Implementing 21st Century Smart Manufacturing

An Actionable Program Agenda
“Meaningful Use” Priorities & Metrics
Recommendations on Public-Private Partnership Programs

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CTO / CIO, UCLA
September 14/15, 2010

This workshop has been made possible through our sponsors and contributions from the NSF Smart Process Manufacturing Leadership Team.

Rockwell Automation; Honeywell Automation and Control Solutions; Praxair; Dow Chemical Company; Department of Energy; National Science Foundation; University of California, Los Angeles; University of Texas, Austin; CACHE
**Who Are We**

- **Executive Office Leads:**
  - Ron Bloom, Senior Advisor for Manufacturing Policy
  - Aneesh Chopra, Chief Technology Officer, OSTP
  - Sridhar Kota, Assist Director Adv. Manufacturing, OSTP

- **Agency Executive Leads:**
  - Kristina Johnson, DOE UnderSecretary
  - Henry Kelly, DOE, Principle Deputy Assistant Secretary
  - Patrick Gallagher, DOC NIST Director

- 23 Companies
- 28 Practitioner Participants
- 12 Supplier Participants
- 5 Universities – systems, control, optimization, manufacturing, high performance computing
- 4 High Performance Computing centers – government lab and university
- 5 Manufacturing consortia/institutions
- OSTP, DOE, NIST, DOD, NSF US Senate Committee
Important Definitions

Smart Manufacturing

*Smart Manufacturing (SM) is a dramatically intensified knowledge-enabled industrial enterprise in which ALL business and operating actions are executed to achieve substantially enhanced energy, sustainability, environmental, safety and economic performance.*

Meaningful Use

*The value a defined set of programs delivers to the general public and the U.S.*
Workshop Concept and Objectives

• Define the action plan for a new potential public-private partnership program that catalyzes breakthroughs and establishes smart manufacturing processes that apply manufacturing intelligence via integrated data and advanced simulation and modeling to produce highly-optimized, dynamic demand-driven and sustainable industrial plants and supply chains.

• Make recommendations to White House and Administration senior advisors for manufacturing, science and technology policy on the program and the “Meaningful Use” of Smart Manufacturing (SM) in supporting national goals to revitalize U.S. industrial competitiveness. The Meaningful Use objective will define expectations and priorities for increased economic, energy, EH&S and sustainability performance.
Workshop Structure

Day 1
Priority Programs & Plan
• 2011, 2015, 2020 actionable goals
• Development and infrastructure
• Action program plan and meaningful uses
• Stakeholders and roles

Day 2
Performance & Collaboration
• Meaningful Use & Energy, sustainability, EH&S and economic performance expectations and metrics
• Collaboration models
• Next steps
Aneesh Chopra (OSTP)
Meaningful Uses of Smart Manufacturing

Sridhar Kota (OSTP)
Manufacturing and US Science and Technology Priorities

Sujeet Chand (Rockwell Automation)
The Motivation, Vision and Call to Action for Discrete, Batch and Process, Manufacturing

Jim Porter (DuPont)
The Motivation, Vision and Call to Action for Capital Programs and Process, Batch and Discrete Manufacturing
Jim Davis

Second Part
Bending the Curve Toward Smart Manufacturing
Achieving Meaningful Use of Production Data

“These goals can be achieved only through end-to-end connected enterprises that capture all manufacturing data to support model-based decision-making and knowledge-enabled processes that improve manufacturing outcomes and accelerate the generation of manufacturing intelligence.”

“Phased-in series of steps to improve manufacturing intelligence and drive new efficiencies.”
Transition Areas

**End-to-end networked controls, information technology, management systems and computational modeling**

1. Network data infrastructure
2. Data to knowledge
3. Knowledge to operating models
4. Operating models to key plant assets

**Dynamic demand-driven, highly-optimized plants & supply networks**

- 5. Models as key plant assets to global enterprise-wide application
- 6. People, knowledge, and models to key performance indicators

**Sustainability & Competitiveness**
Manufacturing Transformation to SMART
Achieving Meaningful Use

2010

2011

SMART Manufacturing Transformation

2015

2020

Smart Mfg. Policies

2011 Meaningful Use Criteria
Establish efficiency measures & planning, e.g., competitiveness
energy/env., sustainability, track/trace, safety

2015 Meaningful Use Criteria
Smart manufacturing processes with demand-dynamic, highly optimized decision support

2020 Meaningful Use Criteria
Improved Sustainability and Competitiveness
## Illustrative Shared Technology Development and infrastructure

<table>
<thead>
<tr>
<th>Network Data Infrastructure</th>
<th>Data to Knowledge</th>
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<tbody>
<tr>
<td>• Wired and wireless sensor networks</td>
<td>• Data audit procedures</td>
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<td>• Scaleable requirements driven security</td>
<td>• Data interoperability</td>
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<table>
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<tr>
<th>Knowledge to Operating Models</th>
<th>Operating Models to Key Plant Assets</th>
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<tbody>
<tr>
<td>• Real time Multi-scale modeling &amp; simulation</td>
<td>• Test beds virtual &amp; physical</td>
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<tr>
<td>• Code dev &amp; operational mgmt</td>
<td>• Life cycle models</td>
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<tr>
<td>• High performance computation and data mgmt facilities</td>
<td>• Tech transfer &amp; workforce training approaches</td>
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<td>• Resilient &amp; fault tolerant control technology</td>
<td>• Large scale optimization</td>
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Workshop Scope & Boundaries

- Manufacturing and supply chain processes *with interface* to digital factory
- Innovation in manufacturing *with interface* to innovation in products, design and engineering
- Roles for modeling and simulation and need for capability *with interface* to code development practice and processor and facility architectures

- Moving beyond vision and defining programs
- Moving beyond the Roadmap not reinventing it
- Prioritizing programs and building program plans not solving challenges
WELL BREAK INTO SMALL GROUPS TO DISCUSS OPTIONS.

WHY? DO YOU THINK WE'LL BE SMARTER WHEN WE'RE IN SMALL GROUPS?

THAT WAY EVERYONE GETS MORE TIME TO TALK.

ACCORDING TO YOUR THEORY, THE IDEAL GROUP SIZE WOULD BE ONE PERSON TALKING TO HIMSELF.

NO, YOU ALSO NEED THE KNOWLEDGE AND PERSPECTIVE THAT EXTRA PEOPLE BRING.

THAT WOULD ARGUE FOR LARGER GROUPS, NOT SMALLER ONES.

FINE! JUST BREAK INTO WHATEVER SIZE GROUPS YOU THINK MAKE SENSE.

I LIKE YOUR STYLE, DILBERT.

THANK YOU FOR NOTICING.
Joan Pellegrino
Goal 1: Implement data sharing and communications protocols between functional organizations in > 50% segment facilities

- Information exchange protocols
- Real-time planning capabilities
- Standard language and indexing

Clearinghouse repository of data definitions
Cyber security protocols

Goal Impacts:
- Reduces cost to manufacture via consistent, rapid process communications by 15%
- Reduces processing time/energy by 20%
- Establish infrastructure for enterprise and industry segment data sharing and product tracking

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<tr>
<td>Operating site data audit protocol</td>
<td>Test bed demonstration of standard language and information exchange protocols</td>
<td>Linked industry segment tracking of product from source to consumer; Test bed demonstration of planning</td>
<td>Enables new product safety and sustainability metrics; Enables integrated response and planning among multiple functions; enables rapid response</td>
<td>Reduced operating costs; Integrated response planning; Safety and sustainability tracking</td>
<td><strong>National Lab:</strong> major input to protocols development; computational facilities  <strong>University:</strong> planning methods  <strong>Industry:</strong> validation and test of protocols  <strong>Standards Organizations:</strong> Standard language and protocol development</td>
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Goal 1: Manufacturers able to effectively use the smart grid > 50% of companies

- Use of networked sensors for real-time monitoring of electricity use
- Water, air, gas, energy, steam managed in production bill
- Production optimized on smart grid variable pricing
- Demand response controllers enable dynamic load strategies
- Data exchange; EPRI load profiles

Goal Impacts:
- Reduces energy usage by 20%
- Reduces carbon footprint with increase fraction of renewables
- Reduces peak power use
- Increases efficiencies through plant-generated combined heat and power, cogeneration and thermal storage

### Breakout Session Activity

#### Major Transition Category

- Priority Actionable Goals
- Technology Target Areas

#### Infrastructure Needs

#### Implementation Actions, Milestones, Meaningful Uses, Metrics, and Stakeholders/Roles

<table>
<thead>
<tr>
<th>Milestones</th>
<th>Meaningsful Uses/Benefits</th>
<th>Performance Metrics</th>
<th>Stakeholders/Roles</th>
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<tr>
<td>2011</td>
<td>Identify plant sites for testing or feasibility studies</td>
<td>Reduces carbon footprint with increase fraction of renewables; real-time optimization and automation</td>
<td>Reduce operating costs; Increased renewables; Improved regional energy management</td>
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<td>2015</td>
<td>Coordinate with utility smart grid projects; Test bed results/refinement for smart microgrids</td>
<td>Expand technologies across industry segment</td>
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<tr>
<td>2020</td>
<td>Expand technologies across industry segment</td>
<td>Reduce operating costs; Increased renewables; Improved regional energy management</td>
<td>University – advanced modeling and optimization methodologies</td>
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Industry – develop operating strategies
Standards org – data exchange & cyber security