



Systems Engineering

Deployment Challenges

SMSWG Meeting
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Systems Engineering – *Deployment Challenges*

Frank Popielas, Managing Partner & Co-Founder

Ed Ladzinski, CEO & Co-Founder

SMS_ThinkTank™ LLC

www.smsthinktank.com

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- What are the Deployment Challenges? *
 - The Hype of MBSE
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 - What is the proper Approach?
 - Perception & Reality
 - Do we know how to measure Success?

Let's have an open exchange during this presentation

The Market and its challenges

Market Challenges and Engineering Trends

Market:

- Global Economy
- Faster than ever changing / evolving technology
- The age of data and information
- Digitalization, visualization, and collaboration
- The complexity issue

More complex technologies are challenging the ability for middle and upper management to understand the emerging needs of the business

Engineering:

- Increased complexity
- Demand for more flexibility and choices
- Improved product quality and robustness guarantee
- Digitalization
- Sustainable innovation

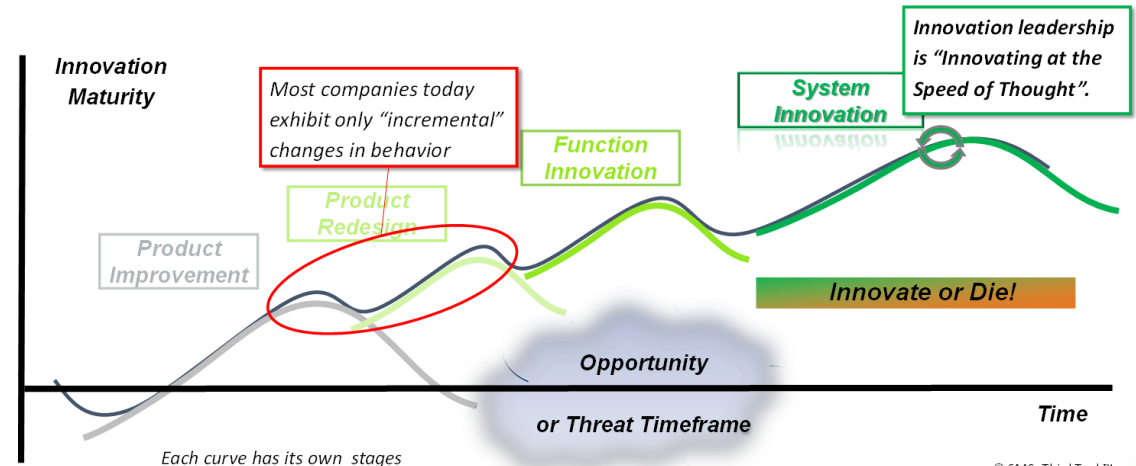
- *Companies are operating in an ever leaner environment*
- *Ever growing demand for accountability*

Achieving Sustainable Innovation

- System modeling and simulation
- IIoT and Industry 4.0
 - New era in manufacturing
- Big Data and IoT
 - The way we collect and distribute data is changing rapidly
 - New infrastructure needed
- Iterative and collaborative approaches
 - Closed-loop
 - Across domains and organizations
- Cognitive engineering
 - Predictive analytics
 - Deep learning
 - Digital twin

SMS is the use of interdisciplinary functional, architectural, and behavioral models (with physical, mathematical, and logical representations) in performing **MBSE (Model-Based Systems Engineering)** to specify, conceptualize, design, analyze, verify and validate an organized set of components, subsystems, systems, and processes..... *

Innovating at the Speed of Thought



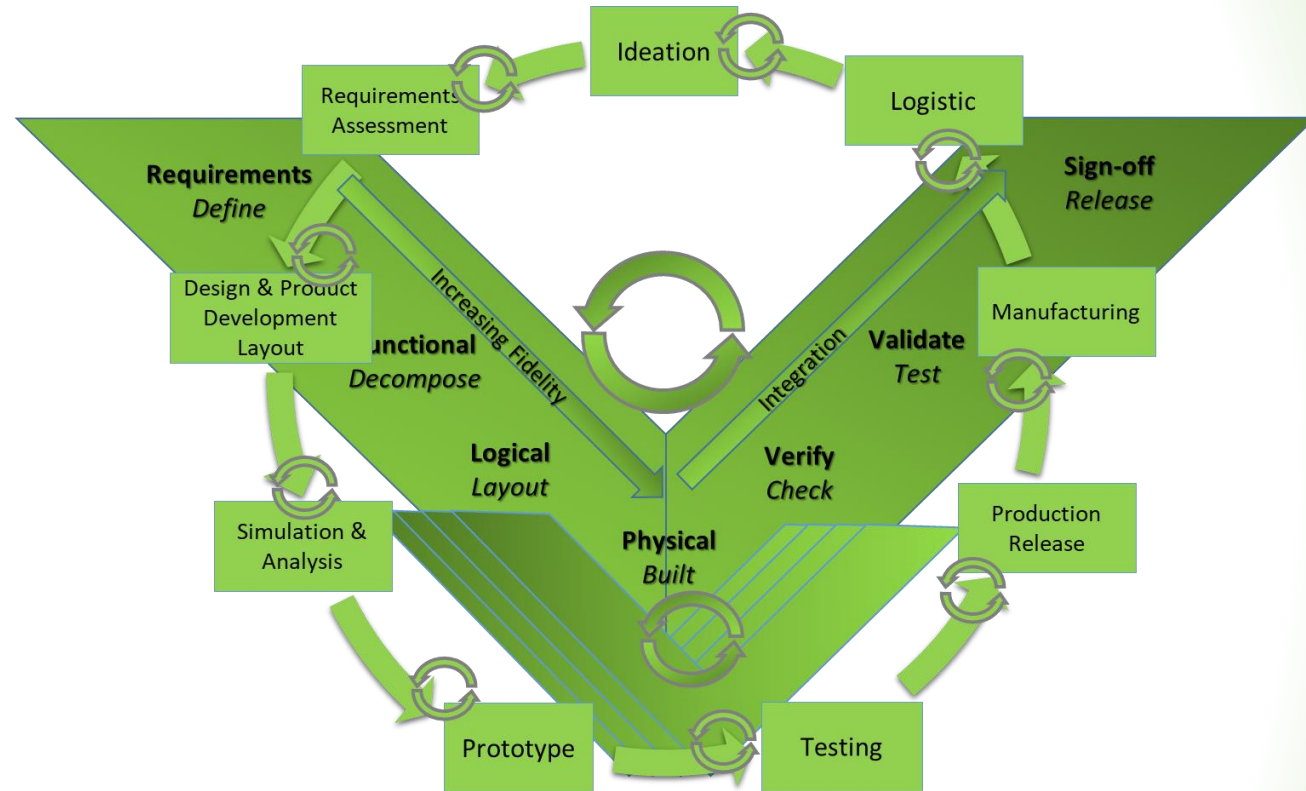
MBSE

Model Based Systems Engineering

What is MBSE?

Model-Based Systems Engineering (MBSE)

➤ ...“the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.” (INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007). MBSE is a subset of Model Based Engineering (MBE) and Systems Engineering (SE).



The engineering “V”, adopted by the SMS_ThinkTank™, provides a process view of the complexity associated with modern engineering environments. This “V” model incorporates related engineering disciplines that are operating in parallel; are iterative; and non-sequential.

Model-Based Engineering (MBE) - a.k.a., Model-Driven Engineering (MDE) and Model-Driven Development (MDD).

“An approach to engineering that uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle.” (Final Report, Model-Based Engineering Subcommittee, NDIA, Feb. 2011). It is the umbrella for many other MBx activities.

Benefits to Systems Engineering and MBSE

➤ Benefits

- Better educated decision making
- Improved products
- Improved quality
- Catalyst for improved processes
- Reduced design lead time
- Reduced engineering changes
- Reduced errors in production
- Improved reliability
- Reduced introduction costs
- Reduced warranty claims
- Reduced through-life costs
- Better able to manage and adapt to change
- Adherence to agreed delivery dates
- Improved risk management
- Improved Collaboration

➤ Results

- Innovation
- Quality
- Improved morale
- Faster time to market
- Increased customer confidence
- Improved customer relationships
- Reduced warranty costs
- Reduced recalls
- Increased sales
- Increased in customers
- Increased profits
- Enhanced knowledge capture

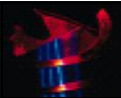








Benefits less obvious

It's difficult to justify the costs of SE in terms that program managers and corporate managers can relate to.

- The costs of SE are evident
 - Cost of resources
 - Schedule time
- The benefits are less obvious and less tangible
 - Cost avoidance (e.g., reduction of rework from interface mismatches)
 - Risk avoidance (e.g., early risk identification and mitigation)
 - Improved efficiency (e.g., clearer organizational boundaries and interfaces)
 - Better products (e.g., better understanding and satisfaction of stakeholder needs)

We need to quantify the effectiveness and value of SE by examining its effect on program performance?

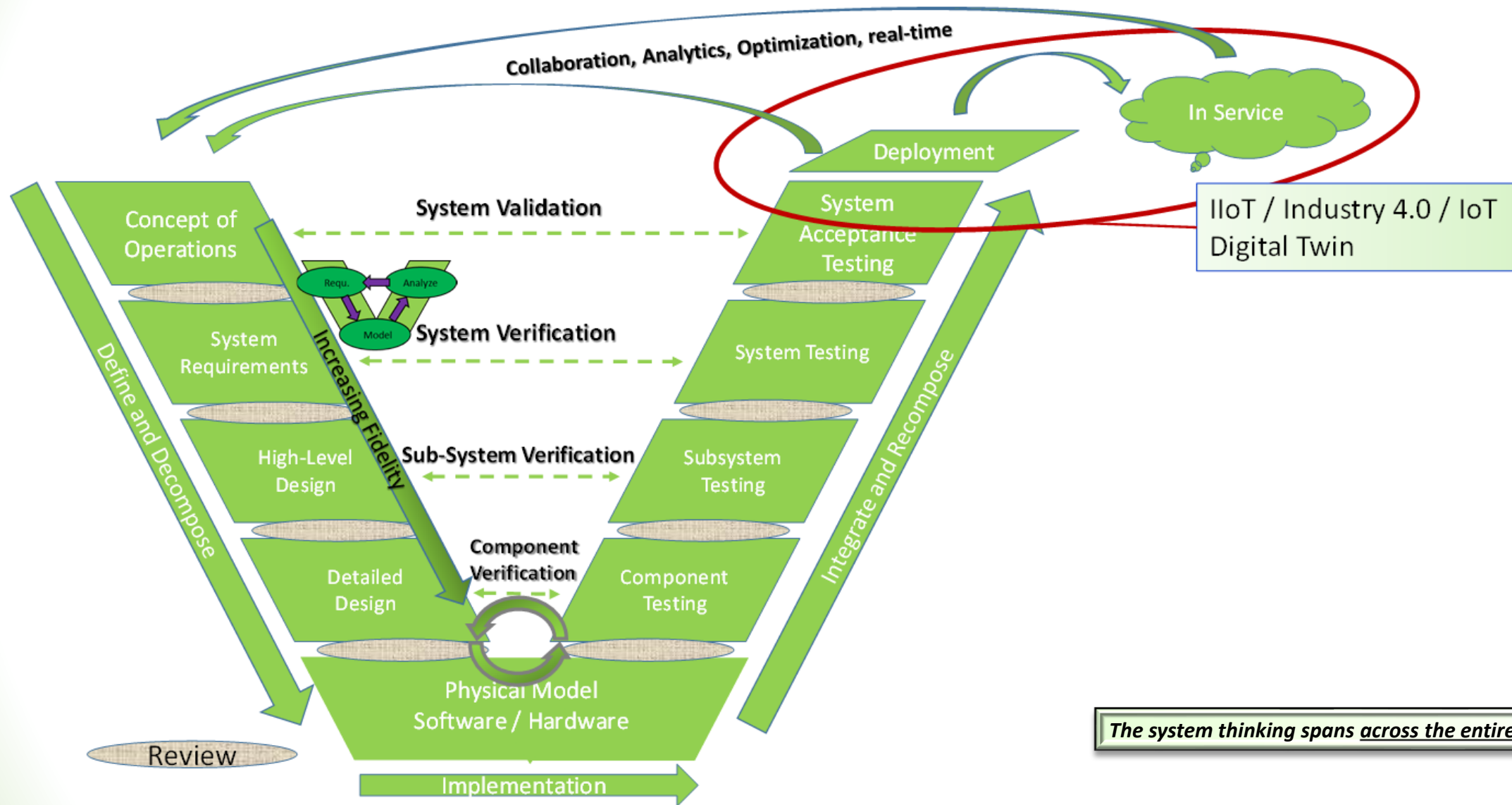
Benefits – Proven Empirically*

<i>Economic Levers</i>	<i>Typical Range of Improvement*</i>	<i>Improvement Rationale</i>	<i>Potential Economic Impact (Over Five Years)</i>
 Increased Revenue through Rapid Product Introduction	↑ 2 - 5%	Improved time to market Better collaboration and leverage of supplier innovation	 <p>Estimated Revenue Uplift \$\$\$\$+</p> <hr/> <p>Top-Line</p> <hr/>  <p>Estimated Cost Savings \$\$+ - \$\$\$+</p> <hr/> <p>Bottom Line</p> <hr/>  <p>Higher Customer and Stakeholder Satisfaction Improved Revenue Reduced Operating Costs</p>
 New Product Design Productivity Gains	↑ 20 - 50%	Design and intellectual capital reuse High availability of information	
 Elimination of Non-Value-Added Activity	↓ 20 - 70%	Reduce manual data reentry Automated workflow for managing the change process	
 Reduced Engineering Change Costs	↓ 30 - 50%	Minimize number of changes through rigorous triage Design right first time	
 Reduced I.T. Capital and Maintenance Costs	↓ 15 - 30%	Improved Return on Assets Lower management and maintenance costs	
 Reduced Product Life Cycle Costs	↓ 20 - 65%	Reduced scrap and warranty costs Increased asset & part commonality across products	

* IBM & DS

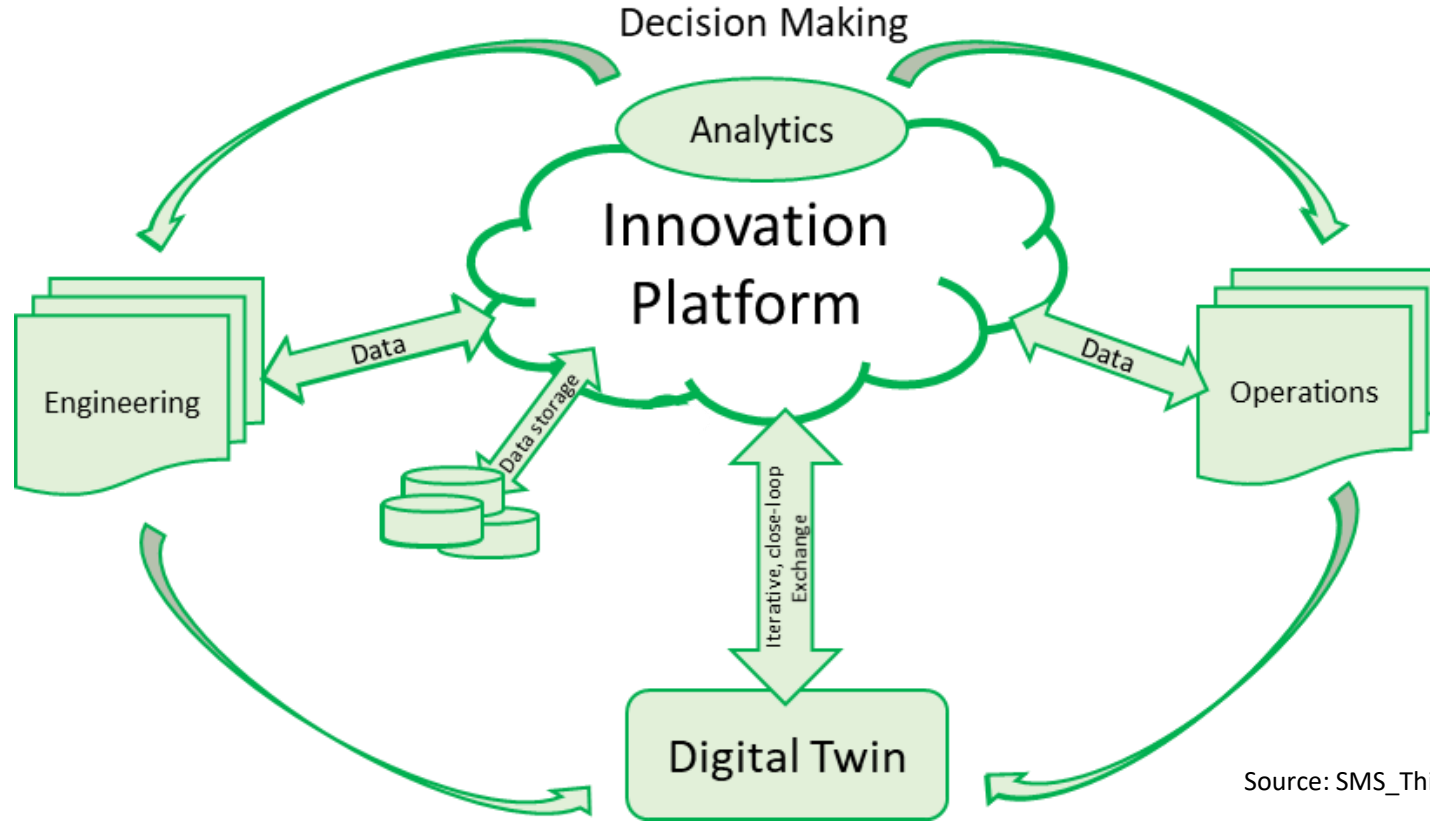
Is that all?

The engineering “V” and the Life Cycle



The system thinking spans across the entire life cycle,

Going Beyond the “V”



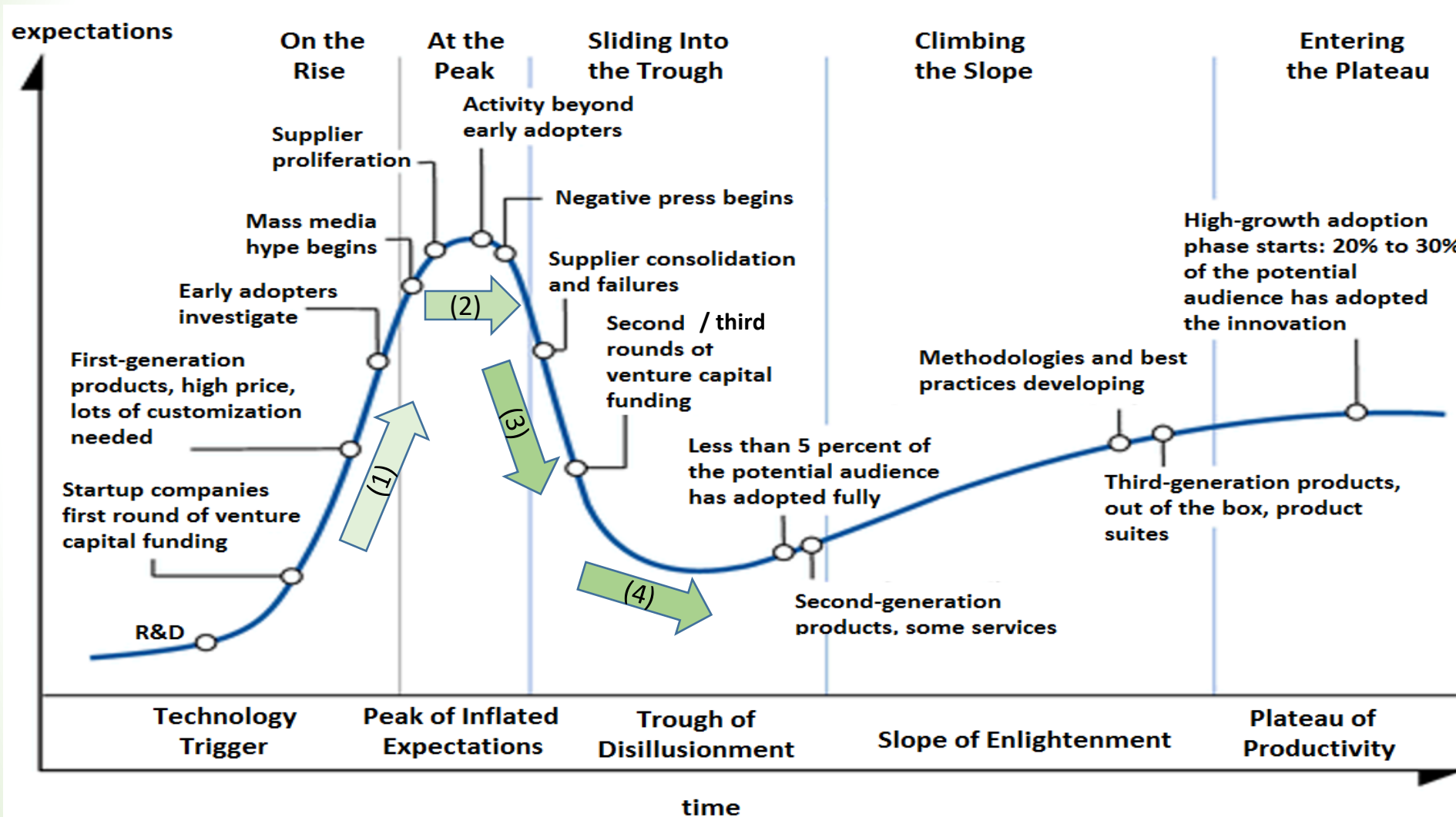
Source: SMS_ThinkTank™, CIMdata

Typically, there are several platforms involved to realize all the benefits of having a Digital Twin available. The underlying Product Innovation Platform needs to be able to bring the threads of all those platforms together to ensure that data and information is consistent and not duplicated.

What else???

What are the Deployment Challenges?

The Hype of MBSE* - Where are you with MBSE?

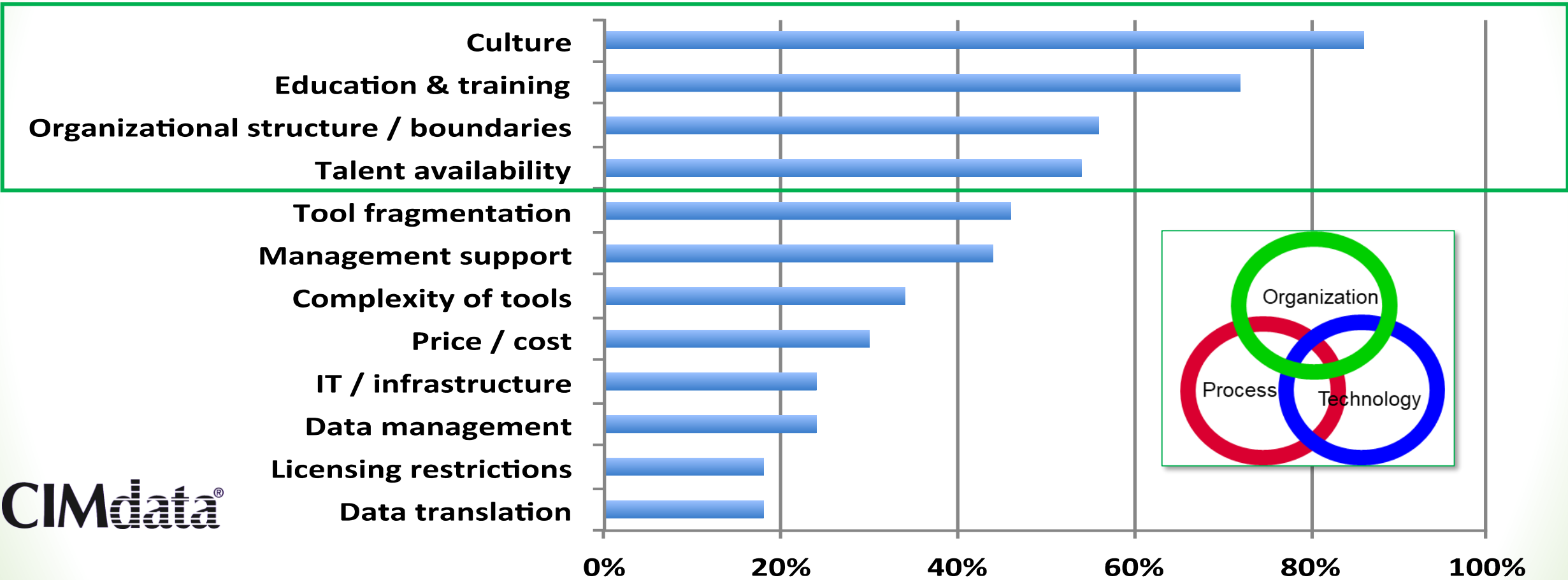


1. Late Adopters
2. Trying to sort things out
3. Establishing roadmap
4. Leaders

Barriers to Industry Implementation

What users cited as problems to overcome in adopting & using MBE/MBSE

➤ It is about people & processes as well – not just technology



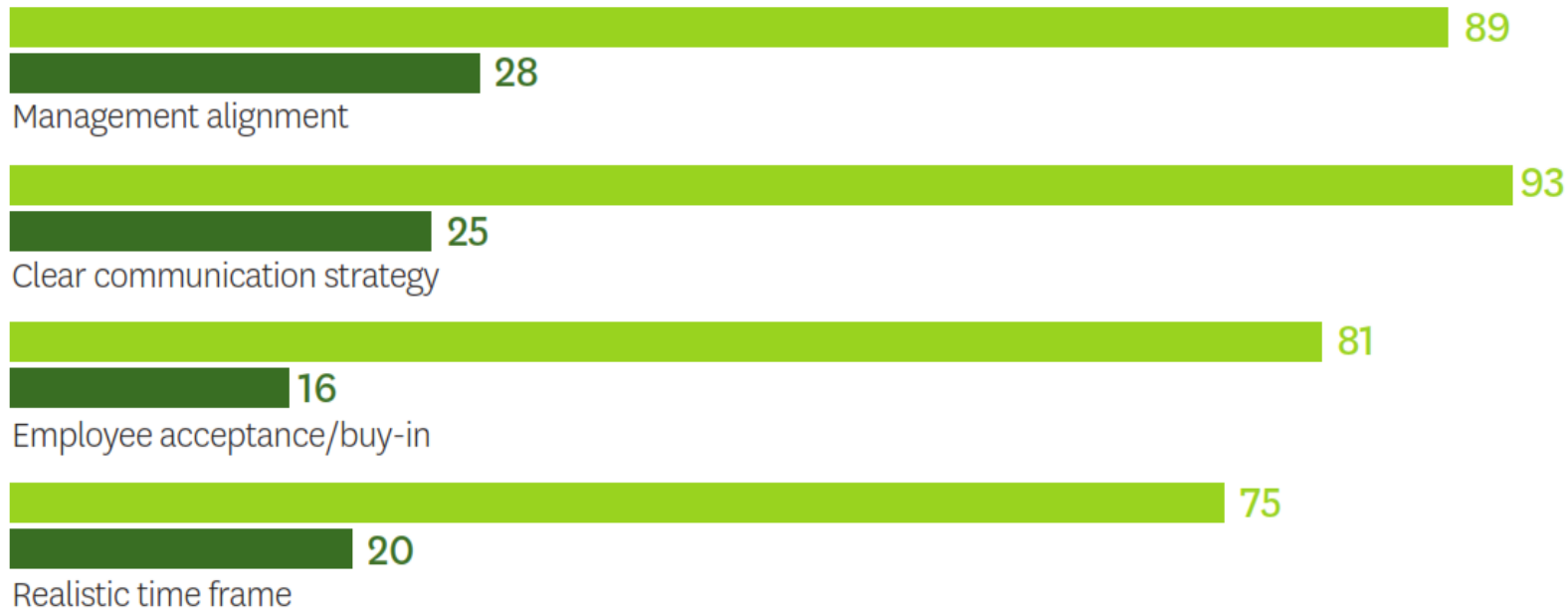
CIMdata®

Moving towards Change Success

The Change Performance Gap

PERCENTAGE OF RESPONDENTS NAMING “HIGH IMPORTANCE” AND “STRONG PERFORMANCE”

● IMPORTANCE ● PERFORMANCE



How important is each of the following to the success of a change initiative, and how well does the organization perform on each of these same factors when implementing the change initiative

Cultural Change: Critical Points of Failure

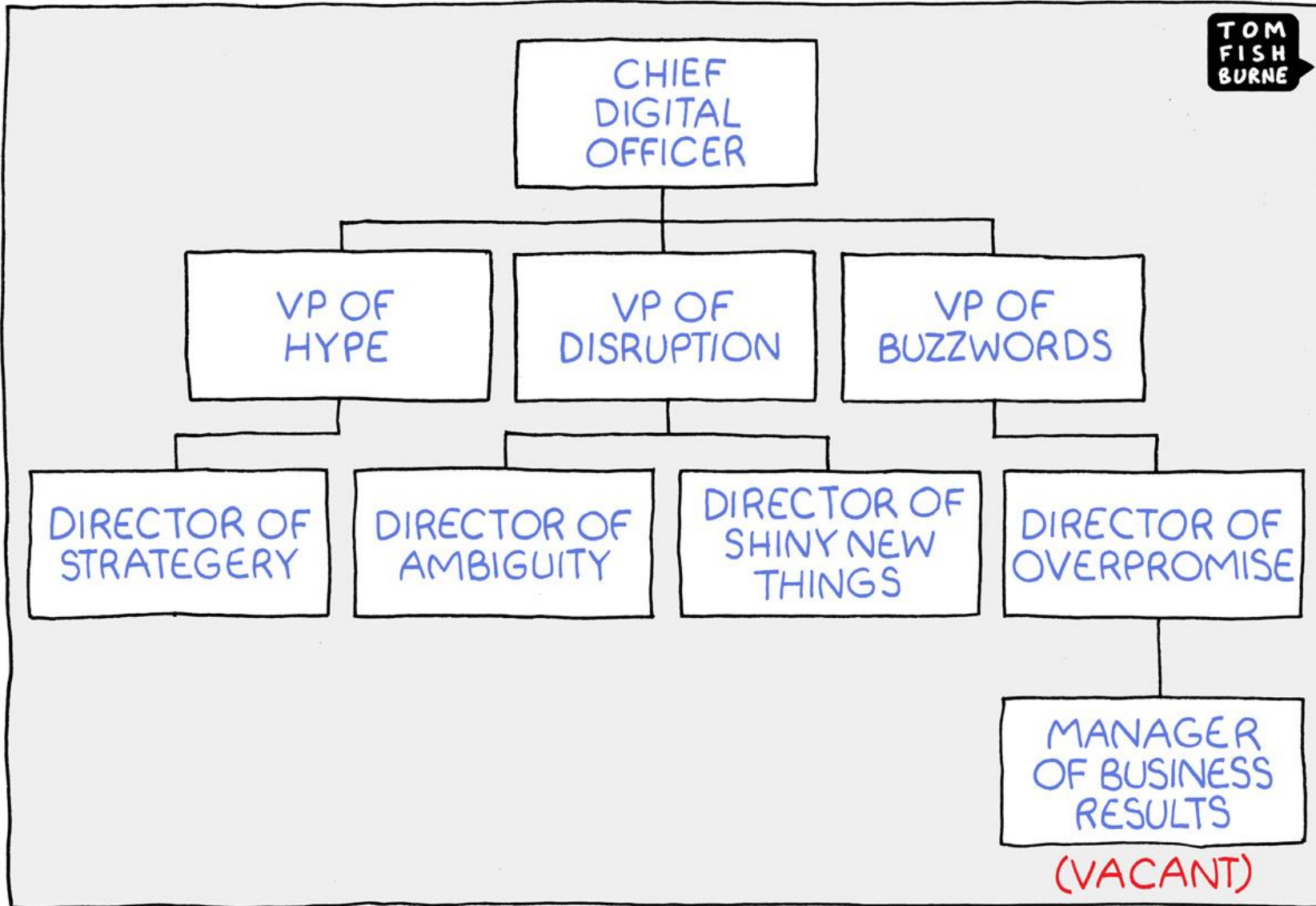


Based on a Harvard survey:

Percentage indicating which of the following are the biggest barriers to successful change

Additional barriers to change success are related to poor leadership and difficulty obtaining user buy-in, each named by about half of respondents (54 percent and 47 percent, respectively). More than one-quarter of survey respondents—26 percent—said senior leadership is often not engaged enough in leading change. Roughly the same proportion said employees are resistant to change.

On the light side?



➤ Often Reality

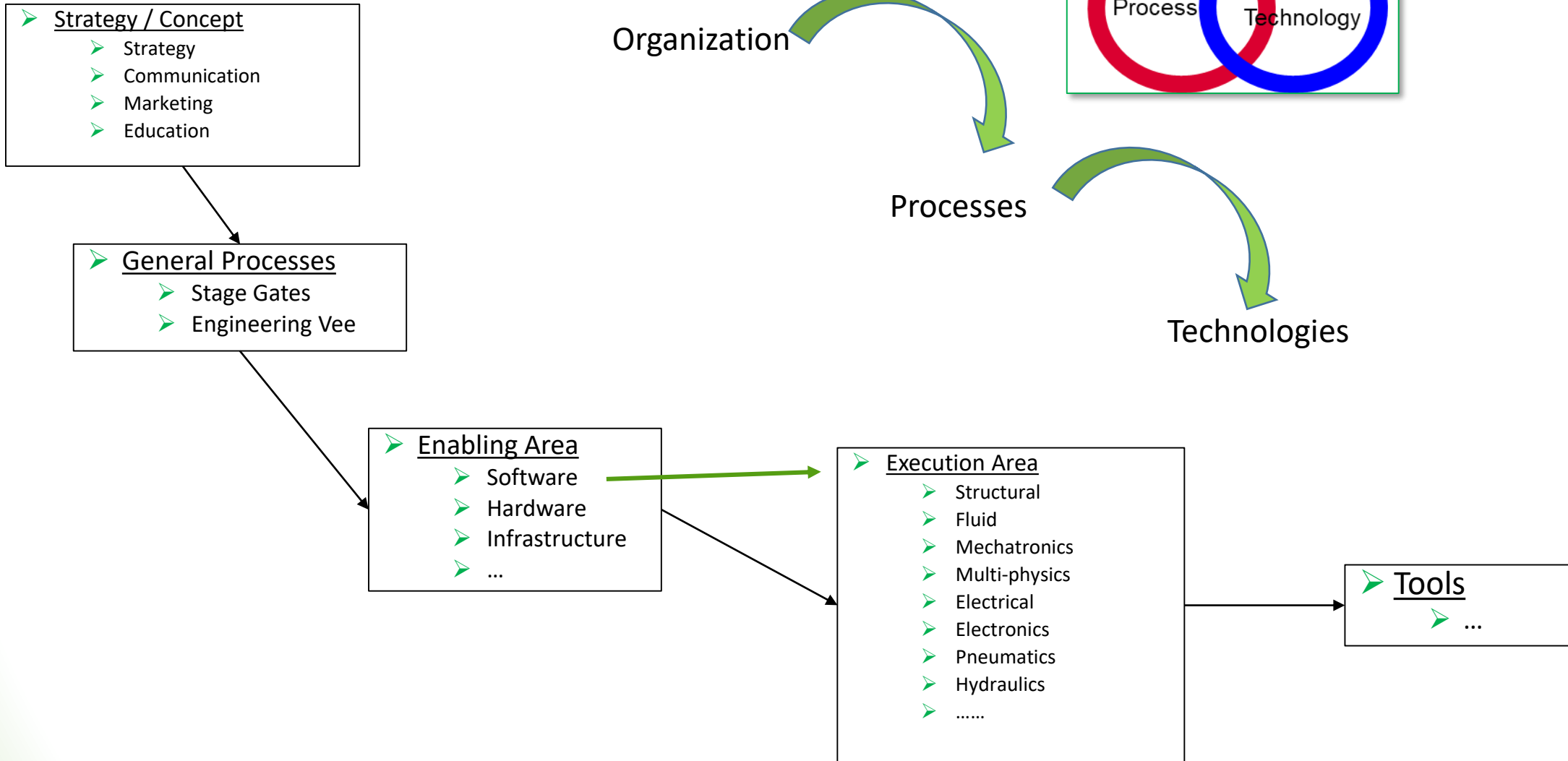
Approach

- How do we start this?
 - Vision
 - Sponsorship
 - Lead
- How do we make it happen?
 - Understand the current state through a **maturity assessment** (“As-Is”, “To-Be” and associated gaps)
 - Ideally CMMI-based
 - Develop an executable roadmap
 - Governance
 - Communication
 - Education
 - ...
- Maintain it !!!

Keep it Simple

Keep it Simple

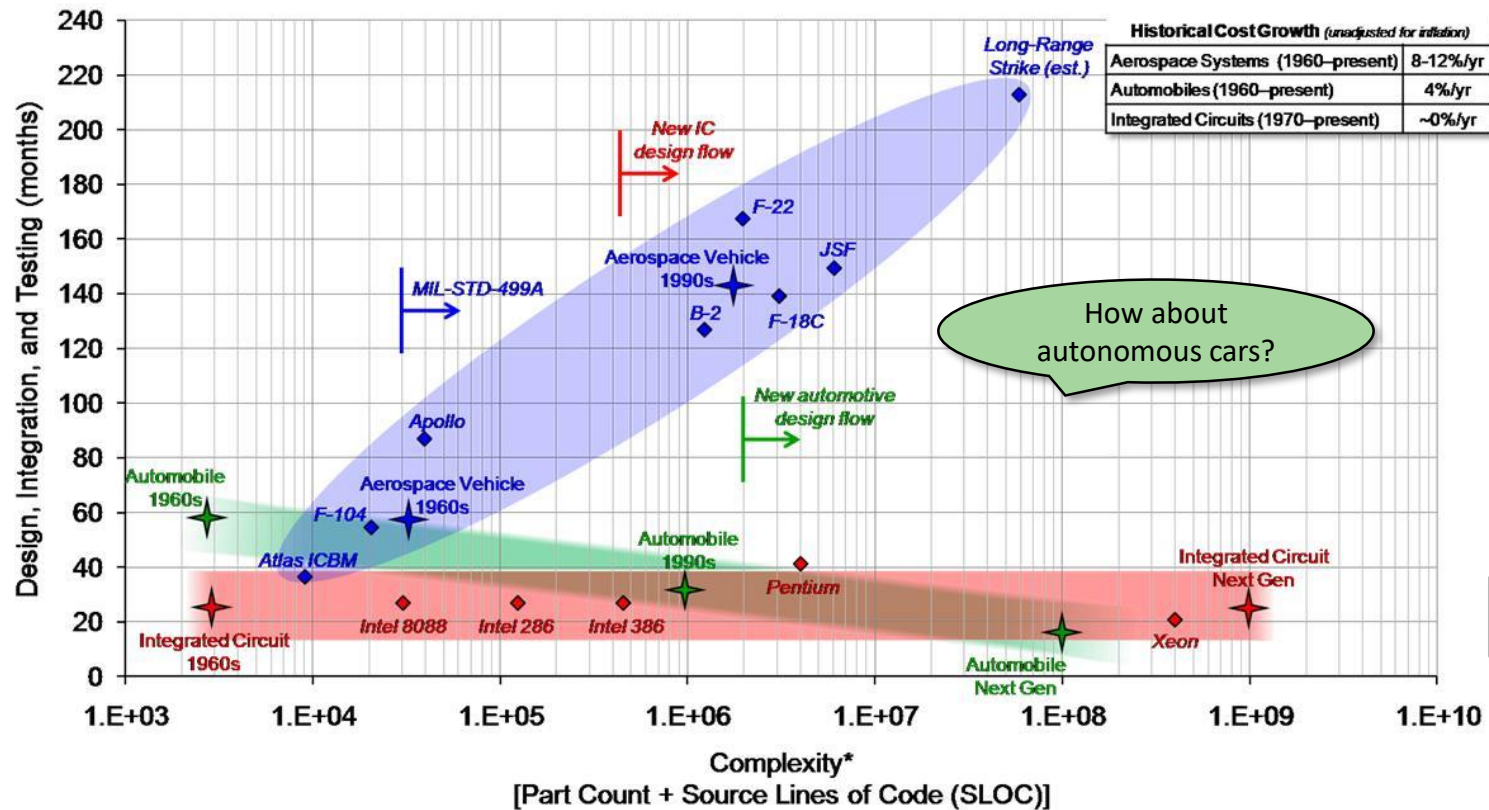
Execution Sequence



SMS Education Material

- MBSE High Level View for Newcomers
- Introduction to MBSE (*How We Explain MBSE without using the Traditional “V Model”*)
- MBSE Existing and Emerging Standards
- MBSE Deeper Dive
- Systems Engineering - *Challenges for Management*
- Systems Engineering – *Deployment Challenges*
- Digital Twin – *Its Role and structure within a modern Systems Engineering Approach* ✓
- MBSE Implications within the OEM/Supplier Community

Market Reality



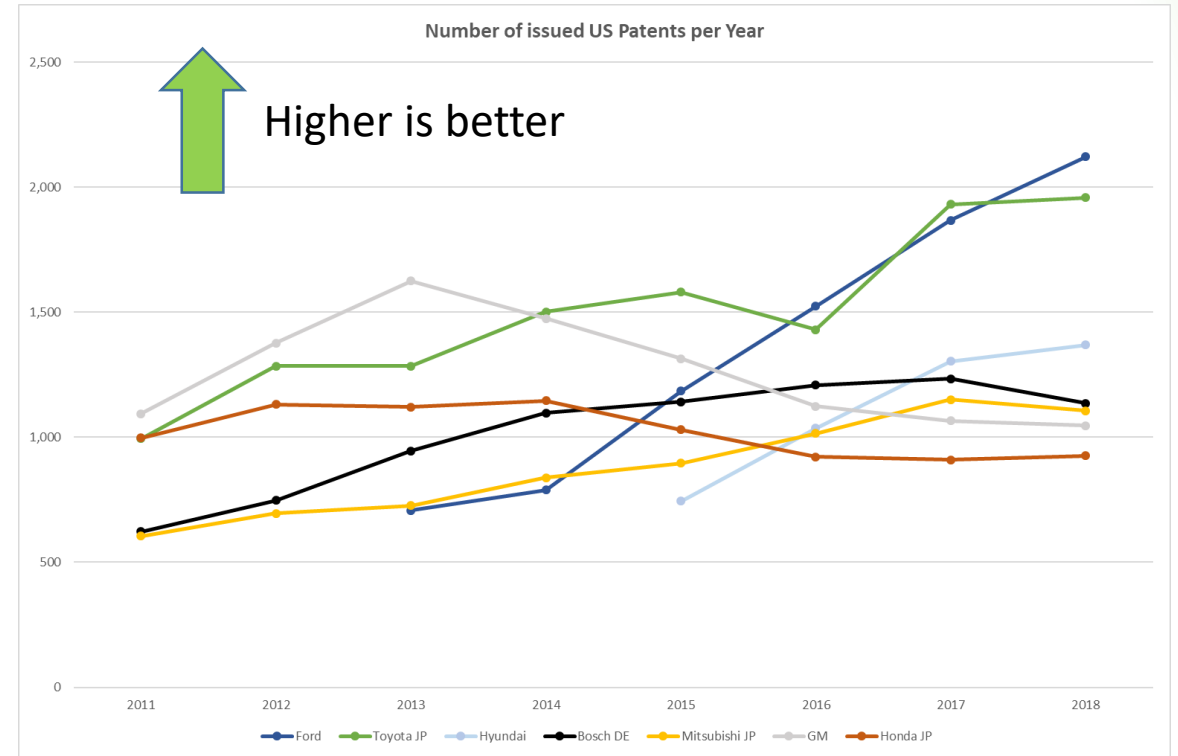
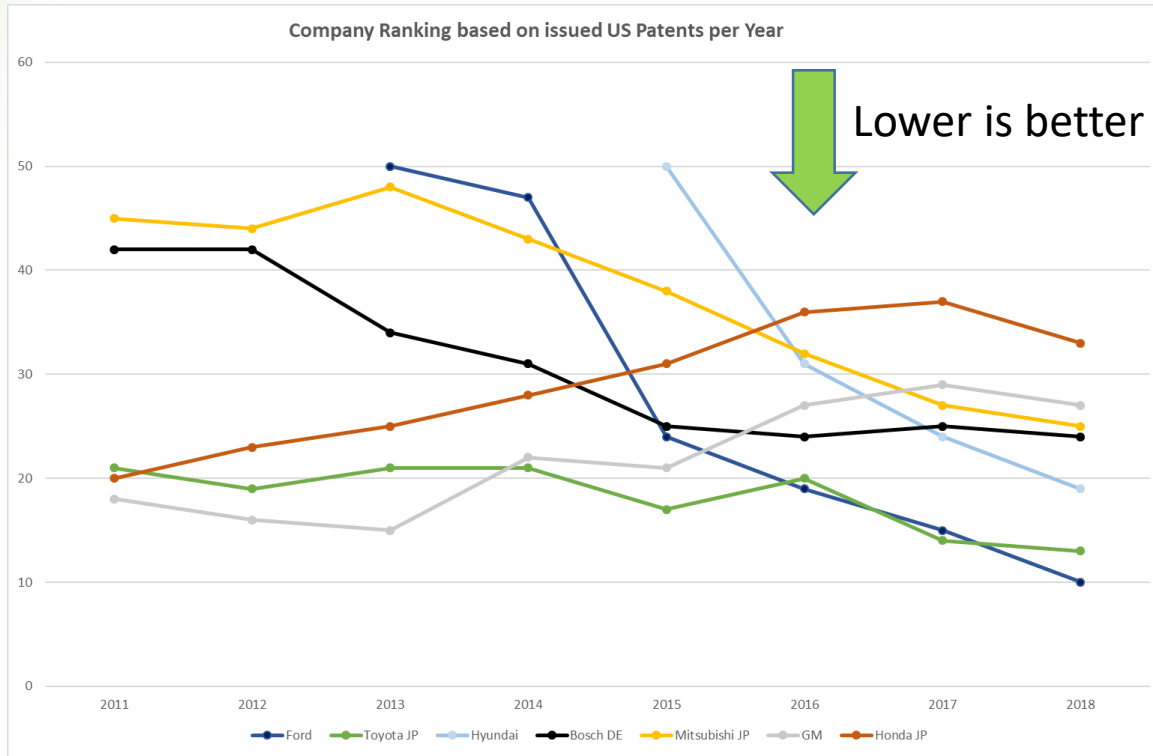
- System complexity increases
- Required time to market decreases (most industries)
- Without disruptive changes, an impossible equation to solve
- The main culprit: (embedded) software complexity



Is there a proper MBSE approach in place?

- How are the various industries performing currently?
- What are those companies say to market analysts?

Automotive Industry (Examples) – Patents*



- How about BMW? ... Mazda? ... JLR?
- Market Guidance for 2019
- Investments into autonomous driving technology
- Regional Influences

Evolution of Systems:

“Systems of Systems” are next in line for Providing Greater Engineering Challenges

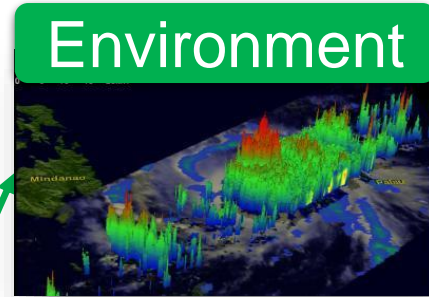
Product



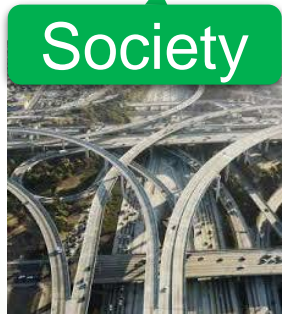
Nature



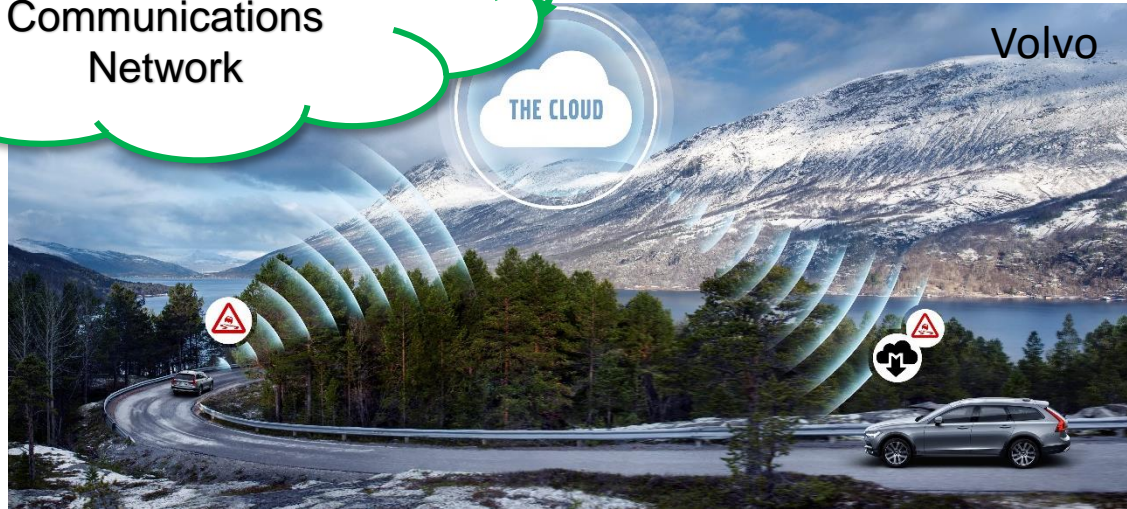
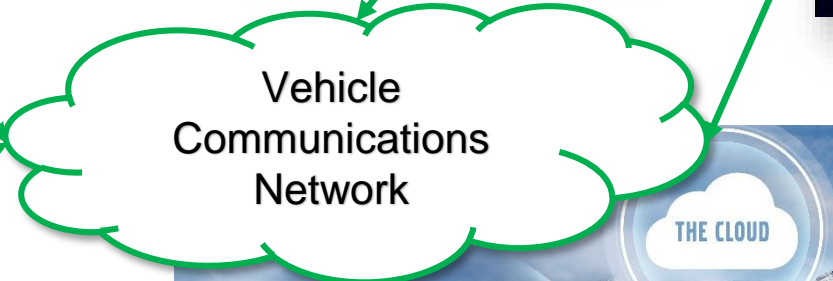
Space



Environment



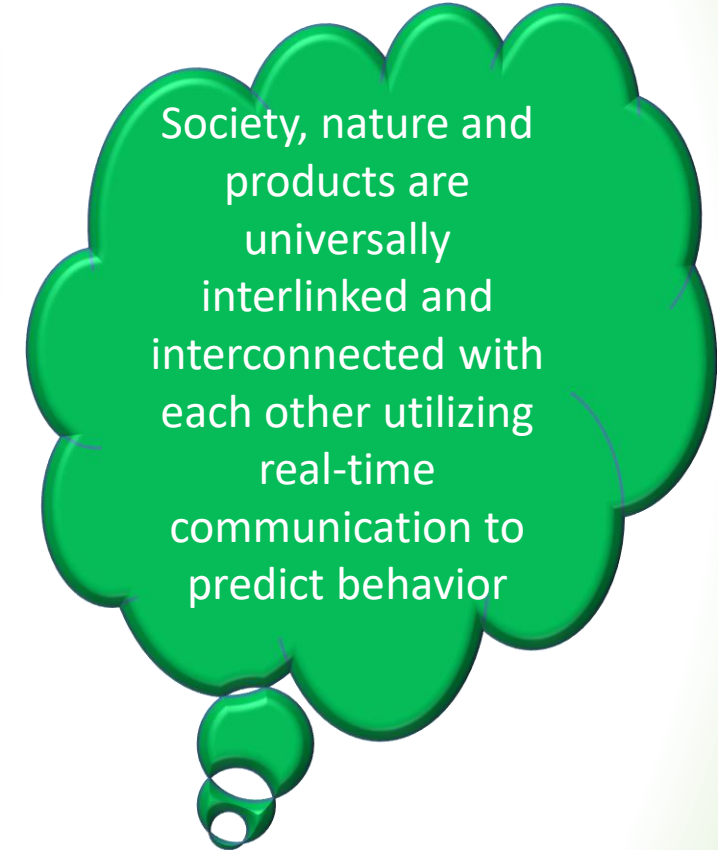
Society



Volvo

THE CLOUD

Process



Society, nature and products are universally interlinked and interconnected with each other utilizing real-time communication to predict behavior

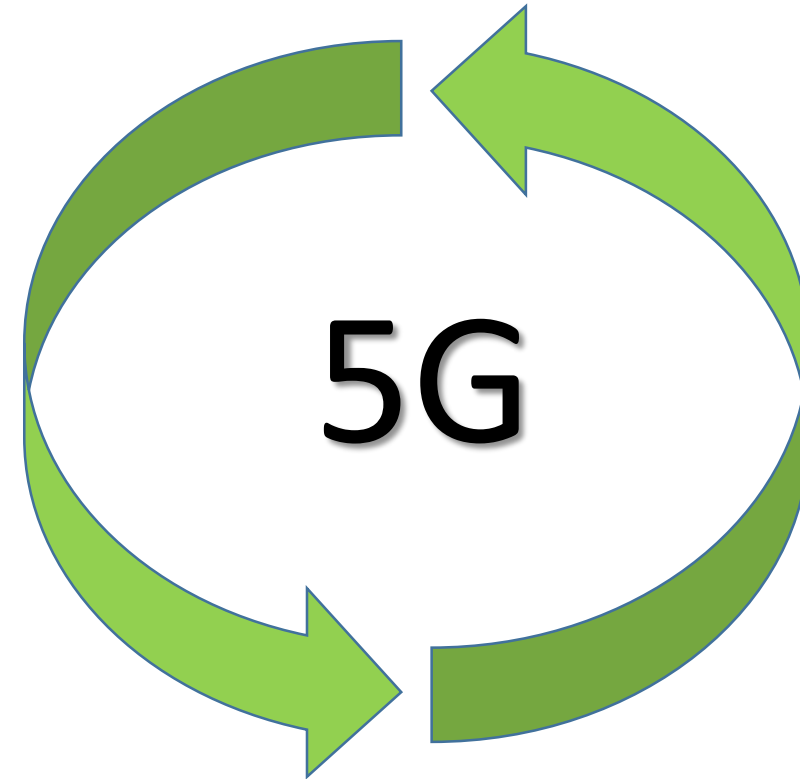
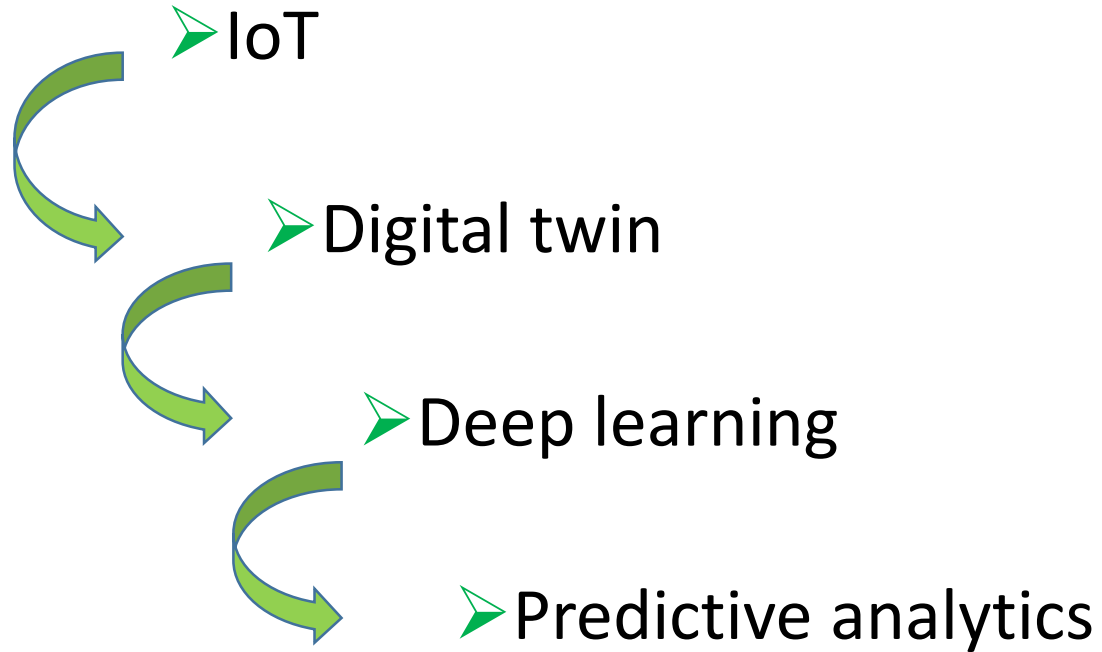
Reactive

Adaptive

Proactive

Cognitive

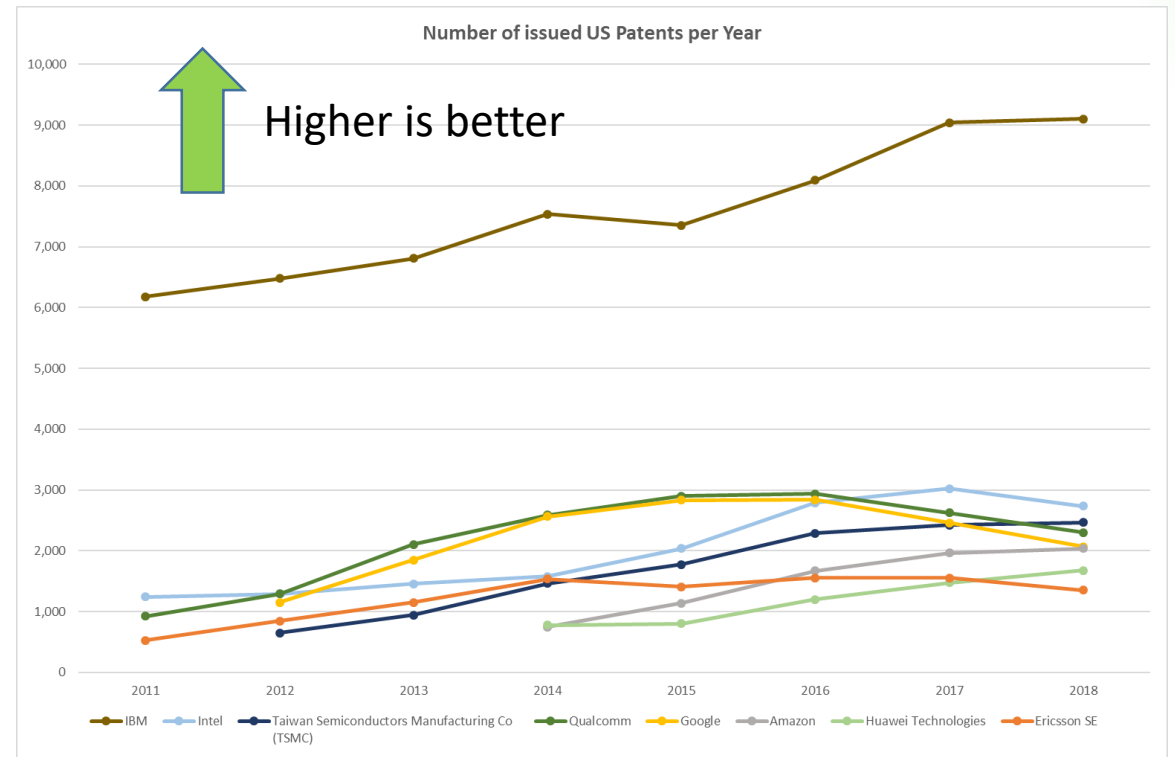
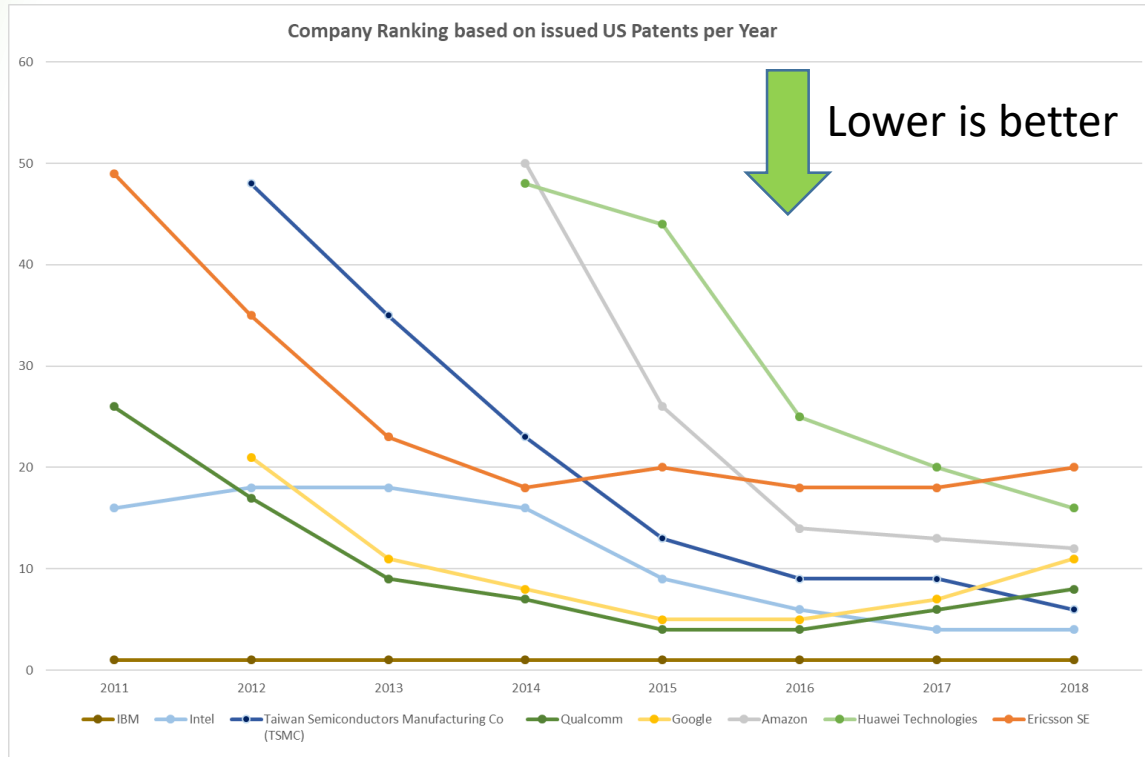
Cognitive Engineering / Ecosystem



Innovating at the Speed of Thought

- Close-looped systems
- Edge computing
- ...

Technology Industry (Examples) – Patents*



- Lots of new technology being developed
- Smaller past players appear on the stage of patent leaders
- Lots of it can be linked to the topic of “cognitive” technology as discussed on previous slide

Market Reality – additional *Talking Points*

- Aerospace
 - Boeing, GE, United Technologies, etc.
- Consumer Products
 - P&G, etc.
- Communication / Social Media Technology
 - Apple, Facebook, etc.

The Real Disruption: Culture

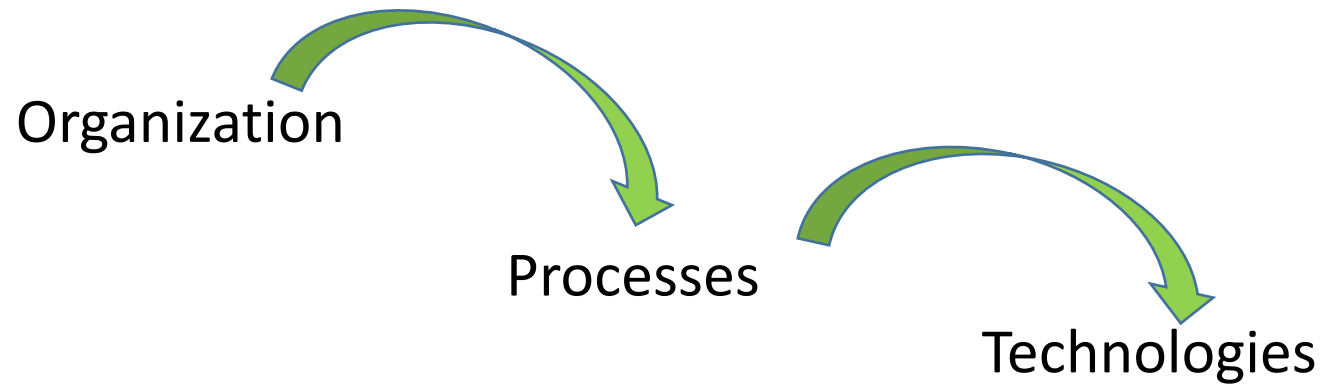
“If you went to bed last night as an industrial company, you’re going to wake up this morning as a software and analytics company”

-- Jeff Immelt
retired GE CEO



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Mature / Enhance

Be Disruptive

Break traditional walls

Think Holistically

Enabling Sustainable Innovation



New Frontiers

New Cultures

New Thinking

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