Simulation Governance:
Managing Simulation as a Strategic Capability
February 11, 2016

Simulation Governance

Managing Simulation as a Strategic Capability

11 February 2016

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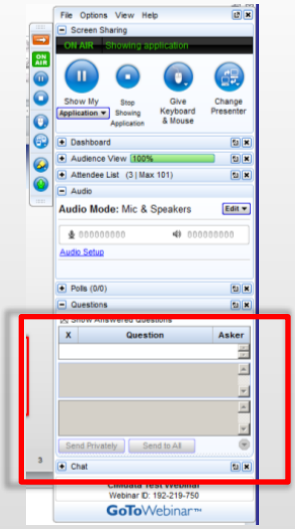
Questions?

Please use the GoToWebinar Question panel

- Please enter questions in the GoToWebinar Question panel
- We will answer as many questions as time allows…
- Those that can't be answered live will be answered by email



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Our Mission...

Strategic management consulting for competitive advantage in global markets

CIMdata is the leading independent global strategic management consulting and research authority focused exclusively on the PLM market.

We are dedicated to maximizing our clients' ability to design and deliver innovative products and services through the application of PLM.

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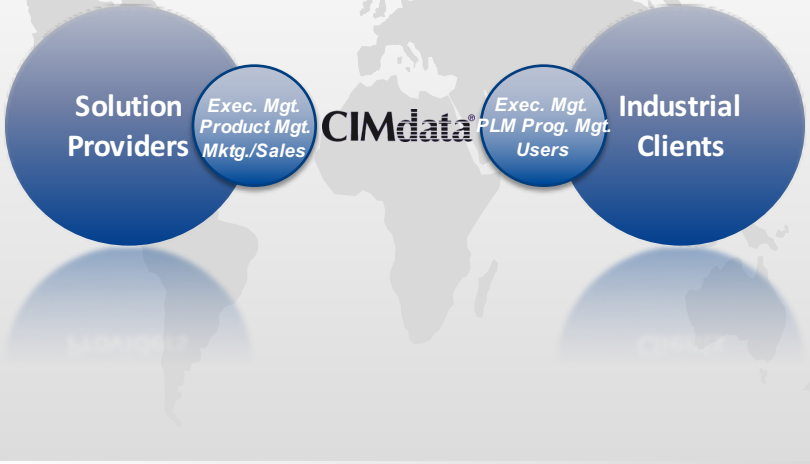
Our Role...

Our role in the PLM ecosystem—facilitating and energizing the PLM economy



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Executive Consultant, S&A

Professional background

- Dr. Keith Meintjes, Executive Consultant
  - Has led Simulation & Analysis research and consulting at CIMdata (CPDA, acquired 2011) since 2008
  - 29-years at GM included numerous positions of technical and strategic leadership
  - Responsible for GM's global strategy for high-performance computing
  - Champion of GM's CAE "Grand Challenge" initiative to improve simulation capability for all aspects of vehicle development
  - Engineering group manager for simulation at GM Powertrain
  - Part of a team to apply simulation tools for powertrain product development
  - Developed CFD tools for engine combustion
  - Ph.D. thesis (Princeton) on fluid flow simulations with combustion
  - Born in South Africa, holds B.Sc. and M.Sc. from U. of the Witwatersrand

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Key Takeaways

What are you going to learn?

- What are the forces and trends around simulation for product and manufacturing system development
- What is Simulation Governance?
- Which problems does it address?
- What should you do about it?
- Further resources

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Simulation Governance

What is it?

The strategic management of

simulation as a corporate competence

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The Rise of Scientific Computing

Moore's Law became a business imperative for computer makers

- Technical computing capability has been doubling every 18 months for the past 50 years
- The multiplying factor is 11 billion, the number of seconds in 340 years (Think: Engineering the Apollo program)
- In 10 years:
  - Your computers will be 100 time faster, and cost less
  - Your employee costs will double
- You must have a plan to leverage this!

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The Changing Nature of Product Engineering

Simulation is driving earlier and earlier into the development process

- Simulation is often faster and more reliable than prototyping
- Simulation is fast enough to influence CAD as it is being developed
- Engineering on the left side of the systems engineering "Vee" involves complex cross-domain tradeoffs
- Optimization and robust design methods are being much more widely used
- Product design and development decisions are increasingly based on simulation

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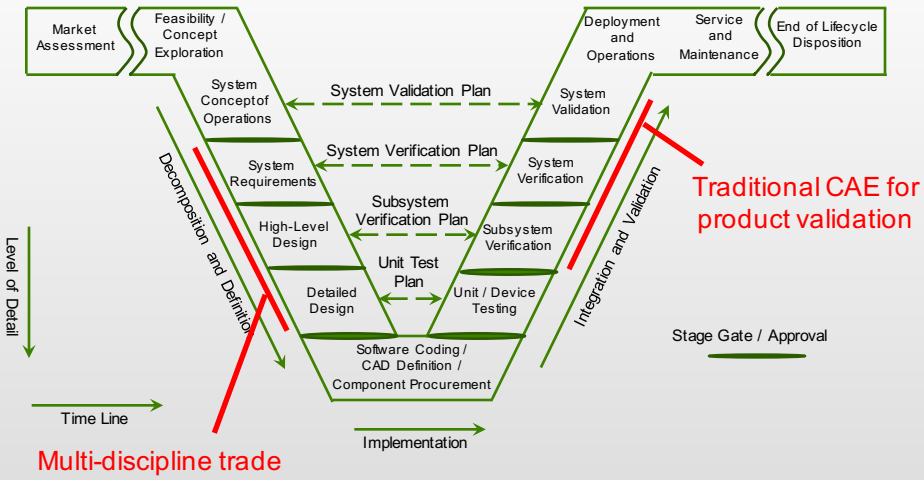
The Systems Engineering "Vee"

A hierarchy of abstractions supported by PLM



Adapted from: US Federal Highway Administration:
http://ops.fhwa.dot.gov/publications/seitsguide/
"Systems Engineering for Intelligent Transportation Systems"

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Simulation and the Systems Engineering "Vee"

How can simulation best be applied on each side?

- Right Side: Integration and Validation
  - Simulation applied to confirm and validate, an analog of physical testing
  - Extremely important, but now routine at many companies
  - Supported by knowledge capture, design templates, standard work, and many other tools
- Left Side: Simulation-Driven Design
  - Simulation applied during product ideation and concept selection
  - Simulation is being used to help define product architecture, before a commitment to detailed CAD component design
  - We need geometry for simulation, we need design for simulation

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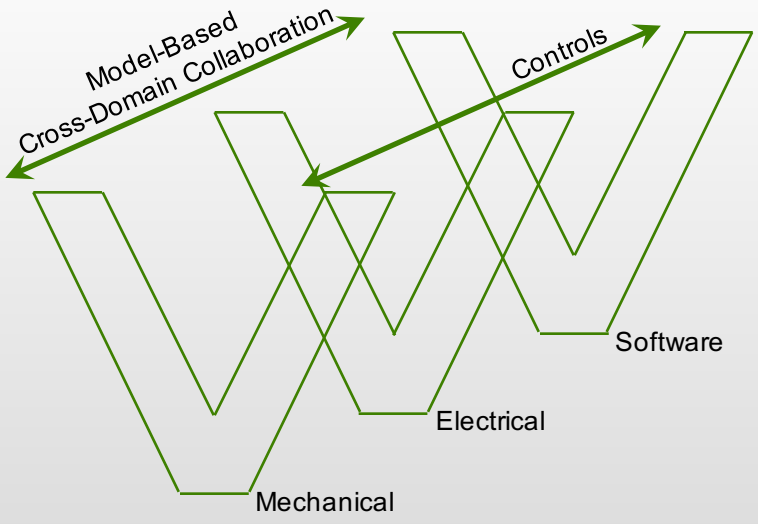
Concurrent Development

Enabling collaboration and managing complexity



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The Need for Simulation Governance

Companies are not realizing the true potential of simulation

- Simulation is not "trusted"
- Simulation is not embedded in their engineering process
- Simulation drives physical testing for confirmation
- Companies do not have confidence in their capability for simulation, and are not working to improve that confidence
- Product development gate reviews focus on readiness to fund manufacturing capacity, not on product performance
- There is insufficient understanding of how simulation can contribute to product development

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Simulation Governance

Simulation Capability as a Strategic Competence

- Reliance on simulation brings new elements of risk
- How do we assure accuracy, reliability and quality?
- Simulation Governance is a strategy to manage and develop simulation capability at all levels:
  - Understanding by CxO executive leaders
  - Communication throughout the organization
  - Development of technical competence
  - Best practices, standard work, and quality assurance
  - Verification, validation, and uncertainty quantification (VV&UQ)
  - Integration in the product and manufacturing development processes
- Simulation is often not simply an analog of some other element of your PLM strategy

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Establish a Structure for Simulation Governance

Finding a way forward

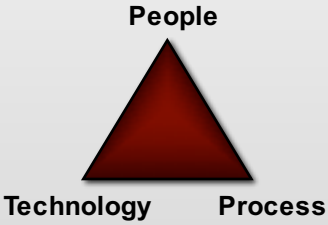
- Executive management needs to set strategy and expectations
- Technical teams should define and develop capability
- Simulation proactively needs to be part of how engineering gets done
- Manage education, training and cultural change to create understanding, especially with a new structure
- This is not something the simulation community can accomplish on their own—they need (to enlist) management support

It's not just about simulation
It's how you best do engineering

People, Process, and Technology

It's not just the tools!

- Technology ("software") is often seen as the (easy) choice
- Process ("language") is more important, and should be a focus
- People and organization ("culture") constitute the biggest challenge
- Decisions must be owned, shared, and bought into



A Maturity Scale for Simulation Capability

A 5-point scale, inspired by CMM

- Level 1: Simulation has some capability, but is not useful
- Level 2: Simulation can be used to sort, but not select, alternatives
- Level 3: Simulation is predictive, but requires physical testing to calibrate models
- Level 4: Simulation is predictive, confirmation testing is required
- Level 5: Simulation is predictive, no confirmation tests are required

Product validation and compliance must always be done!

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A Maturity Scale for Simulation Capability

Add Level 0, to show that Levels 0 and 1 are results of an assessment

- Level 0: Simulation has no capability
- Level 1: Simulation has some capability, but is not useful
- Level 2: Simulation can be used to sort, but not select, alternatives
- Level 3: Simulation is predictive, but requires physical testing to calibrate models
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- Level 5: Simulation is predictive, no confirmation tests are required

This scale is applied to each specific simulation load case

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A Maturity Scale for Simulation Capability

Add Level 6, which cannot be achieved by test alone

- Level 0: Simulation has no capability
- Level 1: Simulation has some capability, but is not useful
- Level 2: Simulation can be used to sort, but not select, alternatives
- Level 3: Simulation is predictive, but requires physical testing to calibrate models
- Level 4: Simulation is predictive, confirmation testing is required
- Level 5: Simulation is predictive, no confirmation tests are required
- Level 6: Simulation is more capable than test (Six Sigma, robust design, stochastics, optimization, …)

Automobile & commercial aircraft OEMs are at Levels 3 - 6

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Improving Simulation Capability

A roadmap on what to do

- Assess: Can simulation address a product requirement?
- Write a standard work procedure (for each load case)
- Assess capability through consensus of analysis, test, and design-responsible engineers
- Validate and confirm capability
- Standardize and automate procedures so they are reliable, repeatable, and robust
- Adopt a process for continuous improvement: Close the loop with testing and validation
- Embed optimization and robust design

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Verification & Validation

Paying attention to the details

- Solving the correct equations
- Solving the equations correctly
- Each organization needs to develop procedures and best practices to raise their confidence and competence
- Can rely partly on commercial software suppliers for the validity of the solution methods
- Nonetheless, V&V can become a black hole and an impediment
- Focus on the best way to do engineering, not only on simulation

Simulation & Test

They are essential companions

- The purpose of simulation is not to reduce (or eliminate) testing
- The purpose is to establish better first-time product capability
- As you improve simulation capability, the nature of testing will change
- Like a test, a simulation is a learning cycle
- You must still do proper validation and confirmation

"A world-class simulation capability must be accompanied by a world-class test capability"
(James Welton, General Motors)

Requirements/Roadmap Plan Structure

The five key areas to be addressed in a tactical plan

- Simulation Governance
  - Manage simulation consistently and at all levels
- Simulation Technology
  - Plan and procure technology resources for simulation
- Simulation Process
  - Make simulation repeatable, reliable, and robust
- Simulation Data Management
  - Manage data and intellectual property for simulation users and customers
- IT Support
  - Provide day to day IT operations support

Summary

What you have heard

- The capability for technical computing continues to improve
- The nature of product development is changing
- Companies are not effectively leveraging their simulation capability and potential
- Simulation Governance is a strategy to manage and develop simulation as a core competence
- A framework to implement Simulation Governance has been described

Market Trends & Observations

Increasing emphasis on Model-Driven Systems Design & Development…early and often

- Advances in technology (both software tools & computing infrastructure) enabling model-based engineering strategy
  - Technology advances continue to provide more value for users of both simulation/analysis and systems engineering tools
- Major providers racing to create, acquire & consolidate MBSE & S&A capabilities deployed across entire lifecycle "V" (from requirements to retirement) and across the physical/logical domain boundaries to enable MBE/MBSE/MBD/MBx
  - ANSYS, Altair, Dassault, ESI, IBM, Siemens PLM, PTC expanding MBE portfolios
  - Other major players investing in MBSE/MBE- SAP, Oracle, Mentor Graphics

Major barriers to greater adoption of MBSE/S&A to realize higher ROI are in the areas of organization, people & process

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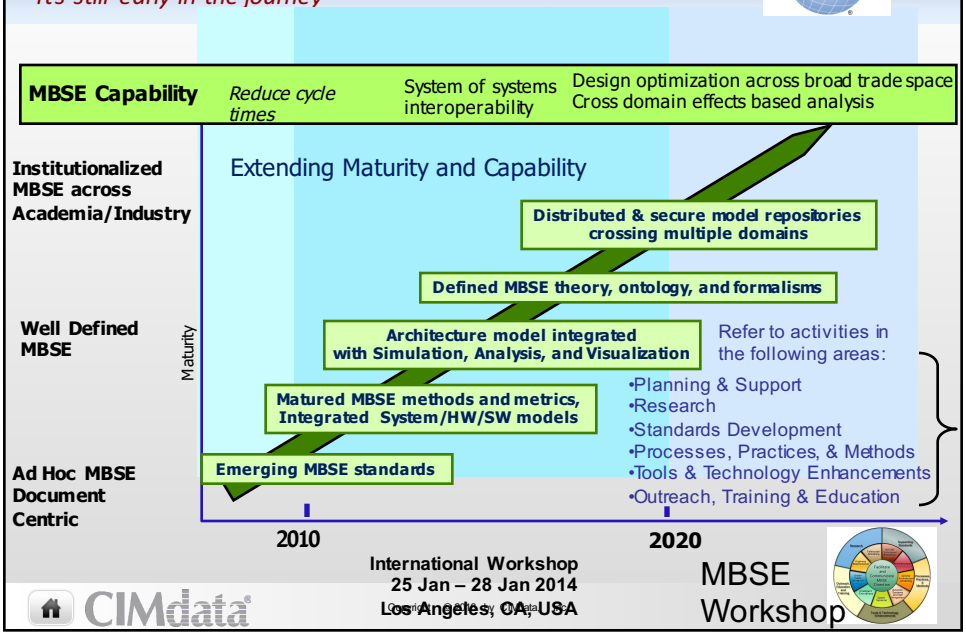
INCOSE MBSE Road Map

It's still early in the journey



Simulation-Driven Systems Development

Professional background

- Donald Tolle, Director
  - 35+ years of experience in the definition, development and implementation of simulation driven engineering solutions
  - Directs the activities of the combined SE and S&A Councils
  - Participates in and manages CIMdata involvement in MBSE/S&A consulting programs leveraging the knowledge and expertise of all CIMdata staff
  - Consulting background with companies across many industries (aerospace, defense, auto, consumer, medical products, heavy equipment, high-tech)
  - Experience in creating & applying maturity models and benefits/metrics/ROI modeling to business initiatives involving PLM/MBE technologies
  - Held senior positions in business/product strategy, M&A, product R&D, product management, marketing and engineering consulting with PLM solutions & services providers (SDRC, UGS/Siemens PLM, Comet Solutions)
  - B.S. in Mechanical Engineering & Master in Business Administration
  - Post-graduate programs in Product Management, Mergers & Acquisitions

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CIMdata's Simulation-Driven Systems Development Practice

Moving the Systems Modeling & Simulation community forward

- Merged the previously separate Simulation & Analysis and Systems Engineering Knowledge Practices into one (SDSD)
- *The merged SDSD Council reflects the cross-industry focus on the ever-expanding intersection of emerging model-based SE methods and technologies with functional systems modeling and simulation tools and best practices required to enable the effective simulation-driven development of today's complex cyber-physical systems.*
- *The Practice will research and publicize market trends, technology gaps, implementation issues and help define best practices & standards for integrating data, processes and tools across currently fragmented engineering disciplines of mechanical, embedded software, controls and electronics as well as related business functions such as requirements traceability, FMEA and reliability.*

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CIMdata Collaboration With NAFEMS

Moving the Systems Modeling & Simulation community forward

- CIMdata SDSD Council Workshop: April 27, Troy, MI
  - Hosted and promoted jointly with the NAFEMS North America team
  - Industry speakers as well as group discussion & Council working session
    - Including representatives from NAFEMS SMS WG, INCOSE and Modelica Association
- NAFEMS Automotive Industry Seminar: April 28, Troy, MI
  - CIMdata and NAFEMS North America will sponsor the reception on the evening of April 27 for those attending either or both events
  - Events will both be held at the MSU Management Engineering Center (MEC)
- To register for one or both events, go to:

  http://www.cimdata.com/en/education/knowledge-council-workshops/sdsd-workshop-2016

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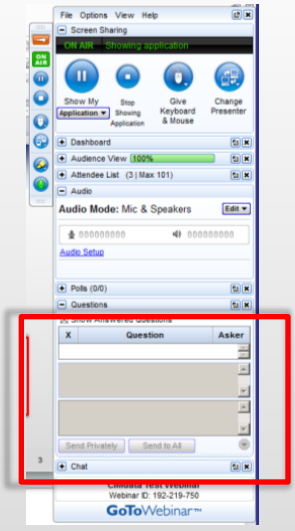

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CIMdata's 2016 Webinar Series

Moving the PLM community forward

- Jan 14: Developing a Sustainable PLM Strategy
  Peter Bilello
- Feb 11: Simulation Governance: Managing Simulation as a Strategic Capability
  Keith Meintjes
- Mar 10: IoT – Hype or Value?
  Laila Hirr
- … http://www.cimdata.com/en/education/educational-webinars

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