Initiatives for Applying Smart Manufacturing to the Continuous Processing Industries

South Texas Local Section

American Institute of Chemical Engineers

January 2016 Monthly Dinner Meeting

Presented by:

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Southwest Research Institute® (SwRI®)

Overview

- Chemical Engineering and Manufacturing
- Revitalizing U.S. Manufacturing
- Smart Manufacturing and the Continuous Processing Industries

CHEMICAL ENGINEERING AND MANUFACTURING

Chemical Engineering and Production

Chemicals

Petrochemicals

Refining

Polymers

Pharmaceuticals

- **Use of data to improve production**
- **Networked information-based approach to production**
- **Process models to improve quality and efficiency**
- **Blending of sensing and modeling for intelligent production**
- **Smart sensors for real-time process analysis and continuous measurement of process uncertainty**
- **Control and automation for increased efficiency, lower cost, higher throughput, and lower variance**
- **High fidelity models for process control and optimization**
- **Integration of process control with planning, scheduling, and logistics**

Chemical Engineering and Production

Smart Manufacturing

- Use of data to improve production
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Chemical Engineering and Manufacturing

- **Chemical Engineers work across most all industries and impact the production of almost everything manufactured on an industrial scale.**
- **Chemical Engineers often work in manufacturing plants and or pilot plants most often specializing in continuous production, process engineering, and process automation, all critical to the manufacture of products.**
- **Chemical Engineers are innovating, developing, and improving manufactured products too numerous to count.**
- **Chemical Engineers invent solutions to problems that are important to manufacturing processes like pollution control, energy conservation, and water conservation to name a few.**

Definition of Manufacturing Innovation

General Definition[1]:

"the act or process of introducing new ideas, devices, or methods"

National Network for Manufacturing Innovation Results[2]

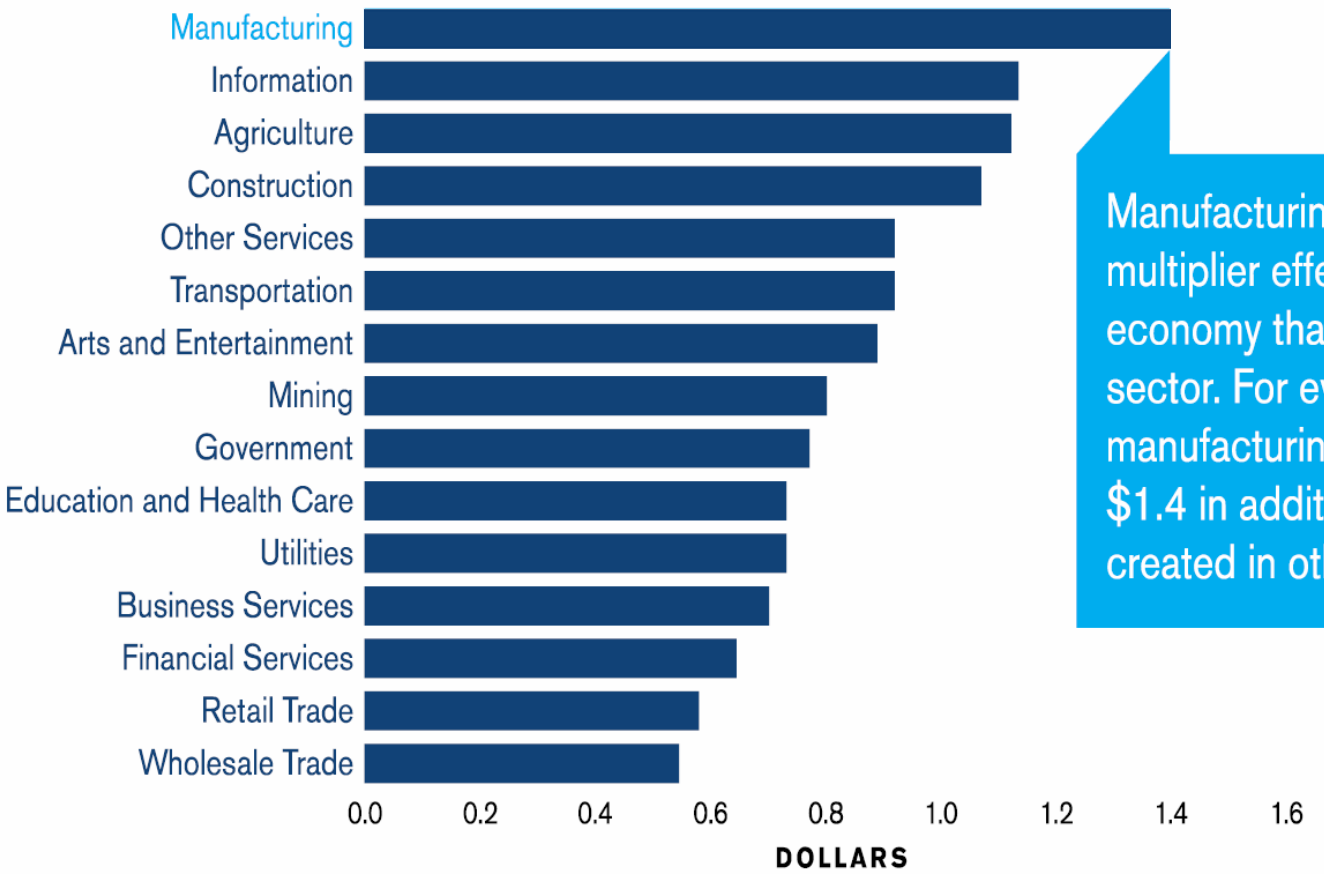
"Allows new manufacturing processes and technologies to progress more smoothly from basic research to implementation in manufacturing"

"the R&D, engineering, and manufacturing capabilities needed to turn inventions into competitive, manufacturable commercial products"

1. Merriam-Webster Definition
2. Advanced Manufacturing National Program Office, National Network for Manufacturing Innovation: A Preliminary Design

REVITALIZING U.S. MANUFACTURING

The Multiplier Effect



Manufacturing has a higher multiplier effect on the economy than any other sector. For every $1 in manufacturing value added, $1.4 in additional value is created in other sectors.

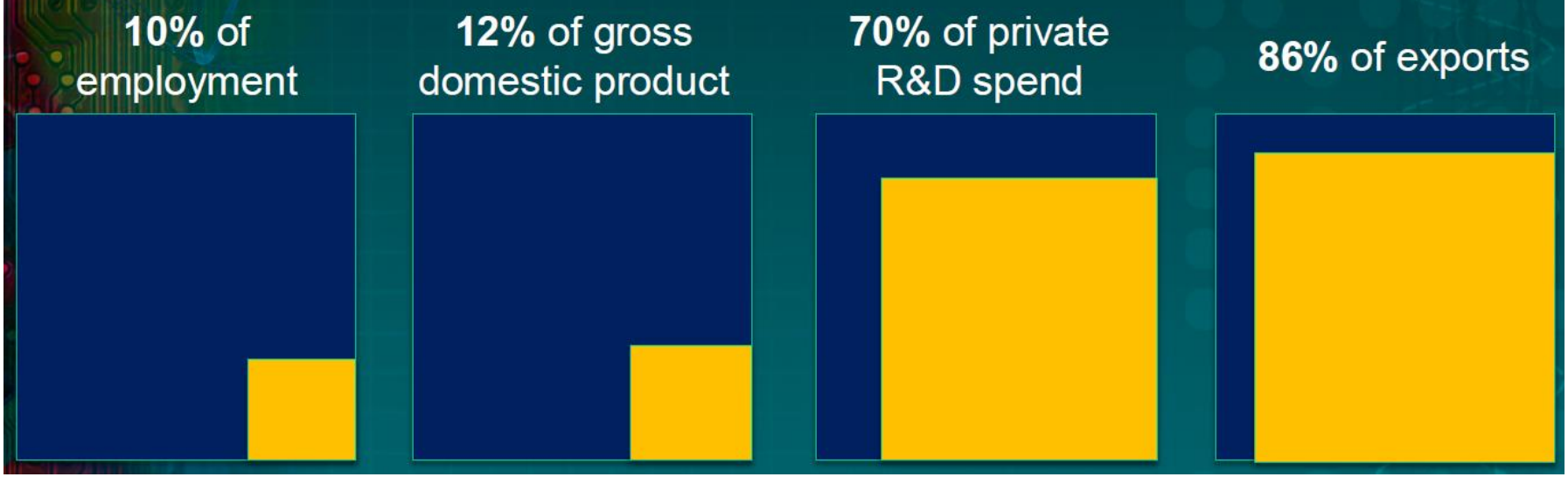
Economic Activity Generated by $1 of Sector GDP

Source: U.S. Department of Commerce, Bureau of Economic Analysis Council on Competitiveness

Why a Strong Industrial Base Matters

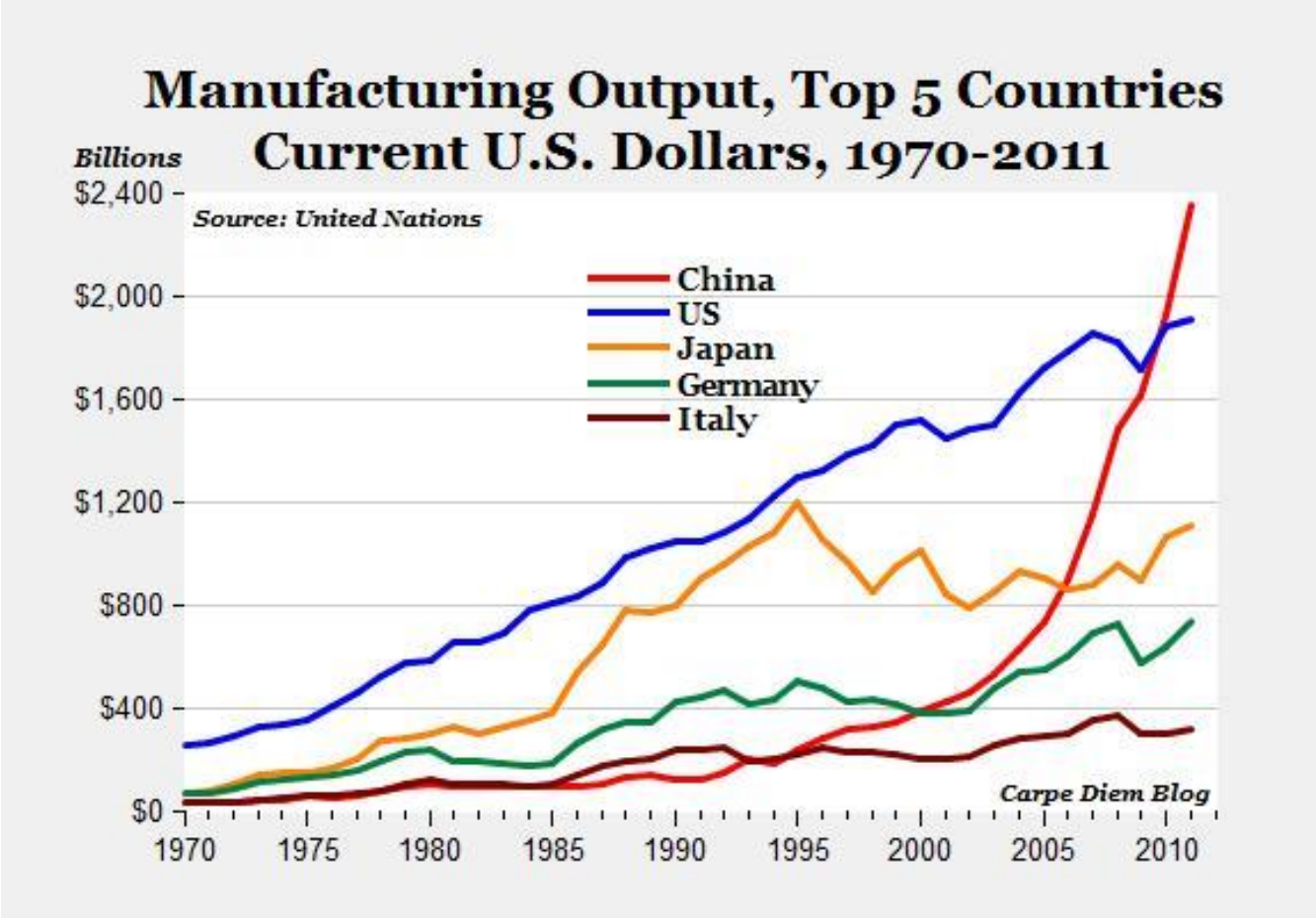
U.S. manufacturers

- Employ over half of all R&D personnel in domestic industry
- Employ over a third of all engineers
- Account for up to 90% of all U.S. patents issued annually



Source: Presentation by Mike Molnar, Director, Advanced Manufacturing National Program Office, Designing for Impact Workshop

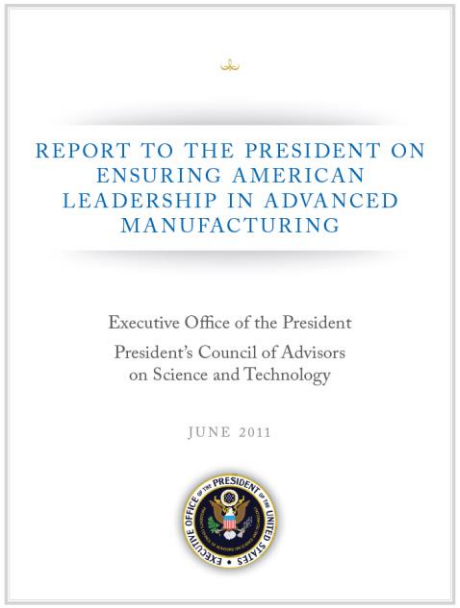
U.S. Ranking in Manufacturing

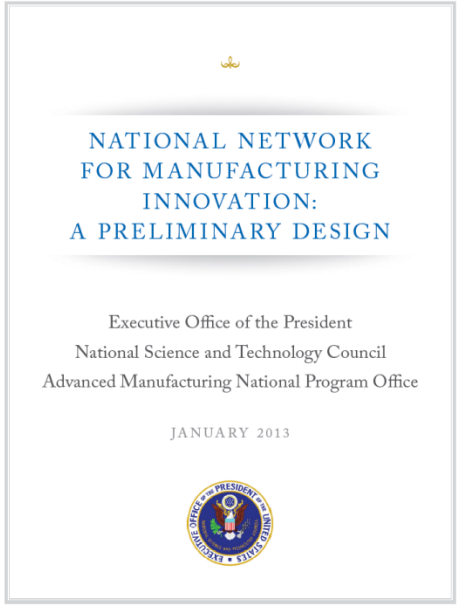


Sourced from American Enterprise Institute, public policy blog by Mark J. Perry

Development of Recommendations

- President's Coun y (PCAST)
- Advanced Manuf
- National Science
- Office of Science
- Interagency work IAM)
- Workshop feedba demia, government, workforce, econo





Recommendations from July 2012

16 Recommendations centered around

1. **Enabling Innovation**
   - **Included recommendation of establishing the National Network for Manufacturing Innovation**
2. **Securing the Talent Pipeline**
3. **Improving the Business Climate**

Advanced Manufacturing Programs

Some notable initiatives for "Enabling Innovation":

1. **National Network for Manufacturing Innovation (NNMI)**
   - Goal is up to 45 Institutes over 10 years
   - To Date: 7 established, 2 in proposal stage, and 4 additional competitions starting soon
   - Each with a unique product, market, technology, or production focus

2. **Advanced Manufacturing Technology Consortia (AMTech)**
   - Formation or development of industry-led consortia
   - Roadmapping and planning

AmTech

Of interest to Chemical Engineers:

Fluid Power

Advanced Lyophilization Technology

Flexible Electronics

Metalcasting

Functional Glass

Pulp and Paper Products

Atomization Technology

SemiSynBio

Structural Thermoplastics

Thermal Manufacturing

Advanced Composites

Biomanufacturing Science and Technology for Biopharmaceuticals

Sustainable Separation Process

Advanced Superconductor Manufacturing

Led by American Chemical Society

Electrochemical

Advanced Joining and Forming

More Info:

http://www.nist.gov/amo/amtech/index.cfm

NATIONAL NETWORK FOR MANUFACTURING INNOVATION

NNMI: Institute Characteristics

- Institutes will be the anchor to a regional innovation ecosystem, with a vision for national and international preeminence.
- Institutes will be partnerships between all stakeholders: industry, academia, government, industry development organizations. Collaboration is critical.
- Each institute will have its own unique focus area, one of:
  - Manufacturing process
  - Advanced Materials
  - Enabling Technology
  - Industry Sector
- Institutes should be proposed by an industry-focused non-profit organization. Focus areas will be ideally be defined by proposing teams.
- Institutes will be self-sustaining after 7 years.

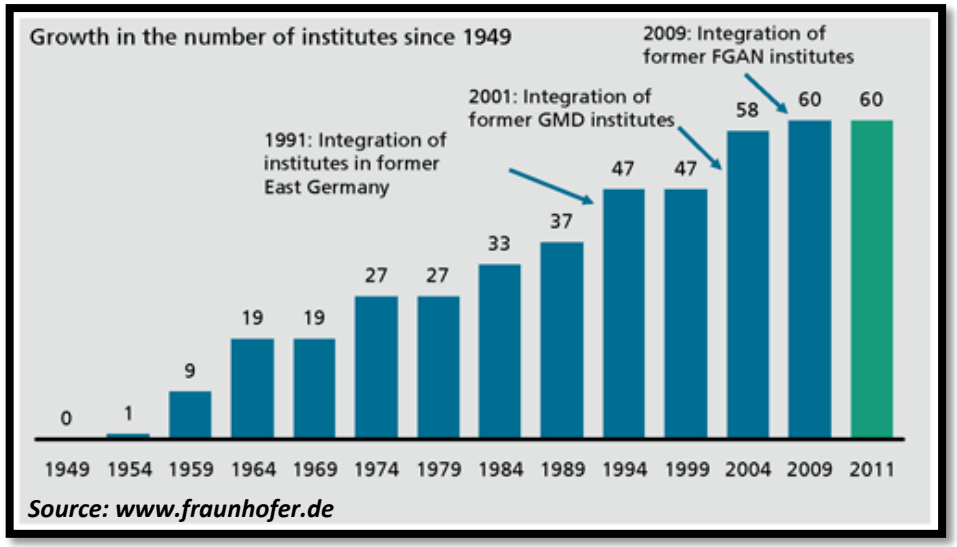
Source: Advanced Manufacturing National Program Office Presentation

Fraunhofer Institutes Inspiration

Germany:

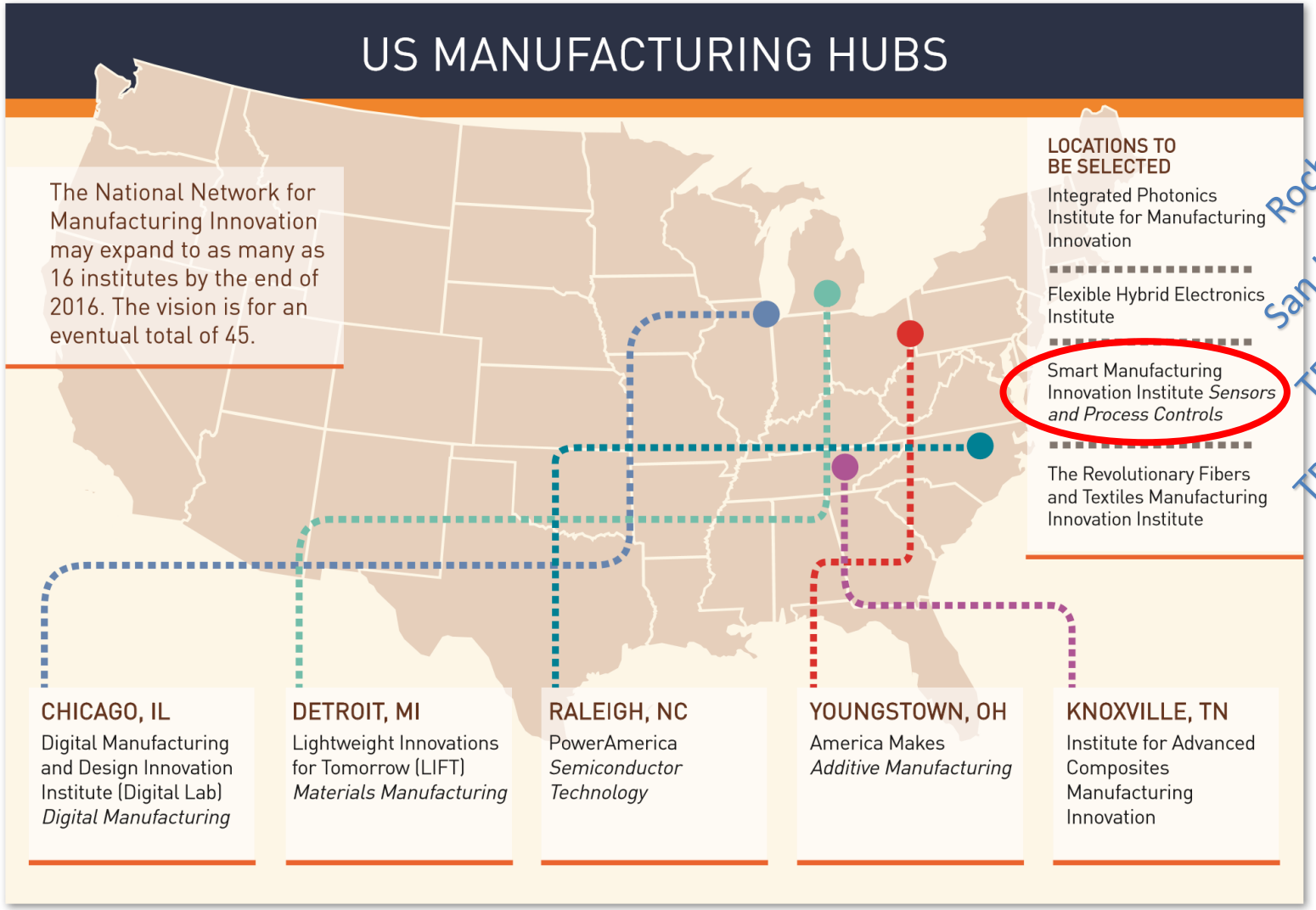
- Has a national industrial strategy
- Manufacturing is 23% of the GDP
- Employees roughly 25%
- Manufacturing workers are well paid (average of $47 per hour)
- Invests heavily in ability to produce
- Education system tailored to provide mfg. workers and engineers
- SMMs are assured access to capital
- Fraunhofer Institutes for applied R&D
- Runs a trade surplus

Fraunhofer



Source: Based on 2011 data from internet sources

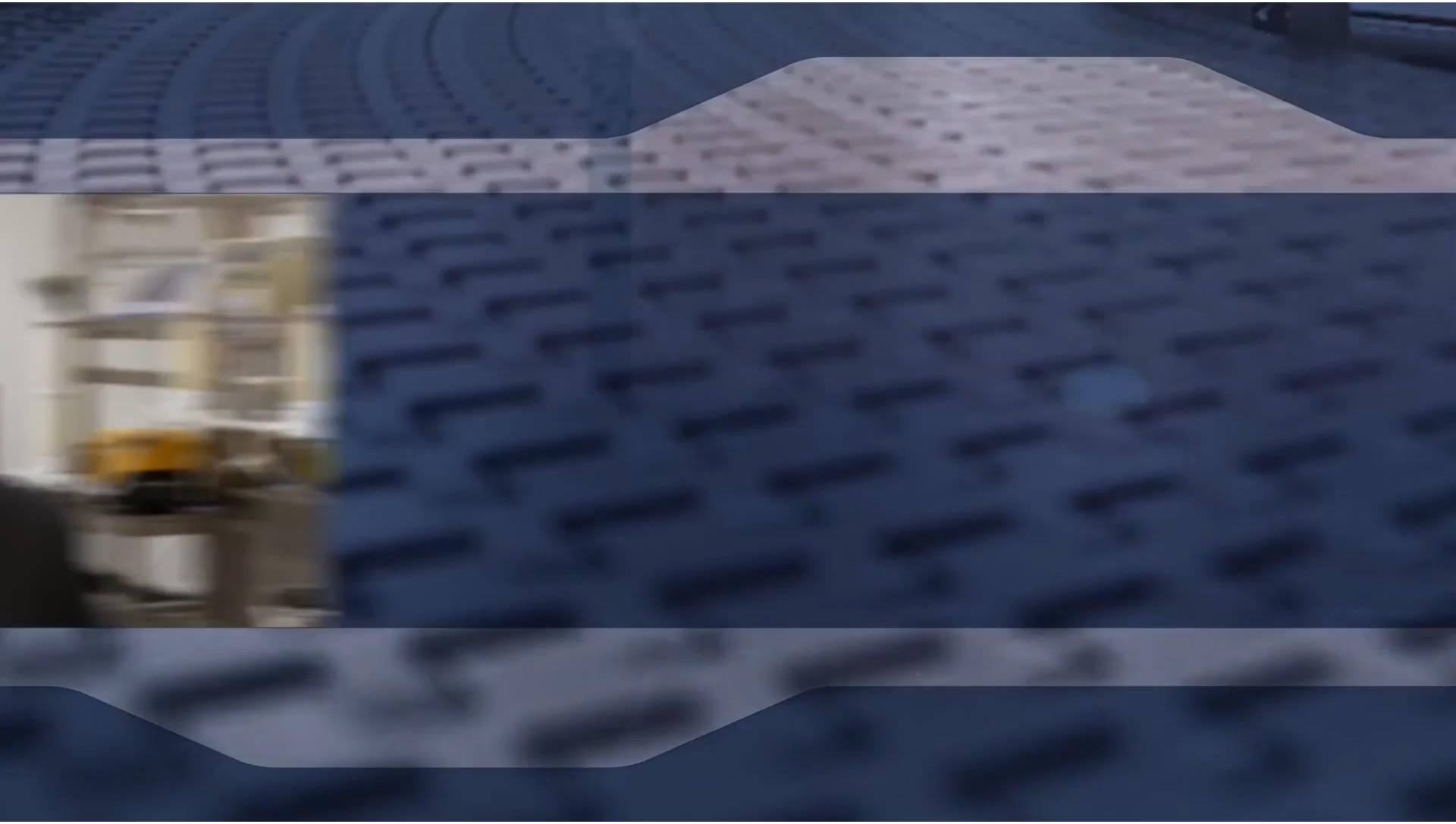
Current IMIs



Map Source: Inside America's Bold Plan to Revive Manufacturing – Special Report, Manufacturing Engineering, June 2015

SMART MANUFACTURING

Smart Manufacturing – Video Clip



Reference: https://www.youtube.com/watch?v=d2BFaiLU9YU

SMLC Members

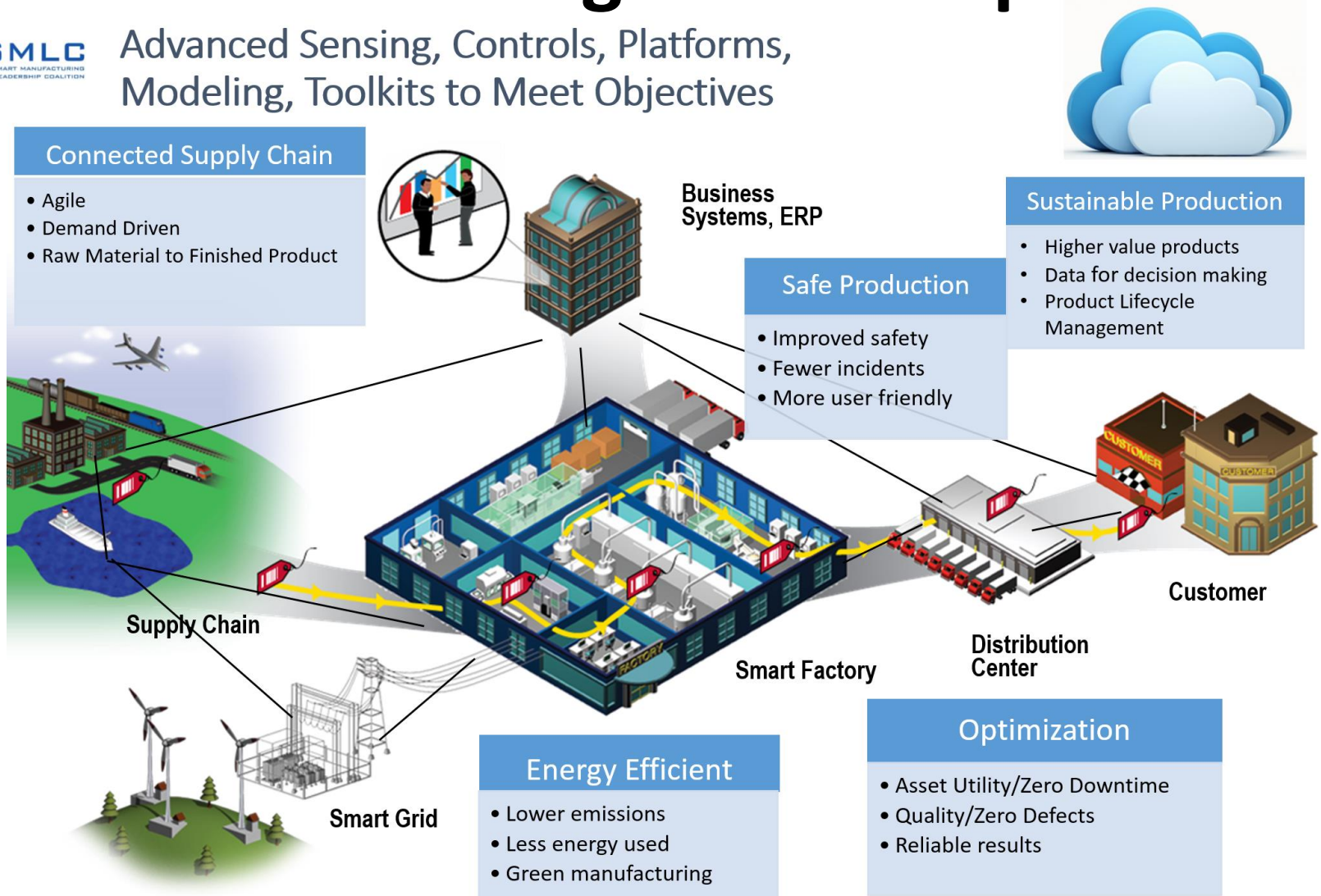
American Council for an Energy Efficient Economy (ACEEE)
AMP Socal
Alcoa
American Institute of Chemical Engineers (AIChE)
American Society of Quality
ARC
Association of State Energy Research and Technology Transfer Institutions (ASERTTI)
Carnegie Mellon
Connecticut Center for Advanced Technology (CCAT)
Corning
Department of Energy (DOE)
Emerson
Electric Power Research Institute
General Electric
General Mills
General Motors
Manufacturing Enterprise Solutions Association (MESA)
MIT
MT Connect
National Association of State Energy Officials (NASEO)
North Carolina State University
Nimbis Services
NIST
NSF
OSISoft
Owens Corning
Pacific Northwest National Laboratory
Pfizer Inc.
Praxair
Purdue University
RPI
Rockwell Automation
Rutgers University
Savannah Rivers National Lab
Savigent Software
Schneider Electric
SME
Southwest Research Institute - SWRI
Sustainable Solutions
Texas A&M Engineering Experiment Station (TEES - TAMU)
Tulane – PolyRMC
United Technology Research Center (UTRC)
UC Berkeley
UConn
UC Irvine
UCLA
USC - EDC
UT Austin
West Virgina University

Source: Smart Manufacturing Leadership Coalition

Smart Manufacturing Leadership Coalition

SMLC
Smart Manufacturing Leadership Coalition

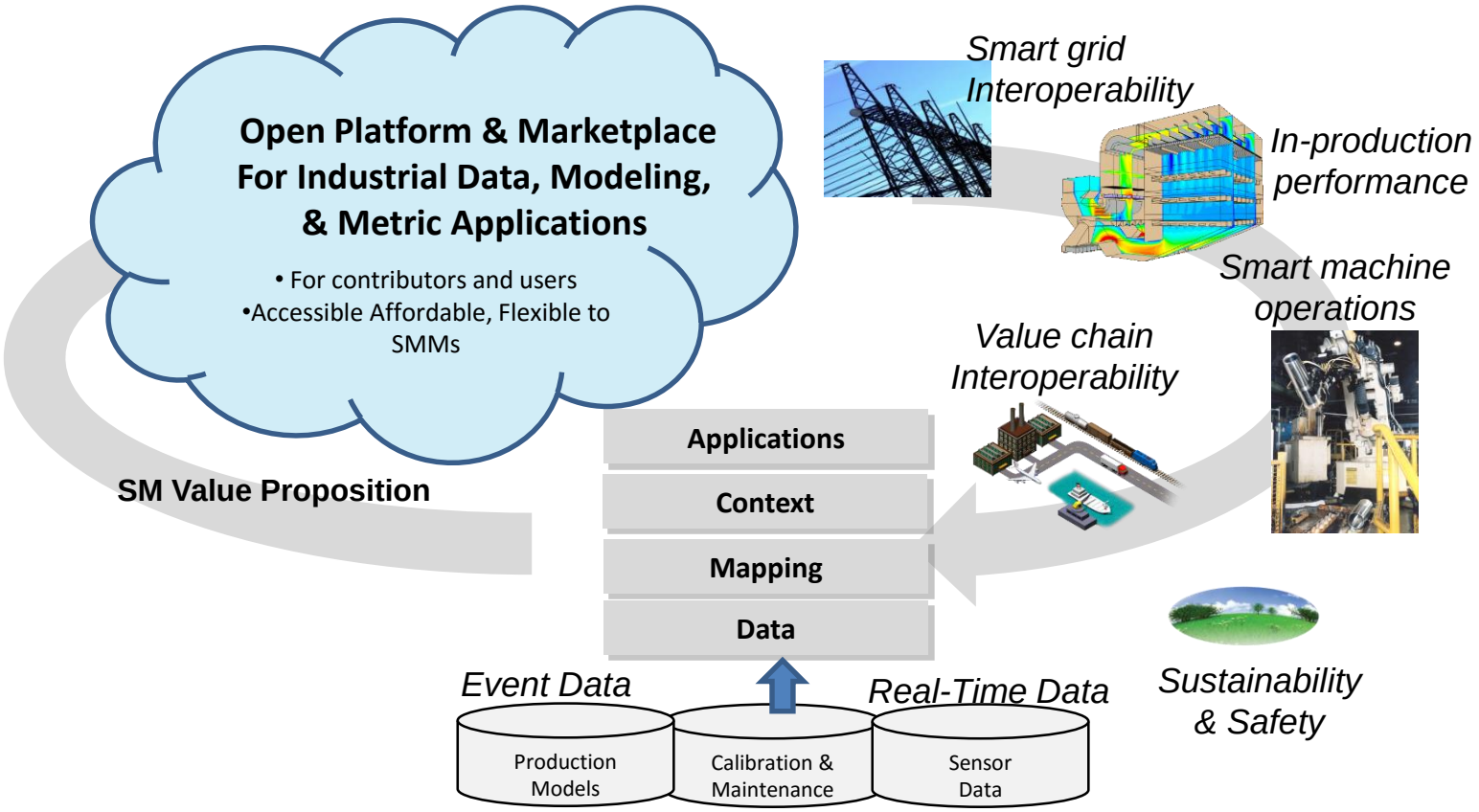
Advanced Sensing, Controls, Platforms, Modeling, Toolkits to Meet Objectives



Source: Smart Manufacturing Leadership Coalition

Smart Manufacturing Platform

Bridging Seams Extending the Real Time Infrastructure across Value Chains

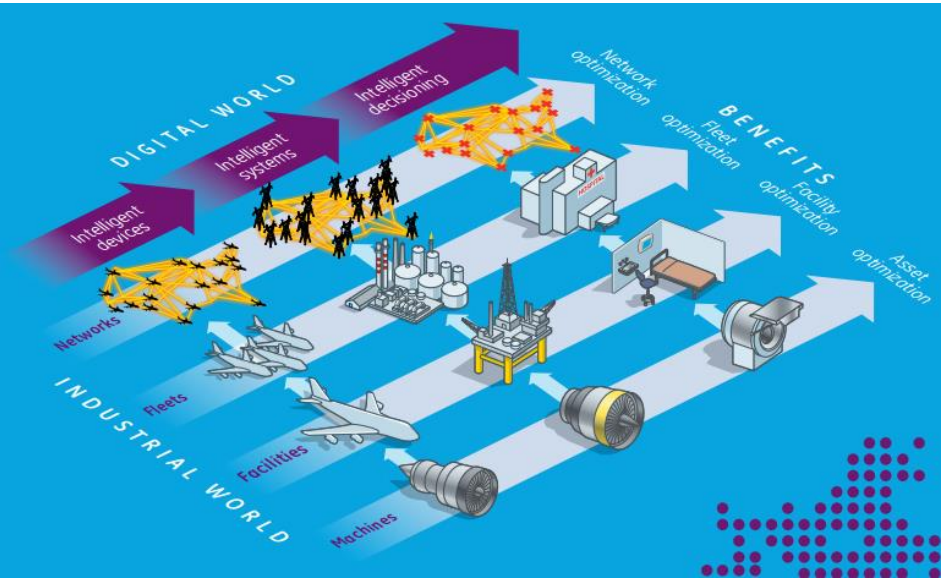


Source: Smart Manufacturing Leadership Coalition

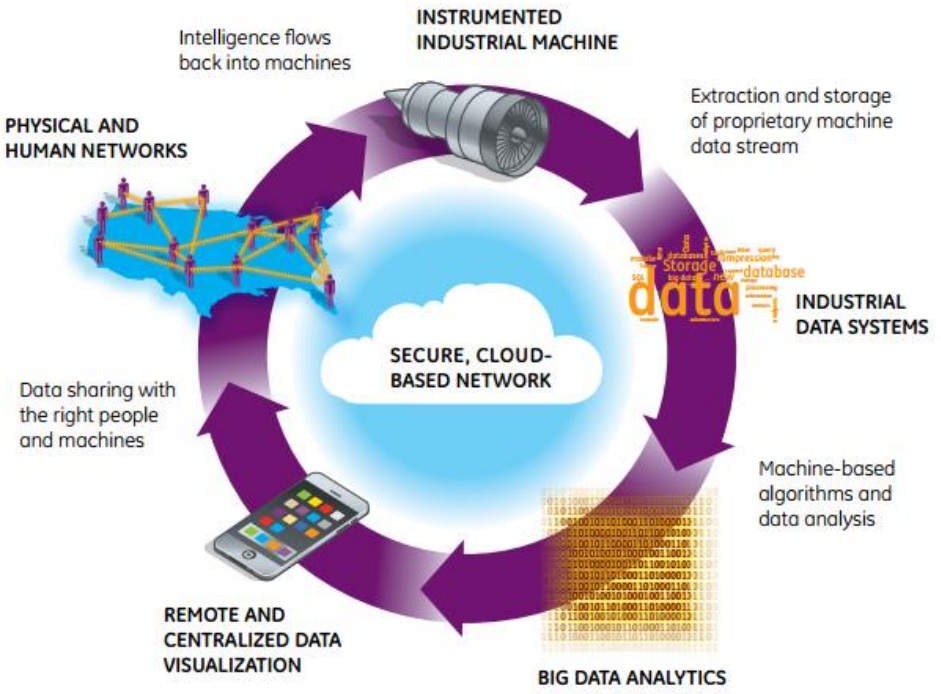
Industrial Internet of Things

"Industrial Internet" – Key Enabler

Applications of the Industrial Internet



Industrial Internet Data Loop



Reference for Images: General Electric Industrial Internet
http://www.ge.com/docs/chapters/Industrial_Internet.pdf

SMLC Testbed Example

Optimization of Steam Methane Reforming Furnaces:

- U.S. DOE Grant
- Collaboration of Government, Industry, and Academia
- Building of SM Platform capabilities
- Praxair reformer, used to make syngas and hydrogen, as testbed
- Integrate sensing technologies and the data to better model process
- Apply information to improve operations and for new process design
- Reduce CO2 emissions and waste heat

Source: SMLC, "What is Smart Manufacturing" video

Accelerating Smart Manufacturing

Clean Energy Smart Manufacturing Institute:

- U.S. DOE funding for a Clean Energy Innovation Institute
- Up to $70 million in funding with minimum 1:1 match

Technology and work practices that:

- Reduce energy, raw material and water intensity by improving and integrating process, plant, and enterprise-wide efficiencies
- Optimize production and improve quality control using cost-effective sensing and control for retrofits and new facilities
- Better visibility, decisions and energy management practices across the manufacturing enterprise

Source: Smart Manufacturing Leadership Coalition and Manufacturing.gov

Clean Energy Smart Manufacturing Innovation Institute

CESMII

- Led by SMLC with support of a national network
- Gulf Coast engagement coordinated by Texas A&M Engineering Experiment Station (TEES)

CESMII research areas:

- Advanced sensors
- Controls
- Platforms
- Modeling technologies

To achieve better management of:

- Real-time energy utilization
- Productivity
- Worker Safety
- Waste

Source: Smart Manufacturing Leadership Coalition

For Your Reference

Some Websites and Links:

- Office of Science and Technology Policy
- Manufacturing.gov
- Smart Manufacturing Leadership Coalition
- Industrial Internet
- Industry 4.0

Contacts for more information or follow-up questions:

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Thank You!

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