Industry 4.0 for Small and Medium Enterprise (SME) Manufacturers

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• Introduction

• Relevance of Industry 4.0

• International Collaborative Manufacturing R&D

• Launch of ManuVation 4.0

• Q&A
**My Background:**

- 40+ years in A&D engineering technology and Advanced Manufacturing
- Championed open innovation and collaborative development
- Engaged in local, national and international manufacturing to address improved business performance
Importance of Manufacturing to the U.S.

- U.S. manufacturing sector valued at about $2.2 trillion in 2015
- Every $1.00 spent in U.S. Manufacturing another $1.80 is added to the economy
- Of 250K manufacturers in the U.S. > 240K are SME’s; of the 240K ~180K have less than 20 employees
- 12.3 million manufacturing workers in the U.S., or 9% of the total workforce
- FDI in U.S manufacturing exceeded $1.2T for the first time ever in 2015
- U.S. manufacturing is preparing for significant shift with manufacturing returning from off-shore

Manufacturing is not only a driver to the U.S. economy, but critical to national security
Industrial Revolution
From Industry 1.0 to Industry 4.0

1.0 1784 based on mechanical production equipment driven by water and steam power

2.0 1870 based on mass production enabled by the division of labor and the use of electrical energy

3.0 1969 based on the use of electronics and IT to further automate production

4.0 tomorrow based on the use of cyber-physical systems
Industry 3.0 – The application of digital data to enhance business performance

- Early in Industry 3.0 design and analysis were performed through manual methods
- Computer Aided Drafting tools and programmable calculators became early enablers
- Specific software was being developed to support design and analysis
- Software tools were implemented but were not interoperable
- Factory and Maintenance Systems were being developed but required manipulation of design information to be useful
- By the mid 1990’s technical and business standards were beginning to emerge
- Standards launched provided a level of tool interoperability
- Supply chain communications was primarily through drawings
- By the late 1990’s design data was also included with drawings to aid suppliers
Industry 3.0 – The application of digital Data in support of the Digital Enterprise

- 2004 saw the definition of the Model Based Enterprise (MBE) and beginning reliance on improving predicable product performance
- MBE focused on modeling and simulation in support of the entire life cycle
- Systems Engineering requirements and traceability drove development
- MBE is comprised of Model Based Engineering, Manufacturing and Sustainment
- Standards were the foundation of the Digital Enterprise
- Cross domain interoperability limited the value that the MBE could provide
Industry 4.0 – The integration of cross domain manufacturing information through IoT

- Reduces non value added data manipulation
- Improves OEM/SME based supply chain communications
- Enhances SME supply chain business performance
- Addresses interoperability concerns across both technical and business domains of the Digital Enterprise
- Opens new manufacturing technological career opportunities
- Integrates the human in the digital world to enhance decision making
Industry 4.0 Value Opportunities:

- Combined Augmented Reality and Modeling and Simulation can reduce errors that drive operational costs when physically implemented
- Improved cybersecurity techniques will protect IP and help ensure competitiveness
- Tools enabling design for manufacturability will optimize manufacturing process design and selection
- Use of Cloud Based tools and computing will enhance business and technical data analysis and decision making
- IoT will provide for not only factory data to be integrated but also data from fielded products
- Robots interacting to perform repeatable complex tasks and improve output quality
- Cross domain and functional integration will greatly improve communications
I4.0 Example Technology - Augmented Reality

• Augmented Reality (AR) technology is human-computer interaction that integrates the natural visual perception of a human with computer-generated information (i.e., 3D models, simulations annotation, and text).

• A communication, design and training enabling technology
Combining Augmented Reality with Modeling/Simulation

- 3D product and manufacturing design and simulation allow for rapid evaluation of trade-offs.
- Allows human interaction with virtual designs.
- Provides virtual environment which enable collaborative development.
- Immersive environment allows non-domain experts to provide valuable input.
International Collaboration Supporting Manufacturing R&D
Pierre Nanterme, CEO of Accenture
“Digital is the main reason just over half of the companies on the Fortune 500 have disappeared since the year 2000.”

Klaus Schwab, Founder and Executive Chairman, World Economic Forum
“We must develop a comprehensive and globally shared view of how technology is affecting our lives and reshaping our economic, social, cultural, and human environments. There has never been a time of greater promise, or greater peril.”
The Benefits of 4IR in Manufacturing

**Smarter supply chains** – greater coordination and real-time flow of information across supply chains and relationships allows better tracking of assets and inventory and integrated business planning and production. This unlocks new ownership and collaboration models across supply chains.

**Smarter production** – the use of data analytics and new production techniques and technologies (such as autonomous robots, multi-purpose production lines and augmented reality) helps to improve yield and speed up production. This allows new business models to be pursued such as mass customization.

**Smarter products** – Rapid innovation and a faster time to market are enabled by data collected from products along with user feedback, whether direct or collected via social sentiment on the internet. This data also allows remote diagnostics and remote/predictive maintenance.

Source: The 4th Industrial Revolution (4IR): A primer for manufacturers
World Economic Forum investigated different countries and scored them on a 7-point scale. This is the top 10 countries scored on the ability to capitalize on the digital revolution:

Scandinavian countries score high on the NRI. Germany, being one of the leading countries in Industry 4.0, only takes the 15th position on the list. China does have the right ambitions, but the country finds itself on a 59th place in the NRI. Whether this has an impact on their current number one position as a manufacturing country and their ambitions as stated in Made in China 2025, depends on how quickly they can improve their networks. In addition, the question is whether having the right circumstances as a country is enough to boost competitiveness.

Sources
World Economic Forum
Report WE Forum
1. **Is there something to be learned from manufacturers in other countries?**

**Industry 4.0 for SMEs - EU Horizon 2020 RISE program**

**Goal:** A great challenge for the future lies in the transfer of Industry 4.0 expertise and technologies in small and medium sized enterprises (SME). Although the high potential of Industry 4.0 in SMEs, the main limit lies in a lack of concrete models for its implementation and application in small and medium enterprises. Thus, this research project titled “SME 4.0 - Smart Manufacturing and Logistics for SMEs in an X-to-order and Mass Customization Environment” aims to close this gap through the creation of an international and interdisciplinary research network. Identifying the needs and enablers for a smart and intelligent SME-Factory, creating adapted concepts and design solutions for SME production and logistics systems and developing suitable organisation and business models will be the main objectives of this research network. The research network includes partners from all over the world (Italy, Slovakia, Austria, Thailand, USA, India).
2. How can MNEs drive I4.0 technologies through their supply chain, especially SMEs?
   - Understanding benefits
   - Learning about applications relevant to their processes
   - Provide/join a platform to share best practices for integration
   - Involve SMEs in RDI projects

Challenges:
- Competing companies don’t want to share
- SME’s have difficulty committing resources
- SME’s may lack capabilities to transform
One of many possible solutions:

- **IMS Project Clustering Platform**
  - Adds the international dimension to take advantage of global RDI
  - New platform for project clustering to leverage R&D, reduce risks, provide global solutions
    - Facilitators
    - International project matching
    - Regional workshops
    - International workshops
    - Proven methodology for cluster formation
    - *No charge for IMS services or workshops!*

- IMS is an industry-led program for international collaboration
- Established networks for 22 years.
Methodology Example

Additive Manufacturing Platform
• Additive Manufacturing Project Cluster Workshop
  • 2 May 2016, Barcelona Spain
  • 38 projects attended worth an estimated 100 million in R&D from the European Union, Mexico, South Africa, and United States
  • 6 new project research clusters formed under IMS
Workshop Methodology

• Topic selected
• Project search
• Request project summaries, top 3 exploitable results, TRL levels
• Circulate summaries and request cross interest (weighted)
• Weighted interest levels charted
• Themes emerge, workshop held
Spreadsheet created from 38 submissions

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- Weighted interest levels charted
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<th>Project ID</th>
<th>Explorable Result</th>
<th>Abbreviated Name</th>
<th>Score</th>
<th>Strength of Interest (ER)</th>
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**SCORING:** 1=LOW INTEREST, 2=MODERATE INTEREST, 3=HIGH INTEREST (BLANK SPACES=NO INTEREST)
Outcomes

• AM Cluster workshop had access to 38 projects worth an estimated 100 million in R&D. Shared R&D conducted at a fraction of the cost.
• Expand knowledge networks beyond borders.
• 3 New Project clusters to be formed, next Industry 4.0. Similar activity expected.
• Global networking for your institution to elevate visibility.
• Companies involved in IMS projects often become part of supply chains
• New project: Global AM Material Properties Database

How can I get involved?

26 October
• I 4.0 Workshop, Quad Cities
7-9 November
• AM Metals Cluster to hold workshop at the World Manufacturing Forum
• I 4.0 international Workshop
My General Observations:

• Manufacturing Small to Medium Enterprises (SME’s) have a great deal to gain from Industry 4.0 technologies

• Most don’t have a good feel for what Industry 4.0 is

• Most aren’t ready to consider it – too complex

• They fear implementing Industry 4.0 is a big bang that could bring them to their knees

• Initial discussion needs to be on the SME business issues and how pieces of Industry 4.0 might help
Partners Launch ManuVation 4.0

ManuVation
Driving Improved SME Performance

IMS
INTELLIGENT MANUFACTURING SYSTEMS

PDES, Inc.
Connecting the Digital Enterprise

NACFAM
National Council for Advanced Manufacturing

ASA
Monterrey, Mexico
November 7-9 • 2017

“Towards a Digital Market & Connected Manufacturing Ecosystems”

The Event Center at the horno3 Museum of Science and Technology
Thank You! - Questions

ManuVation
Driving Improved SME Performance

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U.S. Launches ManuVation 4.0

• U.S. Aerospace States Association, NACFAM, PDES Inc. and IMS are partnering to focus on SME sustainability and growth

• Piloted an industry driven workshop in March 2016 on Additive Manufacturing with follow on participation in IMS international workshop May 2016

• Using the Additive Workshop model held an Industry 4.0 workshop March 2017, partnering with the state of California A&D sector

• Developed an industry survey to get a sense of SME business issues

• Another workshop is scheduled for October 26, 2017 in the Quad Cities of Iowa and Illinois

• An international workshop will be held during the World Manufacturing Forum November 9, 2017 in Monterrey, Mexico
OVERVIEW: The fifth edition of the World Manufacturing Forum will assemble in Monterrey, Mexico on 7-9 November 2017 at the Parque Fundidora to explore the theme “Towards a Digital Market and Connected Manufacturing Ecosystems”. Global policy experts and industry leaders from large multinationals to small-to-medium sized enterprises, and academic leaders will discuss the policy, economic, social, and technical challenges that influence global manufacturing. The sessions will explore:

Opening Session: Mexico’s Manufacturing Competitiveness & Global Partners
Mexican authorities will provide an overview of the influence of design, engineering and advanced manufacturing activities at the WMF host country, Mexico, as strong drivers for economic prosperity, highlighting infrastructure development, job creation, and contribution to the GDP. Such overview will include the presentation of national industrial and trade policies as well as science & technology policies.

Session 1: Industrial Policies for Digital & Interconnected Manufacturing Market
The Digital Marketplace, which forms the “digital thread”, is expected to connect and drive future manufacturing supply chains. This marketplace will further drive rapid innovation, efficiency, and global collaboration. Cross-border policies and cooperation are needed to enable ecosystems of this scope and size.

Session 2: Connected Factories and Value Chains
Platforms for connected factories along a value chain ecosystem must be developed in a standardized way so that those entering or exiting a value chain may easily participate or disconnect. What are the reference architectures currently in development and how can they be implemented in create a value chain ecosystem?

Session 3: Digital Workforce & Future Manufacturing Jobs
Connected manufacturing ecosystems will drive new architectures, but will also change how we utilize our workforce. The future company workforce will extend beyond its walls to also become interconnected as a shared resource. These employees will need to be agile, highly trained, and able to address rapid-fire challenges and changes. How do we train for such a workforce?

Session 4: Energy and Resource Efficient Manufacturing
Efficient use of resources will continue to drive manufacturing from business and social drivers. What are the major barriers for further efficiencies in manufacturing ecosystems? How can value chains drive these efficiencies in a cooperative way to spur innovation, reduce costs, and be environmentally responsible?

Session 5: New Business Models & Service Engineering
The distinction between products and services has blurred as they are integrated into global manufacturing value chains. This major evolution will continue to expand and innovate thanks to powerful digital networks transforming regional businesses to globally integrated enterprises, and global enterprises to reach regional resources. What are the requirements and barriers for this new business model?

Session 6: Technology Trends for the Factory of the Future
New manufacturing technologies to enable production of innovative products, drive resource efficiencies to lower costs, and provide better communication and satisfaction with customers. What are these technologies, materials, and processes on the horizon?

Speakers are expected to present policy views supporting and defining manufacturing megatrends such as the digitalization of industry, challenges for SMEs in the global marketplace, manufacturing intelligence, social innovation as a driver for new products, services, and technologies, financial challenges that affect industrialized and emerging economies, the circular economy and zero waste, and other disruptive technologies.