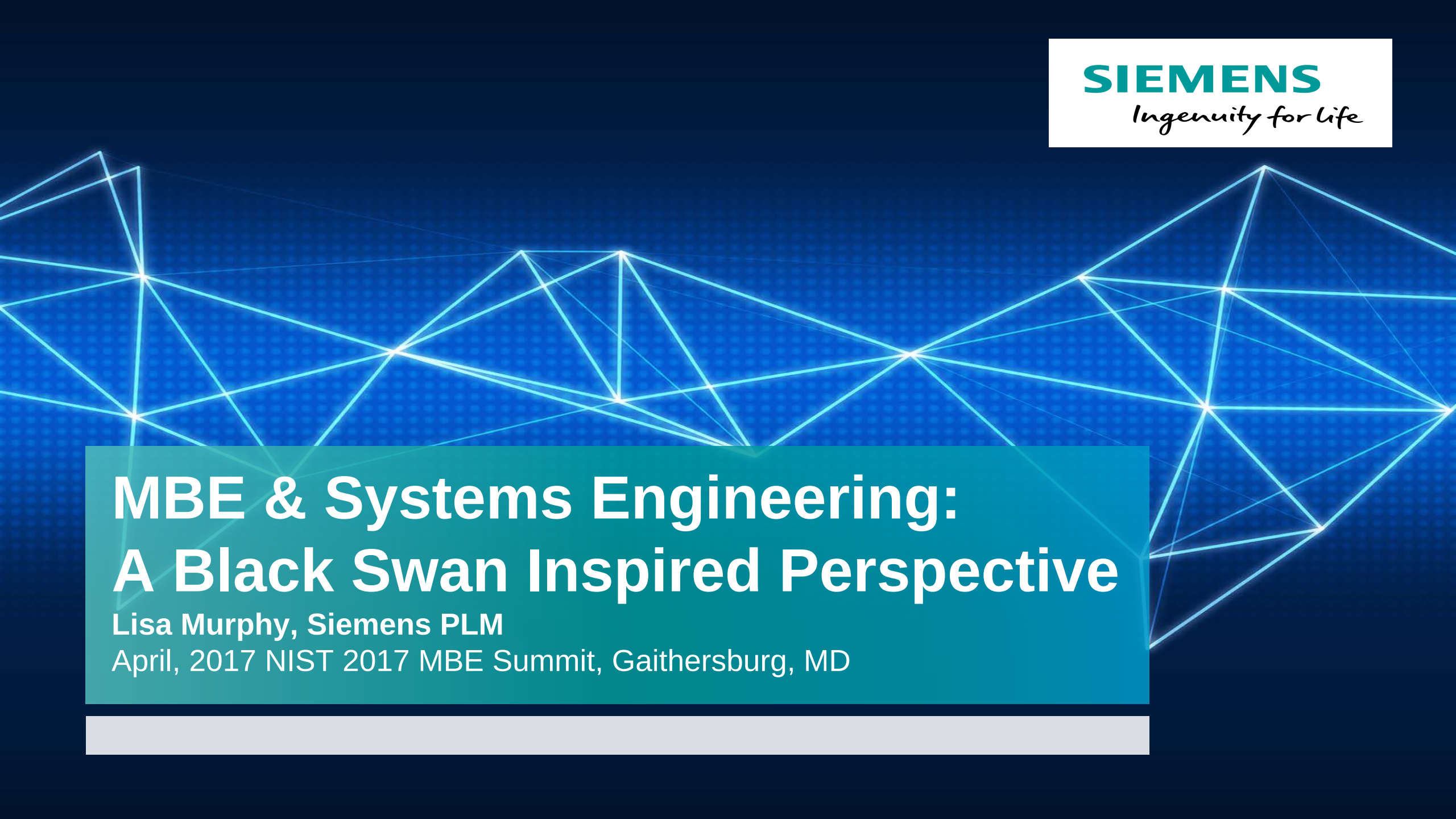

MBE & Systems Engineering: A Black Swan Inspired Perspective

Lisa Murphy, Siemens PLM

April, 2017 NIST 2017 MBE Summit, Gaithersburg, MD

What's Wrong With This Statement?

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"All toupées look fake; I've never seen one that I couldn't tell was fake." *

- This statement can only be said about bad toupées, not all toupées.
- Are there other times when we are subject to this cognitive bias?

* http://rationalwiki.org/wiki/Toupee_fallacy Accessed 17MAR2017

Silent Evidence: A Bias Toward Evidence We Can See

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Diagoras, a nonbeliever in the gods, was shown painted tablets bearing the portraits of some worshippers who prayed, then survived a subsequent shipwreck. The implication was that praying protects you from drowning.

Diagoras asked, "Where are the pictures of those who prayed, then drowned?"

Taleb, Nassim Nicholas (2010). *The Black Swan: The Impact of the Highly Improbable* (2 ed.). New York: Random House Publishing Group.

…and Against Evidence We Can't See

Result:

- Blindness about Truth
- Misunderstand Course of History
- Undervalue Paths Not Followed or Failures
- Believe Outcome We See Was More Probable, More Deterministic, Less Random (aka Lucky)

Why Does This Matter for MBE?

The Model Based Enterprise initiative began with a quest to define what it would take to support having an engineering design model bid (or rebid) with multiple suppliers. The result includes

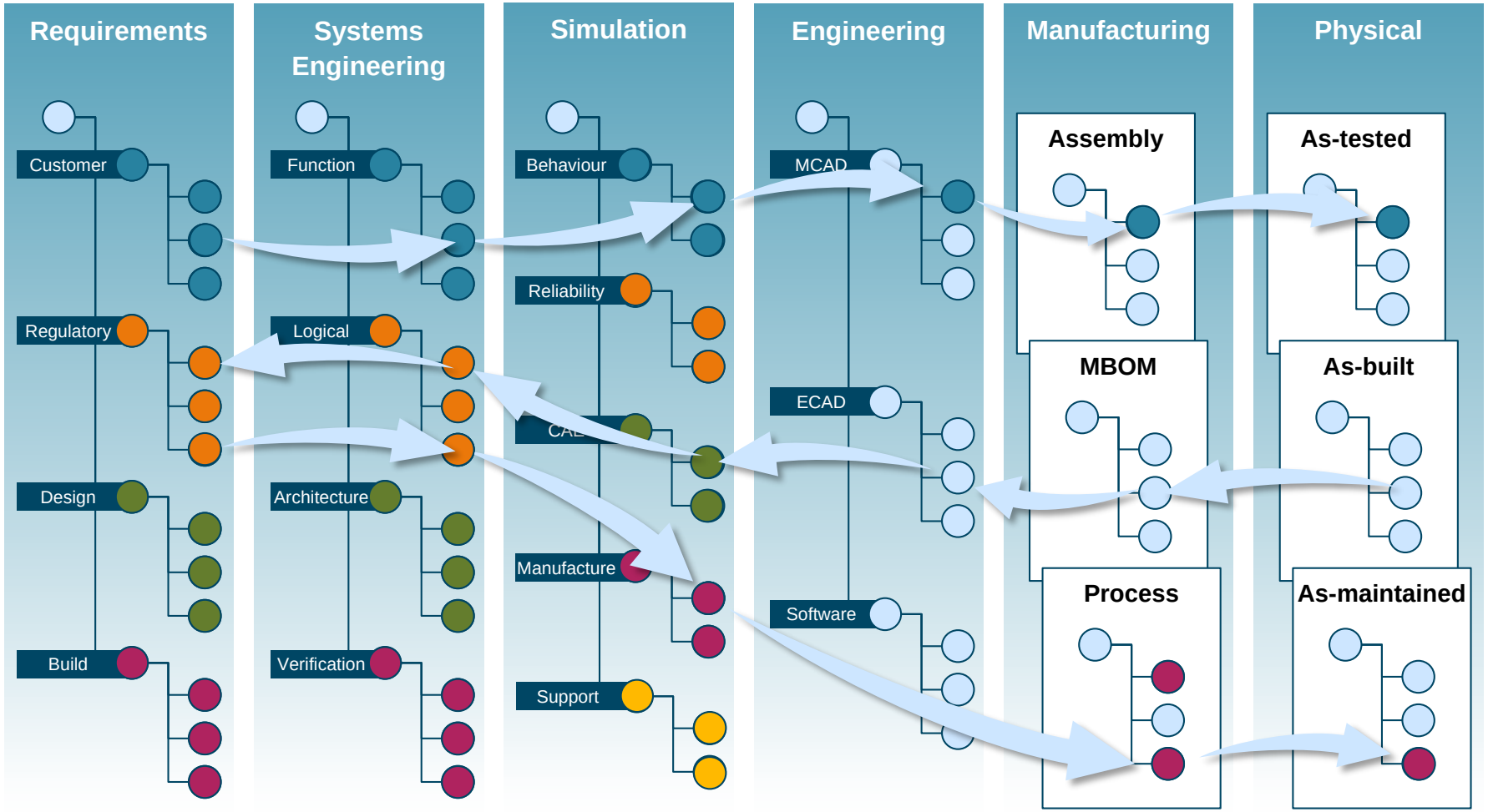
- Significant insight into the barriers experienced by 2nd & 3rd Tier Suppliers to using 3D CAD Model (vs. 2d Drawing):
  - To bid
  - In production (e.g. CNC)
  - For inspection
- Guidance for acquisition as well as users
- Metrics for progress to be MBE-capable
- …and more

At the time, NASA, not being a volume producer, was more concerned with how to share models in early development stages, particularly to support:

- Systems engineering, alternatives analysis, and operational scenario generation and validation
- Reduced data conversion for analyses, modeling, and simulations
- Faster and more accurate model integration, such as outer mold line
- Effective definition of interfaces (ICDs)
- Timely, valid, and cost effective test planning

…but this was NOT within the initial MBE scope.

Links Across the Lifecycle is the Digital Thread

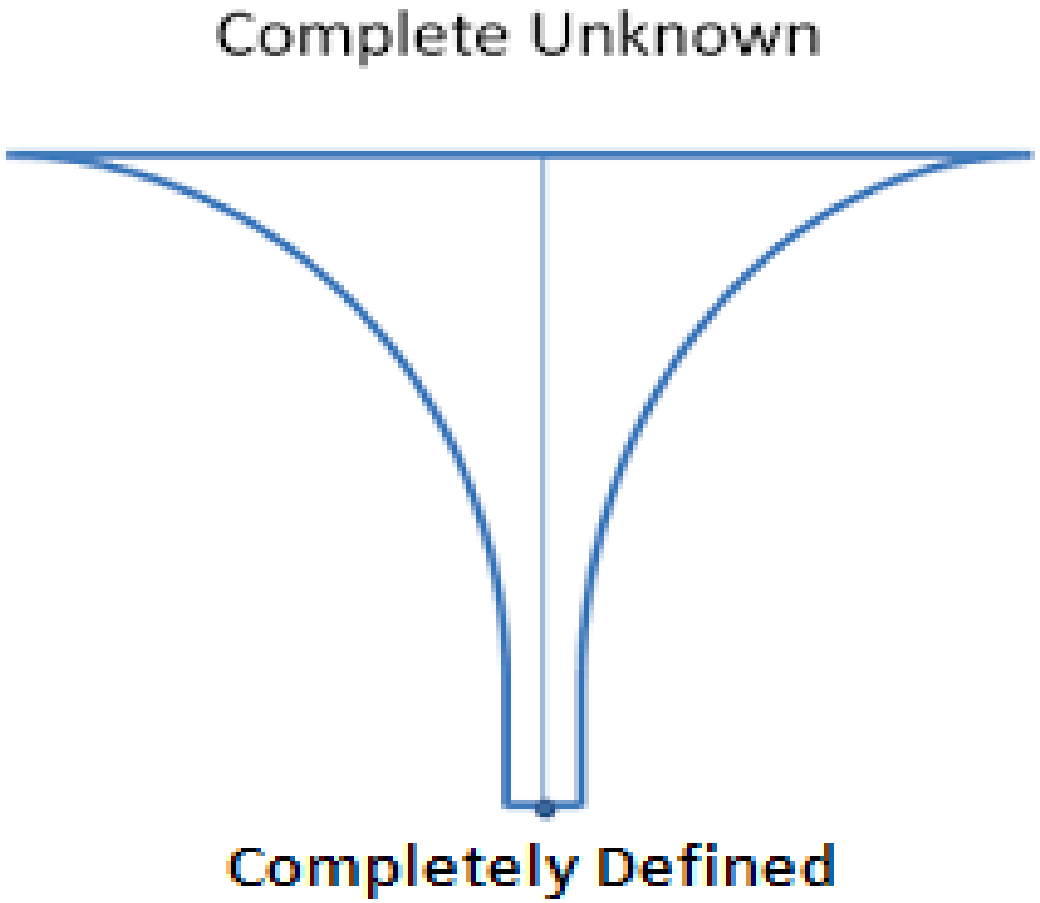


We can call it **a Digital Thread and not a Digital Tangle** because we filter out the Silent Evidence.

In paper world, design notebooks were often kept to capture key data and the resulting decisions. Less information was created, so less was kept.

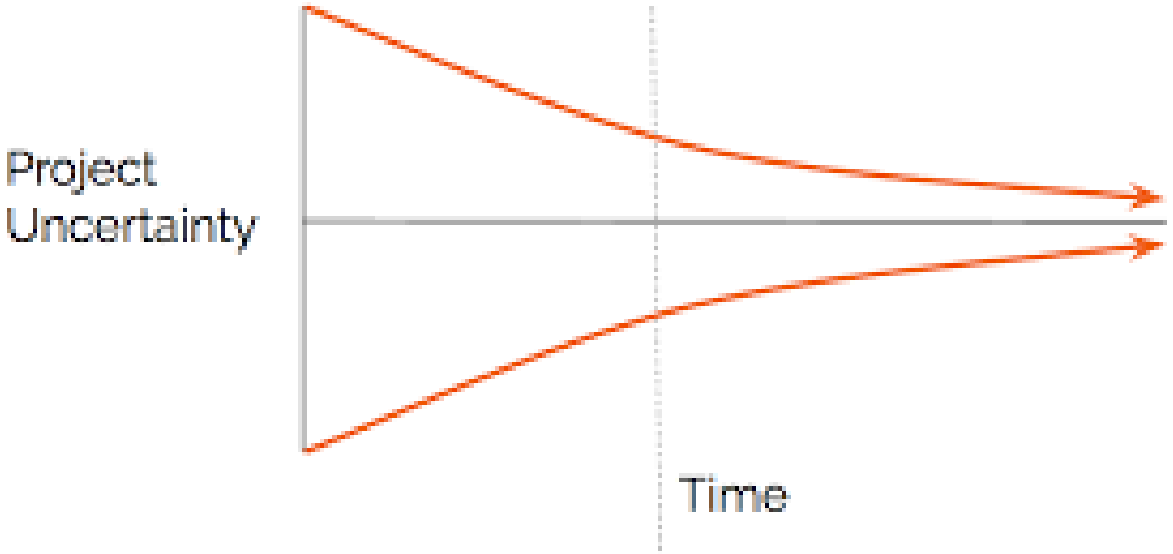
Today, it is very easy to create information. Disconnected from the context of their creation and use, what does it mean?

Factors that Make MBE Silent Evidence Significant



Product development is the process of going from abstract to concrete

Factors that Make MBE Silent Evidence Significant



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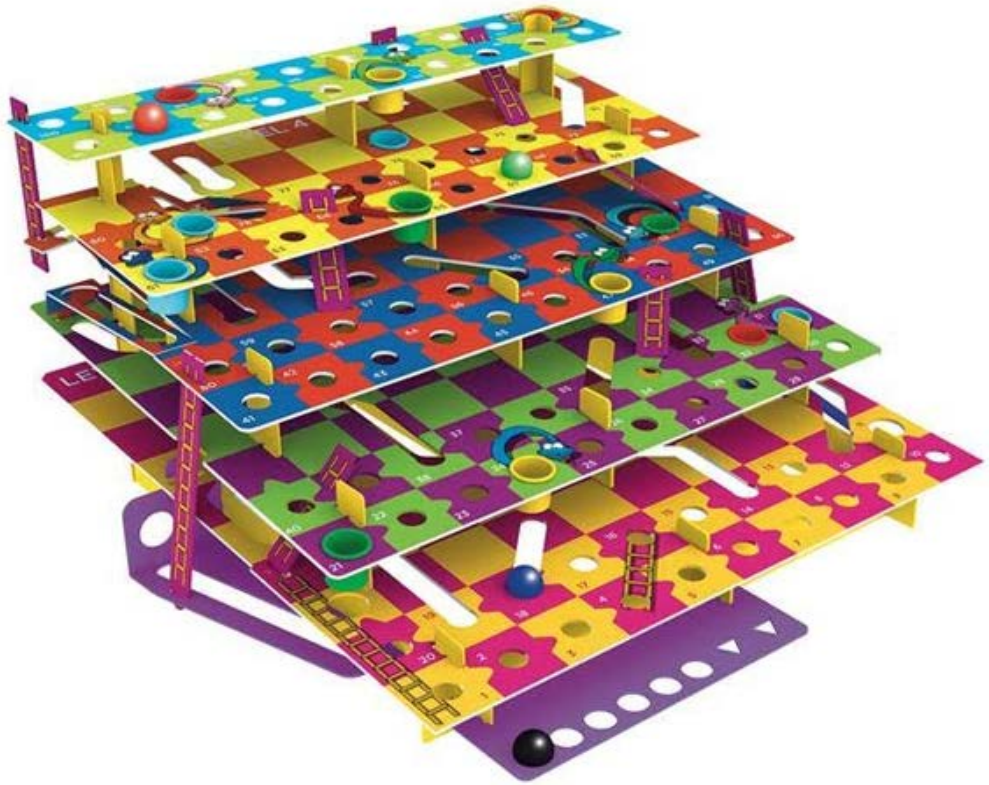

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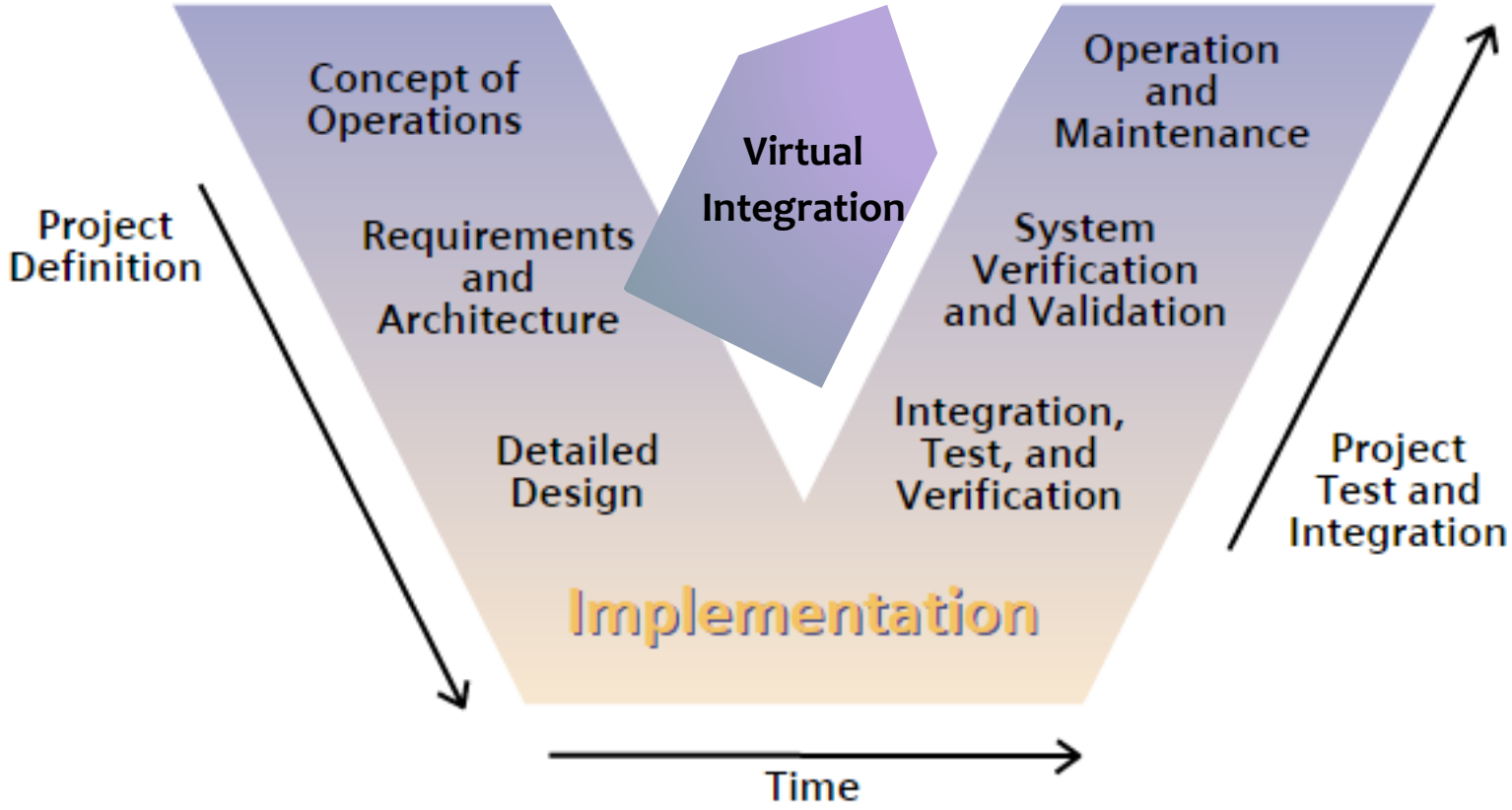
Development methods are seldom pure: stage-gate, concurrent, agile…most are a mix

Applying Integration Models in Systems Engineering



Airbus Helicopters

Use a unique LMS Imagine.Lab Amesim model throughout the V-cycle

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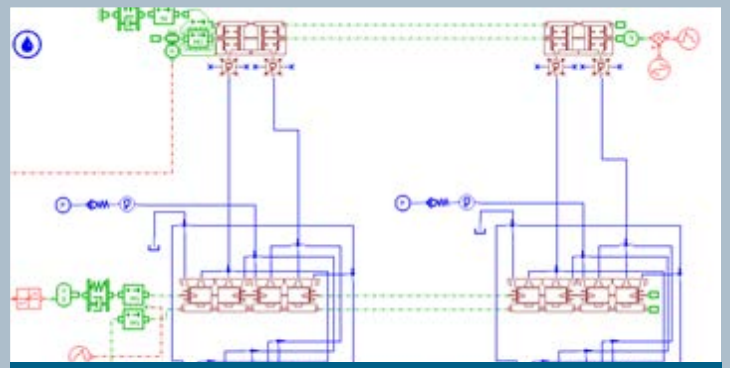
- **Enhanced model management and traceability**
- **Shortened hydraulic system optimization cycle by a factor of 3**
- **Decreased prototype costs by a factor of 4**
- **Avoided late delivery penalties**

From component and system engineering to real-time simulation



Dynamic analysis of hydraulic systems

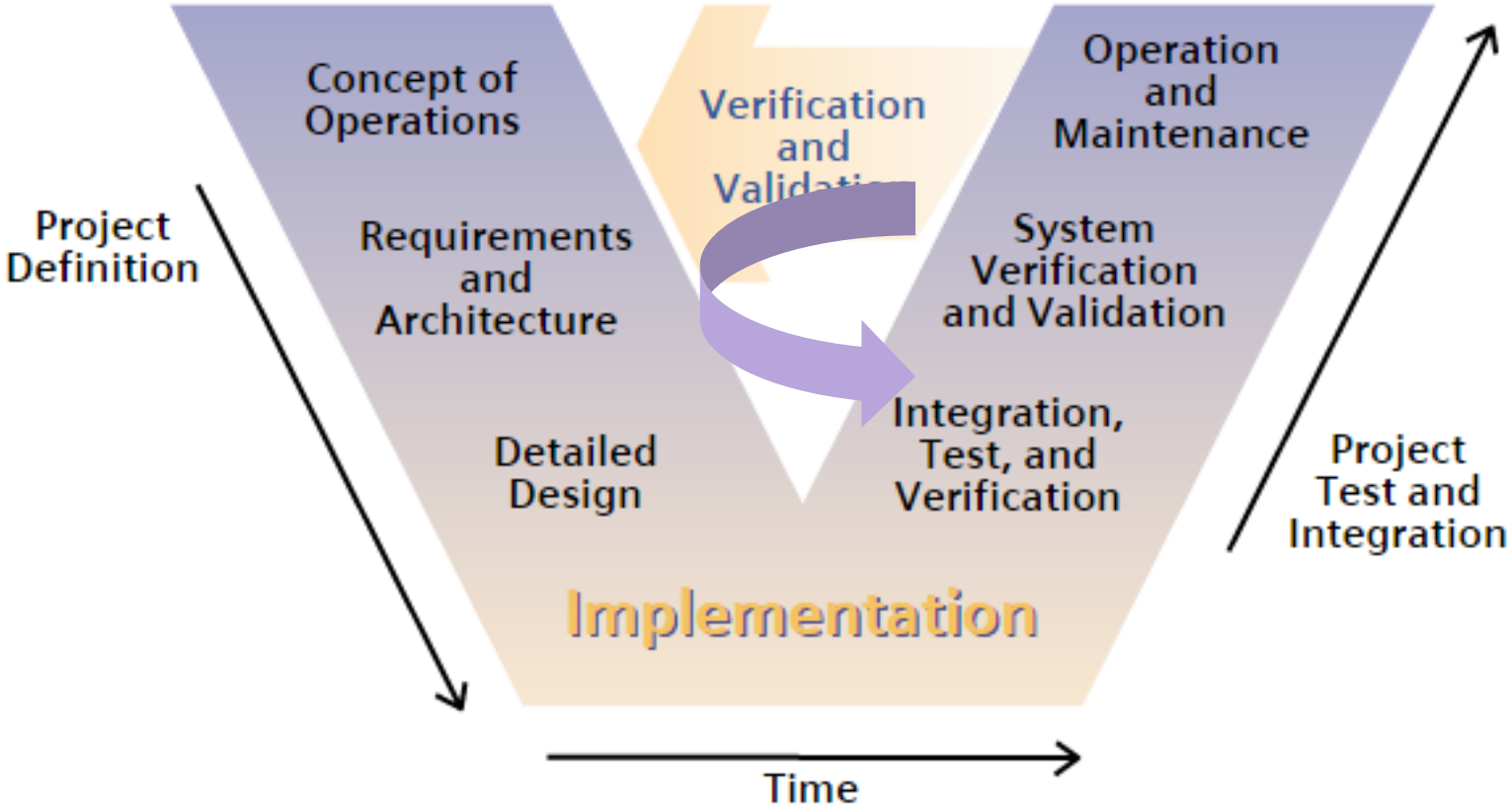
Real-time models for full flight simulators

- Analyze hydraulic system thermal dynamic behavior
- Ensure accuracy of plant and real-time hydraulics models
- Enhance flight simulators' fidelity prior to flight tests

"By using LMS Amesim for the hydraulic system design, we estimate that we have reduced optimization time by a factor of 3, and prototype costs by a factor of 4."

Thibaut Marger, Analysis and Simulation Specialist, Hydraulic and Flight Controls Department

Using Models to Support or Replace Physical Tests



Accelerate Verification
Virtual Testing Complements Physical Testing

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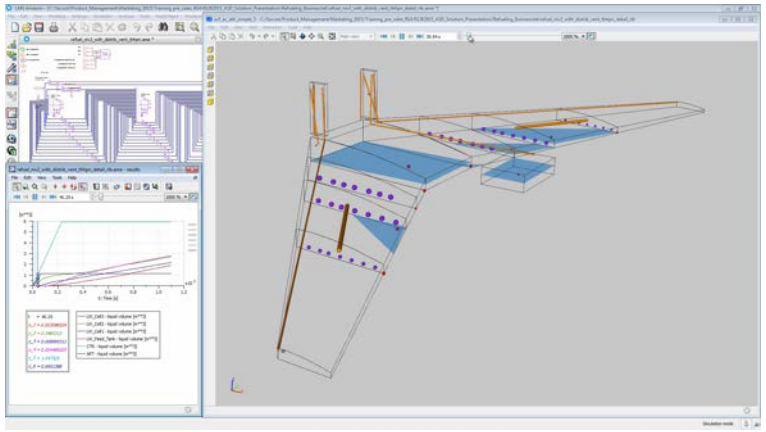
Complement Physical Test with Virtual Test: complementary approach accelerates AND gives more insight

Virtual FUEL Test Rig



Earlier Verification
Quicker & Safer Verification
Observe what you cannot measure
Simulate “the Physically Impossible”

Define Test Bench Configuration

Prepare Physical Test Campaign

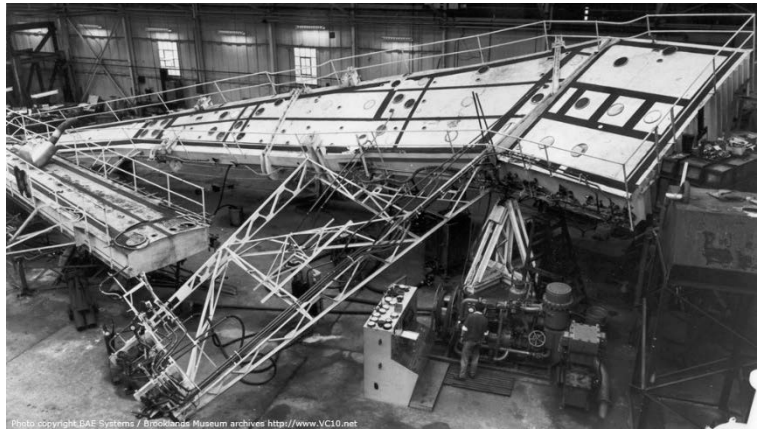
Validate Virtual Models

Verification Campaign

- Basic Load Cases
- Critical Load Cases
- Dangerous Cases
- Certification Cases

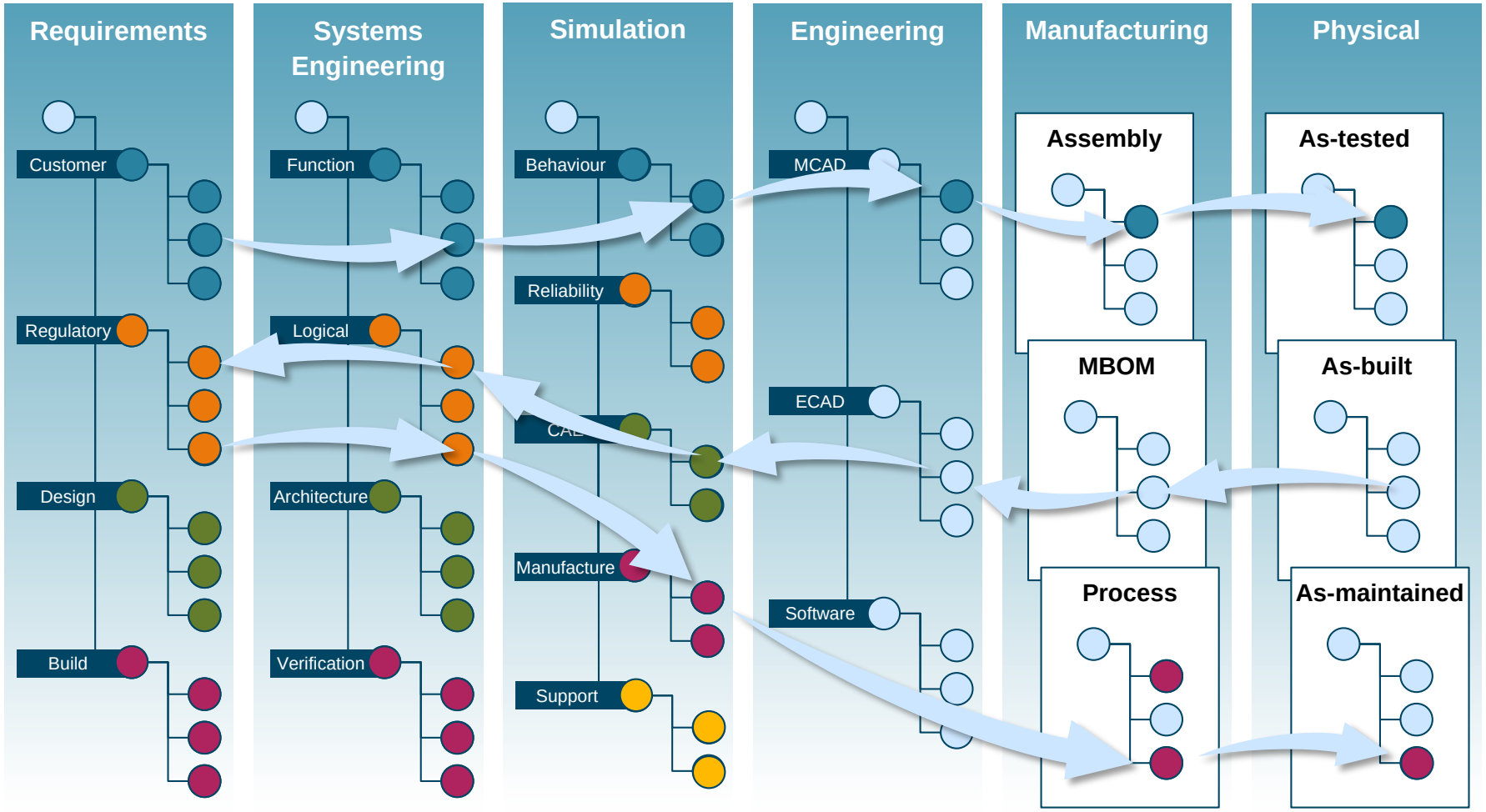
+ Reduced Cost
+ Reduced Risk
+ Faster & Safer

Physical FUEL Test Rig



Critical cases on Physical System
Increased Confidence
Limit to absolutely necessary
Certification Evidence

Digital Thread Looks Different Forward than Backward



Fallacy of Silent Evidence: It's Green, It's Linear, It's Direct
Reality: It Came From an N-Dimensional Rainbow

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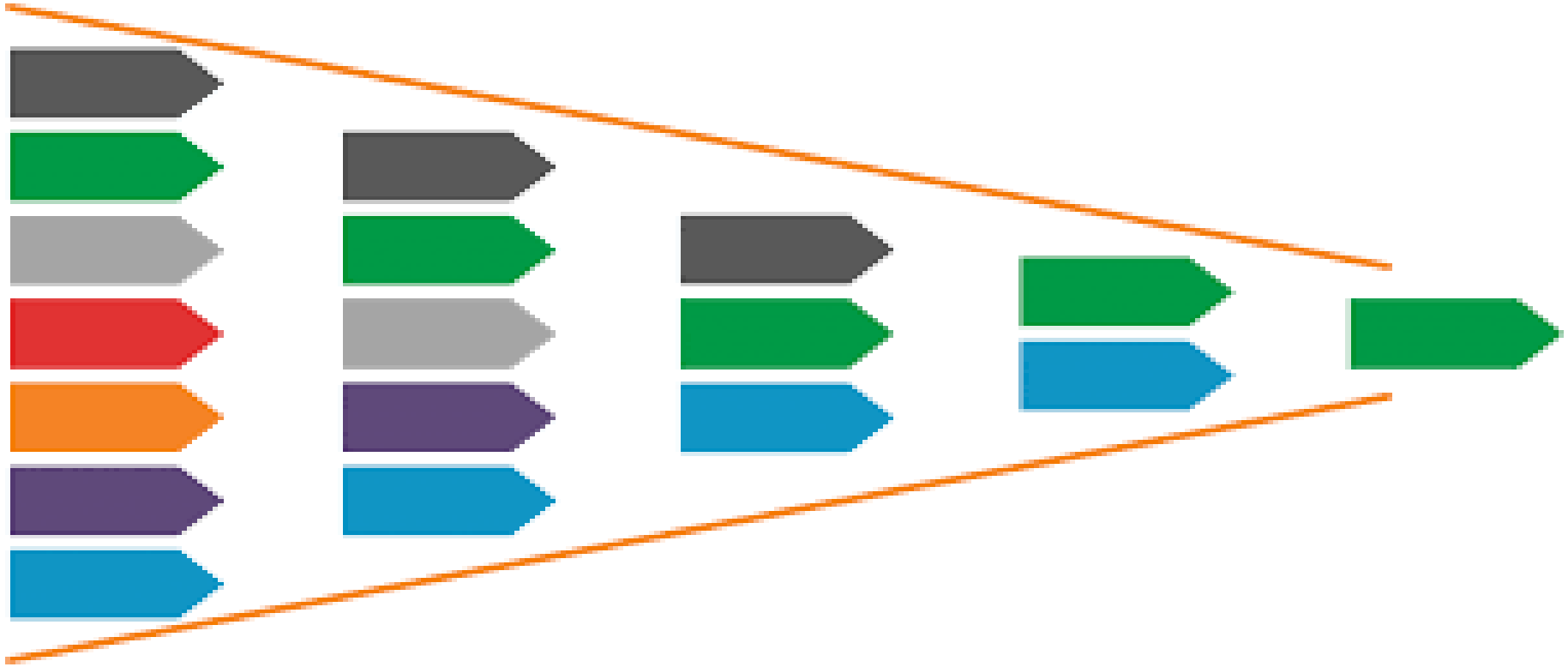

Questions & Thank you

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