# Smart Manufacturing @ NIST

Thomas Hedberg, Jr., P.E.

Systems Integration Division

MBSE and Evaluating a Data Interoperability Ecosystem Workshop

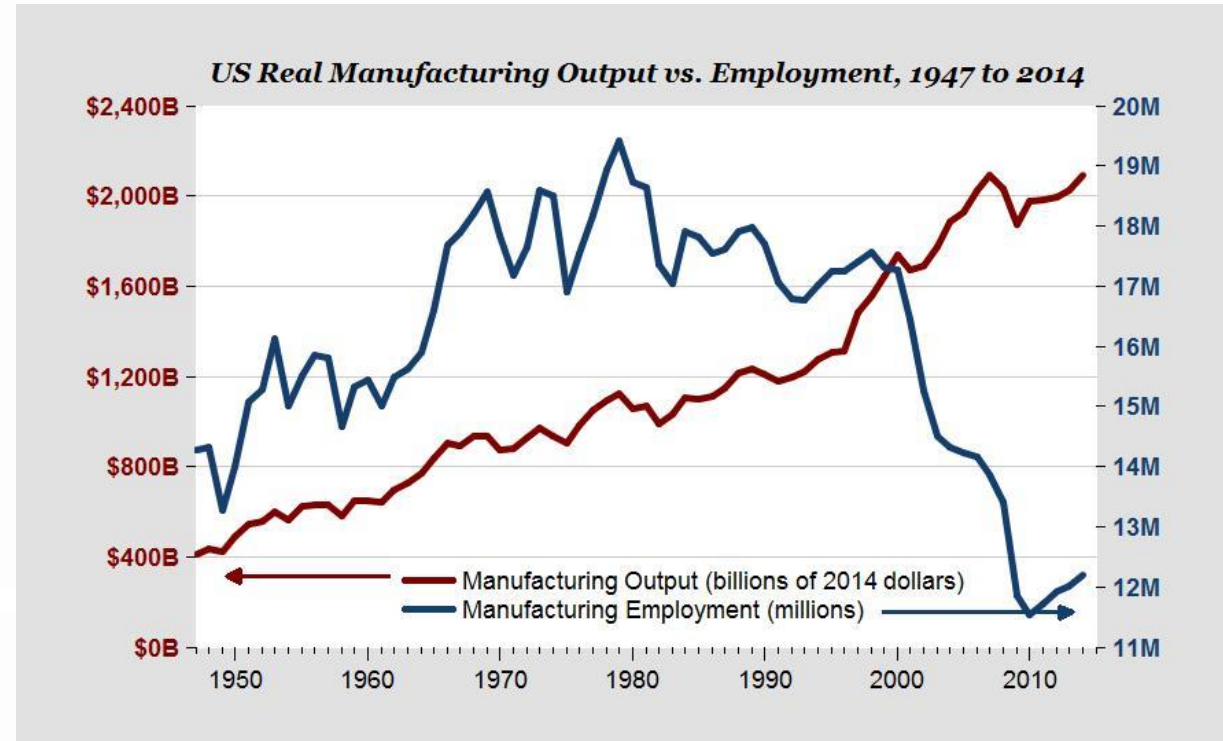September 18, 2017

# Presentation Overview

- What is NIST doing in Smart Manufacturing?

- Role of NIST in Standards

- Interoperability: Standards and Practice

# Engineering Laboratory Goals

- Disaster-Resilient Buildings, Infrastructure, and Communities

- Cyber-Physical Systems

- Smart Manufacturing

- Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure

# Context: U.S. Manufacturing

- $2.1T in value added to the U.S. economy, highest multiplier effect of any economic sector

- 12.3 million manufacturing workers in the United States, accounting for 9 percent of the workforce

- In addition, manufacturing supports an estimated 18.5 million jobs in the United States—about one in six private-sector jobs

- Output per hour for all workers in the manufacturing sector has increased by more than 2.5 times since 1987

- Manufacturers in the U.S. perform more than three-quarters of all private-sector research and development (R&D) in the nation



US Real Manufacturing Output vs. Employment, 1947 to 2014

Manufacturing Output (billions of 2014 dollars)
Manufacturing Employment (millions)

www.aei.org based on BEA and BLS data

**Smart Manufacturing:** the synthesis of advanced manufacturing capabilities and digital technologies to produce highly customizable products faster, cheaper, better, and greener

- Internet of Things/Ubiquitous Sensing

- Big data & advanced analytics

- Cloud computing

- Broadband communications, wireless

- Mobile computing/apps

- Security technologies

- Advances in additive processes/3D printing

- Advances in robotics

- Model-based everything

- Cyber-physical systems engineering

- Advances in materials

# Primary Objective of the Smart Manufacturing Goal

**Drive innovation** and **reduce risks of adoption** of Smart Manufacturing technologies through measurement science and standards:

- EL products include:
    - Performance metrics
    - Measurement, testing methods, and artifacts
    - Predictive modeling and simulation tools
    - Information and knowledge modeling
    - Protocols and specifications
    - Reference Technical data

- Collaborations with academia and industry

- Critical technical contributions to standards

# Common Themes in
# Advanced Manufacturing Trends Reports

- Additive Manufacturing

- Advanced Robotics

- Smart Manufacturing Systems Design and Analysis
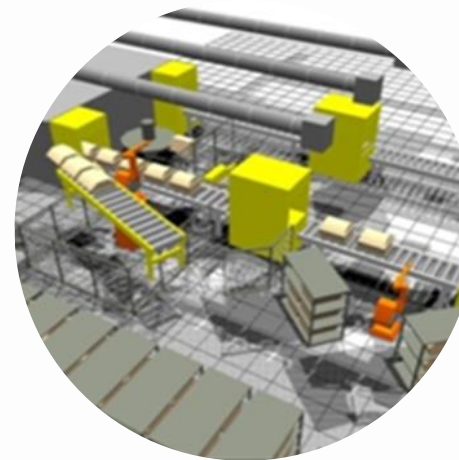
- Smart Manufacturing Operations

# Sampling of Available Facilities

1. Industrial Control Systems Cybersecurity Test Bed

   - https://www.nist.gov/industry-impacts/nist-impacts-industrial-control-systems-cybersecurity

2. Industrial Wireless Systems Test Bed

   - https://www.nist.gov/laboratories/tools-instruments/nist-industrial-wireless-systems-testbed

3. Metal Additive Manufacturing (AM) Research Facility

   - https://www.nist.gov/laboratories/tools-instruments/metal-additive-manufacturing-am-research-facility

4. Manufacturing Robotics Test Bed

   - https://www.nist.gov/laboratories/tools-instruments/manufacturing-robotics-testbed

5. Smart Manufacturing Systems (SMS) Test Bed

   - https://www.nist.gov/laboratories/tools-instruments/smart-manufacturing-systems-sms-test-bed

# Role of NIST

- Does not develop standards, instead provide expertise to standards

- Work in collaboration with academia, industry, and SDOs

- Support innovation and advancement of standards through basic and applied research

# Interoperability in General

- NIST conducts research to support advancing interoperability
  - Intra-domain (e.g., CAD-to-CAD)
  - Inter-domain (e.g., CAD-to-CAM, MCAD-to-ECAD)

- NIST needs interoperability of tools and data / information to support our research goals

# Interoperability in MBSE

- Quick adoption of SysML 2.0 when published

- Canonical XMI, it's a must!

- Reference models and repositories

# Questions?