Digital Manufacturing and Design Innovation Institute Update

Presented by:
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Program Manager
Digital Manufacturing & Design Innovation Institute (DMDII)

29 November, 2014
Definition of Digital Manufacturing

• The use of integrated, intelligence-based systems (both human and digital) to facilitate the bi-direction flow and coordination of information, instructions and manufacturing intelligence through interoperability standards from the device level throughout the factory floor and the manufacturing supply chain. Digital Manufacturing enables and includes:

  ▪ A coordinated and efficient manufacturing enterprise that is responsive to the needs of the customer
  ▪ Takes advantage of 3D visualization, communication, modeling & simulation, analytics and collaboration tools to create products and advanced business practices
  ▪ Model based tools and approaches to optimize producibility during early design and support standard data environments which facilitate life cycle support
  ▪ Network centric manufacturing capabilities to facilitate resilient and adaptable supply chains
  ▪ Intelligent manufacturing planning and factory execution
Digital manufacturing and design is the aggregation and application of digital data across the lifecycle of a manufactured product.

Digital Manufacturing enables faster and better decision making based on real-time information.
Digital Manufacturing Vision

- **Digital link** 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
DMDII

- A **public-private partnership** created to foster the development and implementation of digital manufacturing technology to US industry
- Accomplish a goal which neither **industry**, **academia or government** can accomplish on its own
- Leverage the best **research and technology** in the country to deploy solutions on a broad scale
- Established through a **5-year cooperative agreement** with $70M in federal government funding and over $250M in matching funding from industry, academia, local government and community partners
A consortium of industry, academia and government

A partnership of world-class companies including:

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

Top universities including:

- Northwestern University
- Texas at Austin
- Purdue University
- RIT
- UIC University of Illinois at Chicago
- UL University of Cincinnati
- University of Michigan
- University of Wisconsin
- Iowa State University
- Oregon State University
- The University of Wisconsin Madison

Proven talent from numerous state, educational, and vocational institutions:

Hundreds of Small and Medium Sized Manufacturing Enterprises (SMEs) seeking to improve competitiveness:
Consortium Status

• Membership Agreement incorporates Articles of Collaboration, Intellectual Property Management Plan and membership application

• Focus to date has been to finalize content, IP management, governance and tier structure

• Foundational Executive Board meeting to be held on 30/31 October to finalize membership agreement terms
Institute Goals

- Foster and enable **collaborative investment** in pre-competitive research and development for digital manufacturing technology
- Facilitate the transition and insertion of **digital manufacturing technology** into US industrial manufacturing base (large and small)
- Assemble and integrate **workforce development initiatives** to prepare the future manufacturing workforce for digital manufacturing technology
- Establish an **online commons** for manufacturers to use as a marketplace, learn about digital manufacturing, exchange detailed product design information, access the latest innovative digital capabilities and collaborate on design development – all on a secure, neutral and IP-safe environment
Technology Thrust 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".

The Institute will facilitate the *maturation and integration* of the three core technology areas because it is in the integration of these technologies from which the dramatic improvements in manufacturing competitiveness will occur.

**OPEN SOURCE PLATFORM**

**DIGITAL COMMONS**

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

**CYBER PHYSICAL SECURITY**

**CYBER PHYSICAL**

Meet industry and national needs for security, trust, and IP protection within the manufacturing environment.
DMDII: Not just R&D, but skills, access and workforce

**Applied Research & Demo projects for**
- Reducing cost and risk of commercializing new technology
- Solving pre-competitive industrial problems

**Technology Integration**
- Development of innovative methods and practices for supply chain integration

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

**Education, technical skills and workforce development**
DMDII Process

**Input**
- DMDII Tech Roadmap
- Strategic Investment Plan

**Participation**
- R&D Projects
- WFD Initiatives
- DMC Development
- Tech Transition Efforts
- Corporate Interest Projects

**Results**
- Pre-Competitive Knowledge
- Technology Implementation
- Instructional Platforms
- Skills Training
- Online Manufacturing Commons
- New Ventures
- Commercial Deployments
There is broad alignment for several problems to solve

<table>
<thead>
<tr>
<th>Theme</th>
<th>Sub-theme</th>
<th>Industry</th>
<th>Academia</th>
<th>Government</th>
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</thead>
<tbody>
<tr>
<td>Integration of the digital thread</td>
<td>Optimization across value chain</td>
<td>★</td>
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<td></td>
<td>Big data</td>
<td>★</td>
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<td>Standard data format and machine communication</td>
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<td>Cyber-Security</td>
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<td>Make-design link</td>
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<td>Tracking product performance in the field</td>
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<td>“Real time” supplier visibility</td>
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<td>Leadership/organization capabilities</td>
<td>Commercialization of lab technologies</td>
<td>★</td>
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<td>Articulation of business case for digital</td>
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<td>Workforce training/availability</td>
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<tr>
<td>Other</td>
<td>Enabling of mass-customization</td>
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<td>★</td>
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<td></td>
<td>Barriers to user adoption</td>
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</table>
Despite the recognition of importance for digital design and manufacturing, most participants believe their organizations lack capability.

- There is widespread recognition of the importance of digital design and manufacturing to future company success.
- Most participants believe this organizations lack mature digital capabilities.

SOURCE: DMDI Survey, Q11, Q13
Majority of senior leaders agree that digital is a priority, but few have a clear bold vision and strategy.

- **Digital is a senior leadership priority**: 53%
- **We have a strategy for how digital will enable competition**: 29%
- **Our digital efforts are innovative/bold**: 34%

Percent of respondents who “agreed” or “strongly agreed”

People, culture and leadership elements related to implementation of digital design and manufacturing.
Translating strategy to clear action is a clear gap in a majority of organizations.

- Digital strategy is translated to specific initiatives: 20% agreement
- There is clear communication from leadership on digital strategy: 24% agreement
- We have well defined metrics/KPIs: 16% agreement

People, culture and leadership elements related to implementation of digital design and manufacturing.
DMDII - SIP

**Intelligent Machines**
- Intelligent Machine Standards
- Operating System for Cyber physical Manufacturing
- Intelligent Machine Cyber Security
- Intelligent Machine Toolkit

**Advanced Manufacturing Enterprise**
- Design for "ility" tradeoffs including design for manufacturability
- Mfg Visibility & Factory Optimization
- End to End Supply Network Synchronization
- Full System Integration of the Digital Fabric
- Completing the Model Based Definition
- Gap in SME Engagement in Digital Manufacturing

**Advanced Analysis**
- Agile Manufacturing to Compensate for Production Variability
- Model-Based Source-Agnostic Product Design
- Shop Floor Augmented Reality
## DMDII Activities and Taxonomy

<table>
<thead>
<tr>
<th>Program &amp; Design Innovation Institute</th>
<th>Initiative</th>
<th>IM</th>
<th>AME</th>
<th>AA</th>
<th>WT</th>
<th>Description</th>
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<tbody>
<tr>
<td>Digital Manufacturing &amp; Design Innovation Institute</td>
<td>Intelligent Machine Standards</td>
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<td>Operating System for Cyber physical Manufacturing</td>
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<td>Intelligent Machine Cyber security</td>
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<td>Intelligent Machine Toolkit</td>
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<td></td>
<td>Design for &quot;ility&quot; tradeoffs including design for manufacturability</td>
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<td></td>
<td>Mfg Visibility &amp; Factory Optimization</td>
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<td>Completing the Model Based Definition</td>
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<td></td>
<td>Gap in SME Engagement in Digital Manufacturing</td>
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<td>Agile Manufacturing to Compensate for Production Variability</td>
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<td></td>
<td>Model-Based Source-Agnostic Product Design</td>
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<td></td>
<td>Shop Floor Augmented Reality</td>
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<td></td>
<td>Digital Manufacturing Commons</td>
<td>Strong focus</td>
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<td>Project to provide an open source system for collaboration through out the supply chain</td>
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<td></td>
<td>1000 Jobs Campaign</td>
<td>Strong focus</td>
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<td>Work Force Development initiative with partners in the Chicago area</td>
</tr>
</tbody>
</table>

### Focus Levels

- **Strong focus**: IM Intelligent Machines
- **Moderate focus**: AME Advanced Manufacturing Enterprise
- **Minimal focus**: AA Advanced Analysis
# Army ManTech Digital Manufacturing Activities and Taxonomy

<table>
<thead>
<tr>
<th>Program</th>
<th>Initiative</th>
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<th>WT</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>MBE</td>
<td>Adaptive Agile Army Innovation Enterprise (FY12-16)</td>
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<td>Implement the tools and processes of MBD and MBE for transition, demonstration and implementation into the Army Organic Industrial Base</td>
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<td>MBE</td>
<td>Net-Centric Model Based Enterprise 1 (FY11-14)</td>
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<td>Enabling the Army DoD to use Model Based Definition and Model Based Enterprise Capabilities</td>
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<tr>
<td>MBE</td>
<td>Net-Centric Model Based Enterprise 2 (FY16-21)</td>
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<td>Enhance MBE capabilities, and processes. Allow PMs to collaborate more efficiently with OEMs.</td>
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<td>Direct Digital Mfg for Helicopter Engines</td>
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<td>Improve manufacturing capabilities and affordability of both legacy and future critical gas turbine engine components using DDM. Project consist of parts selection, mfg process development, engineering validation, mfg plan development, component testing and validation. Leverages previous General Electric work to produce demonstration articles.</td>
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<td></td>
<td>Additive Mfg to Restore/Reuse/Reclaim High Value Aviation Assets (FY 15-18)</td>
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<td>Provide advanced additive/direct manufacturing technologies to repair and return to service high value aviation assets that cannot be repaired or reclaimed using traditional processes. Leverages $19.7M of current NCDMM America Makes projects.</td>
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<td></td>
<td>Additive Manufacturing Technology for Energetics and Electronics (FY15-17)</td>
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<td>Develop a flexible and agile common fuze manufacturing process utilizing 2D and 3D Printing and Additive Manufacturing technologies as applied to energetic materials with integrated electronics. Reduces the Load, Assemble and Pack footprint from multiple sites over 20 miles to a single operation at a single site.</td>
</tr>
<tr>
<td></td>
<td>Additive Manufacturing for New Build, Remanufacturing and Life Extension of Critical Weapon Systems Components (FY15-18)</td>
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<td></td>
<td>Develop and qualify additive fabrication and reclamation processes for use on Army components to accelerate innovation, decrease sustainment costs and increase service life; establish additive manufacturing processes as a viable, qualified and certified alternative for rapid fielding and repair of parts, especially in theatre.</td>
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<td></td>
<td>Additive Manufacturing for Optimized Missile Components and Structures (S&amp;T: FY 14-16)</td>
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<td>Develop and demonstrate the capability to design and fabricate missile components that exploit the capabilities of additive manufacturing (reduced weight, internal features, low cost, short lead times). Project consist of using topology optimization for strength and frequency, conducting trade studies for cost and performance to determine best material and process, and conducting component level structural and dynamic testing.</td>
</tr>
</tbody>
</table>

**Army Manufacturing Technology Program**

**Additive Manufacturing**

**Strong focus**
- IM: Intelligent Machines

**Moderate focus**
- AME: Advanced Manufacturing Enterprise

**Minimal focus**
- AA: Advanced Analysis
## ERS Activities and Taxonomy

<table>
<thead>
<tr>
<th>Program</th>
<th>Initiative</th>
<th>IM</th>
<th>AME</th>
<th>AA</th>
<th>WT</th>
<th>Description</th>
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<tbody>
<tr>
<td>Engineered Resilient Systems</td>
<td>Automated tradespace ingestion of system data</td>
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<td>Cross-domain Tradespace Analytics, Cost/Lifecycle Analysis, Integration of Manufacturability, Producibility, and other “-ilities</td>
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<tr>
<td></td>
<td>Modeling and analysis of mfg, costs, and sustainment</td>
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<td></td>
<td>Cross-domain Tradespace Analytics, Cost/Lifecycle Analysis, Integration of Manufacturability, Producibility, and other “-ilities</td>
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<td></td>
<td>Estimation of risk, uncertainty, and mitigation methods</td>
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<td>Cross-domain Tradespace Analytics, Cost/Lifecycle Analysis, Integration of Manufacturability, Producibility, and other “-ilities</td>
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<tr>
<td></td>
<td>Reconfigurable and extensible tools</td>
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<td>Cross-domain Tradespace Analytics, Cost/Lifecycle Analysis, Integration of Manufacturability, Producibility, and other “-ilities</td>
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<td></td>
<td>Conceptual and computational models</td>
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<td>Physics-based representations of systems, environments, and mission contexts</td>
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<td></td>
<td>Environmental simulations &amp; characterizations</td>
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<td></td>
<td></td>
<td>Physics-based representations of systems, environments, and mission contexts</td>
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<td></td>
<td>Simulated operational / mission contexts</td>
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<td></td>
<td></td>
<td>Physics-based representations of systems, environments, and mission contexts</td>
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<td></td>
<td>Rapid set up &amp; execution of M&amp;S tools</td>
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<td></td>
<td>Physics-based representations of systems, environments, and mission contexts</td>
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<td></td>
<td>Access to specific system data, tools, information, and knowledge</td>
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<td>Knowledge management and decision support across communities</td>
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<td></td>
<td>Maintenance &amp; reuse of data, digital representations, and tradespace analyses</td>
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<td>Knowledge management and decision support across communities</td>
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<td>Results sharing among diverse, distributed stakeholders</td>
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<td></td>
<td></td>
<td>Knowledge management and decision support across communities</td>
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<td></td>
<td>Transparent accommodation of data, analysis &amp; collaboration</td>
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<td>Open, extensible architectural framework that integrates representations, tradespace, and analysis tools</td>
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<td></td>
<td>Tool-agnostic, multi-level analysis across diverse systems</td>
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<td></td>
<td>Open, extensible architectural framework that integrates representations, tradespace, and analysis tools</td>
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<td>Baseline capability extensible to future DoD capabilities</td>
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<td></td>
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<td>Open, extensible architectural framework that integrates representations, tradespace, and analysis tools</td>
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<tr>
<th>Focus</th>
<th>IM</th>
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<td>AA</td>
<td>Advanced Analysis</td>
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DMDII addresses IM, AME and AA pretty evenly

Army ManTech is focused on IM and AME technologies

ERS is focused on AME and AA technologies
### Technology Portfolio

<table>
<thead>
<tr>
<th>Activity</th>
<th>Result</th>
<th>Impact</th>
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<tbody>
<tr>
<td><strong>1. First Projects</strong></td>
<td>• First Project Call – AVM Transition Q3</td>
<td>• Quickly brings to life DMDII approach to value creation</td>
</tr>
<tr>
<td>Identified in proposal and by</td>
<td>• Digital Manufacturing Commons (GE online collaboration platform) Q4</td>
<td>• Kick-starts DMDII operations</td>
</tr>
<tr>
<td>federal government customer</td>
<td>• Project calls in each technology thrust area Q4</td>
<td>• DMC is opportunity for quick win and builds core capabilities</td>
</tr>
<tr>
<td><strong>2. Technology Roadmap</strong></td>
<td>• Identifies value opportunities from digital manufacturing, and obstacles preventing the value from being realized Q2</td>
<td>• Stakeholder alignment and engagement</td>
</tr>
<tr>
<td>Driven by DMDII Technical</td>
<td>• Offers taxonomy and ranking of biggest market pull opportunities Q2</td>
<td>• Deepened engagement of industry participants</td>
</tr>
<tr>
<td>Advisory Committee</td>
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<tr>
<td><strong>3. Strategic Investment Plan</strong></td>
<td>• Identifies 13 specific technology investment topics Q4</td>
<td>• Allows DMDII to quickly launch a huge technology portfolio</td>
</tr>
<tr>
<td>Driven by DMDII Technical</td>
<td>• Investment plan is structured into problem statements with near-term impact (rather than potential solutions) Q4</td>
<td>• Projects will drive real ROI for industry members</td>
</tr>
<tr>
<td>Advisory Committee</td>
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Goose Island Facility

- Focus on inspiring, educating and advancing digital design and manufacturing
- Digital manufacturing lab, instructional and meeting space as well as traditional office
- 94k sq ft buildout:
  - 22k sq ft collaboration space
  - 24k sq ft manufacturing lab
  - 20k sq ft office space
  - 28k sq ft future expansion
- 10-year lease signed on 2 Jun 2014
- Demolition starts in mid-Oct
- Ground breaking on 30 Oct 2014
- Construction to start in mid-Nov
- Target Move In Date: Q1 2015
How do we measure success?

**RETURN ON INVESTMENT**
For industry investors. ROI in the first year and every year.

**FASTER**
Time to market. Rapid progress through the product development cycle.

**NEW BUSINESS GROWTH**
For manufacturers, suppliers, and entrepreneurs. Get more from your existing resources.

**DoD IMPACT**
Widespread utilization of digital technologies in defense manufacturing, reduced cost and time to market.

**REDUCED BARRIERS**
For small businesses to use digital manufacturing technologies.

**SELF-SUSTAINING MANUFACTURING INSTITUTE**
Continued investment from industry and government, based on value creation and ROI.
Year 1 Actions

• Finalize **Membership Agreement** and launch DMDII Consortium
• Develop DMDII **Technology Roadmap** and **Strategic Investment Plan**
• Initiate formal Institute **governance** mechanisms with Executive Board and Technology Advisory Committee
• Develop, solicit, evaluate, contract and launch **programs** in research and development, workforce development and technology transition
• Establish **Digital Manufacturing Commons** Beta site
• Develop 5-year **sustainability** plan
• Populate, launch and use **manufacturing laboratory**
Questions?