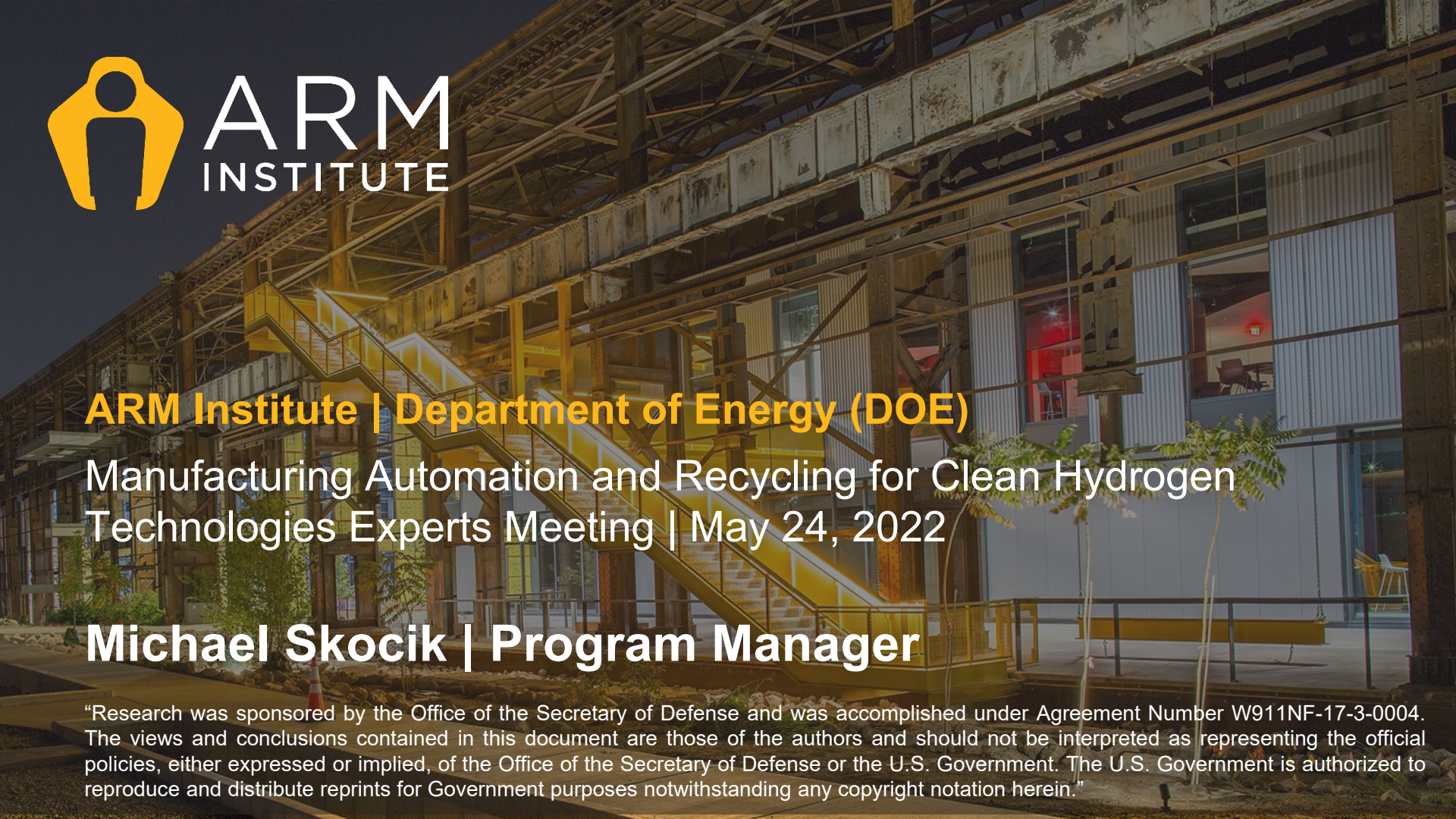


ARM INSTITUTE

ARM Institute | Department of Energy (DOE)

Manufacturing Automation and Recycling for Clean Hydrogen Technologies Experts Meeting | May 24, 2022

Michael Skocik | Program Manager

“Research was sponsored by the Office of the Secretary of Defense and was accomplished under Agreement Number W911NF-17-3-0004. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the Office of the Secretary of Defense or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation herein.”

Outline

1. ARM Institute | Background

2. Technology Development | Experience

ARM INSTITUTE

The ARM Institute

Leads the way to a future where people and robots work together to respond to our nation's greatest challenges

About The ARM Institute

- Established 2017 by Carnegie Mellon University
- One of 16 national Manufacturing Innovation Institutes (MIIs)
- $80M DoD Technology Investment Agreement (TIA)
- Target of $173M non-Government cost share
- Complete ecosystem ~ 350 members
- Over 80 projects funded to date in both technology and workforce development
- Headquartered at Mill 19, Hazelwood Green, Pittsburgh

ARM INSTITUTE

The ARM Institute Mission

The ARM Institute accelerates the development and adoption of innovative robotics technologies that are the foundation of every advanced manufacturing activity today and in the future.

We leverage a unique, robust and diverse ecosystem of partners across industry, academia and government to:

Make robotics, autonomy, and artificial intelligence more accessible to U.S manufacturers large and small

Strengthen our economy and global competitiveness

Train and empower the manufacturing workforce

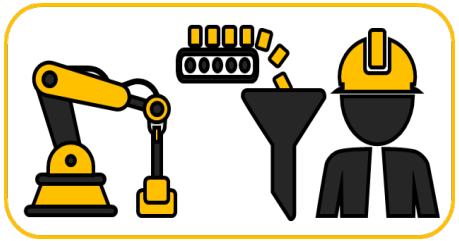
Elevate our national security and resilience

ARM INSTITUTE

Pursuing our Mission on Three Fronts.

Ecosystem Development

Convening and leveraging a nationwide consortium of innovators



Technology Development

Lowering barriers to adoption of robotics by advancing technology

Education & Workforce Development (EWD)

Expanding the robotics workforce with new and better career pathways

ARM INSTITUTE

More than 300 Members - Building the Right Ecosystem via Ecosystem Engagement.

- **Small & Start-up** businesses across a variety of industries with over 75 Small robotics companies
- **Large DoD OEMs** and businesses and dominant share of robot suppliers to the US with broad industry representation (AI, Space, Textiles, Logistics, Materials Automotive)
- **Top Research Universities** with leading robotics programs
- **Community Colleges and Trade Schools**
- **Government Partners** including the Army, Air Force, Navy, DoC/NIST, NIOSH, DoL
- **Economic Development Partners** – MEPs, workforce training, STEM programs

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Strategic Technology Focus Areas

1. Risk Reduction for Transition to the Factory Floor
2. Human-Robot Interaction
3. Interoperability
4. Reconfigurable, Agile, and Flexible Robotic Workcells
5. Intelligent Robotic Systems

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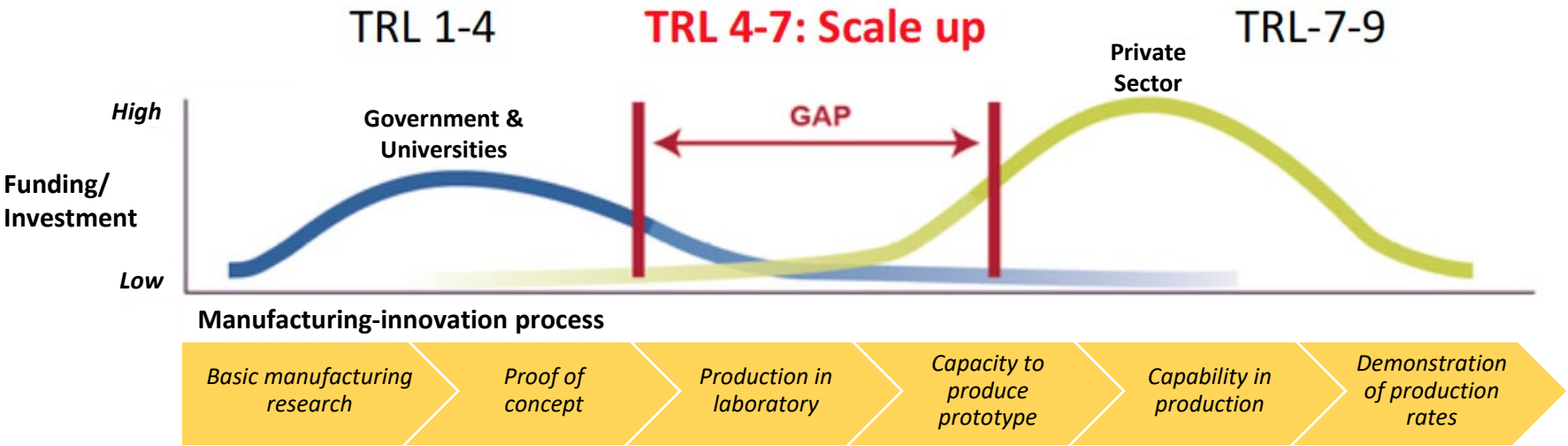
The Robotics for Manufacturing Innovation Gap



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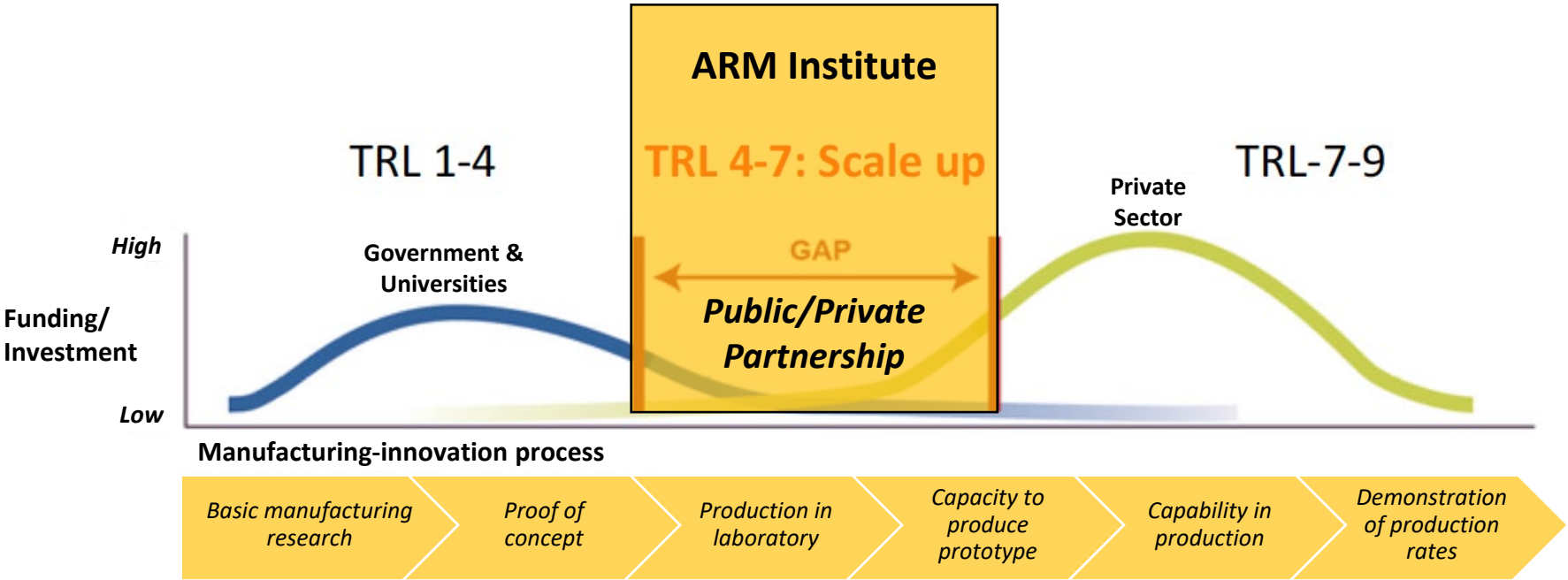
The Robotics for Manufacturing Innovation Gap



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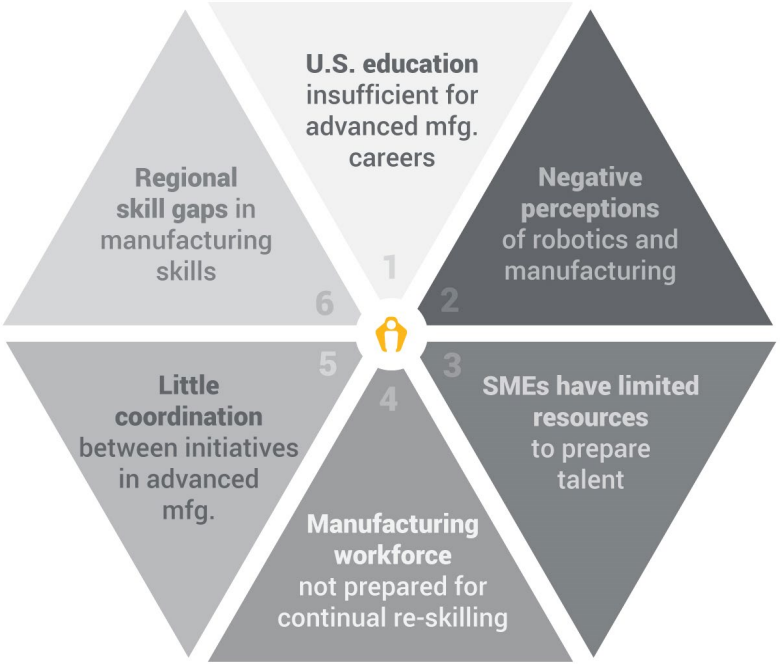
Education & Workforce Development

Focus Areas



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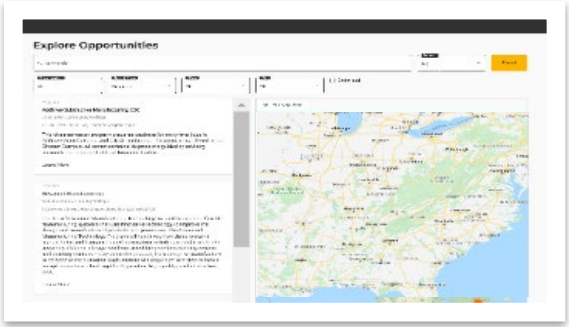
RoboticsCareer.org

POWERED BY ARM INSTITUTE

Connecting Students & Workers With Leading Robotics Education Programs for Manufacturing Careers

Online Platform

- Designed for employers, employees, job seekers, and students
- Unique mapping of advanced manufacturing robotic competencies to career pathways



Content

- Provides information about robotic training programs from micro-credentials and apprenticeships to PhDs
- Search over 13,000 training programs from 2,500 training organizations nationwide

ENDORSED ARM INSTITUTE

Program Endorsement

- ISO-like audit to provide validation & endorsement
- ARM “Seal of Approval”
- Identifies best practices

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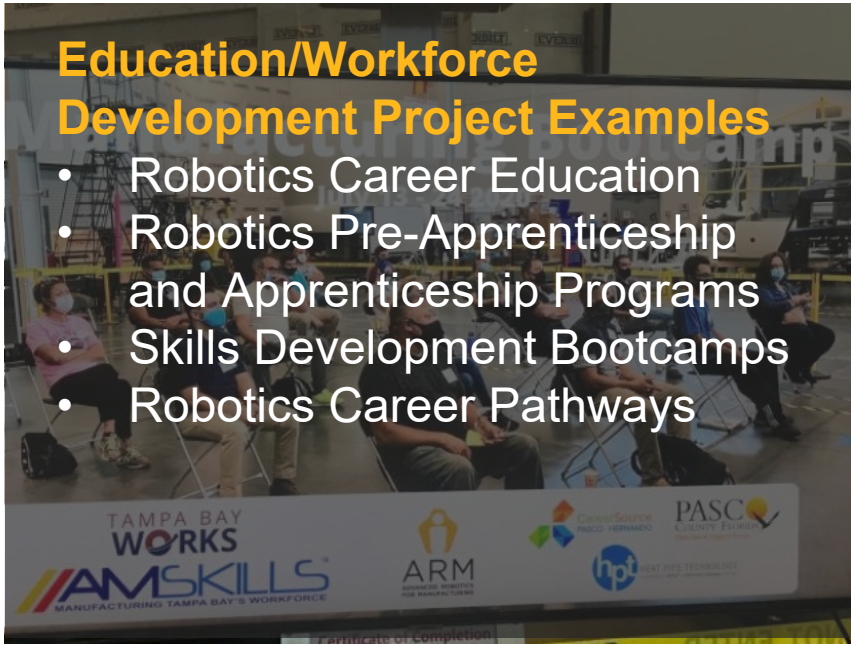
More than 80 Projects Catalyzed



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Technology Development

Technology Development | *Expertise*

- Membership / Ecosystem of experts in Manufacturing and/or Robotics
  - Leverage diverse expertise
  - Convening
  - Teaming
  - Develop capabilities with impact

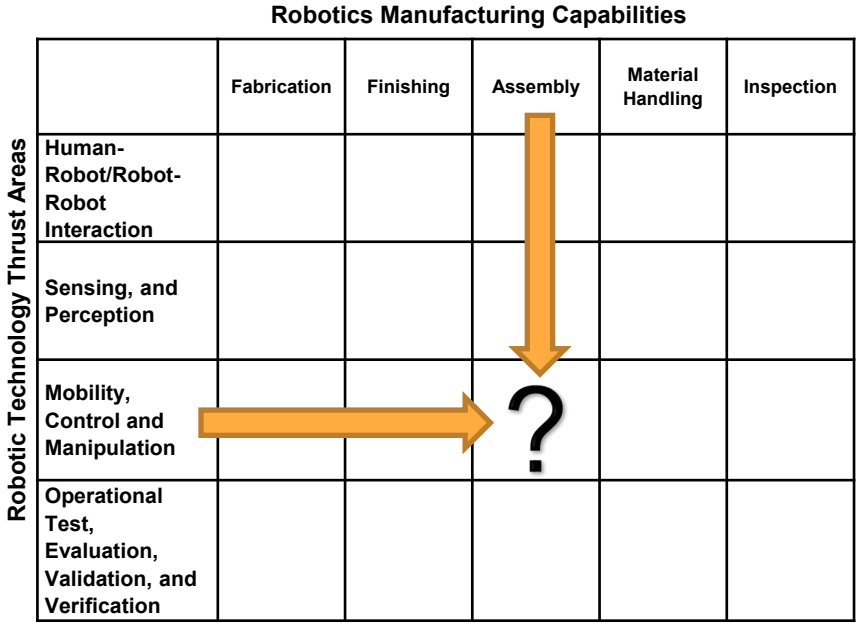
- Funded over 60 technology development projects since 2017
  - Competitive Project Calls
  - Competitive Sponsored (Air Force, Navy)
  - Directed (sole sourced)
  - Non-TIA

ARM INSTITUTE

Specialize in leveraging our ecosystem to solve the most challenging manufacturing problems through advanced robotic systems

Technology Development | *Strategy*

- Needs of the ecosystem
- Impact across markets, application or products
- Intersection of Robotic *Technology* and Manufacturing *Capability*



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Technology Development | *Experience*

- **Capability**
  - Assembly
  - Fabrication
  - Finishing
    Inspection
  - Logistics

- **Markets (Use Cases)**
  - Aerospace
  - Automotive
  - Distribution / Warehouse
  - Defense (DoD)
  - Energy
  - Textile / Apparel
  - Food
  - Energy
  - Electronics

Develop robotic manufacturing solutions that are pervasive across markets and application.

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Automated Defect Inspection of Complex Metallic Parts

- **Scope:**
  - Advisor robotic platform that will provide comprehensive parts inspection of complex metallic components and high-fidelity recommendations for defect identification and characterization.
- **Technology Development:**
  - AI to detect surface defects on aerospace engine blades based on robotically collected images in a controlled lighting environment
- **Benefit:**
  - Fast, accurate characterization / inspection of surface profiles of parts with high reflectivity, complex geometry.

ARM INSTITUTE

SwRI SOUTHWEST RESEARCH INSTITUTE

Human-Robot Collaboration in Quality Inspection

- **Scope:**
  - Empower Workforce to Easily Program and Operate Automated 3D Scanning for quality control.
- **Technology Development:**
  - Cobotic 3D scanning system with an intuitive user-experience (UX), and collect and analyze human-robot interaction data to develop an AI that enables collision free robotic programing.
- **Benefit:**
  - Robotic 3D scanning for quality inspection results in improvements over legacy system:
    1. resolution,
    2. cycle time, and
    3. enhanced insights.
  - Reduces complexities / barriers to utilizing robotics

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FCA FIAT CHRYSLER AUTOMOBILES

ARIS AUTOMATED ROBOTIC INSPECTION SYSTEM

Robotic Assistants for Composite Layup | assembly

- **Scope:**
  - Demonstrate technical feasibility of automating composite layup process through robotic assistants working with humans
- **Technology Development:**
  - Deep Neural Network based image detection and localization pipeline to detect irregularities (e.g. wrinkles) in how the composite material is laid on the mold.
- **Benefit:**
  - Eliminates human safety issues, leverages human expert, improves quality, and performance.
  - https://www.lockheedmartin.com/en-us/capabilities/research-labs/advanced-technology-labs/atl_robotic_manufacturing.html

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LOCKHEED MARTIN

SwRI SOUTHWEST RESEARCH INSTITUTE

Bot Couture: Robotic Cloth Manufacturing | assembly

- **Scope:**
  - Flexible robotic assembly line for garment (Levi Jeans)
- **Technology Development:**
  - Modular, Open-Source software to automate assembly and advance sewing operations
- **Benefit:**
  - Groundbreaking implications of a robotic solution to textile handling

ARM INSTITUTE
SIEMENS Ingenuity for life
ISAIC
HENDERSON
SEWBO
Levi's
bluewater defense

Summary

- **ARM Institute | *Background***
  - DoD MII est. 2017 by CMU
  - $80M DoD TIA
  - Ecosystem ~ 350 members
  - Technology Development
  - Education and Workforce Development
  - Headquartered Pittsburgh, PA
- **Technology Development | *Experience***
  - Ecosystem / Membership of Experts in Robotics, Automation and Manufacturing
  - Leverage ecosystem and processes to develop Advanced Robotic Systems for Manufacturing
  - Impact developing pervasive robotic technologies to enable robotic manufacturing capabilities
  - Technology Transition
  - Experience and Portfolio

ARM INSTITUTE

ARM Institute has the right Ecosystem and Experience to address the needs of Department of Energy and Fuel Cell Manufacturing / Recycling

The ARM Institute

Leads the way to a future where people and robots work together to respond to our nation's greatest challenges

Michael Skocik: Michael.Skocik@arminstitute.org

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