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:
Paul Evans, P.E.
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

- 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

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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\textsuperscript{1}:

“the act or process of introducing new ideas, devices, or methods”

National Network for Manufacturing Innovation Results\textsuperscript{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”

\textsuperscript{1} Merriam-Webster Definition
\textsuperscript{2} Advanced Manufacturing National Program Office, National Network for Manufacturing Innovation: A Preliminary Design
REVITALIZING U.S. MANUFACTURING
1. What sector has the highest multiplier effect on the economy?

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*
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
1. What sector has the highest multiplier effect on the economy?

**U.S. Ranking in Manufacturing**

*Manufacturing Output, Top 5 Countries*

*Current U.S. Dollars, 1970-2011*

*Source: United Nations*

*Image Sourced from American Enterprise Institute, public policy blog by Mark J. Perry*
Development of Recommendations

- President’s Council of Advisors on Science and Technology (PCAST)
- Advanced Manufacturing Partnership (AMP)
- National Science and Technology Council (NSTC)
- Office of Science and Technology Policy (OSTP)
- Interagency Working Group on Advanced Manufacturing (IAM)
- Workshop feedback from participants from industry, academia, government, workforce, economic developers, etc.

Chaired by:
Andrew Liveris of Dow Chemical
Rafael Reif of the Massachusetts Institute of Technology
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
Functional Glass
Pulp and Paper Products
SemiSynBio
Structural Thermoplastics
Advanced Composites
Biomanufacturing Science and Technology for Biopharmaceuticals
Sustainable Separation Process
Advanced Superconductor Manufacturing
Flexible Electronics
Metalcasting
Atomization Technology
Thermal Manufacturing
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

Source: Based on 2011 data from internet sources
Current IMIs

US MANUFACTURING HUBS

The National Network for Manufacturing Innovation may expand to as many as 16 institutes by the end of 2016. The vision is for an eventual total of 45.

LOCATIONS TO BE SELECTED
- Integrated Photonics Institute for Manufacturing Innovation
- Flexible Hybrid Electronics Institute
- Smart Manufacturing Innovation Institute Sensors and Process Controls
- The Revolutionary Fibers and Textiles Manufacturing Innovation Institute

SMART MANUFACTURING
Smart Manufacturing – Video Clip

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

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*Source: Smart Manufacturing Leadership Coalition*
Smart Manufacturing Leadership Coalition

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

Connected Supply Chain
- Agile
- Demand Driven
- Raw Material to Finished Product

Business Systems, ERP

Safe Production
- Improved safety
- Fewer incidents
- More user friendly

Sustainable Production
- Higher value products
- Data for decision making
- Product Lifecycle Management

Supply Chain

Energy Efficient
- Lower emissions
- Less energy used
- Green manufacturing

Optimization
- Asset Utility/Zero Downtime
- Quality/Zero Defects
- Reliable results

Customer

Smart Grid

Source: Smart Manufacturing Leadership Coalition
Smart Manufacturing Platform

Bridging Seams Extending the Real Time Infrastructure across Value Chains

Open Platform & Marketplace
For Industrial Data, Modeling,
& Metric Applications

- For contributors and users
- Accessible Affordable, Flexible to SMMs

SM Value Proposition

Event Data
Real-Time Data

Production Models
Calibration & Maintenance
Sensor Data

Applications
Context
Mapping
Data

Smart grid Interoperability
In-production performance
Smart machine operations
Value chain Interoperability

Sustainability & Safety

Source: Smart Manufacturing Leadership Coalition
Industrial Internet of Things
“Industrial Internet” – Key Enabler

Applications of the Industrial Internet

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

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Thank You!

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