Smart Manufacturing
The Journey Ahead

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Advancing Manufacturing IT
Introduction to MESA International

MESA is a not-for-profit industry association with members in over 40 countries, serving industry since 1992. MESA works to drive clarity on the role and value of modern Information Technology in production environments within professional, safe, non-commercial environments, within which companies can address their important business challenges.

Find Business Value Where Manufacturing Meets IT
How MESA Delivers

MESA International: Building Bridges-of-Understanding from the Plant to the Enterprise

- Peer-to-Peer
- Points-of-View
- Global Education Program

Speaking with the Voice of Industry’s Practitioners
Smart Manufacturing - The Journey Ahead

Agenda

• The Fourth Industrial Revolution is Coming
• What is Smart Manufacturing?
• Building blocks to Smart Manufacturing: IIoT, Cloud, Digital Thread
• The roadmap to Smart Manufacturing
• A new Manufacturing IT Platform Framework is shaping up
• Getting started on the journey to Smart Manufacturing

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4th Industrial Revolution starts

- **1st Industrial Revolution** – water and steam powered mechanical manufacturing facilities
- **2nd Industrial Revolution** – manufacturing assembly line and infrastructure of electricity, gas, water, telegraph, roads
- **3rd Industrial Revolution** – electronics, telephones, PLCs, NC machines, PCs, CAM, CIM, spreadsheets, Lean manufacturing
- **4th Industrial Revolution** – mobile, cloud, smart connected devices, cyber physical systems, smart factory, robots, mass customization, product as-service

Timeline:
- **End of 18th century**
- **Start of 20th century**
- **Late 20th century**
- **Today**
Smart Manufacturing is fueled by a convergence of technologies and process improvement initiatives.

Source: McKinsey Global Institute, May 2014
What is Smart?

Smart

Auto-ID
Sensors (Location, Motion)
Connected (WiFi, Internet)
Apps (Calendar, Maps, Alerts, Controls)
Smart at Home...
We Like It...
We want Smart at work too!
Smart Manufacturing is the **endeavor** to design, deploy, connect and manage enterprise manufacturing operations and systems that enable proactive management of the manufacturing enterprise through informed, timely (as close to **real-time** as possible), in-depth decision execution.

Systems with Smart Manufacturing capabilities are realized through the **application of** advanced information, communication, and manufacturing process technologies to create new and/or extend existing manufacturing system components that are then synergistically integrated for manufacturing systems that possess the desired advanced automation, analysis and integration capabilities.”
Goals for Smart Manufacturing

- Achieve **new levels of efficiency** to elevate manufacturing to core-competency, support **new services and business models** including mass customization (highly configured products) and product-as-a-service.
- Ability to **publish data from equipment** using secure open standards, analyze and aggregate the data.
- Leverage data from connected equipment and processes directly into **new analytics and event triggering capabilities** into systems of record and **process workflows into the value chain** and sometimes **looping back** to trigger programming, tuning or maintenance changes on connected equipment.
- Manage more complex operations automatically. Enable more autonomous and **distributed decision support** at the plant floor level as smart machines are equipped with their own processing abilities and connectivity to enterprise systems.
- Promote the use of machine-to-machine (M2M) and application-to-application (A2A) **connectivity standards** in order to make these advanced capabilities accessible to manufacturers of all sizes and in all industry sectors, **across multi-vendor solutions**, at **acceptable levels of cost and implementation complexity**.
Characteristics of Smart Manufacturing

- Automated, integrated, monitored, and continuously evaluated
- Connecting the smart factory, smart machines, robots, advanced sensors via IIoT standards to intelligence that can automate routine decisions and adjust or switch their operation based on sensing the product, diagnostic or environmental conditions.
- Communicating between people, equipment, and enterprise and operations management applications in a natural yet structured manner including the ecosystem of designers, producers, factories, suppliers and customers
- Validating against the virtual product and process model and simulating to select optimal path
- Leveraging auto-identified components with tags (e.g. RFID, ) and smart products with onboard product configuration, usage and self-diagnostics.
- Managing on a modular manufacturing-IT platform with the ability to receive IIoT data, analyze, aggregate, and trigger process controls, history recording, and work flows.
- Providing ubiquitous use of mined information throughout product value chain.
The Smart Manufacturing Roadmap...

The five layers of the Smart Manufacturing roadmap:

- Business Strategy
- Empowered Team
- Streamlined Processes
- Connective Technologies
- Connected Things
The IoT will connect our Smart Homes and Smart Devices
IoT applications advancing faster in Industry than Consumer market

The IIoT will connect Smart Machines in the Smart Factory

- Monitor production flow in real-time to eliminate wasted time and reduce in-process inventory.
- Manage equipment remotely using sensors and limits to conserve energy and reduce costs.
- Implement condition-based maintenance alerts to reduce downtime and increase throughput.
- Aggregate product and process data, analyze, identify constraints and improvement areas.
- RFID sensors identify product and materials.
- Production line triggers autonomous material handling vehicles.
- More intelligent, autonomous and connected machines.

Source: @MicrosoftIoT in Manufacturing infographic
The IIoT is an enabler for Smart Manufacturing

<table>
<thead>
<tr>
<th>Smart Manufacturing</th>
<th>Industrie 4.0</th>
<th>Smart Factory</th>
<th>Digital Manufacturing</th>
<th>IIoT</th>
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<td>Smart Manufacturing umbrella includes multiple consortium efforts to modernize industrial practices with more open connectivity in the entire value chain between smarter equipment, facilities, products and processes.</td>
<td>A German hi-tech strategy project that promotes Smart Manufacturing concepts including cyber-physical systems monitoring physical processes and making decentralized decisions.</td>
<td>The Smart Manufacturing Leadership Coalition (SMLC) in the US has been spearheading a Smart Manufacturing platform and the Smart Factory. Interoperability, virtualization, real-time capability, service orientation, modularity, connected systems and open standards.</td>
<td>Digital Manufacturing is the ability to connect different parts of the manufacturing life-cycle through digital data that carries design intent and process information, and utilizes that information for intelligent automation and smarter, more efficient business decisions.</td>
<td>The Industrial Internet of Things or IIoT is a subset of the IoT that is dedicated to connect things in the manufacturing ecosystem. The Internet of Things (IoT) represents a network of physical objects or “things” embedded with electronics, software, sensors and connectivity to exchange data with business processes.</td>
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The Smart Manufacturing Roadmap...

Why do we care about smart connected things?

So we can be part of the revolution!

It’s not about ROI it is a strategic investment!
Manufacturers create business value with smart manufacturing

Manufacturers create business value with digital

- Establish 1:1 consumer relationships
- Reward and incent the channel in new ways
- Deliver new value with connected products
- Reimagine the customer journey
- Evolve from a product company into a services-centric organization
- Incorporate usage data into the innovation and marketing processes
- Redesigning operational processes
- Make automation processes faster and easier
- Maintain equipment more predictably and proactively
- Use things and data to increase quality, output and revenue
- Challenging business models
- Augment physical experiences with digital ones

Source: Microsoft blog, 2015
Manufacturers create business value with smart manufacturing and smart products

Some thoughts...

- Produce or co-produce with partner
- Connecting up- & downstream
  a) Could a supplier become part of your production environment?
  b) Could you become an active part in your customers distribution?
- Value Chain optimization
  a) foresee stronger partnerships or keep classical vendor relationships?
- It is about SPEED and creating new value for your customer !!

What about your vision?

1) Factory of the Future
2) World class manufacturing
3) End-to-End Engineering
4) Digital Factory
5) Human Centered Production
6) Production Network
7) Eco Production
The Smart Manufacturing Roadmap...
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The Digital Thread

Source: “Weaving the Digital Thread across Industry” Infographic, LNS Research, 2015
Example: DMDII is working on Digital Thread R&D projects

DMDII = Digital Manufacturing and Design Innovation Institute
The Smart Manufacturing Roadmap...

Technology Building Blocks

- Smart machines and advanced robotics
- Industrial Internet of Things (IIoT)
- Business Process Orchestration tools
  - ESBs, MSBs, API Managers, Cloud services
- Advanced analytics and Big Data tools
Old Tiers of IT and OT

Enterprise Information Technology
- PLM
- MES
- ERP
- SSO
- GPS
- BI

Manufacturing Operations Technology
- SCADA
- Energy Mgt
- OEE
- PLC
- Sensors
- Meters
New IT Platforms for Smart Manufacturing

- Smart Machines:
  - Robots
  - 3D Printers
  - RFID Sensors

- Workforce Roles:
  - Engineering
  - Procurement
  - Supplier Mgt
  - Tooling Mgt
  - Operations
  - Quality Mgt
  - Facilities
  - Accounting

- Apps:
  - Plan (Design, Schedule)
  - Source (Purchase, Receive)
  - Make (Data Collect, Mgt Dash)
  - Sustain Plant (Prev Maint, Energy Mgt)

- Services:
  - SSO
  - GPS
  - BI

- M2M+ A2A + B2B

- Platform Application Services
- Business Services and LOB apps
- Role Based Portals
- Document Stores
- Business Process Workflow
- Business Rules Interface
- Interfaces

- GPS
- SSO
- BI
The Product Value Chain extends into Suppliers and Customers
Over 50% of communication with suppliers is unstructured

Make sure that parts are inspected this way, okay?

Have you told your supplier about the new revision?

Have you got the new revision of the component?

Make sure you don’t subcontract that component, it is ITAR protected.

Did your supplier make design change? Why didn’t you tell me about that? You did? I have no record about it.

OEM talking with Tier 1 Supplier

Source: OAGi ppt, 2014
Enterprise Business Process Management (BPM) includes Manufacturing

Replace phone/email with B2B messages

Source: NIST, 2014
Cloud Services are also an enabler...

The Cloud facilitates communication across the Product Value Chain.

How much will be in the cloud?
Two areas of the IT infrastructure for Smart Manufacturing requiring more research and development:

- Secured communication mechanisms that assure identity for participants in publish and subscribe processes
- Open standards for M2M, A2A and B2B communications for business processes that cross:
  - the internal walls between departments
  - and external walls with the supply chain
Integration standards: participate, use, promote for better ecosystem
Institutes and consortia are leading the way

• Goals for Institutes and Consortia
  – Drive innovation through shared cost and risk
  – Promote guidance for connectivity and standards
  – Provide test beds

• Examples:
  – Industrial Internet Consortium (IIC) - IIoT
  – Industrie 4.0 - Cyber-Physical Systems, Smart Factory
  – Smart Manufacturing Leadership Coalition (SMLC) - Open Platform
  – CEMII - Smart Manufacturing for Cleaner Energy
  – Digital Manufacturing and Design Innovation Institute (DMDII) - Digital Manufacturing, Digital Thread
  – NIST - promote measurement science, standards and technology
The Smart Manufacturing Roadmap...

New workforce skills
Multi-discipline Collaboration Culture and Technical Skills

• The World Bank Studies estimate that 220,000 new engineers are required every year from 2014 to 2022 to connect the unconnected.

• For the next two decades, a large generation of workers will be reaching retirement age and ready to leave the workforce.

• IT and OT convergence requires collaboration among these traditionally siloed departments.

• Social online collaboration across disciplines with remote people in the value chain.

• New IT skills needed on integration standards, reference architectures, logical topologies, protocols, switching and routing infrastructure, physical cabling and wireless technologies.

• New manufacturing skills on advanced equipment installation, configuration and maintenance.

• We must attract young people to these jobs and prepare them with the required collaboration, science, math, engineering, and technology skills.
"Bridging the Gap"?!

Source: Atos / MESA Whitepaper 38
Manufacturing Maturity Model: Step by Step Approach

Source: Atos / MESA Whitepaper 38
Summary: Smart Manufacturing is...

“Smart Manufacturing – The intelligent, real time orchestration and optimization of business, physical and digital processes within factories and across the entire value chain.”

**MESA Smart Manufacturing Working Group**

<table>
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<th>Key concepts</th>
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<td><strong>“intelligent”</strong></td>
<td>- active intelligence vs passive information system</td>
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<td></td>
<td>- local routine decisions are made by automated systems based on high-level constraints</td>
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<td><strong>“orchestration”</strong></td>
<td>- Of business processes and resources across the manufacturing value chain so they are in-sync and data flows smoothly</td>
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<tr>
<td><strong>“business, physical, digital processes”</strong></td>
<td>- people, physical equipment and digital IT processes together. Orchestrating them so they connect “value chain” from design to supply chain, fabrication, assembly and product services</td>
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<td><strong>“optimization”</strong></td>
<td>- using simulations with the digital definitions to do what if analysis and optimize decision</td>
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<td>- using capacity of available resources to deliver as soon as possible to the customer.</td>
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<td>- adjusting schedules to work around issues while minimizing overtime, minimizing energy use</td>
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<tr>
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<td>- selecting the quickest cheapest route to expedite a missing part or deliver to customer</td>
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Summary: To Do List on Journey to Smart Manufacturing

Manufacturers should get started on the journey

1. Review Business Structure for Future Market Strategy
2. Establish Evolution Milestones for the Journey
3. Nurture New Culture around New Vision
4. Address Skills Gap for Knowledge Workers
5. Build Partnerships to Support the New Vision
6. Evolve the Information Technology Infrastructure
With the right focus ... opportunities can be significant

- Digital transformation is **not** about technology ...

- Technology enabled devices do not make **machines smarter** ...

- Success is not all about **data and analytics** ...

  ... but about creating **value** using an enhanced set of asset base

  ... rather they enable business to **evolve** their model to **serve** differently

  ... but leveraging the information with **judgement** and **expertise**

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**Industrial Internet of Things is not about smarter machines, but about **business transformation****

Source: Krishnamurty, Industru of Things USA, San Diego 2016
Because we want Smart at our shops!

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Thanks for Participating

This presentation was made possible by all the contributors to the white paper:

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Thank You!
More MESA Resources on Smart Manufacturing

White papers:
• “Smart Manufacturing – The Landscape Explained”, Dec 2015

Recorded Presentations:
• “The Internet of Things (IoT) and Manufacturing”, Dec, 2015
• “A Software Platform to Enable Smart Manufacturing”, Dec 2015

Blog posts:
• “5 Hurdles to Smart Manufacturing” - Brad Williams
• “How to Achieve Smart Mfg – Skills Needed” - Mike Hannah

More will continue coming so stay tuned to MESA on Smart Manufacturing...

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