Smart Manufacturing

The Case for an Open Architecture Platform

Energy Productivity Management

ACEEE 2014

Smart Manufacturing Leadership Coalition (SMLC)

Jim Davis, Vice Provost – IT & CTO, UCLA

https://smartmanufacturingcoalition.org
http://smartmanufacturing.com

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EERE DOE “Project Smart Manufacturing”
Development of an Open Architecture, Widely Applicable Smart Manufacturing Platform

Test Bed: Praxair

Design

Operations

Supply Chain

Dynamic Energy Risk Management & Cross Unit Performance

Test Bed: General Dynamics

Heating & Forging

Cutting & Machining

Power Mgmt & Energy Grid

Integrated Line Operations Management

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General Mills Networked-Based Manufacturing

EDI transaction & quality certifications

Recipe Management
Mapping formula into operating recipes

Mapping SAP information
Into operation

Supply Chain

Smart Grid

Green Light
Analyze - to put into production
Make – right ingredients – confirmation on recipe
Release – meet requirements to release

Customer

Distribution Center

FDA Tracking & traceability

Graphics courtesy of Rockwell Automation
Technical and Business Drivers for Shared Infrastructure

Achievable Meaningful Use Goals and Magnitude of Impact

• Demand-driven efficient use of resources and supplies in more highly optimized plants and supply
  – 25% reduction in safety incidents
  – 25% improvement in energy efficiency
  – 10% improvement in overall operating efficiency
  – 40% reduction in cycle times
  – 40% reduction in water usage

• Product safety
  – Product tracking and traceability throughout the supply

• Sustainable production processes for current and future critical industries
  – 10x improvement in time to market in target industries
  – 25% reduction in consumer packaging

• Maintain and grow existing U.S. industrial base
  – Environment for broad innovation
  – 25% revenue in adjacent industries
  – 25% revenue in new products and services
  – 2x current SME’s addressing total market
  – More highly skilled sustainable jobs created

A Set of Issues Beyond Individual Company

• ROI constrained or prohibitive
  – Requires broader infrastructure investment to scale
  – Incremental investment difficult
  – Requires IT investment with 70% of cost non-value
  – Depends on other companies - supply chain
  – Need 80% reduction in cost of implementing modeling and simulation
  – 10x reduction in the cost of sensors and sensor infrastructure

• ROI opportunity comprehensive
  – Multiple systems
  – Integrated global performance metrics
  – Aggregating data

• Installed base of serviceable manufacturing facilities
  – $60 B in IT investment
  – Retrofit

• Risk
  – Major change & New business model
  – Uncertain about technology, security & IP

• Organization
  – IT capability lacking or IT not talking to operations
  – Workforce skills
  – Collaboration
Architect for Scalability, Cost, Extensibility, Entrée, Security & Multi Vendor
Orchestrate function, data and time
Compose heterogeneous environment workflows at User Level
Provision secure IT on as needed basis

No single scale time requirement in workflow
Data to apps paradigm
Separate Data & apps

Data collection, modeling & synchronization defined by workflow

Smart Manufacturing
Open Architecture Platform
Composability

Market Place

Sensor Data

Data Partnership Workflow Orchestration

Control & Automation Propriety Optimized Automation Workflows

Design to manufacturing Workflow libraries

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# Performance Metrics with Platform

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease R &amp; D</td>
<td>25%</td>
<td>30%</td>
<td>35%</td>
<td>40%</td>
<td>50%</td>
<td>Compared to no platform baseline; 1st year decrease - data &amp; modeling infrastructure; 2nd year progressive decrease - building on shared research</td>
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<tr>
<td>cost/risk</td>
<td></td>
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<tr>
<td>Accelerated pace of</td>
<td>2 years</td>
<td>+5% faster</td>
<td>+10% faster</td>
<td>+15% faster</td>
<td>+20% faster</td>
<td>1st year reduced duration - flexibility with modeling infrastructure; 2nd year progressive - more interface apps, better use standards, better modeling tools, consolidated experience</td>
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<tr>
<td>R &amp; D outcomes</td>
<td>to 1 year</td>
<td></td>
<td></td>
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<tr>
<td>Decrease in</td>
<td>60%</td>
<td>65%</td>
<td>70%</td>
<td>80%</td>
<td></td>
<td>1 year shift because R &amp; D faster; Year 2 cost progression; consolidated experience, more interface apps, better standards, better modeling tools; pace accelerated multiple parallel replications</td>
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<tr>
<td>replication/deployme</td>
<td>1 – 2</td>
<td>1 year shift</td>
<td>multiple replication</td>
<td>Multiple replication</td>
<td></td>
<td>n cost/risk &amp; accelerated pace</td>
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<tr>
<td>nt cost/risk &amp;</td>
<td>replications</td>
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<td>Multiple replications</td>
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<tr>
<td>accelerated pace</td>
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<tr>
<td>Retrofit modeling</td>
<td>20%</td>
<td>30%</td>
<td>35%</td>
<td>40%</td>
<td>50%</td>
<td>Advance control and low hanging fruit practices 20 – 25%; advanced real time modeling &amp; integration next 20%; sophisticated integrated modeling next</td>
</tr>
<tr>
<td>- waste heat</td>
<td>Low hanging fruit</td>
<td></td>
<td>1st phase R &amp; D</td>
<td>2nd phase R &amp; D</td>
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<td>minimization/energy</td>
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<td>Calculated for control and IT retrofits for existing process – measurements, new, dynamic operating conditions; does not account for potential for new equipment</td>
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<td>productivity - base</td>
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<tr>
<td>no advanced technology</td>
<td>(See DOE proposal)</td>
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Manufacturing Methods from Macro View
What is Smart Manufacturing

Internal & External Value Chain Networked-Based Manufacturing

- EDI transaction lot & quality certifications
- Business Systems, ERP
- Tracking & traceability
- More customer freedom To customize
- Minimum just in case inventory & corrective actions thru entire system

- Supply Chain
- Smart Grid
- Chain of custody
- Configurable high fidelity/statistical modeling and analytics
- Dynamic plant configuration and readiness
- Dynamic product component/material configuration
- Faster changeovers & more variable order sizes
- Dynamic inventory minimization & management

Use Cases Mike Yost Mesa

Graphics courtesy of Rockwell Automation
## AMP 2.0 Recommendations

**Table 1.** AMP2.0 technology strategy recommendations for three prioritized Manufacturing Technology Areas.

<table>
<thead>
<tr>
<th>Technology areas:</th>
<th>Advanced Sensing, Control, and Platforms for Manufacturing</th>
<th>Visualization, Informatics and Digital Manufacturing</th>
<th>Advanced Materials Manufacturing</th>
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<tbody>
<tr>
<td>R&amp;D Infrastructure to Support the Innovation Pipeline</td>
<td>▪ Establish Manufacturing Technology Testbeds (MTTs) to demonstrate the use of and business case for new technologies, including “smart manufacturing” capabilities.</td>
<td>▪ Create a Manufacturing Center of Excellence (MCE), focused on basic research at earlier technology development levels, on the Digital Thread, including tools for digital design and energy efficient digital manufacturing.</td>
<td>▪ Launch Materials Manufacturing Centers of Excellence (MCEs) to support R&amp;D in topics that support MIIs and other manufacturing technology areas in the national strategy.</td>
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<tr>
<td>The National Network for Manufacturing Innovation</td>
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<td>Establish an institute focused on ASCPM for energy use optimization in energy-intensive and digital information-intensive manufacturing.</td>
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<td>Launch a Big Data MII focused on secure analysis of and decision-making via large, integrated data sets for manufacturing processes (in addition to the current Digital Manufacturing and Design Innovation Institute).</td>
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<td>Leverage supply chain management of defense assets to spur innovation and RD&amp;D in critical materials reprocessing.</td>
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<th>Public-Private Technology Standards</th>
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<td>Develop new industry standards, including data interoperability standards for key systems and vendor support.</td>
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<tr>
<td>Craft and deploy policy standards for manufacturing cyber-physical security and digital data exchange and ontology.</td>
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<tr>
<td>Design data standards for material characterization to enable rapid uptake of new materials and manufacturing methods.</td>
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