Implementing a Digitally Enabled Environment for Product Realization

Gregory A. Harris, Ph.D., P.E.
Auburn University
My career timeline - Bio
Did not exist in 2006

- iPhone
- iPad
- Kindle
- 4G
- Uber

- Android
- Oculus
- Instagram
- Snapchat
- Airbnb
Time to reach 100 Million customers

- Telephone: 75 Years
- Web: 7 Years
- Facebook: 4 Years
- Instagram: 2 Years
- Pokemon Go: 1 Month
Manufacturing Systems

Global Product Data Interoperability Summit | 2018

- Equipment
- Processes
- Automation
- Materials

- WIP
- Final Inventory
- Material Handling

Product & Processes

Materials & Logistics

Humans

Information & Data

- Ergonomics
- Skills
- Training
- Human in the Loop

- Digital Manufacturing
- Model Based Enterprise
- IIoT
- Industrie 4.0
- Data Analytics
The Industrial Revolutions

1st - Mechanization, water power, steam power
2nd - Mass production, assembly line, electricity
3rd - Computer and automation
4th - Cyber Physical Systems
Typical Industry 4.0 Components

- Autonomous Robots
- Simulation
- Big data analytics
- Horizontal and vertical system integration
- Augmented reality
- Industrial Internet of Things
- Cyber Security
- Additive Mfg
Disruptive Technologies

Global Product Data Interoperability Summit | 2018

A number of disruptive technologies will enable digitization of the manufacturing sector

Digitization of the manufacturing sector – Industry 4.0

**Data, computational power, and connectivity**
- Big data/open data
  - Significantly reduced costs of computation, storage, and sensors
- Internet of Things/M2M
  - Reduced cost of small-scale hardware and connectivity (e.g., through LPWA networks)
- Cloud technology
  - Centralization of data and virtualization of storage

**Analytics and Intelligence**
- Digitization and automation of knowledge work
  - Breakthrough advances in artificial intelligence and machine learning
- Advanced analytics
  - Improved algorithms and largely improved availability of data

**Human-machine interaction**
- Touch interfaces and next-level GUIs
  - Quick proliferation via consumer devices
  - Virtual and augmented reality
  - Breakthrough of optical head-mounted displays (e.g., Google Glass)

**Digital-to-physical conversion**
- Additive manufacturing (i.e., 3D printing)
  - Expanding range of materials, rapidly declining prices for printers, increased precision/quality
  - Advanced robotics (e.g., human-robot collaboration)
  - Advances in artificial intelligence, machine vision, M2M communication, and cheaper actuators
  - Energy storage and harvesting
  - Increasingly cost-effective options for storing energy and innovative ways of harvesting energy

SOURCE: McKinsey
Challenges in implementation of Industry 4.0

Global Product Data Interoperability Summit | 2018

- IT security issues
- Reliability and stability needed for critical machine-to-machine communication (M2M), including very short and stable latency times
- Need to maintain the integrity of production processes
- IT issues that cause expensive production outages
- Need to protect industrial know how
- Threat of redundancy of corporate IT
- General reluctance to change by stakeholders
- Loss of jobs to automatic processes and IT-controlled processes
- Low top management understanding and commitment
- Unclear legal issues and data security
- Unclear economic benefits/excessive investment
- Lack of regulation, standard and forms of certifications
- Insufficient qualification of employees, lack of adequate skill-sets
Industry 4.0 will affect everything

Global Product Data Interoperability Summit | 2018

- Services and business models
- Reliability and continuous productivity
- IT security
- Machine safety
- Product lifecycles
- Industry value chain
- Worker education and skills
- Socio-economics
Why Industry 4.0?

Global Product Data Interoperability Summit | 2018

- Traditional productivity levers have been widely exhausted.
  - In the 1970s and 1980s, lean adoption was the enabler, with Toyota’s system widely adopted in Western regions (mostly high-cost countries).

- Outsourcing and offshoring allowed greater profitability in the 1990s by moving low-skill manufacturing to low-cost countries (LCC).
  - In the 2000s, the advantages of offshoring began to shrink as LCC wages rose and freight costs increased.

- Time to market and customer responsiveness are today’s key factors of competitiveness
  - Companies are investing in automation and robotics technologies that have the potential to meet LCC labor cost levels in any location.
Why Industry 4.0? (2)

The pressure on companies to find new opportunities to boost productivity.

The disruptive technologies of Industry 4.0 hold the promise of smart factories that are highly efficient and data integrated.

Data is the core driver
- A big data/advanced analytics approach can result in a 20 to 25 percent increase in production volume and up to a 45 percent reduction in downtime.

Digitally enabled disruptive technologies will have a significant impact on manufacturing in the next 10 years.
### Top 10 Skills to be relevant in Industry 4.0

**Global Product Data Interoperability Summit | 2018**

<table>
<thead>
<tr>
<th>Top skill</th>
<th>in 2020</th>
<th>in 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Complex Problem Solving</td>
<td>1. Complex Problem Solving</td>
</tr>
<tr>
<td></td>
<td>+2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Critical Thinking</td>
<td>2. Coordinating with Others</td>
</tr>
<tr>
<td></td>
<td>+7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Creativity</td>
<td>3. People Management</td>
</tr>
<tr>
<td></td>
<td>-1</td>
<td>4. Critical Thinking</td>
</tr>
<tr>
<td></td>
<td>-3</td>
<td>5. Negotiation</td>
</tr>
<tr>
<td></td>
<td>4. People Management</td>
<td>6. Quality Control</td>
</tr>
<tr>
<td></td>
<td>5. Coordinating with Others</td>
<td>7. Service Orientation</td>
</tr>
<tr>
<td></td>
<td>+1</td>
<td>9. Active Listening</td>
</tr>
<tr>
<td></td>
<td>-1</td>
<td>10. Creativity</td>
</tr>
<tr>
<td></td>
<td>-4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. Judgment and Decision Making</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. Service Orientation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. Negotiation</td>
<td></td>
</tr>
<tr>
<td>New to list</td>
<td>10. Cognitive Flexibility</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Future of Jobs Report, World Economic Forum
The implementation of digital capabilities in the product realization process, such as early consideration of manufacturability during the development of the science & technology and the design & acquisition phases, is essential to dealing with this complexity and succeeding in this 4th industrial revolution.

Despite the recognition of importance for digital design and manufacturing, most participants believe their organizations lack capability.

Majority of senior leaders agree that digital is a priority, but few have a clear bold vision and strategy.

Translating strategy to clear action is a clear gap in a majority of organizations.

SOURCE: McKinsey survey. >200 responses from subject matter experts, industry leaders.
The need is known

Organizations have recognized the need
- to integrate physics-based characteristics into models
- enable the simultaneous consideration of the physical configuration, computational elements, and predictable system behaviors
- promote products and processes that are designed and built correctly.

As with all revolutionary change there are significant hurdles to overcome before the digitally enabled environment for product realization becomes the norm.
Evolutionary and Revolutionary Change

System change seems to occur in an evolutionary manner, until change can no longer evolve in that system. At that point the system must change in a revolutionary manner, or else the system will essentially retreat to its former state (Greiner, 1972).
Obstacles

Global Product Data Interoperability Summit | 2018

- Interoperability
- Infrastructure
- Culture
Interoperability

Global Product Data Interoperability Summit | 2018

• Inefficient technical data exchange between suppliers and customers increase costs

• Costs are typically associated with manual re-entry, reformatting of data and corrections of errors injected by manual processing

• Communications inefficiencies increase costs and time while stymying innovation.

• NIST research indicates that these challenges contribute to a $1 billion per year cost to the U.S. automotive supply chain.¹
Interoperability (2)

• Reduction in lead time and error rate have long been goals of manufacturers and a significant contributor to long lead times and increasing errors are interoperability problems between systems in the design, manufacture, deliver, and sustainment processes and is a significant source of pain, difficulty and increased costs.

• Even with a sustained effort by industry to become model centric, there is still a significant manual intervention in the supply chain to adapt to a Model Based Enterprise environment.

• Most collaborative exchanges around technical data are executed via unstructured communications and unstructured data does not easily allow for capture, analysis and re-use.

• Typical sources of Interoperability include proprietary software, software version incompatibility, lack of standards, differences in procedures, etc.
Infrastructure

Global Product Data Interoperability Summit | 2018

- The world of product and process data is changing at a rate faster than most large organizations can keep up.

- Large organizations like the Department of Defense (DoD) and component branches and agencies have not been able to maintain the level of capabilities of their industry partners.

- Investment in infrastructure is difficult to authorize when the need and return on investment is not fully understood.

- This can be attributed to the reality that the need to work with models has not reached the level of urgency that other issues achieve in the day to day functions within the organization.

- This does not change the genuine issue that the inability to perform the required functions using models is going to cause in the very near future.

- Many organizations currently do not possess the capability to receive and utilize 3D models to perform the functions for which they are responsible to support.
Culture

Global Product Data Interoperability Summit | 2018

- People
- Image/Perception
- Procedures
- Monuments
“I’ve learned three things about new programs:

- Never oppose them; if you do you will get fired.
- Never do any work on them.
- In three months you will never hear about them again.

I’ve been here 23 years, and I’ve seen 23 of these things come and 23 of them go.”

(Auto Supplier Supervisor)

D.V. Landvater, 1997. World Class Production and Inventory Management, p.11
Organizational Change

Communicationtoolbox.com
Overcoming Culture

Global Product Data Interoperability Summit | 2018

- Communication
- Education and training
- Capable infrastructure
- Appropriate systems
- Trust/Organizational Credibility
- Changed procedures and processes
- Cortez method for change and adoption
THANK YOU!

QUESTIONS?

Thank You!
Gregory A. Harris, Ph.D., P.E.
greg.harris@auburn.edu