Robots in Manufacturing Environments
Manufacturing Innovation Institute (RIME-MII)

A new initiative of the National Network for Manufacturing Innovation (NNMI)

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Robots in Manufacturing Environments – Manufacturing Innovation Institute (RIME-MII)

• **Vision:** A state-of-the-art, end-to-end, sustainable Manufacturing Innovation Institute in support of Robots in Manufacturing Environments

• Eighth and last of the NNMI Institutes

• **RFP released end of July, 2016**

• $80M Federal investment FY 17-21

• 1:1 cost sharing with members

• Administered by US Army TARDEC National Automotive Center

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**Concept Papers due September 1, 2016**  
**Full Proposals due mid to late November 2016**
Robotics Manufacturing Themes

“CAD to Code”

Mass Production in Quantity of 1

Collaborative Robotics

Multi-scale Manufacturing

Exploitation of Big Data
RIME-MII Goal: Successful Commercialization Of Advanced Robotics For Manufacturing

- **Affordable** to acquire, operate, maintain and repurpose
- Evolvable macro-system able to incorporate new technologies, platforms, standards
- **Accessible** – to new technology developers, and new users, what needs to be open for effective collaboration among diverse robots
- **Trusted** – reliability and safety
- **Situated** in the context of the entire manufacturing operation for production efficiency, manufacturing and assembly adaptability, and mass customization (vice robot function or technology
RIME-MII Functional Ecosystem Concept

**Roadmaps above are notional examples**
Value Propositions for Robotics and Automation in Manufacturing

- Utilization of investments in manufacturing plants and equipment
- Increased production rate
- Mass customization
- Rapid reconfiguration
- Rapid incorporation of new technology
- Reduced risk exposure to expert retirement & turnover
What are your value propositions for robotics and automation in manufacturing?

What is standing in your way?

What translational R&D is needed?
NNMI Concept:
Focused public-private partnerships to promote manufacturing competitiveness and a robust and sustainable manufacturing R&D infrastructure.
NNMI Role in Technology Transition Acceleration

Bridge dual “valleys of death” of Technology & Manufacturing Readiness Levels 4-7
# Technology & Manufacturing Readiness Levels

<table>
<thead>
<tr>
<th>TRL 1:</th>
<th>Basic principles observed and reported</th>
<th>MRL 1:</th>
<th>Manufacturing feasibility assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRL 2:</td>
<td>Technology concept and/or application formulated</td>
<td>MRL 2:</td>
<td>Manufacturing concepts defined</td>
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<tr>
<td>TRL 3:</td>
<td>Analytical and experimental critical function and/or characteristic proof of concept</td>
<td>MRL 3:</td>
<td>Manufacturing concepts developed</td>
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<tr>
<td>TRL 4:</td>
<td>Component and/or breadboard validation in a laboratory environment</td>
<td>MRL 4:</td>
<td>Capability to produce the technology in a laboratory environment</td>
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<tr>
<td>TRL 5:</td>
<td>Component or breadboard validation in a relevant environment</td>
<td>MRL 5:</td>
<td>Capability to produce prototype components in a production relevant environment</td>
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<tr>
<td>TRL 6:</td>
<td>System/subsystem model or prototype demonstration in a relevant environment</td>
<td>MRL 6:</td>
<td>Capability to produce prototype system or subsystem in a production relevant environment</td>
</tr>
<tr>
<td>TRL 7:</td>
<td>System prototype demonstration in an operational environment</td>
<td>MRL 7:</td>
<td>Capability to produce systems, subsystems or components in a production relevant environment</td>
</tr>
<tr>
<td>TRL 8:</td>
<td>Actual system completed and qualified through test and demonstrated</td>
<td>MRL 8:</td>
<td>Pilot line capability demonstrated; Ready to begin Low Rate Initial Production</td>
</tr>
<tr>
<td>TRL 9:</td>
<td>Actual system proven through successful mission operations</td>
<td>MRL 9:</td>
<td>Low rate production demonstrated; Capability in place to begin Full Rate Production</td>
</tr>
</tbody>
</table>

Roadmaps above are notional examples
IP – You Own What You Fund, But Share

• IP generated within the Institute belongs to the member(s) who generated it (unless otherwise stipulated in advance)

• Members generating IP with Institute funds *should* grant limited, non-exclusive license to other members in good standing for Institute R&D. Licenses for commercial use are negotiated outside of the Institute framework

• Non-Institute Developed IP belong to the developer. Institute facilities and equipment can be used and does not create a use right, but must be reimbursed at full cost recovery rates

• Background IP remains the owner’s. Limited, non-exclusive licenses to Institute members in good standing for Institute R&D are encouraged

• Proprietary data allowed for Institute R&D will be held as confidential.

• Publication of results can be delayed for participants to assess the proprietary value and patentable nature of project findings
RIME-MII Motivation

• Risks for *individual companies* to develop, implement and scale advanced robotic technologies is considered high, and access to future robotic technologies is limited.

• Competition on many fronts makes it difficult for individual companies to capitalize or develop these technologies for a global marketplace.

• Manufacturing enterprises need the flexibility to employ robotics and automation technologies from different suppliers, and transition to new suppliers and technologies

*The goal of the RIME-MII is to address these risks by establishing a national advanced manufacturing innovation institute as a resource to focus on the complex issues in digital and robotic manufacturing.*
Interoperability and interchangeability enlarge the pie

- Proprietary systems and integral solutions can provide short term advantages to the customer and supplier
- Modular Open System Architecture approaches advance sustainable, long-term advantages

Scalable and affordable manufacturing technologies to enable and expand the market for robot platforms

- High recurring and non-recurring cost of robot platforms
- Cost and uncertainty of R&D to enable unique robotic technology
- Willingness to take risks on investment in next-stage technology
- Economies of scale
- Market pressure to reduce production costs over time
- Customized designs lack price elasticity
Collaboration, Competition, and Commercialization

- Challenges
  - Collaboration on pre-competitive standards
  - Competition on implementation
  - Commercial support to partners in the long haul
- Pre-competitive
  - Robust function, interface and operation definitions & standards
- Proprietary
  - Licensable technologies
  - Proprietary Implementation
Interoperability: The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things (IoT) or the Internet of People (IoP).

Information transparency: The ability of information systems to create a virtual copy of the physical world by enriching digital plant models with sensor data. This requires the aggregation of raw sensor data to higher-value context information.

Technical assistance: First, the ability of assistance systems to support humans by aggregating and visualizing information comprehensibly for making informed decisions and solving urgent problems on short notice. Second, the ability of cyber physical systems to physically support humans by conducting a range of tasks that are unpleasant, too exhausting, or unsafe for their human co-workers.

Decentralized decisions: The ability of cyber physical systems to make decisions on their own and to perform their tasks as autonomous as possible. Only in case of exceptions, interferences, or conflicting goals, tasks are delegated to a higher level.
RIME-MII Technology Thrust Areas

- Collaborative Robotics
- Robot Control: Learning, Adaptation and Repurposing
- Dexterous Manipulation
- Autonomous Navigation and Mobility
- Perception and Sensing
- Testing, Verification, and Validation (TV&V)

*What about translation from enterprise objectives to technology objectives?*
Organization: A Public-Private Partnership

Sponsoring agency: U.S. Army TARDEC (Warren, MI)

RIME-MII Lead: a Not-for-Profit institution

Membership
- Small, medium and large commercial enterprises
- Universities, Colleges, and Technology Centers
- Government and National Labs
- Manufacturing Extension Partnership Centers (NIST)
RIME-MII Proposal Evaluation Criteria

- Business Plan
  - Organization, Governance, and Operations
  - Management Capabilities
  - Physical Infrastructure
  - Intellectual Property Management
  - Self Sufficiency
  - Impact on Defense and Economy
- Technical Plan
  - Technical Strategy
  - Innovation Beyond Current Practice
  - Technical Personnel Qualifications
- Education and Workforce Plan
- Cost
Advanced Robotics Manufacturing Institute

A consortium of Universities and Industry partners companies seeking to improve productivity through industrial robotics

A Mid-West team bidding to become the RIME-MII

www.arminstitute.org
Vision

To transform U.S. manufacturing through innovations and education in robotics and related automation technologies

Mission

The ARM Institute conducts industry-led applied R&D, develops and delivers education and workforce training, and provides access to shared capabilities through a nationwide network of regional innovation collaboratives.
Benefits of Participation

- Networking with broad membership from industry, academia and government
- Participation in road-mapping for robotics in manufacturing environments
- Access to new robotics technologies and IP created during projects
- Access to the national network of ARM’s state-of-the-art robotics facilities
- Workforce training for industry needs
- Workshops to introduce robotics to the factory floor
- Access to trained workforce and opportunities for periodic training
- Develop pathways for efficient human/robot collaborations
- Accelerate mass-customization capability using advanced robotics
- Scale-up of existing manufacturing operations while reducing risk
- Opportunities to contribute to project proposals within the institute
Institute Goals

- Develop and demonstrate robotics technologies for advanced manufacturing
- Create and train the workforce for new jobs in US manufacturing
- Empower American workers for greater productivity and global competitiveness
- Lower entry barriers for small, medium and large manufacturing enterprises
- Create an ecosystem of sustained innovation
- Become the global leader in robotics technology

To reach these goals, ARM will conduct industry-led robotics projects of national importance to address American manufacturing needs.
Questions?

Interest?

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