></td>
<td><strong>100 Points</strong></td>
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Do not underestimate the importance of detail for this section!
Get Involved in DMDII Now

➢ Go Online – No Obligation
  – [http://dmdii.uilabs.org/]  
  – Sign up for the DMDII Newsletter

➢ Build a Team, Submit a Proposal
  – Hurry! Next Project Call White Papers Due 1 April 2015!
  – No membership necessary to submit a proposal

➢ Contact DMDII
  – Ask for Jacob Goodwin – Director of Membership Engagement