The Digital Manufacturing and Design Innovation Institute (DMDII)

DMDII + Rolls-Royce Roadshow Event
Rolls Royce Meridian Center Indianapolis
30 July, 2015

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The Digital Revolution in Manufacturing

Evolution within Digital Environment
The State of Manufacturing and Technology Today

• **A Set of Extremes** – Sophisticated Early Adopters of Digital Manufacturing Technology compared to SME’s Not Able to Comprehend the ROI Let Alone Implement for the ROI

• **Social Stigma** Surrounding Manufacturing Work – Most Universities Aren’t Seeing the Market for the Manufacturing Curriculum – Lack of Student Demand

• **Lack of Sufficient Regional Infrastructure** – IoT Will Saturate the Existing Data Transports; rural areas affected most

• **Need for** an Emerging Wave of **New Standards** to link Tools – More Value from Tool to Tool Data Exchanges

• An Emergence of **Regional Cooperation** in the US to Address Specific Export Markets – State Interactions and Politics
The “Scale-up” Gap or Missing Middle

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
Some Ways the Institute Generates Value

- Develop **new manufacturing processes** and capabilities
- Fund projects to **develop “plug-ins”** and **extensions** for today’s proven OEM tools that provide connectivity and enhanced capability
- **Open source web based manufacturing platform** to enable collaboration, linking 3rd party analysis tools, and interconnecting applications
- Low cost **pay by the hour** and other short term licensed cloud based tool services (training and operations)
- **Encourage the Supply Chain** to adopt digital manufacturing technology through state membership funded demonstration projects
- **Establish Standards** through funded efforts
- Execute a national scale **workforce development** program
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 Call Process Overview

1. Project Call
2. Workshop
3. White Paper
4. Evaluation Board

- Project Awarded
  - Government Approval
    - Cost Proposal
      - Project Kickoff

Approved for Public Release
Evaluation Process

- Evaluators selected from a mix of 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>
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<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>
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<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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Project Call Summary

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

<table>
<thead>
<tr>
<th>AVM</th>
<th>DMDII-14-01</th>
<th>DMDII-14-02</th>
<th>2-8 projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>DMDII-14-06</td>
<td>DMDII-14-07</td>
<td>DMDII-14-08</td>
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**DMDII Internal Project**

*Digital Manufacturing Commons (online collaboration platform) 16Q1*  
Quickly brings to life DMDII approach to value creation
# CY 2014 Project Calls

<table>
<thead>
<tr>
<th>Advanced Manufacturing Enterprise</th>
<th>AVM DMDII14-01 and DMDII14-02</th>
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<tbody>
<tr>
<td>Information systems integration throughout the product lifecycle.</td>
<td>Transition of technologies from DARPA AVM program. Focus on improving a manufactured product or manufacturing process.</td>
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<tr>
<td>Digital links between design and fabrication.</td>
<td><strong>AME DMDII14-06</strong></td>
</tr>
<tr>
<td>Smart factory and supply chain management.</td>
<td>Model-based engineering principles and infrastructure. Link MBE requirements to shop floor and supply chain</td>
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<thead>
<tr>
<th>Intelligent Machines</th>
<th>IM DMDII14-07</th>
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<tbody>
<tr>
<td>Integration of smart sensors and controls to enable equipment to automatically sense and understand current production environment in order to conduct “self-aware manufacturing”.</td>
<td>Geometric adaptive machining. Create Plug-and Play Toolkit to enable real-time in-situ (on the machine) sensing/metrology, adaptive tool path modifications and virtual metrology of the resulting outcomes</td>
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<table>
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<tr>
<th>Advanced Analysis</th>
<th>AA DMDII14-08</th>
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<tbody>
<tr>
<td>Computing to model materials, products and processes to enable “design with manufacturing in mind”.</td>
<td>Integrated design and manufacturing models with metrology. To deliver quality information to the shop floor in real-time</td>
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</tbody>
</table>
CY 2015 Q1 Project Calls

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
CY 2015 Q1 Project Calls

**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.
CY 2015 Q1 Project Calls

**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.
The Digital Manufacturing Commons
Powered by Three Key Feature Sets

1 Collaboration Platform
   - Distributed and Federated
   - File Sharing and Data Management
   - Work Flow Management

2 Digital Service Marketplace
   - App Space
   - Platform as a Service
   - User Generated Code
   - User2: Data, Data, Project, Data
   - User1: Data, Data, Data
   - Service Wrappers for Executable Code

3 Systems Engineering
   - Advanced Composition of Service Chains
   - Data
   - Analysis
   - Data

Systems of Systems
   - DDAD DDAA DDAD
   - DA DD A
   - DA DD D
   - DA DD
   - DA

PDMDII
1. Collaboration Platform

Files can be uploaded and shared within a virtual project space

“Your file has been modified!”

Users can subscribe to updates and alerts

All changes are tracked and auditable

CHANGE HISTORY
12-09-15 8:40:12 new file added
12-11-15 3:32:09 geometry change
12-12-15 3:39:45 .................
2. Digital Service Marketplace

Projects can also contain analytical software models.

Both data and models can be published to the service marketplace where they can be discovered and run in real-time.
Data and analytical models can have their inputs and outputs chained together to create complex systems. These can be executed and published back to the marketplace.
Examples of DMDII Project Deliverables

- Integrated analysis software suites
- Open source DMC tools
- Open source extensions to proprietary OEM software tools
- Automated manufacturing cost and lead time analysis tools
- Digital manufacturing data exchange standards
- Various manufacturability, assembly, and machinability assessment tools
- Cloud services for NC generation
- Auto-tolerancing modules
- MBD methodology generation using CAD neutral formats
- Orchestration of machining and measurement processes using tablets
- CAD platform independent software implementation of adaptive machining
- System to compensate for machine tool workspace errors induced due to part, fixture, tooling, or machine tool errors
- Tools to assess impact of manufacturing tolerance on cost
July 2015 Open Project Calls

**AME**
- **DMDII-15-11 Completing the Model-Based Definition**

**AME**
- **DMDII-15-12 Technologies Enabling Supply Chain Visibility**

**IM**
- **DMDII-15-13 Cyber Security for Intelligent Machines**

**IM**
- **DMDII-15-14 Hardware/Software Toolkit for Real-time Machine and Process Diagnostics, Monitoring and Self-Correction**

**AA**
- **DMDII-15-15 Agile Manufacturing to Compensate for Production Variability**

**DMC**
- **DMDII-15-16 Open Source Software Applications for Digital Manufacturing**
Questions?