NSF/NIST Sponsored Symposium

Strategy for Resilient Manufacturing Ecosystems through Artificial Intelligence
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2020-2022 Workshops

Workshop 1
Aligning AI and U.S. Advanced Manufacturing Competitiveness
December 2020

Workshop 2
R&D Strategies to Scale the Adoption of AI for Manufacturing Competitiveness
June-July 2021

Workshop 3
National Priorities for Adoption of AI in Advanced Manufacturing
February 2022
Bringing AI and Manufacturing Together

Industry: 26
- Boeing, Cargill, Corning, Dow, GE Aviation, GE Power, GM, GMI, JPL, Lockheed, Merck, Mazak, MSC, Procter & Gamble, Raytheon

AI Providers: 17
- Amazon Robotics, Autodesk, C3.ai, Google Cloud, IBM, Intel, Microsoft, PTC, Rockwell, Siemens, Ready Robotics

Government: 22
- DoA, DoD, DoE, FDA, NIOSH, NSF, NIST, NITRD, ONR, USDA, White House

Academia: 16
- CMU, Clemson, FIT, Georgia Tech, MIT, MSU, NCSU, PSU, Dartmouth, UCLA, UM, UNC Charlotte, USC, Malaysia Inst. Supply Chain

Manufacturing Institutes/ National Labs: 8
- CESMII, LIFT, MxD, NIMBL, MTDG, ORNL

MEP: 1
- California Manufacturing Technology Consulting

Manufacturing Associations/Consultants: 4
- Advanced Manufacturing International, AMT, Kearney, Manufacturing Leadership Council
**Important Definitions**

**Artificial Intelligence (AI)** in manufacturing refers to software systems that can recognize, simulate, predict, and optimize situations, operating conditions, and material properties for human and machine action.

**Machine Learning** (generally seen as a subset of AI) refers to algorithms that use prior data to accurately identify current state and predict future state, with the goal of improving productivity, precision, and performance.

**Scale** means readily accessible, easy to use, and cost effective for manufacturers of all sizes.

**Models** are digital, software representations (quantitative, qualitative, pattern, causal, inference, etc.) of real-world events, systems, or behavior, which can use data to simulate or predict future results.

**Standard Data Format** refers to the organization of information (protocol) according to agreements on preset specifications that describe how data should be stored or shared for consistent collection and processing across different systems and users.

**Tools** refer to software platforms that support the availability of data, knowhow, and models for use in business and operations.
Workshop 1: Industry-Wide Strategies for the Adoption of AI in Manufacturing

- AI for Building Resilient Supply Chains
  - Prioritize Industry-Wide Data-Centered Supply Chain Resilience Network Effects

- AI for Industry-Wide Data Sharing
  - Prioritize Secure Affordable Available Managed Data Exchange

- AI for the Factory Floor
  - Prioritize Factory/Shop Floor Data-Centered Machine/Process Operations

Meaningful Shared Data
- AI Tools and Applications
- Interconnectedness with Trust Network Effects and Manufacturing Web

- AI for Discovery of Capabilities and Solutions
  - Prioritize Data Savvy Workforce Using/Sharing Data
Workshop 2: Path to a Networked/Interconnected Manufacturing Industry

AI Monetization Layers

Layer 1
Asset Management

Layer 2
Interoperability

Layer 3
Supply Chain Resilience

Goal 1
Digitalize SMMs Skills & Capabilities

Goal 2
Apply AI Methods in Large Company Supply Chains

Goal 3
Enable New Business Models

Industry Connectedness and Network Effects

Industry Data, Knowhow and Model Sharing
Workshop 2: Relationship of Risks

Layer 1: Factory Floor Asset Mgmt
- AI for verification & validation
- AI for machine process assets

Layer 2: Factory Supply Chain Interoperability
- AI for asset systems factoy/product svc discovery analytics
- AI for supply chain visibility

Layer 3: Supply Chain Resilience
- AI for contract & service monitoring security
- AI for factory management factory opportunity

Shared Operations & Business Tools
- Data Exchange Factory/Supply Chain Interoperability
- Ecosystem Data Trust Industry Supply Chain Mgmt

AI in Operational Roles
- Data/Knowhow Mgmt & Application Engineering Solution Building

AI in Business Roles
- Risks with Trusted Data, Knowhow and Model Sharing
  - AI for Brokerage data, knowhow and model discovery and search
## Workshop 3: Roadmap for Manufacturing Program Strategies and AI Adoption

<table>
<thead>
<tr>
<th>Goal 1: Enable Digital Capabilities at Small and Medium-Sized Manufacturers (SMMs)</th>
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<tbody>
<tr>
<td><strong>Overcome lack of resources, infrastructure, data, expertise, and administrative capacity</strong></td>
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<tr>
<td><strong>Enable SMMs to share data and knowhow for AI applications</strong></td>
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<td><strong>Provide SMMs with tools to easily adopt AI solutions</strong></td>
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<th>Goal 2: Incentivize AI Adoption Throughout Established Supply Chains</th>
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<td><strong>Develop partnerships to define data, applications, and tools for supplier network interoperation</strong></td>
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<td><strong>Enable companies to conduct demonstrations that define the value of scaled AI projects</strong></td>
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<td><strong>Establish partnerships to converge on common AI applications and associated software tools and infrastructure</strong></td>
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<th>Goal 3: Enable New Business Models for AI Adoption</th>
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<td><strong>Develop scalable data sharing, applications, software tools, and educational tools to enable benefits of collaboration</strong></td>
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<tr>
<td><strong>Develop AI data sharing and software tools to enhance supply chain discovery and ecosystem resiliency</strong></td>
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<td><strong>Adapt AI business models to manufacturing</strong></td>
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### Address Industry Constraints

### Identify New Sources of Revenue

### Scale Success

### Time
Workshop 3: R&D Areas

1. AI methods, tools and data aggregation for manufacturing’s time centered data types

2. Data to automate algorithm building and continuous tuning

3. Going beyond incremental change

4. Scaling data and operation interoperability

Technologies required for robust, scaled, unbiased access, and trustworthy AI in manufacturing are largely at a nascent stage and require continued R&D investment
Workshop 3: Interrelated Structural Constraints Inhibiting AI Adoption

1. **Data Standards**
2. **Business Platforms**
3. **Upgrades**
4. **Education**
5. **Use Cases**
6. **Legacy Machines**
7. **Cost Share**

**R&D Programs to Expand AI Applications**

**Industry R & D**
First Pass Integration Demonstration

Invest with emphasis on SMMs
Recommendations for Roadmap Execution

• Explore opportunities to expand existing and/or establish new PPPs

• Focus initial implementations(s) on currently available technologies and tools

• Initiate research on highest priority manufacturing-relevant machine learning methods

• Precede the Roadmap execution with a program that demonstrates industry collaboration on an integrated set of “first pass” actions on the seven constraints

• Guided by industry use cases, expand into the execution of the Roadmap with phased development and demonstration of advanced software tools, models, and infrastructure for scaling
Thank You & Written Comments

Please send your written comments to the organizing committee:

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