Implementing a Digitally Enabled Environment for Product Realization

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My career timeline - Bio

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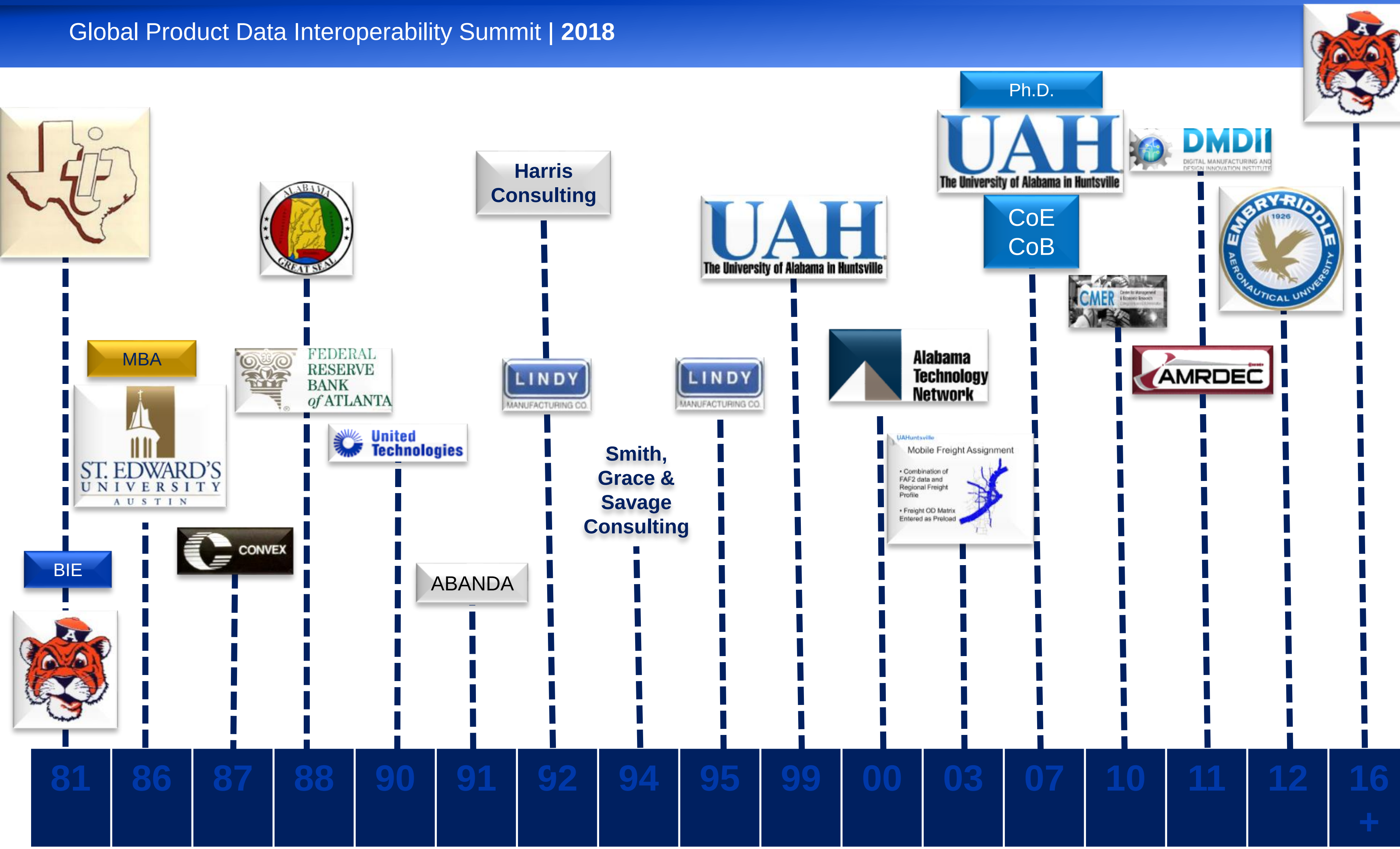

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Did not exist in 2006

- iPhone
- iPad
- Kindle
- 4G
- Uber
- Android
- Oculus
- Instagram
- Snapchat
- Airbnb

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Time to reach 100 Million customers

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- **Telephone** — **75 Years**

- **Web** — **7 Years**
- **Facebook** — **4 Years**
- **Instagram** — **2 Years**
- **Pokemon Go** — **1 Month**

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Manufacturing Systems

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- Equipment
- Processes
- Automation
- Materials

- WIP
- Final Inventory
- Material Handling

- Ergonomics
- Skills
- Training
- Human in the Loop

- Digital Manufacturing
- Model Based Enterprise
- IIoT
- Industrie 4.0
- Data Analytics

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The Industrial Revolutions

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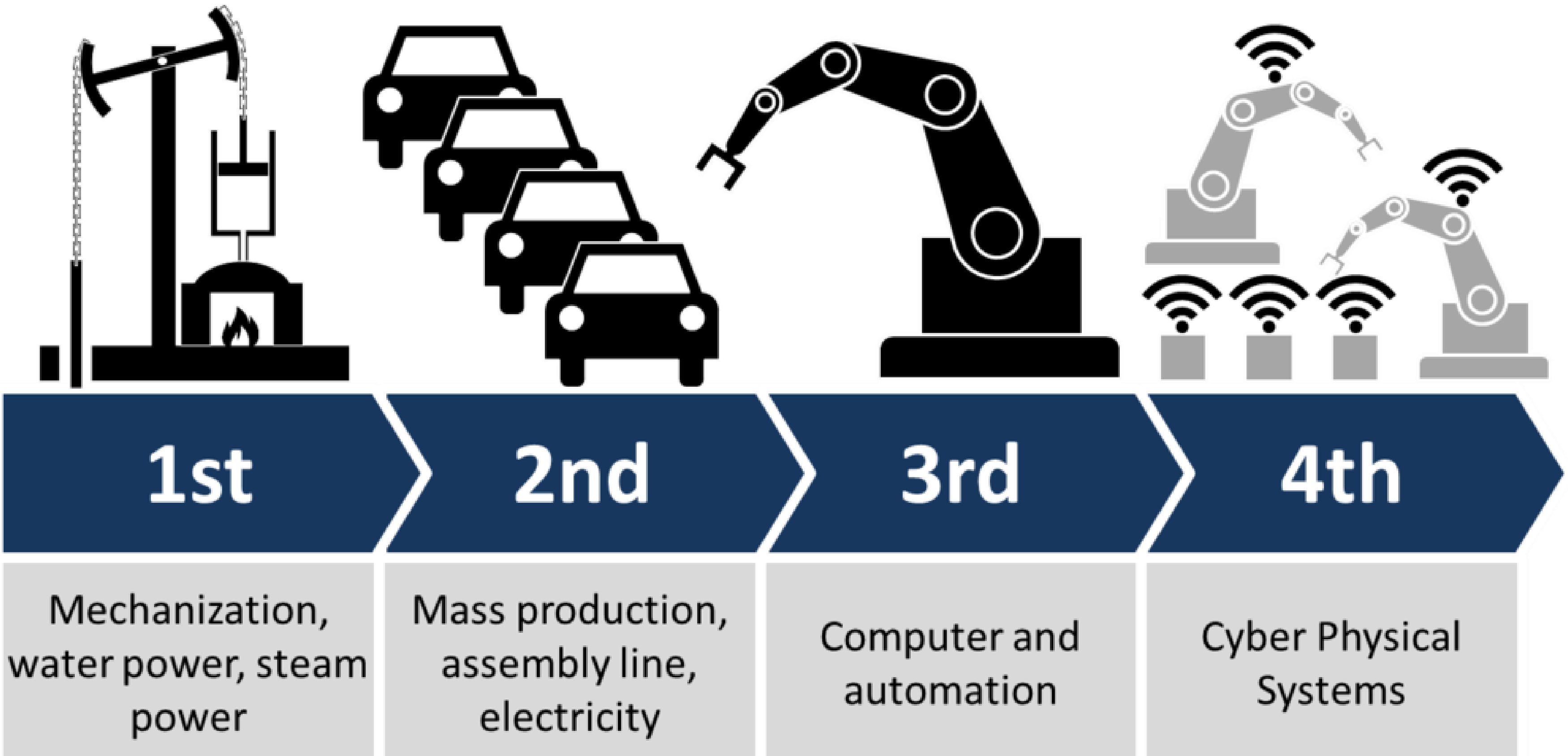

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Typical Industry 4.0 Components

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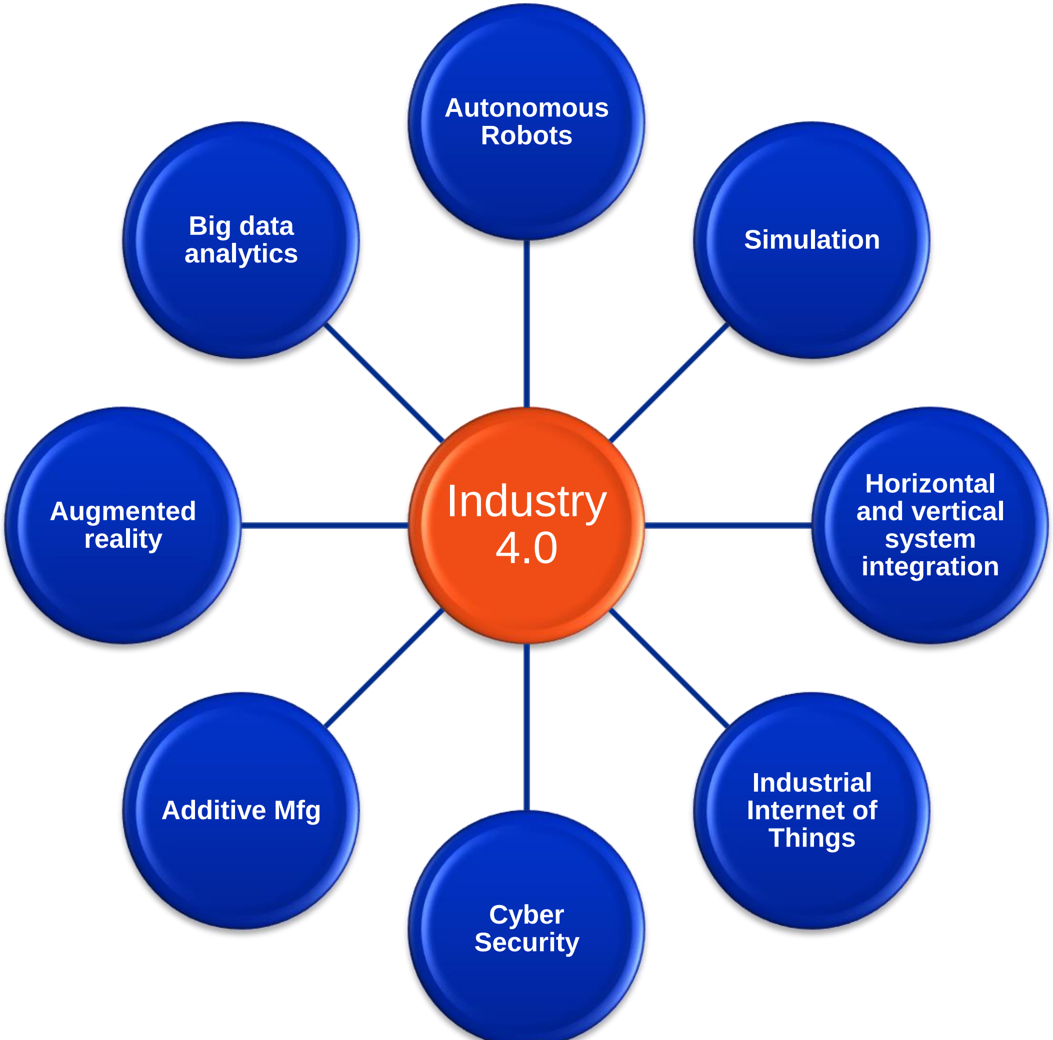

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Disruptive Technologies

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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

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Challenges in implementation of Industry 4.0

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- 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

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Industry 4.0 will affect everything

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

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Why Industry 4.0?

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- 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.

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Why Industry 4.0? (2)

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- 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.

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Top 10 Skills to be relevant in Industry 4.0

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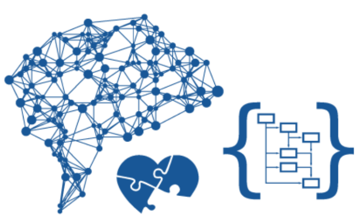
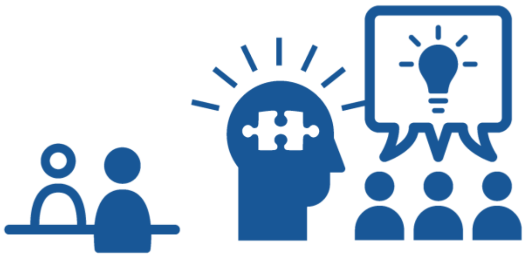
in 2020

Top skill	1.	Complex Problem Solving
+2	2.	Critical Thinking
+7	3.	Creativity
- 1	4.	People Management
- 3	5.	Coordinating with Others
New to list	6.	Emotional Intelligence
+1	7.	Judgment and Decision Making
- 1	8.	Service Orientation
- 4	9.	Negotiation
New to list	10.	Cognitive Flexibility

in 2015

1. Complex Problem Solving
2. Coordinating with Others
3. People Management
4. Critical Thinking
5. Negotiation
6. Quality Control
7. Service Orientation
8. Judgment and Decision Making
9. Active Listening
10. Creativity





Source: Future of Jobs Report, World Economic Forum

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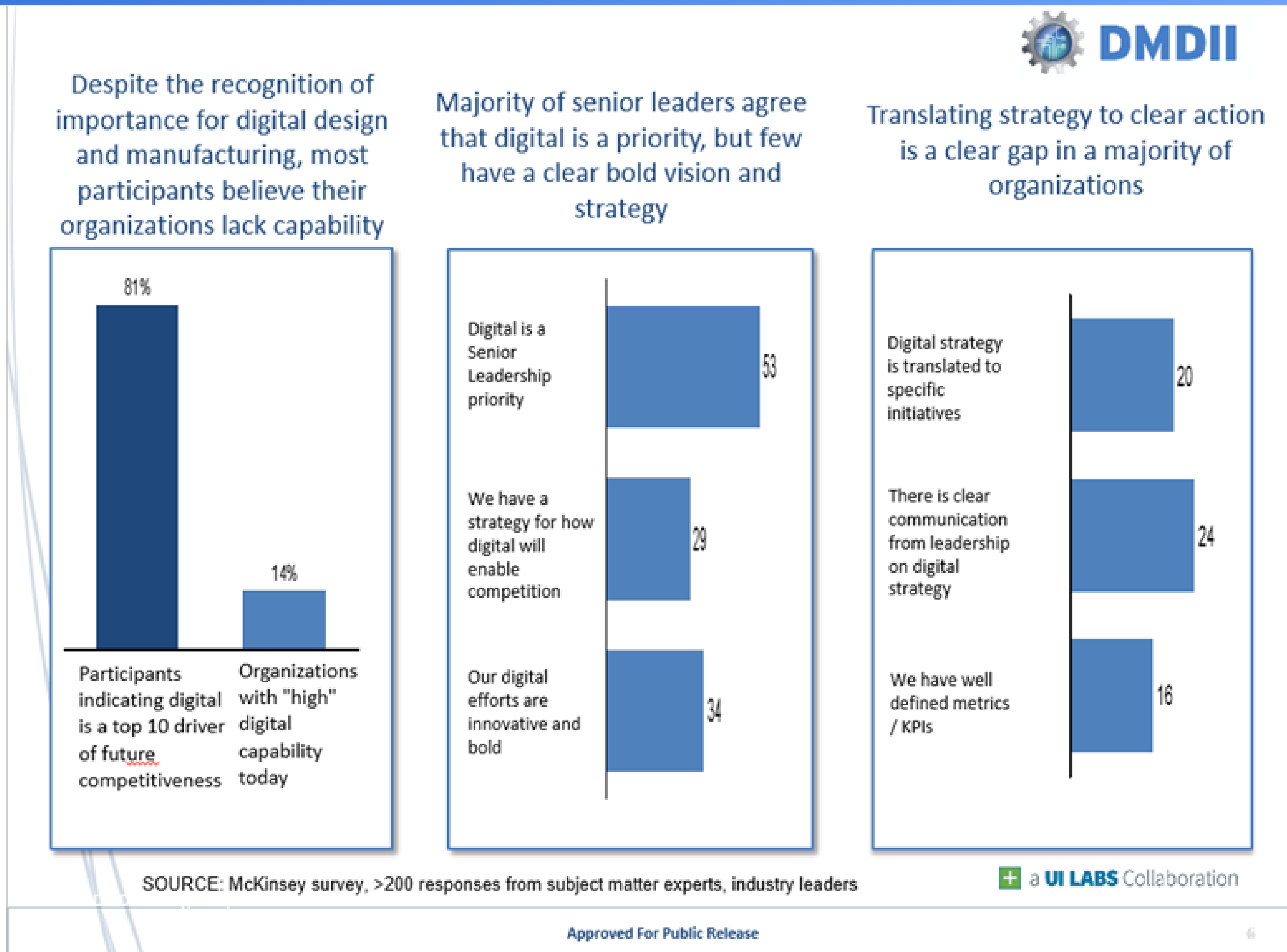
Importance of Digital Capability

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.



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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.

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Evolutionary and Revolutionary Change

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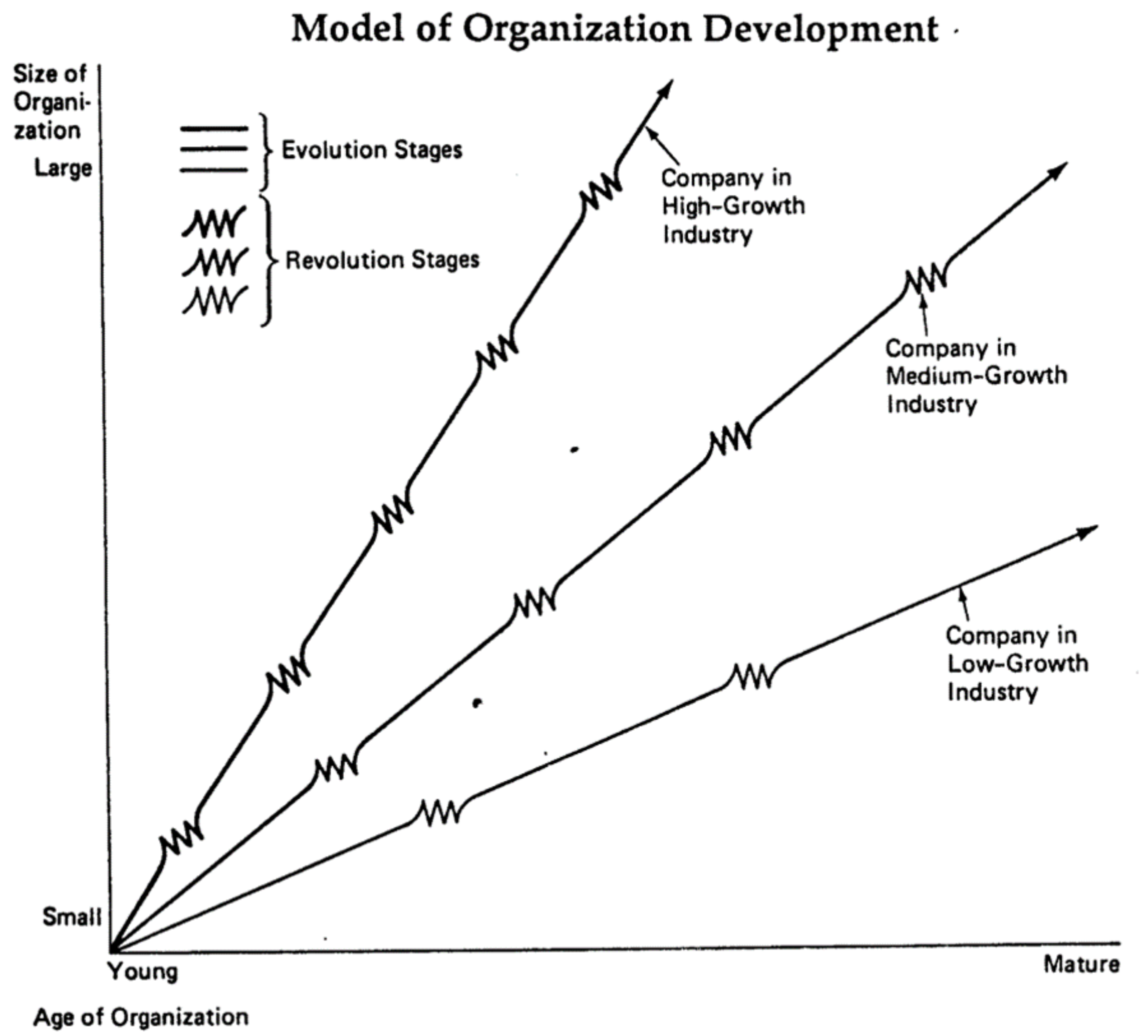
System change seems to occur in an evolutionary manner, until change can no longer evolve in that system. At that point the system must change in a revolutionary manner, or else the system will essentially retreat to its former state (Greiner, 1972).



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Obstacles

- Interoperability
- Infrastructure
- Culture

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Interoperability

- 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]

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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.

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Infrastructure

- 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.

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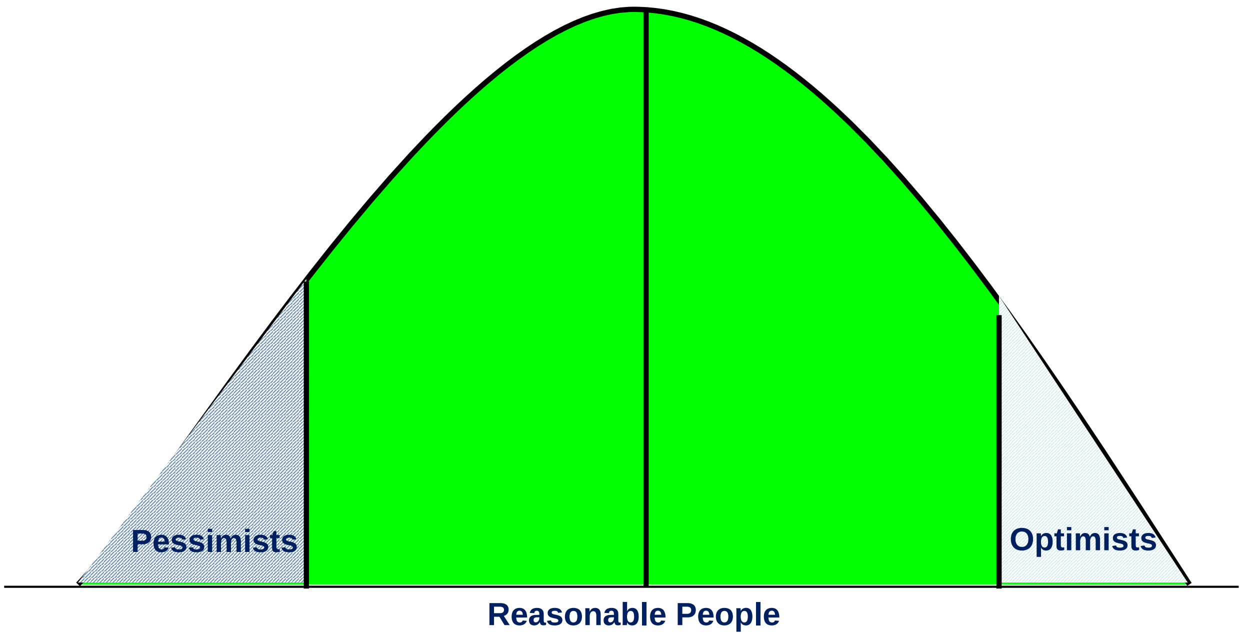
Culture

- People
- Image/Perception
- Procedures
- Monuments



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Change? Ha!

"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

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Organizational Change

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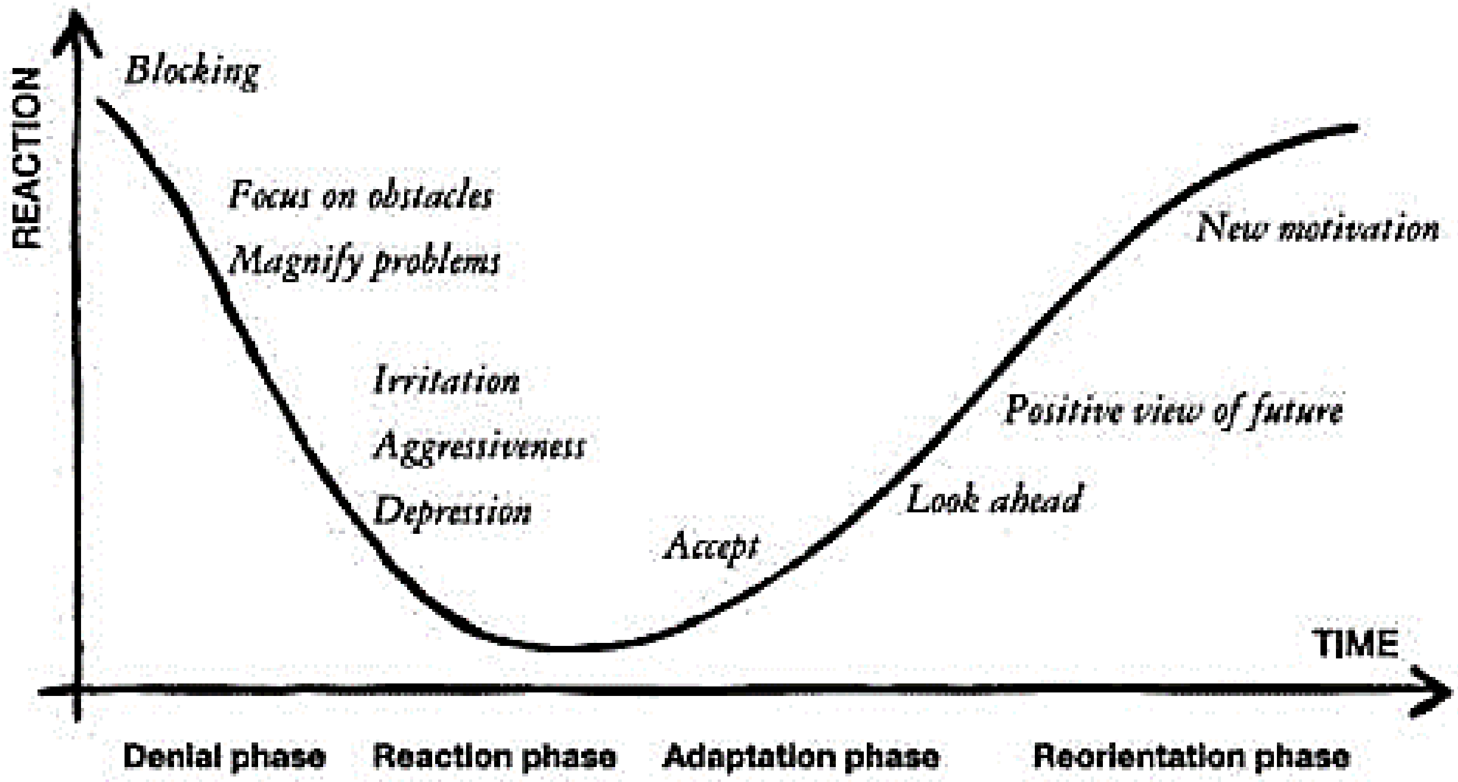

Communicationtoolbox.com

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Overcoming Culture

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

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Cortez Method for Change Management

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THANK YOU!

QUESTIONS?

Thank You!

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