Smart Manufacturing, Manufacturing Intelligence and Demand-Dynamic Performance

Smart Manufacturing Leadership Coalition (SMLC)

http://smartmanufacturing.com
“The second transformation? Smart manufacturing. This is the first structural shift since Henry Ford launched the economic power of "mass production."

“We are just entering an era where the very fabrication of physical things is revolutionized by emerging materials science. Engineers will soon design and build from the molecular level, optimizing features and even creating new materials, radically improving quality and reducing waste.”

“The Internet is evolving into the "cloud"—a network of thousands of data centers any one of which makes a 1990 supercomputer look antediluvian.”

“From social media to medical revolutions anchored in metadata analyses, wherein astronomical feats of data crunching enable heretofore unimaginable services and businesses, we are on the cusp of unimaginable new markets.”
21st Century Smart Manufacturing

- Demand-dynamic economics keyed on the intelligence of the ‘customer’

- Coordinated enterprise responses throughout the entire manufacturing supply chain

- Predictive, preventive

- Integrated computational materials engineering

- Performance-oriented enterprise, minimizing energy and material usage and maximizing environmental sustainability, health and safety and economic competitiveness

Dramatically intensified application of manufacturing intelligence using advanced data analytics, modeling and simulation to produce a fundamental transformation to transition/new product-based economics, flexible factories and demand-driven supply chain service enterprises
If Smart Manufacturing is such a smart idea why aren’t companies already doing it?

Already Investing in Information Technology, Automation and Controls for 40 years
Smart Manufacturing is the Application of Networked-Based Manufacturing Intelligence & Integrated Performance Metrics

Untapped degrees of Freedom: performance, efficiency & productivity

Actionable business & operations tradeoffs

Anticipate, plan, manage risk across suppliers

Supply Chain

Business Systems, ERP

New forms benchmarking

Smart Factory

Tracking & traceability

Customer

Distribution Center

Computational Materials Engineering
High Fidelity Materials & Product Management

Courtesy of Rockwell Automation : Copyright © 2009 Rockwell Automation, Inc. All rights reserved.
Performance and Demand Dynamics

- Less vertically integrated
- More information driven
- Workforce ecosystem

- Customers “pushing” demands
- Flexible production - smaller volumes of custom products

New real-time global Performance metrics –
  - customization
  - energy performance
  - reuse

Courtesy of Rockwell Automation : Copyright © 2009 Rockwell Automation, Inc. All rights reserved.
Multi-Dimension Smart Manufacturing (MDSM)
“One-to-Many” - Manufacturing Across the Seams

Design Data

Prototype
Materials & Process Tech
Product Manufacturing
Qualification

APP Store
• Reference Flows
• Process Models
  • Control
  • Metrics

Macro Layer
• Product Volume
• Scheduling
• Supply Chain

Meso Layer
• Management
• Machine Flow
• Optimization

Micro Layer
• Sensors/Actuators
• Control/Optimization
• Automation

Virtual MDSM Host
• Dash Board
• Collaboration

MDSM Program
“Host” Manufacturing Initiatives
Multi-Layered Smart Manufacturing Management (MLSMM)
Transformational Machines – People - Materials Dynamic Manufacturing Ecosystem

Meta Models

Prototype | Materials & Process Tech | Product Manufacturing | Qualification | AVM
---|---|---|---|---

Macro Layer

10s of control loops
Control Points - ?
Manpower - X
Time – days

Meso Layer

100s of control loops
Control Points - ?
Manpower – 10X
Time - hours

Current Practice – One Pass per Day per Event;
Too Late, Stale Data, Slow Responsive Manufacturing

Goals: 100x Event Variability Adjustment Capability & Dynamic Certification Improvement

Focus: Manufacturing & Qualification

Targets: Additive Manufacturing and Casting/Forging

Micro Layer

1000s of control loops
Control points - ?
Manpower – 100X
Time - minutes
Multi-Dimension Smart Manufacturing (MDSM) Challenges!

**Challenge 1 – Workforce, Cyber, Physical Performance, Reduced Variability**

*Physical Test Bed/ At Scale Factory and Supply Chain Demonstrations of Applied Manufacturing Intelligence*

- Scalable, secure, selective data and model interoperability cross-industry environment
- Configurable distributed workforce physical system framework for best practice distributed optimization, decision and automation across the micro, meso and macro range
- Configurable integrated performance metrics meeting company and industry requirements across the micro, meso and macro layers

**Challenge 2 – Source to Customer Optimization Framework**

*Multidimensional integration of manufacturing enterprise data, control, automation, management and optimization infrastructures*

- Architectures for integrated micro, meso and macro time scale data collection, data management, modeling, action and completion agreement
- Increased macro layer planning and qualification passes
- Data and modeling interoperability with vendor applications and provider platforms
- Secure interoperability with shared service hubs

**Challenge 3 Multi-Dimensional Ecosystem- Real-time Syncing Virtual Models and Physical Operations**

*Integrated service framework for:*

- Real-time validation and measurements
- Coordinated synchronization of micro, mesa and macro models at right time scales
- Task agreements between virtual models and physical operations & between micro, meso and macro layers
- Actionable windows in time and computational tractability

**Challenge 4 Dynamic Supply Chain Intelligence**

*Precompetitive and competitive Factory and Supply Chain Community Source Modeling Innovation & Simulation Assimilation Platform*

- Common infrastructure for real-time data-driven models that supports lite application layer
- Composable data, modeling and metrics ‘apps’ at application layer
- New modeling and simulation marketplace contribution and distribution architecture
Scaling a Multi-Dimensional Smart Manufacturing Infrastructure

Challenge 1
Physical Test Bed/At Scale Factory and Supply Chain Demonstrations of Applied Manufacturing Intelligence

Meta 1
Integrated Workforce, Cyber, Physical System (WCPS) Performance & Variability Reduction

Meta 2
Demand-Dynamic Customer to Source, Variability Adjustment, More Planning Passes

Multi-Dimensional Smart Manufacturing
Virtual Manufacturing Demonstration Facility HUB

Meta 3
Real-time Qualification Integrated Computational Materials Engineering High Fidelity Production & Materials Operations

Challenge 2
Multidimensional integration of manufacturing enterprise data, control, automation, management and optimization infrastructures

Challenge 3
Real-time Syncing Virtual Models and Physical Operations

META 4
Interoperable Supply Chain Network Control, Automation, Optimization Management & Decision

Challenge 4
Precompetitive and competitive Factory and Supply Chain Community Source Modeling Innovation & Simulation Assimilation Platform

Enabling New & Dormant Technologies
Smart Manufacturing Platform
Infrastructure for Real-Time Data Driven Modeling and Simulation

SMLC Industry-Driven
Integrated Performance Metrics
Micro, Meso, Macro

Community Source Resources

Variability Management
Real-time Plan Passes

Pre-competitive & Competitive Hub

Apps Store Cloud Services

Real-time Data & Modeling Workflow
& Metric Toolkit/App Development

Benchmarking Rapid Qualification ICME

Community Source
Market Place

SMEs Small & Medium Enterprises Manufacturing Consortia

Test Bed Manufacturer & Supplier Crosslinking Engagements

Key Development Resources
Universities, SME’s Manufacturers, Labs

Community Source

Standards and Reference Architecture IT Providers

Real Time Virtual Manufacturing Demonstration Facility (VMDF)
Applying the SM Platform

Performance Management Data & Modeling Workflow

Process sensor data

- Ref Arch Data Collection Manufacturer
- Ref Arch Data Collection Supplier

Data and Computation

- Manufacturer Real-time
- Manufacturer Data Warehouse

Management Dashboard

- Local/Global Integrated Productivity Metric Dash Board

SM Platform Data and Computation Services

Linked Apps to Form Function

- Data Validation App
- EPM App from Toolkit
- Risk Scenarios App
- Real-time Action & Risk Support App
- Reduced Order Model Scenarios App

Encrypted links
Smart Manufacturing

http://smartmanufacturing.com

https://smartmanufacturingcoalition.org