U.S. Future in Industrial Robots – An Update on the Advanced Robotics for Manufacturing (ARM) Institute

Jay Douglass
Advanced Robotics for Manufacturing Institute
ARM mission to be the leading catalyst of robotics innovation and expertise in the U.S., accelerating growth in manufacturing and high value careers.
Green states have major participants in Manufacturing USA Institutes
ARM Institute Foundation

- Robotics powerhouse
  Carnegie Mellon University led effort to establish ARM
- Separate non-profit entity
- Currently co-located with Carnegie Mellon’s National Robotics Engineering Center (NREC)
- Moving to Mill 19 @ Hazelwood Green (Pittsburgh) in Spring 2019

Established: Jan 13, 2017
Location: Pittsburgh, PA
Federal Funding: $80M
Industry Cost Share: $173M
ARM Was Formed to Help With These Challenges

- **National security exposure**
  - Important products (electronics, clothing, etc) are manufactured primarily outside of the United States

- **Lack of skilled workers**
  - Top issue for many manufacturers
  - Mismatch between current skill sets and current job openings
  - Lack of wide-spread trade education for robotics jobs

- **Custom implementations**
  - Lack of common and easy-to-implement software and hardware components

- **Lack of US domination** in manufacturing on a global basis

- Manufacturing (and trades in general) **not perceived as good career path** for young people
ARM Will Bridge Gaps and Empower Workers

1. Assert US leadership in advanced robotics manufacturing
2. Lower the technical, operational, and economic barriers for companies to adopt robotics technologies
3. Empower American workers to be cost-competitive with low-wage workers abroad
4. Aid in creation and sustenance of valuable manufacturing jobs
ARM Pursuing Mission on Three Fronts...

Technology development

Workforce development

Building the right ecosystem
… Driving Impact Across a Number of Sectors

Including...

- Aerospace
- Automotive
- Electronics
- Food & beverage
- Logistics
- Textiles & apparel
- Composites
Helping to Bridge US Manufacturing Innovation Gap

- Basic manufacturing research
- Proof of concept
- Laboratory production
- Capacity to produce prototype
- Capability in production environment
- Production rate demonstration

Manufacturing innovation process:
- Investment
  - Government and universities
  - Private Sector

INNOVATION GAP
Driving Impact through our Members

- Member-based, non-profit consortium
- Eight (8) membership levels from start-up/non-profits to platinum
- Approx. 120 members today in manufacturing, academia, technology and economic development
- Members drive projects to support mission
Membership Benefits

- **Network** with broad membership from industry, academia and government
- **Influence** roadmapping
- Lead and participate in project proposals
- Access **Consortium-Developed Intellectual Property (CDIP)**
- Access ARM Institute **expertise (technical & workforce development)**
- Access shared R&D **infrastructure**
- Help **influence young people** to choose manufacturing careers
A Diverse and Influential Membership
Membership by Level

- Bronze: 29%
- Core: 13%
- Gold: 17%
- 5%
- 8%
- 13%
- 6%
Membership by Industry

- Education
- Technology
- Manufacturing
- Non-Profit
- Aerospace
- Consulting
- Research
- Automotive
- Engineering
- Apparel
- Chemicals
- Electronics
- Energy
- Shipping
Quick Start: UTRC, UConn, and ABB
Perception-aided Collaborative Robotic Wire Harness Assembly

Quick Start: RPI and GE
Robot Assistant for Composites Manufacturing

Quick Start: Clemson and BMW, USA
Smart Companion Robot for Automotive Assembly

Quick Start: Lockheed Martin, USC, and Texas A&M
Robotic Sanding and Finishing
ARM Project Calls

- ARM issued first member project calls for technical and EWD proposals on October 16, 2017
- Two-phase process with final award expected in March 2018
- Additional project calls anticipated in spring and fall 2018
- Awards range from $200-$500K per selected project
## Current Technical Project Calls

<table>
<thead>
<tr>
<th>Seven Technical Project Call Topics</th>
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<tr>
<td><strong>Identify specific parts, tools, and/or products and place them</strong> into cart or bin for transport (i.e. part-kitting)</td>
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<tr>
<td><strong>Unloading</strong> truck or box, identifying which objects within are needed</td>
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<td><strong>Transport and delivery</strong> of tools, materials or loaded pallets safely through complex, crowded factory floor</td>
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<td><strong>Inspection of non-standard materials</strong> (e.g. fabrics or composites)</td>
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<td><strong>Traceability</strong> through automated component detection and supply chain management and tracking²</td>
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<tr>
<td><strong>Manipulation of Compliant Materials</strong> Food, Textiles, Wire harness, Composite</td>
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<td><strong>Surface Treatment</strong> Sanding, painting, polishing</td>
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Current EWD Project Call

**APPRENTICESHIPS**

- Facilitate an apprenticeship exchange as well as innovative funding models for small/medium sized manufacturers (SMMs) to create scale and increase access to resources

- Critical component to ensure a continued skilled pipeline of workers into industries that depend on advanced manufacturing to remain competitive
Driving Local Impact through Regional Collaboratives

Collaborative collections of members associate with one of 8 regions in the country to extend ARM’s reach locally

Provide insight and support for robotics technology and workforce development needs
Fear of Tech Stealing Jobs has been Constant for ~500 Years

"I have too much regard for the poor women to forward an invention [an automated knitting machine] which, by depriving them of employment, would reduce them to starvation."— Queen Elizabeth I

"The automatic machine is the precise equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor."— Norbert Wiener, MIT

"There will be fewer and fewer jobs that a robot cannot do better [than a human]. These are simply things that I think probably will happen."— Elon Musk

"We are being afflicted with a new disease of which some readers may not yet have heard the name—technological unemployment."— John Maynard Keynes

"As machines continue to invade society, it is human labor itself that is gradually rendered redundant."— Robert Heilbronner, New School
Manufacturing Jobs Reached Peak around 1950
Since 1990, US Manufacturing Growing at <50% the Rate of Rest of World

Manufacturing contribution to GDP\(^1\) ($B)

- Rest of World (excl. US) +4.1%
- **US growing at 48% the rate of rest of world**
- United States +2.0%

1. Manufacturing contribution to GDP is total value add, defined as total manufacturing revenue minus all direct and indirect costs and components.
Source: Oxford Economics, 2017
Several Factors Converging to Make U.S. More Attractive Place to Manufacture

1. Wages in formerly "low cost countries" rising quickly (e.g., increasing ~14% per year in China)
2. Energy and natural gas costs substantially lower in U.S.
3. U.S. workers are most productive

2016 manufacturing costs, indexed vs. U.S. (U.S. = 100)

Source: BCG Global Manufacturing Cost Competitiveness Index; BCG analysis & expertise
What Role Does Robotics Play?

Key productivity benefits from advances in robotics / automation

1. Potential to create more attractive goods (i.e. mass-customized, more durable, etc.), driving increased consumer demand

2. Decreased defect rate / reduced material waste during manufacturing

3. Better technology at a lower cost – less capital investment required to adopt

4. Improved worker utilization as increasingly complex tasks can be automated
Robots Create Jobs by Increasing Productivity

Change is inevitable ... and good for net jobs

1. The U.S. automotive industry installed ~60,000 industrial robots, while automotive sector employees increased by 230,000 (2010–2015).

2. A study across 17 countries found that robots increased wages while having no significant effect on total hours worked.

3. More than 90% of jobs will not be fully automatable in the future. Instead, robots and people will work together.

...But Won’t Succeed Without A Skilled Workforce
Skilled Work Shortage

U.S. manufacturers may be putting up to 11% of EBITDA at risk annually as a result of a shortage of skilled workers and increased production costs.

80% of executives report a moderate to severe shortage of highly skilled workers.

75% of executives report a moderate to severe shortage of skilled workers.

61% say it has been difficult to hire the skilled people they need.

Increased production costs

50% plan to increase production by 5% or more in the next five years.

BUT, as manufacturers use overtime to maintain base production levels, overtime costs increase . . .

70% say overtime costs are up at least 5%.

. . . and downtime also increases.

62% say downtime increased at least 5%.
Expect Industry 4.0 to Impact the Jobs Manufacturers Must Fill…

Industry 4.0 technologies drive link between workers, equipment, software, and machines…

...increasing the need for certain jobs and creating new jobs altogether

- IT solutions architects
- Robot coordinators
- Industrial data scientists
- Sales and marketing agents
- Digitally assisted field service engineers
High-Level Perspective on Workforce Development

- Skills profile of manufacturing workforce will undergo a dramatic shift

- U.S. faces significant structural challenges, which ARM can help overcome to enable this shift, including
  - U.S. education system offers insufficient prep for advanced mfg. careers
  - Current workforce not prepared for continual re-skilling
  - SMEs have limited resources to prepare workforce
  - Negative perception of robotics and manufacturing
  - Little coordination across advanced mfg. ecosystem
  - Regional skills gaps that hold U.S. manufacturing back from capturing full growth potential

- Opportunity for ARM to play key role in U.S. workforce development
Six Major Challenges ARM Can Address to Prepare the U.S. Workforce for the Future of Advanced Manufacturing

1. U.S. education insufficient for advanced mfg. careers
2. Negative perceptions of robotics and manufacturing
3. SMEs have limited resources to prepare talent
4. Manufacturing workforce not prepared for continual re-skilling
5. Little coordination between initiatives in advanced mfg.
6. Regional skill gaps in manufacturing skills
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