

MAKING AN IMPACT ON U.S. MANUFACTURING

Manufacturing 4.0/Smart Manufacturing “Primer”

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6th Annual Northwest and Central Louisiana

MANUFACTURING SUMMIT

**MANUFACTURING 4.0 &
SMART MANUFACTURING**

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Agenda

- ☐ Industry 4.0/Smart Manufacturing
 - ☐ Definition
 - ☐ PePE Transformation
- ☐ Mfg 4.0 Why/Where and \$\$
- ☐ Resources
 - ☐ MEP Centers Embedding Program
 - ☐ Mfg 4.0 “Focused” Institutes (5)
 - ☐ Local “Expertise”
- ☐ Summary/Question/Discussion



What is Manufacturing 4.0

Manufacturing is continuing to change faster than you can innovate. You're running hard to just keep pace with digitization, automation, expansion, and shifts in customer demand and employee demographics—the megatrends collectively known as Manufacturing 4.0.

Often interchanged with Industry 4.0, a term coined at a conference in Hanover, Germany, a few years ago, or Smart Manufacturing, the use of sensors and digital transfer of data, the Manufacturing 4.0 paradigm comprises *major technological innovations* including **advanced robotics, IoT (Internet of Things), sensors, mobile services, 3-D printing, and data analytics.**

In sum, if you add the technological innovations, the changes in global middle-class demand, shifting markets, and the demographics of the workplace, what we have before us is the industrial revolution of our lifetime.

From [Jill George, Ph.D.](#), DDI's Global Auto/Manufacturing Practice Leader, 8/26/2017



What is Manufacturing 4.0 (Another Definition from RCAP NOFO)

“Industry/Manufacturing 4.0” refers to the set of technologies and practices that “focuses on the end-to-end **digitization** of all physical assets and **integration** into digital ecosystems with value **chain partners**.”

The definition comes directly from the PwC study “Industry 4.0: Building the digital enterprise”: <https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf>.



The Four (Five?) Industrial Revolutions

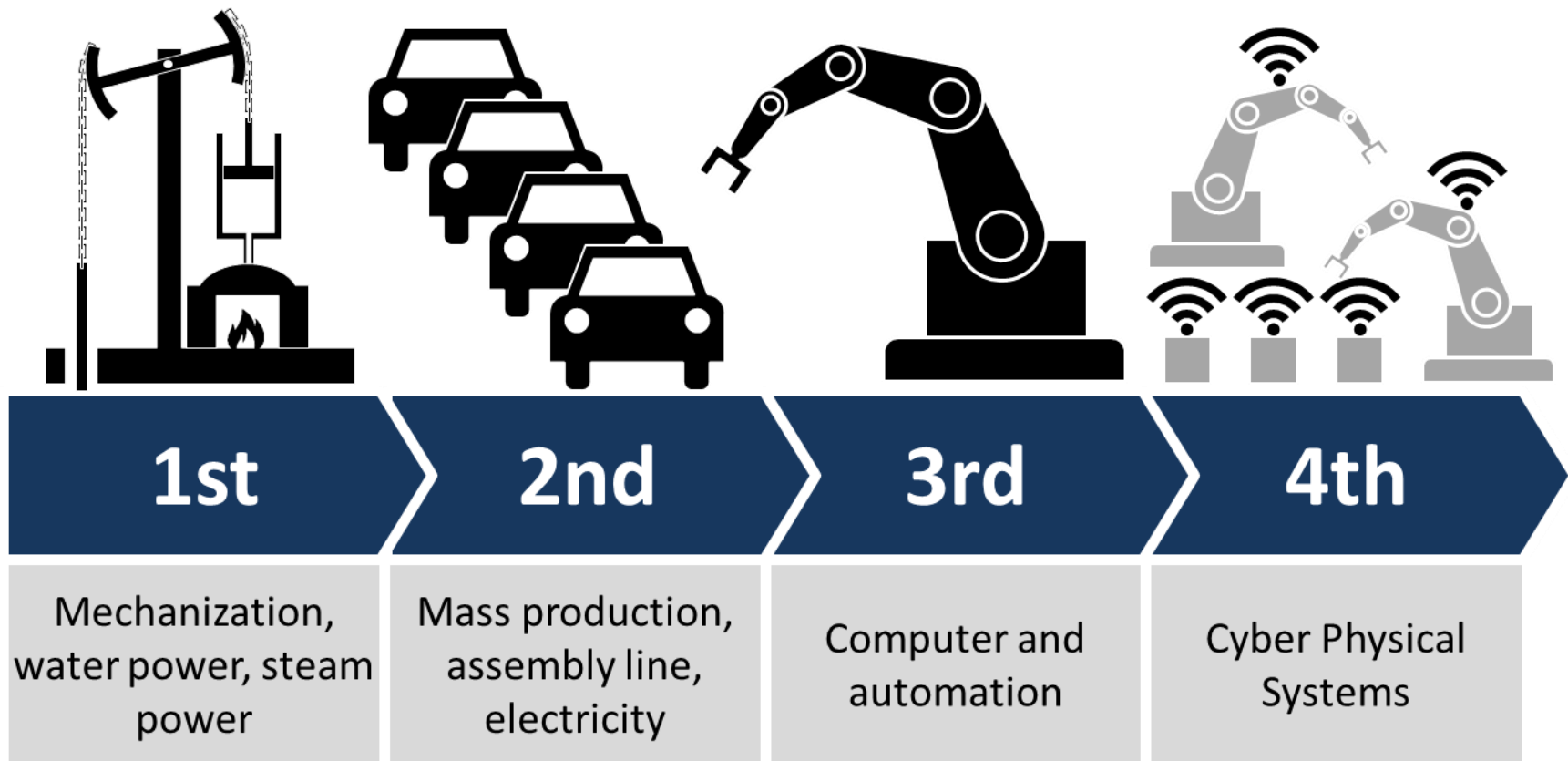
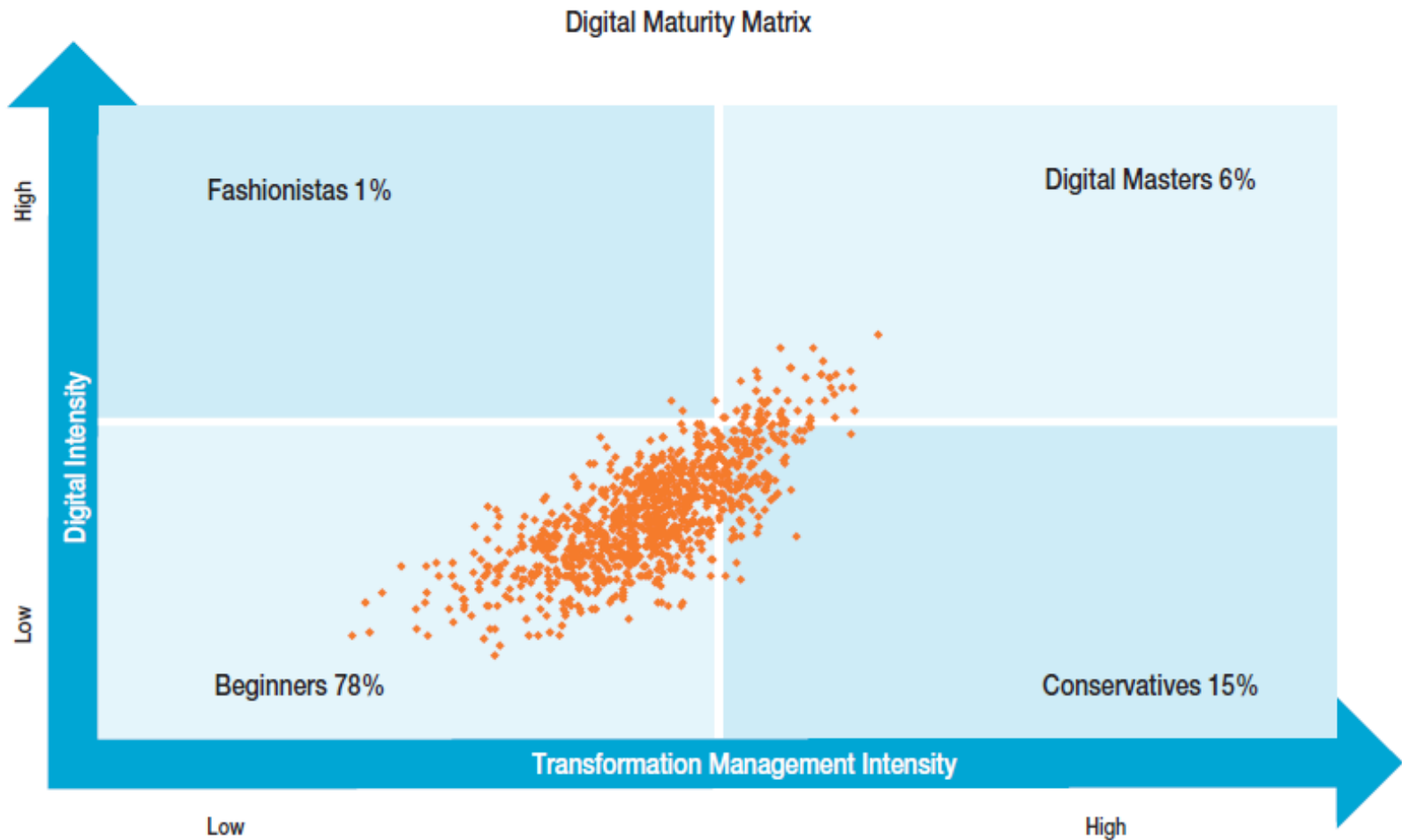
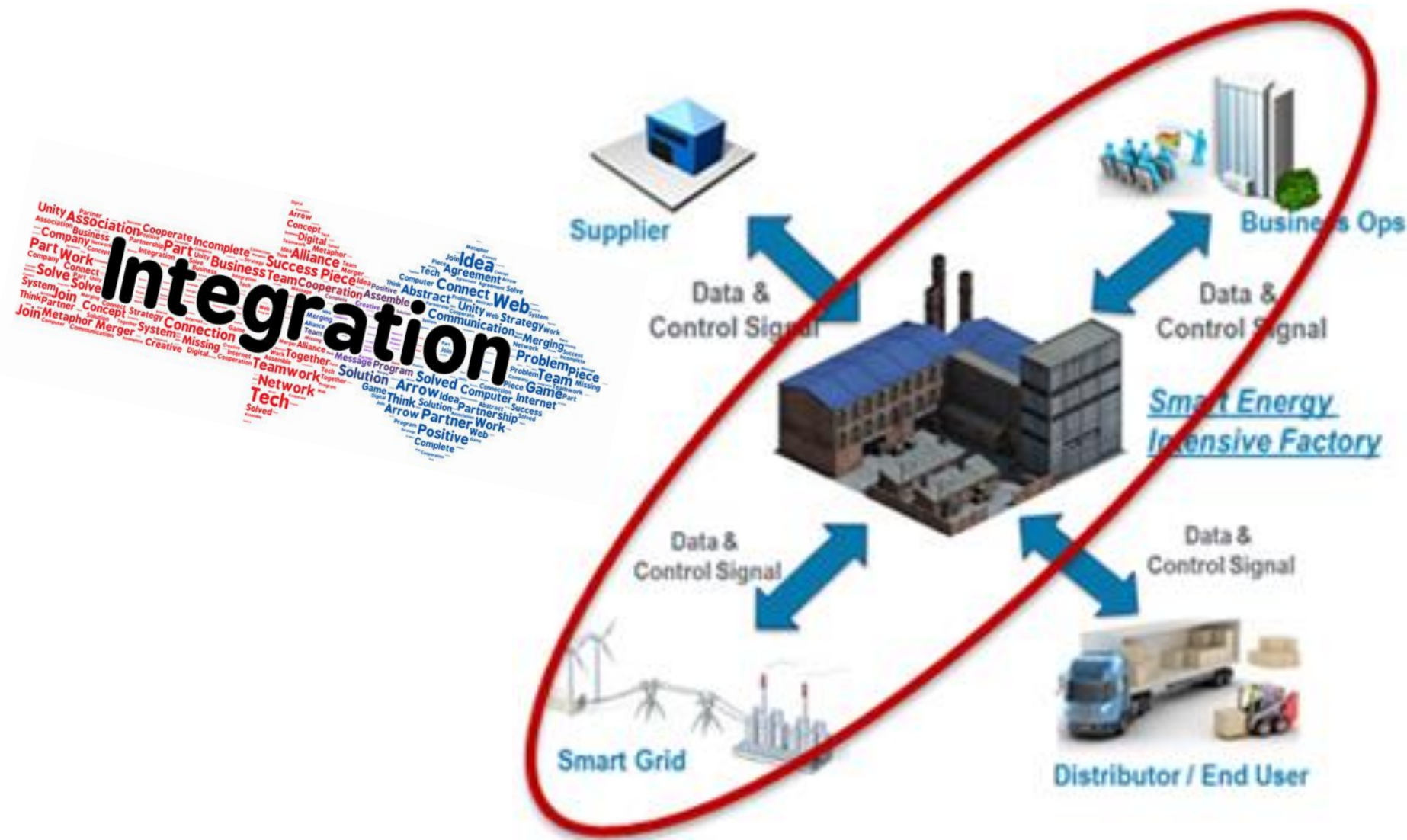


Figure 6: The majority have a long way to go to digital maturity



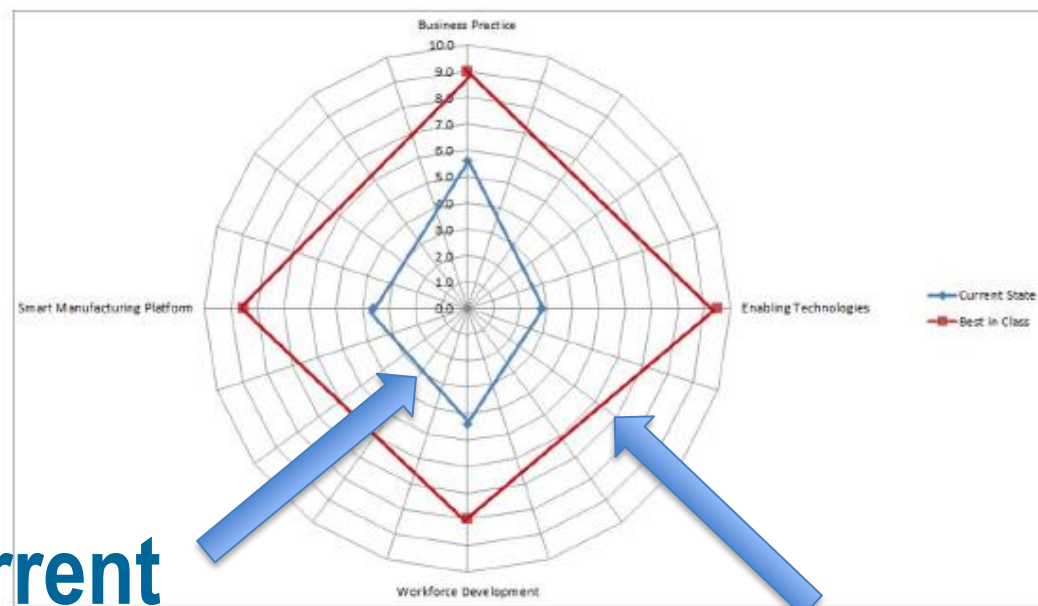
Source: Capgemini Digital Transformation Institute analysis, Capgemini Digital Transformation Institute, smart factory survey, February-March 2017



Assessing Enterprise Readiness for SM

Assess Enterprise along CESMII technology roadmap factors:

- Business Practices
- SM Platform Readiness
- Enabling Technologies
- Workforce Development



Current

Target





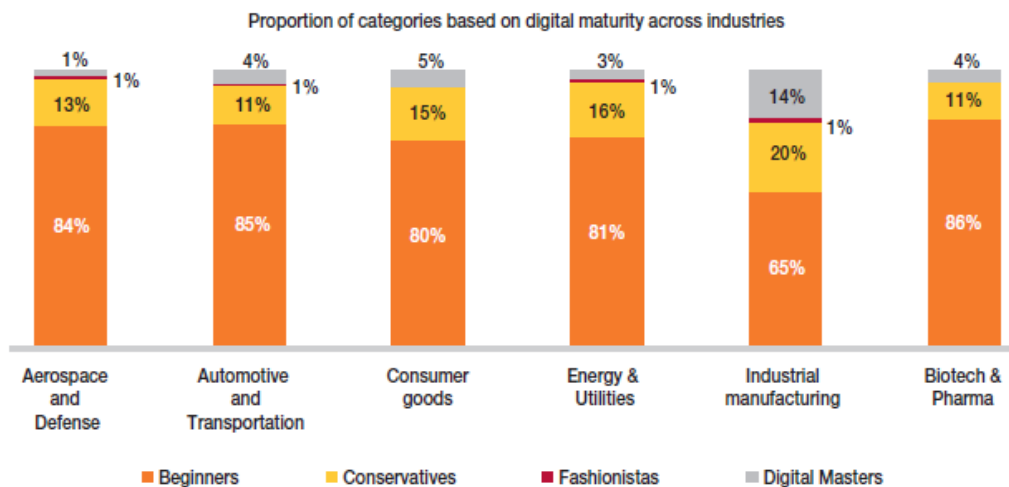
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Quiz

First Step After Today?

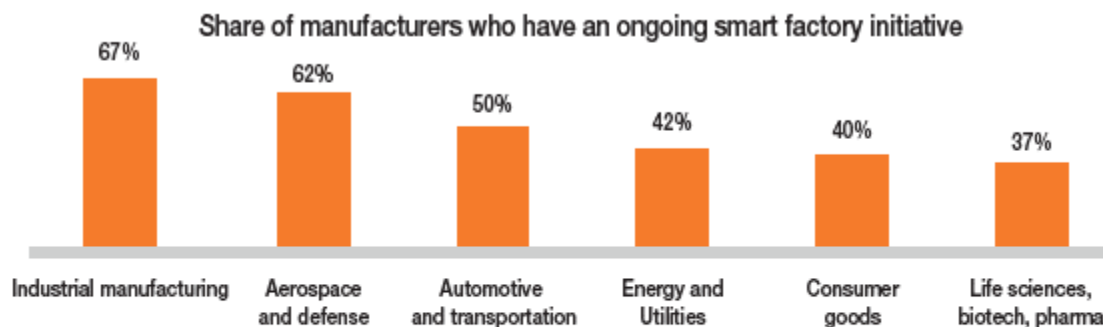


Figure 7: Digital maturity of firms across sectors



Where is your sector in the Mfg 4.0 transformation?
Required by Market or Opportunistic?

Source: Capgemini Digital Transformation Institute, smart factory survey, February-March 2017



Percentages indicate share of organizations in each industry which reported they have an ongoing smart factory initiative

Source: Capgemini Digital Transformation Institute, smart factory survey, February-March 2017





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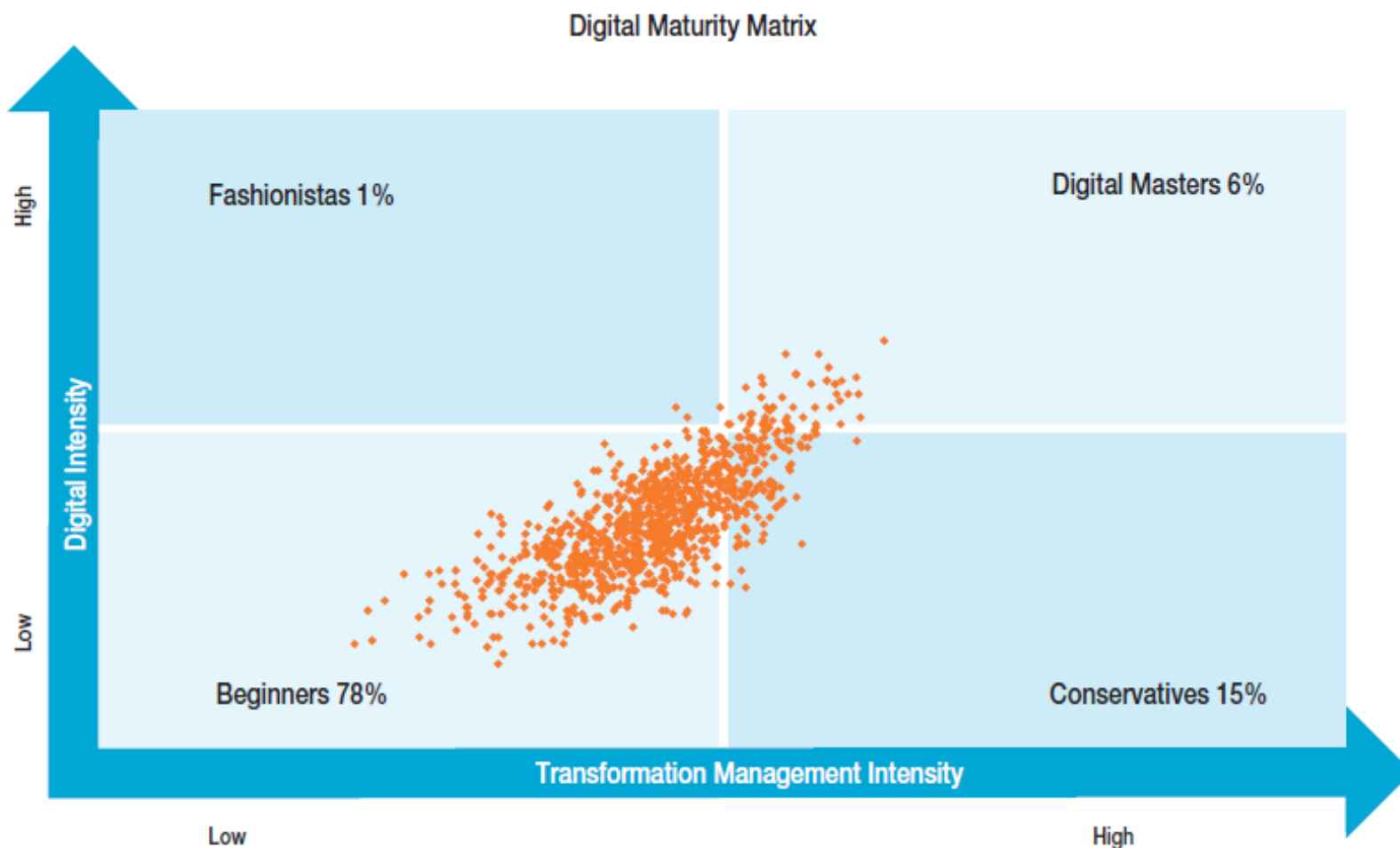
Second Step

Where are you right now?

(beginner...digital master, now and future)
and
\$\$\$\$

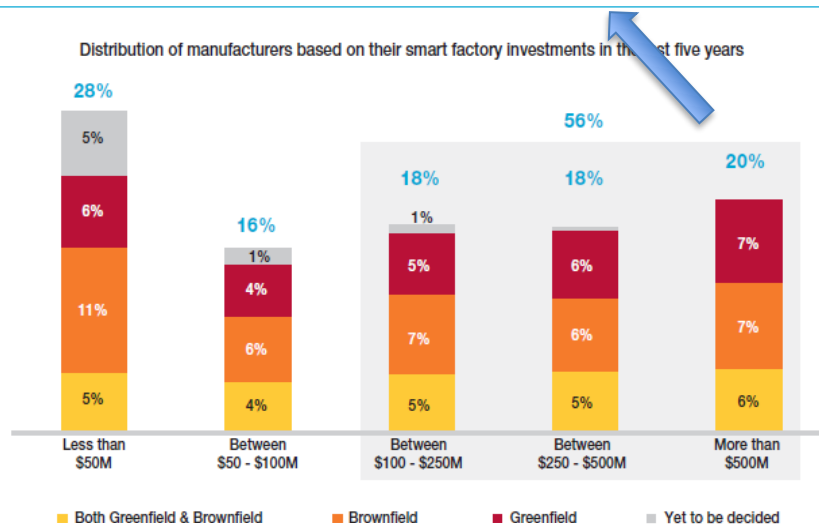


Figure 6: The majority have a long way to go to digital maturity



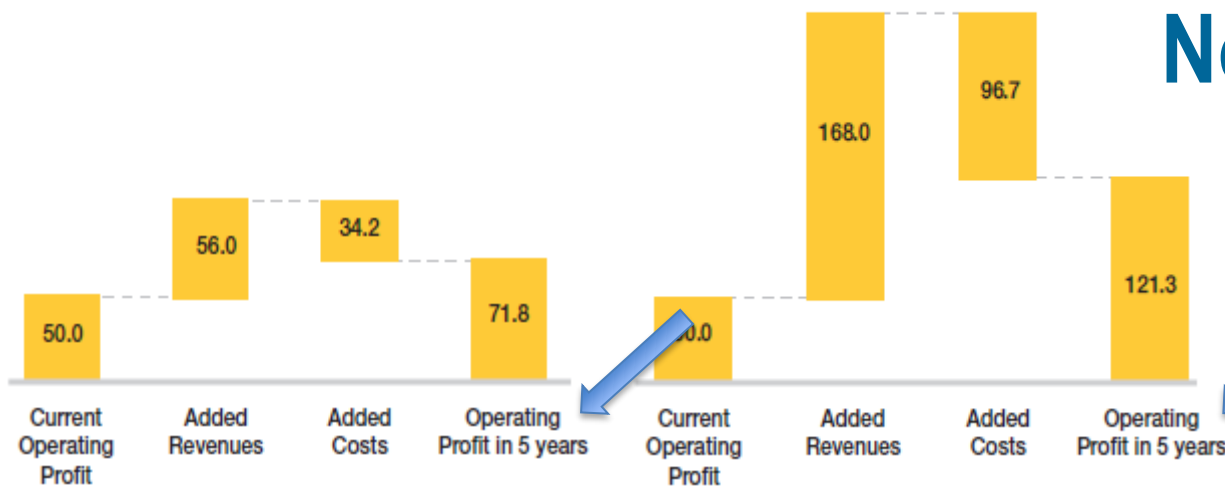
Source: Capgemini Digital Transformation Institute analysis, Capgemini Digital Transformation Institute, smart factory survey, February-March 2017

Figure 5: More than half of the manufacturers invested over \$100 Mn in smart factories



Conservative estimates of financial gains
(in million US\$)

Optimistic estimates of financial gains
(in million US\$)

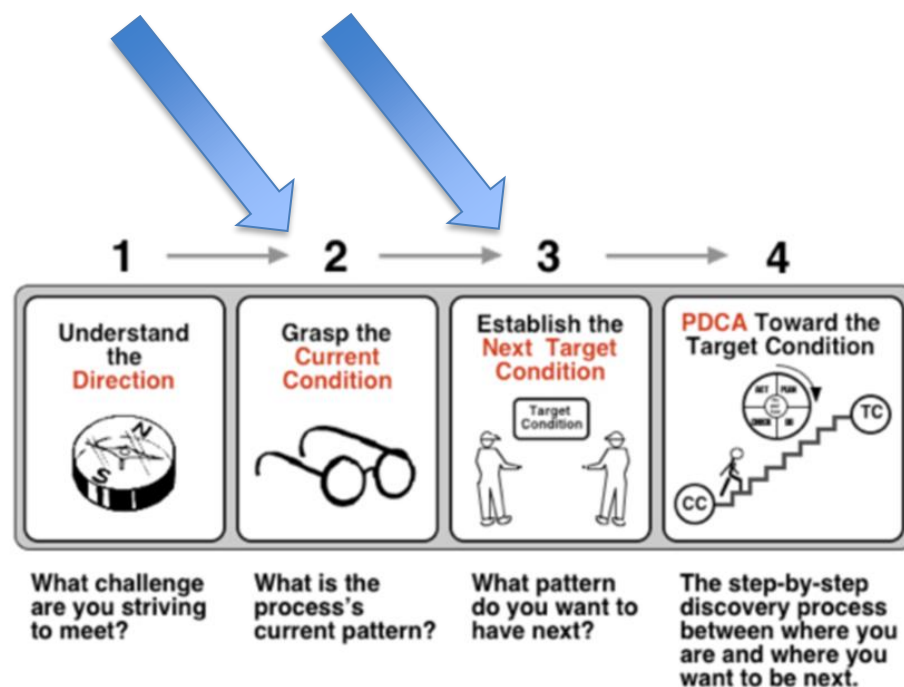


Understand Mfg 4.0
“known” ROI
versus company’s
financial models;
IRR, NPV, ROI.
Notice the 5 year
results.



Smart Manufacturing Transformation - Preliminary Steps/Considerations

- Company Vision Alignment with transformation (Beginners versus Digital Masters)
- Understand/model the process as is
- Identify linear/continuous steps interactions
- Identify non-continuous steps interactions
- **Technological level of inspection steps (i.e., sensors, visual versus computerized analysis, phenomenological models, etc.)**

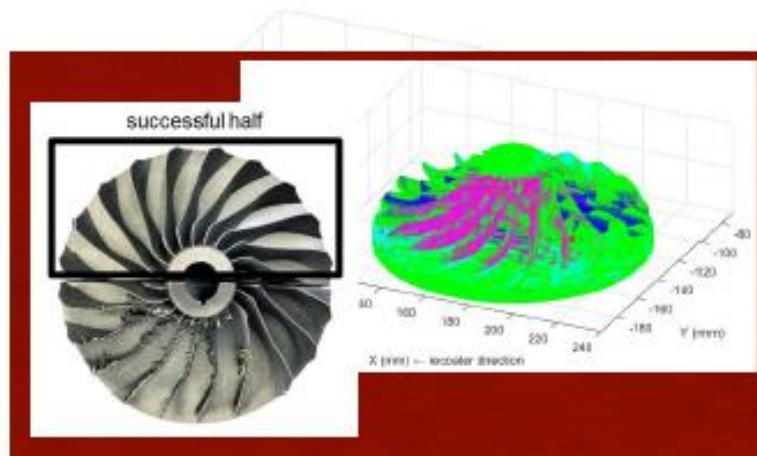




Sensors, Inspection and Prognostic Health Management (alias Total Preventive Maintenance 2.0)

Build monitoring: The new way

Aggregate data...



powder bed image

CAD design

defect identification

aggregate layers

successful prediction

...to predict (and fix) problems before they occur.

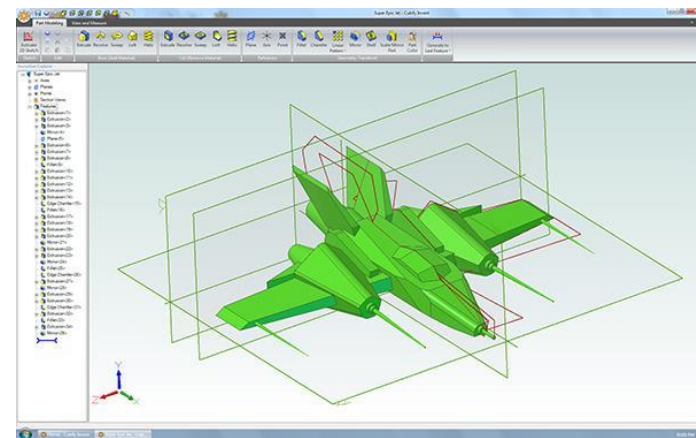
Carnegie Mellon University 10

Provided by **Professor Elizabeth A. Holm, PhD FASM**

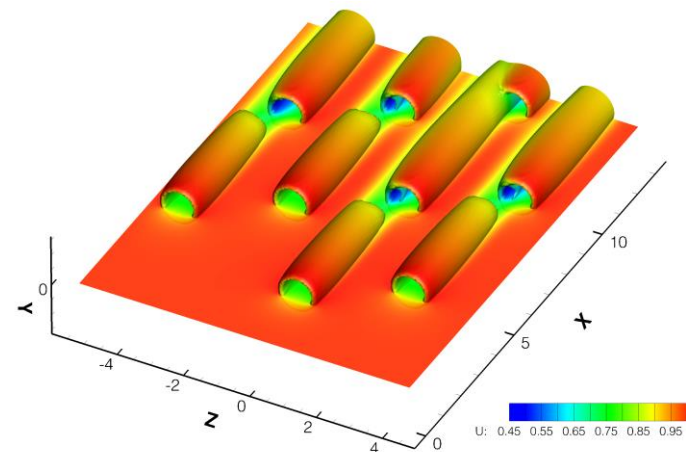


Smart Manufacturing Transformation - Preliminary Steps/Considerations, cont.

- Develop Computer based product models;
Digitization frenzy.
- Robots? Automation versus manual operation?
- Additive Manufacturing
- Financial expectations (5 years ROCs?)
- AND.....



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Get Ready

Not IF
BUT
WHEN





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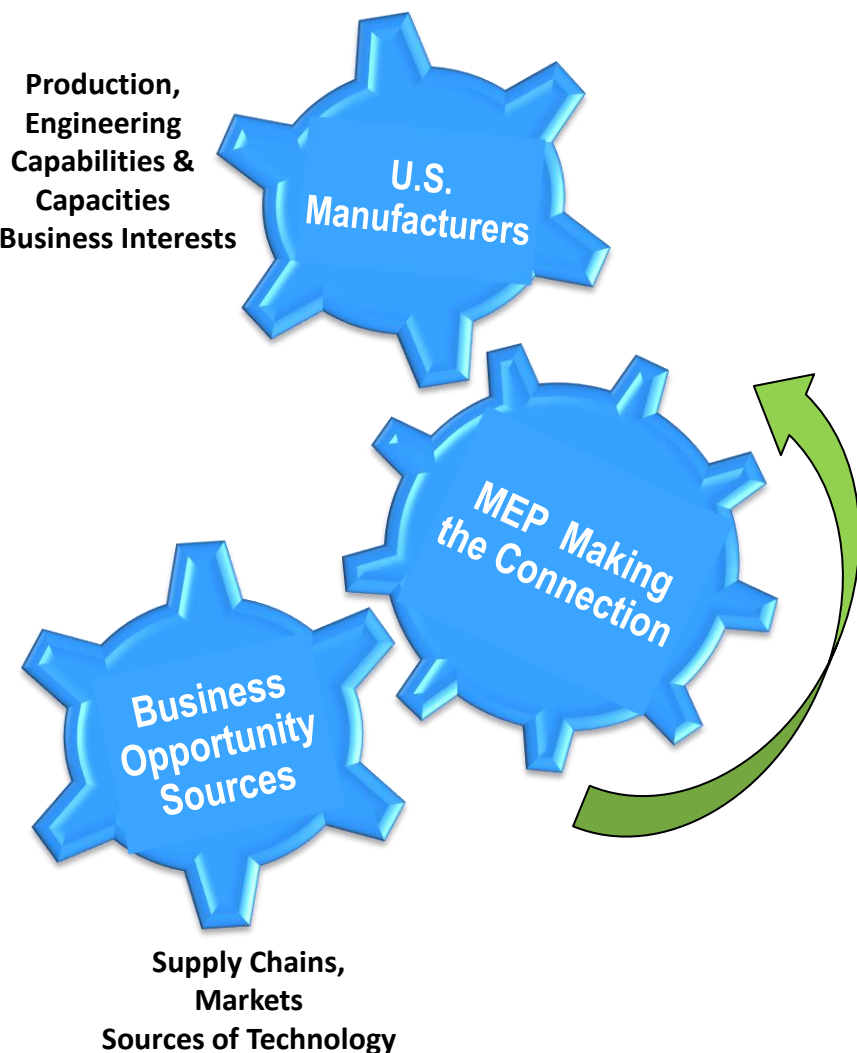


Useful
resources

MEP Network
Mfg USA Institutes
“Local Resources”



MEP: Connecting and Assisting U.S. Manufacturers



- Enhance business opportunities for U.S. manufacturers
- *Connect* products, capabilities, capacities of U.S. (small) manufacturers with:
 - ✓ Resources available from Nation's technology sources, including NIST Labs and Mfg USA Institutes, plus others
 - ✓ New market opportunities
 - ✓ Supply chain needs of OEMs, Tier 1s, gov agencies
- Provide *assistance* to manufacturers, including:
 - ✓ Technical manufacturing services for products, processes
 - Product/Process Development and Innovation
 - Manufacturing Strategy, Scale-up, Plant Layout
 - Production Optimization, (Re)tooling (Lean/Quality/Automation)
 - Engineering Practices
 - New Technology Awareness and Implementation – Robotics Additive, Digital, NIST Labs, Mfg. USA Technology Focus Areas
 - Cybersecurity – NIST Framework, DFARS, NIST SP 800-171
 - ✓ Supply Chain Development
 - ✓ Exporting, Market Diversification
 - ✓ Workforce Development
 - ✓ Marketing, IP Management, Financing/Access to Capital
 - ✓ Sustainability



Embedding MEP into Manufacturing USA Institutes



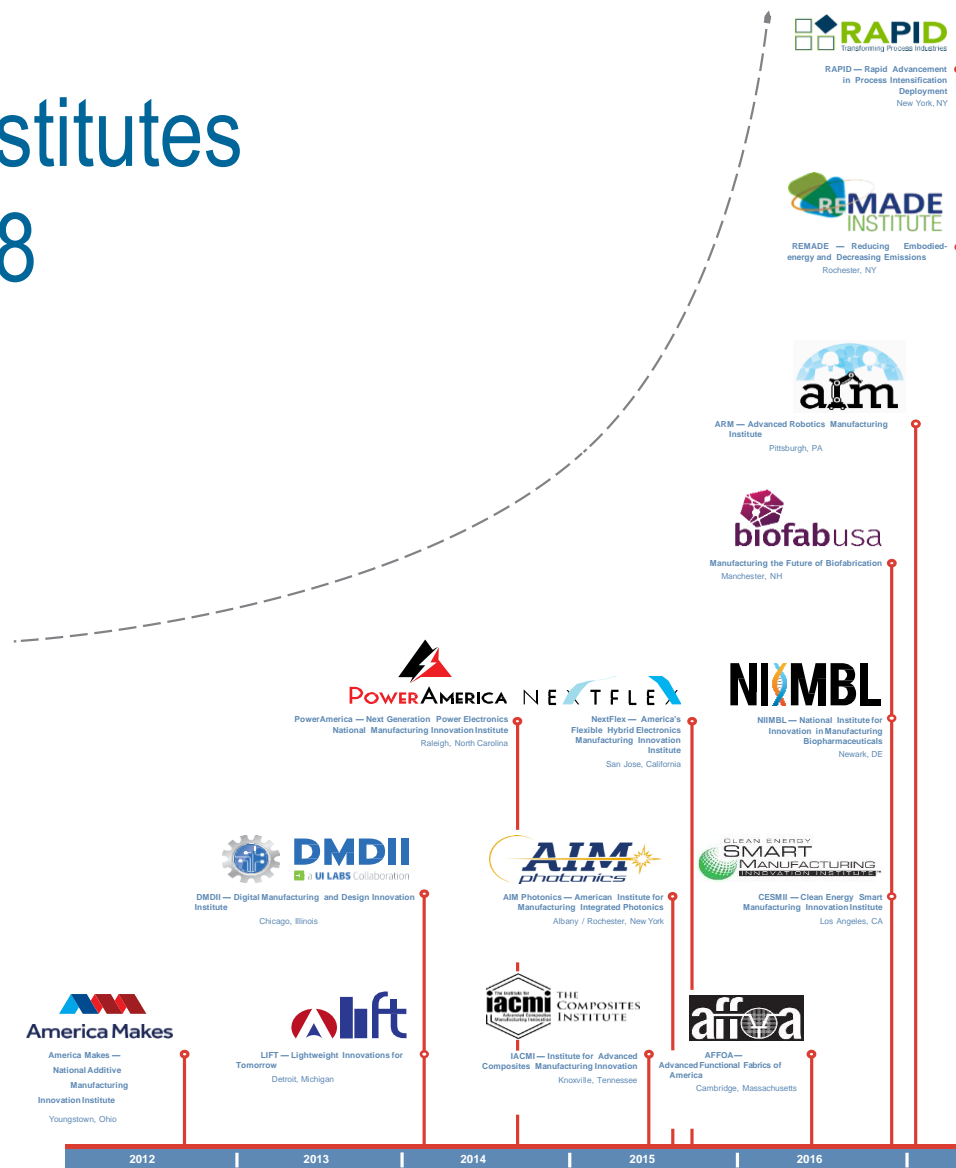
- **NIST MEP-funded Pilot Projects to embed MEP Center personnel at Mfg. USA Institutes.**
- **14 Awards**
- ✓ **California Mfg. Technology Consulting**
 - Next Flex and **CESMII**
- ✓ **Illinois Mfg Excellence Center - DMDII**
- ✓ **Massachusetts MEP - AFFOA**
- ✓ **Michigan Mfg. Technology Center – LIFT**
- ✓ **DEMEP - NIIMBL**
- ✓ **MassMEP – BioFab**
- ✓ **NYMEP - REMADE**
- ✓ **North Carolina MEP - Power America**
- ✓ **New York MEP - AIM Photonics**
- ✓ **Pennsylvania MEP - America Makes**
- ✓ **Tennessee MEP - IACMI**
- ✓ **OMEP – RAPID**
- ✓ **PA MEP – Advanced Robotics**

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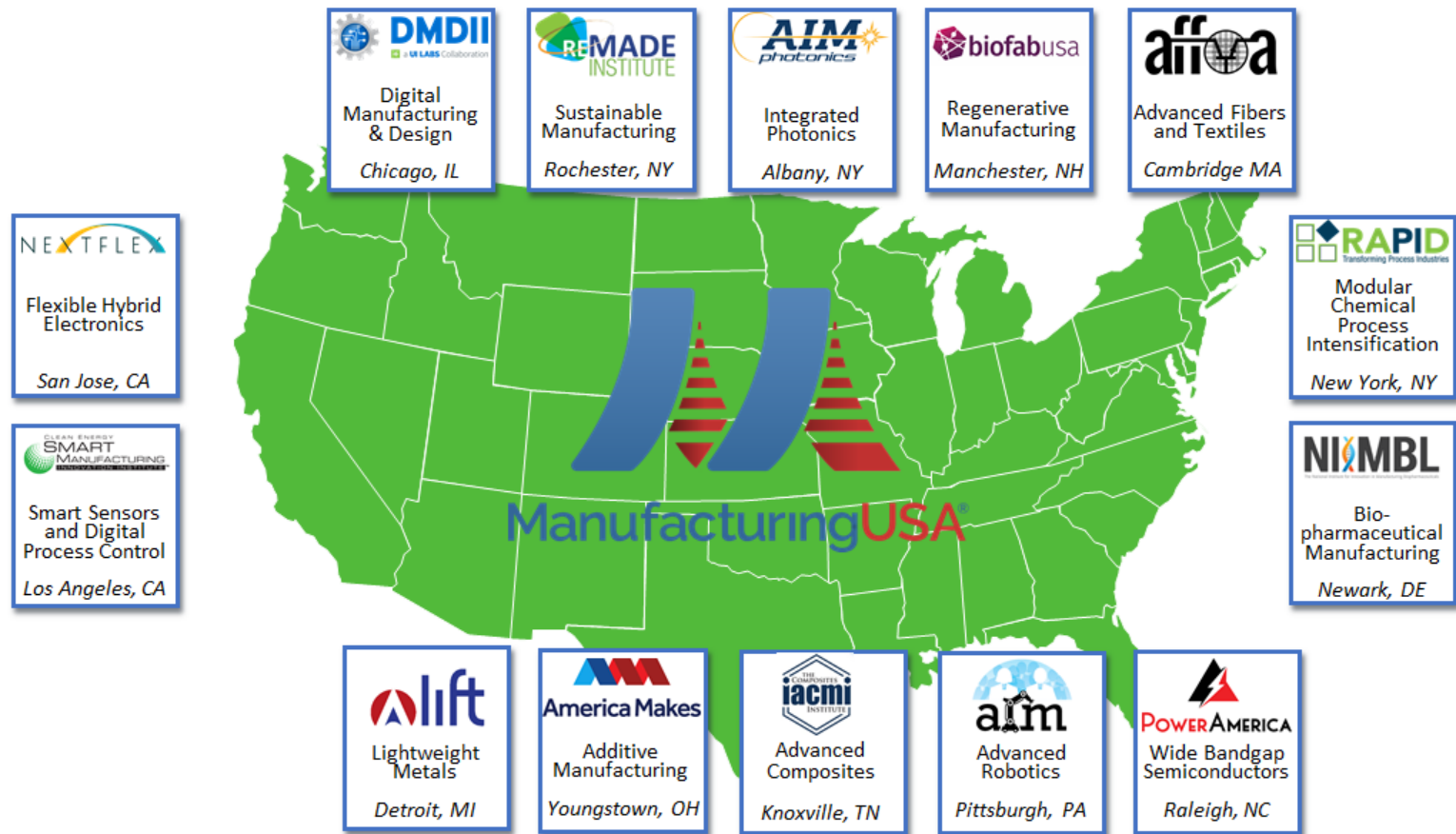


Fourteen Institutes Total in 2018



Manufacturing USA Today

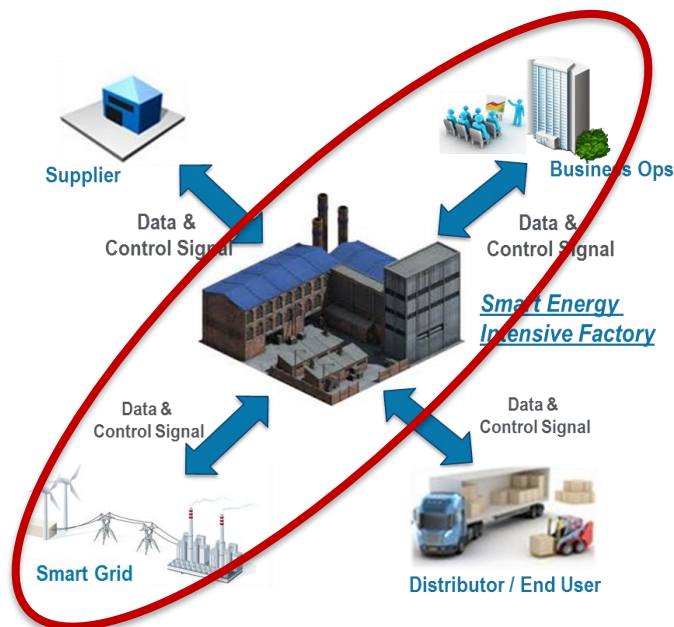
Regional Hubs with National Impact





Smart Manufacturing

Advanced Controls, Sensors, Models and Platforms – Los Angeles, CA



- Encompass machine-to-plant-to-enterprise real time sensing, instrumentation, monitoring, control, and optimization of energy (**>50% improvement in energy productivity**)
- Enable hardware, protocols and models for advanced industrial automation: requires a holistic view of data, information and models in manufacturing at Cost Parity (**>50% reduction in installation cost**)
- Significantly reduce energy consumption and GHG emissions & improve operating efficiency – (**15% Improvement in Energy Efficiency**)
- Increase productivity and competitiveness across all manufacturing sectors:

Special Focus on Energy Intensive & Energy Dependent Manufacturing Processes

Lead: Smart Mfg Leadership Coalition

West Hub: **UCLA** Gulf Hub: **Texas A&M**

NE Hub: **RPI** SE Hub: **NC State**

NW Hub: **Pacific NW National Lab**

- **~200 partners from industry, academia, NGOs and state/local**
- **\$70M federal investment, \$70M match**





DMDII

DIGITAL MANUFACTURING AND
DESIGN INNOVATION INSTITUTE

Est.: February 2014

Lead: UI LABS

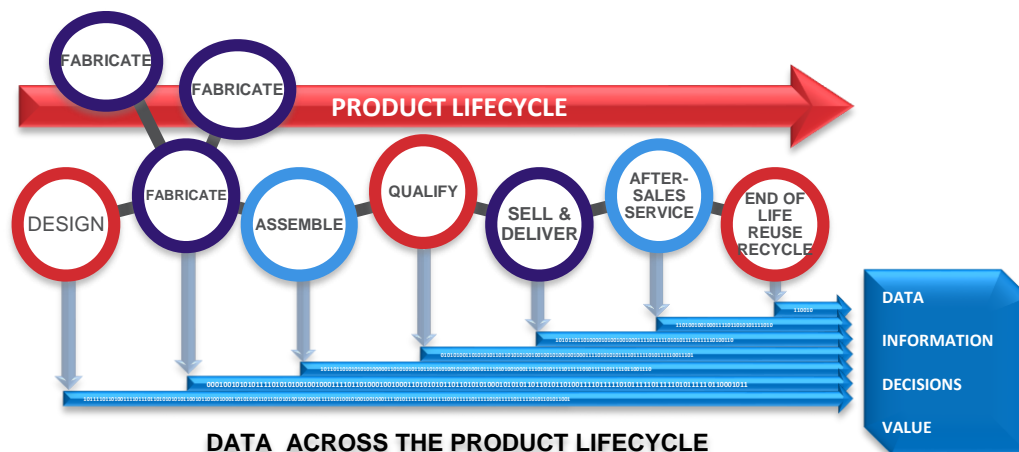
Hub location: Chicago, IL

Current number of members: 308

Federal Funding: \$70M

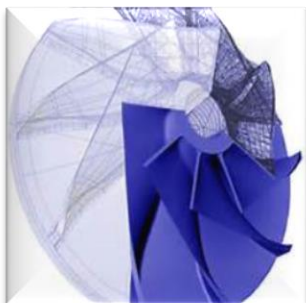
Cost Share (UI Labs): \$106M

Mission: Digitize American Manufacturing



COMPETITIVENESS PERFORMANCE IMPROVEMENTS:

- **Lower design costs** through better collaboration with suppliers
- **Lower manufacturing cost and capital requirements** from better optimization of end-to-end product lifecycle
- **Reduced time to market** due to more rapid iteration
- **Next-gen innovations first:** digital design, digital factories, digital supply chains
- **New and legacy products**



Future Factory Platform demonstrates key applications of digital manufacturing that create high value organizational impact

- + Like most transformative techniques, the **introduction of digital tools into the manufacturing environment** spans across multiple functions.
- + **Workshops showcase companies and use cases** that likewise **span multiple functions of the production cycle** in order to allow everyone to experience some of the exciting technologies that are currently available to assist with each organizations unique digital journey needs.
- + Participants will find **proven, actionable approaches** that help them solve problems and capitalize on new opportunities.

PEOPLE



Optimize Workflow and Productivity

Digital factories need to focus on bringing people and digital technology together to enhance operations on the shop floor.

This experience will focus on:

- + Leveraging real-time production data
- + Reducing the time it takes to train employees
- + Turning static work instructions into dynamic processes

PROCESSES



Improve Product and Service Quality

Advances in virtual and augmented reality and next-level interfaces are redefining manufacturing processes and impacting product and service quality.

This experience will focus on:

- + Gaining real-time visibility of inventory locations
- + Connecting remote experts and field technicians in real time to collaborate through a task

EQUIPMENT



Optimize Equipment Operations

Embedded systems, machine to machine learning and generative design will play a key role in enhancing overall equipment effectiveness and optimizing operations on the factory floor.

This experience will focus on:

- + Adaptive control and machine monitoring
- + Leveraging generative design and simulation





America Makes

Est. August 2012; Hub location: Youngstown, OH

Lead: National Center for Defense Manufacturing and Machining (NCDMM)

Regional location: "TechBelt" Cleveland to Pittsburgh Corridor

Mission: Accelerate additive manufacturing innovation and widespread adoption by bridging the gap between basic research and technology development/deployment.

- 53 companies, 36 universities & labs, 26 other organizations
- \$50M federal investment and 1:1 cost share pledged to support development and management of the institute plus applied research projects over 5 years
- 22 research projects underway with \$13.5M federal funds plus \$15M private funds so far
- Industry entrusted 14 machines to the institute
- Strong tech transition, workforce education & STEM focus



AIM Photonics

American Institute for Manufacturing
Integrated Photonics – Rochester, NY



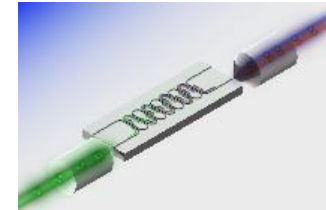
Est: July 2015

Lead: RF SUNY

Hub location: Albany and Rochester, NY

Federal Funding: \$110 M

Industry Cost Share: \$503 M



Objective

Develop and demonstrate innovative manufacturing technologies for:

- Ultra high-speed transmission of signals for the internet and telecommunications
- New high-performance information-processing systems and computing
- Sensors and imaging enabling dramatic medical advances in diagnostics, treatment, and gene sequencing



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This Institute will focus on developing an end-to-end photonics 'ecosystem' in the U.S., including domestic foundry access, integrated design tools, automated packaging, assembly and test, and workforce development.



***All these developments
will require cross-cutting
disciplines of design,
manufacturing, packaging,
reliability and testing.***



ARM

Advanced Robotics for Manufacturing – Pittsburgh, PA



Established: January 2017
Hub Location: Pittsburg, PA
Lead: American Robotics
Federal Funding: \$80 Million
Industry cost share: \$173 Million

Problem: The use of robotics is becoming widespread in manufacturing environments but the robots are typically **expensive, singularly purposed, challenging to reprogram,** and require **isolation from humans for safety.**

Need: Robotics are increasingly necessary to achieve **the level of precision necessary for defense and other industrial manufacturing requirements** which limits the participation of mid-size to small manufacturers due to capital cost and complexity of use.



Technologies ripe for significant evolution within the RIME institute include, but are not limited to:

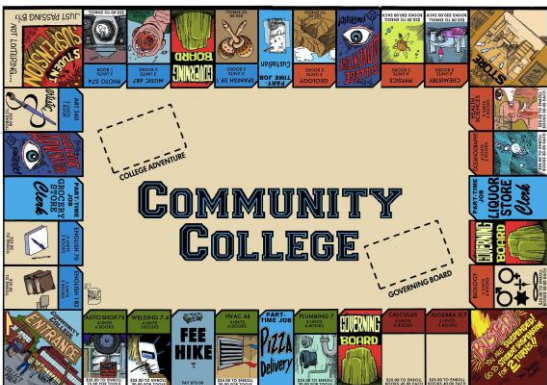
- Robot control (learning, adaptation, & repurposing)
- Collaborative robotics
- Dexterous manipulation
- Autonomous navigation and mobility
- Perception and sensing
- Testing, verification, and validation (TV&V)

Solution: ARM will integrate industry practices and institutional knowledge across many disciplines to **realize the promises of a robust manufacturing innovation ecosystem.**

<http://www.arminstitute.org/>



Use Your Local Resources



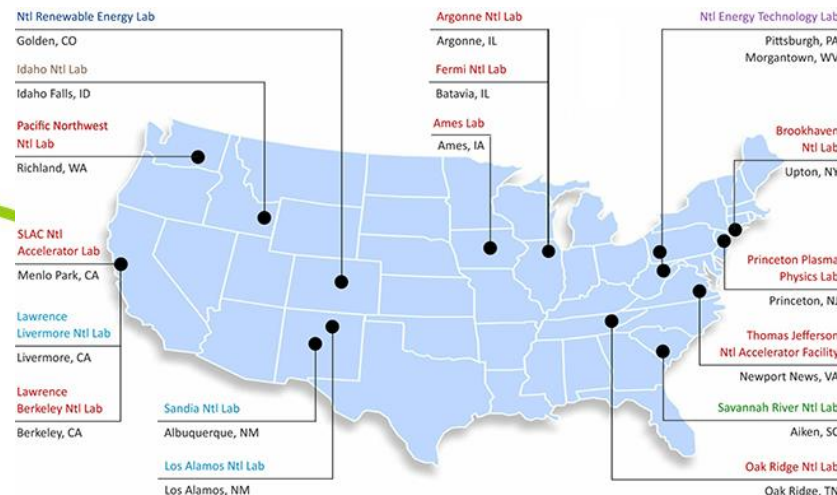
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INSTITUTE



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- Office of Science (SC)
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- NtL Nuclear Security Administration (NNSA)
- Office of Fossil Energy (government owned & operated) (FE)
- Office of Energy Efficiency and Renewable Energy (EERE)
- Office of Environmental Management (EM)



MEP • MANUFACTURING
EXTENSION PARTNERSHIP





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In Summary:

- ☐ Determine Company Baseline and Future Mfg 4.0 Quadrant
- ☐ Determine the “gaps” in People, Processes and Equipment (PePE) transformation
- ☐ We MEP Centers are your Go To Trusted Advisor for identifying resources and defining/executing the transformation.





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Questions / Discussion?

