Smart Manufacturing and University Integration

2015 UC CIO/VCR Summit
Smart Manufacturing Leadership Coalition (SMLC)
Jim Davis, Vice Provost – IT & CTO, UCLA

https://smartmanufacturingcoalition.org
Using Infrastructure to Drive Research
Building a Research Channel
Smart Manufacturing

“Information that drives the next century’s structural shift in manufacturing.”

Smart Manufacturing Leadership Coalition (SMLC) – 501c (6)

Making real-time info available:
• when it is needed,
• where it is needed
• and in the form it is needed throughout the Manufacturing ecosystem

SMLC Partnerships

**Test Beds** - General Dynamics, General Electric, General Mills, General Motors, Praxair, Corning, Pfizer, Alcoa, Owens Corning, Advanced Manufacturing Partnership SoCal, Southwest Research Institute **Design/Manufacturing Platform Providers** – JPL/NASA, UCLA, Rockwell, Schneider Electric, Nimbis, OSISoft, Savigent Software **Modeling & Simulation Materials, Design, Manufacturing** – Caltech/JPL, UCLA, UT Austin, Tulane, NCSU, CMU, Purdue, WVU, UC Berkeley **Smart Manufacturing/Smart Grid** – EPRI **Global Metrics/Outreach** – AIChE, ASQ, ACEEE, NCMS, MESA, MT Connect, Society of Manufacturing Engineers (SME), Sustainable Solutions, Spitzer & Boyes **Agency partners** – DOE, NIST, NSF **Regional Partners** – Pacific Northwest National Lab (PNNL), TAMU, Center for Advanced Technology Systems/RPI, AMP SoCal, Association of State Energy Research & Technology Transfer Institutions (ASERTTI), National Association of State Energy Officials (NASEO)
SMLC’s Industry-Driven Strategy

**Roadmap:** Operations & Technology for SM systems

**Action Plan:** Implementing 21st Century Smart Manufacturing

**Infrastructure Specification:**
Increasing SM Platform Definition & Development

**Implementation Plan:**
Review & Refine Collaboration Roles & Alignment

**SMLC Incorporates as 501c6:**
Building Capacity & Resources; Leveraging Resources; Advocacy for SM

**Establish Work Groups:**
Identify & Drive Priority areas
- Test Bed
- Platform
- People
- Business

**Spin-off parallel activities**
- Board Meetings, Calls, Advisory Groups, Focused Workshops, etc.

**DOE, NSF, NIST Awards:**
$13 million in Project Work to develop SM Platform Prototype

**DOE Workshop**

**NSF Workshop**

**AIChE Workshop**

**DOE FOA**

**ACCELERATE DOE Workshop**

**SMLC Forum Workshop**

**Membership Expansion**

2006-09

2010

2011

2012

2013

2014-15
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>
</tr>
</thead>
<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 MII’s 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>---------------------------------------------------</td>
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<tr>
<td>Establish an institute focused on ASCPM for energy use optimization in energy-intensive and digital information-intensive manufacturing.</td>
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<tr>
<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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<tr>
<td>Leverage supply chain management of defense assets to spur innovation and RD&amp;D in critical materials reprocessing.</td>
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<table>
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<tr>
<th>Public-Private Technology Standards</th>
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<tbody>
<tr>
<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>
</tr>
<tr>
<td>Design data standards for material characterization to enable rapid uptake of new materials and manufacturing methods</td>
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</table>
DOE FOA Clean Energy Manufacturing Innovation Institute on Smart Manufacturing

ADVANCE SENSING, CONTROLS, PLATFORMS AND MODELING FOR MANUFACTURING
Cyber Infrastructure → Data → Research
Technological advances in mediated communication

Era of Data


Image: Jillian Wallis and Roy Pea
Research Sustainability

The Business Model of Data

Practice Valuation
Collective vs. Proprietary

Data Valuation
Collective vs. Proprietary

The Business of Open Architecture
Market, Valuation of Data & Innovation

Collective Wisdom
Converting Knowledge to Wisdom
Converting Information to Knowledge
Converting Data to Information

IoT
Big Data
Collective
Innovation &
Practice
Data, Analytics,
Research &
Meaningful Use
Data & Device Integration &
Orchestration
Secure Data Highways
Secure Infrastructure

Data Valuation
Collective vs. Proprietary

Research Enterprise

Smart

Research Sustainability
The Coalition and Smart Manufacturing
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

Business Systems, ERP

Customer

Distribution Center

Smart Factory

FDA Tracking & traceability

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

Graphics courtesy of Rockwell Automation
Building Infrastructure Powering Smart Decisions

Enterprise Business System

Enterprise Optimization & Sustainable Production
- Higher value products
- Improved quality
- Zero downtime
- Increased equipment life/utilization

Agile, demand-driven

Agile Demand-Driven Supply Chains
- Higher product availability
- No inventory
- Product lifecycle management

Sustainable

Sustainable Supply Chains
- Improved safety
- Reduced energy and emissions
- Highly sustainable

Optimization

Plantwide

Production

Factory

OEM Machine Builders

Distribution Center

Customer
## What is SMART Test Bed Smart Systems

<table>
<thead>
<tr>
<th>Smart Machine Line Operations</th>
<th>In-Production High Fidelity Modeling</th>
<th>Dynamic Decisions</th>
<th>Enterprise and Supply Chain Decisions</th>
<th>Design, Planning and Model Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated process machine and product management</td>
<td>Enhanced management complex behaviors</td>
<td>Performance management global integrated decisions</td>
<td>Variability reduction</td>
<td>Design models in production</td>
</tr>
<tr>
<td>Benchmarking machine-product interactions</td>
<td>Rapid qualification components products materials</td>
<td>Untapped enterprise degrees of freedom in efficiency, performance, and time</td>
<td>In situ measurement and integrated value chains</td>
<td>Product/material in-production ability</td>
</tr>
<tr>
<td>Machine-power manage management</td>
<td>Integrated computational materials engineering (ICME)</td>
<td>Enterprise analytics and business operational tradeoff decisions</td>
<td>Tracking, traceability and genealogy</td>
<td>New product, material technology insertion</td>
</tr>
<tr>
<td>Adaptable machine configurations</td>
<td>Configurable data and analyses for rapid analytics and model development</td>
<td></td>
<td>External partner integration and interoperability</td>
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</tbody>
</table>
Manufacturing Health & Sustainability

The Business Model of Data

Practice Valuation
Collective vs. Proprietary

Open Architecture – Vendor Agnostic
Open Access – low cost Platform access
Open Market Place – open access to composable software libraries & non-proprietary deployment data

Data Valuation
Collective vs. Proprietary

IoT

Secure I, P and SaaS

Secure Data Highways

Data & Device Integration & Orchestration

Smart Factory Manufacturing

Smart Enterprise Manufacturing

Collective Innovation & Practice

Converting Data to Information

Converting Information to Knowledge

Converting Knowledge to Wisdom

Collective Wisdom

The Business of Open Architecture Market, Valuation of Data & Innovation

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Open Platform

Marketplace as a Service

- Buyer/Seller Dashboard
- Composable apps & libraries
  - Data tools, viewers, metrics, models
- Toolkits, App data services

Development

- Workflow as a Service
- Validated/licensed software environments
- Data models
- Secure historian & private virtual computation
- Secure data connectors

Deployment

Performance

Reuse as a Service
# Performance Metrics with Platform

<table>
<thead>
<tr>
<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 cost/risk</td>
<td>25%</td>
<td>30%</td>
<td>35%</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>Accelerated pace of R &amp; D outcomes</td>
<td>2 years to 1 year</td>
<td>+5% faster</td>
<td>+10% faster</td>
<td>+15% faster</td>
<td>+20% faster</td>
</tr>
<tr>
<td>Decrease in replication/deployme nt cost/risk &amp; accelerated pace</td>
<td>60%</td>
<td>65% 1 year shift</td>
<td>70% multiple replications</td>
<td>80% Multiple replications</td>
<td></td>
</tr>
<tr>
<td>Retrofit modeling - waste heat minimization/energy productivity - base no advanced technology (See DOE proposal)</td>
<td>20% Low hanging fruit</td>
<td>30% 1st phase energy R &amp; D</td>
<td>35% 2nd phase energy R &amp; D</td>
<td>40%</td>
<td>50%</td>
</tr>
</tbody>
</table>

- Compared to no platform baseline; 1st year decrease - data & modeling infrastructure; 2nd year progressive decrease - building on shared research
- 1st year reduced duration - flexibility with modeling infrastructure; 2nd year progressive - more interface apps, better use standards, better modeling tools, consolidated experience
- 1 year shift because R & D faster; Year 2 cost progression; consolidated experience, more interface apps, better standards, better modeling tools; pace accelerated multiple parallel replications
- Advance control and low hanging fruit practices 20 – 25%; advanced real time modeling & integration next 20%; sophisticated integrated modeling next

Calculated for control and IT retrofits for existing process – measurements, new, dynamic operating conditions; does not account for potential for new equipment
Integrating with Universities
UCLA Research rEcosystem

In Progress

UC & LA Shared Patient Data

Hoffman2 Computation Cluster

Dawson2 Computation & Visualization Cluster

MobilizeLabs - Sensing Devices

In the field

Secure Access & High Speed Transfer

100G

10Gb Campus Backbone

UC Shared System

UCLA Health Enterprise Patient Data

(Terasaki*)

(CNSI*)

National Resources

Local support UCLA Expertise Area

rEcosystem User Web/Mobile Interface

UC & LA Shared Patient Data

HPC Storage

Archival Storage

Data Orchestration

Researcher Zone

Data Sharing Tools
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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Integrating Research and Manufacturing