

ASSESS 

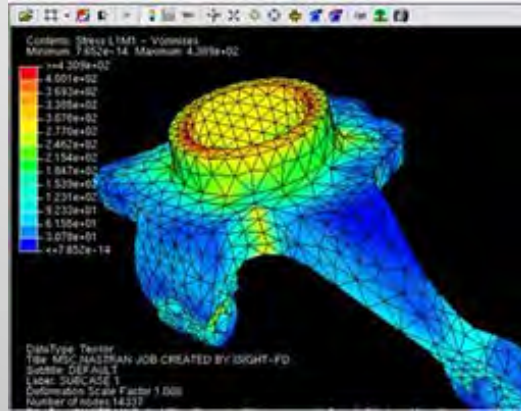
**Understanding and Enabling
the Simulation Revolution**

Understanding the Simulation Revolution



Understanding the Simulation Revolution

Business Value



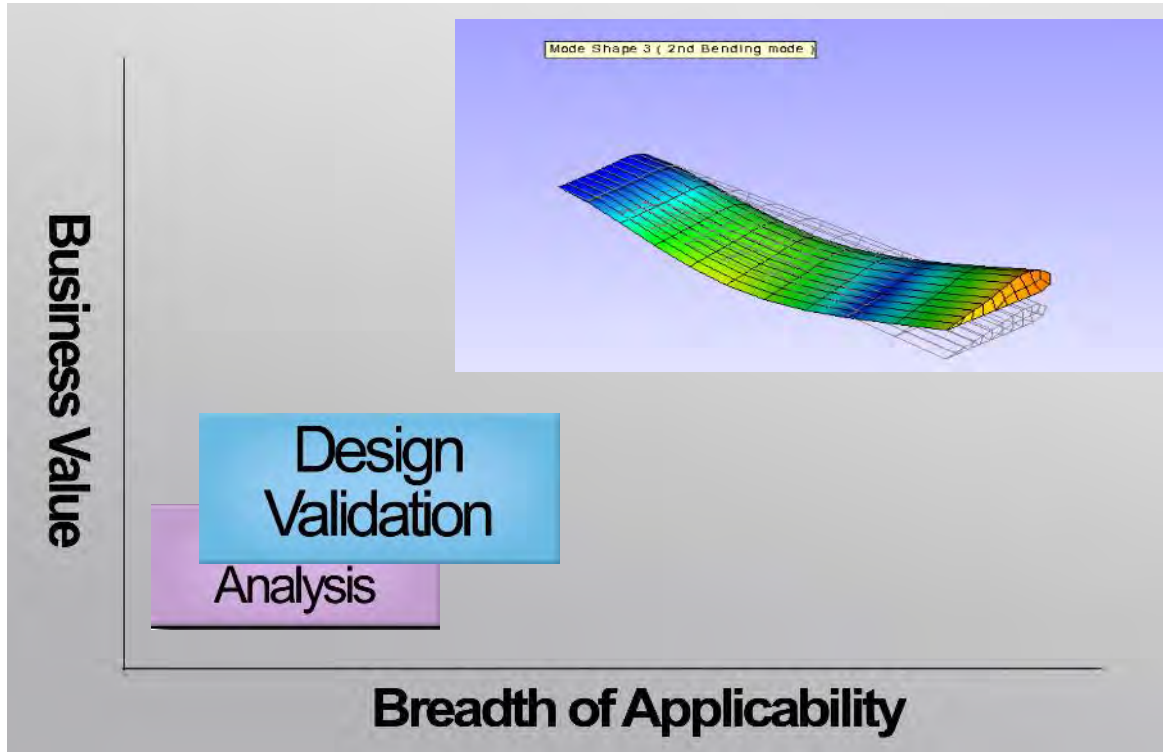
Failure Analysis

Breadth of Applicability

- **Failure Analysis**
- This is where simulation begins
 - Understanding “why it failed”
- Run by a few “experts”
- Dominated by test vs analysis comparisons

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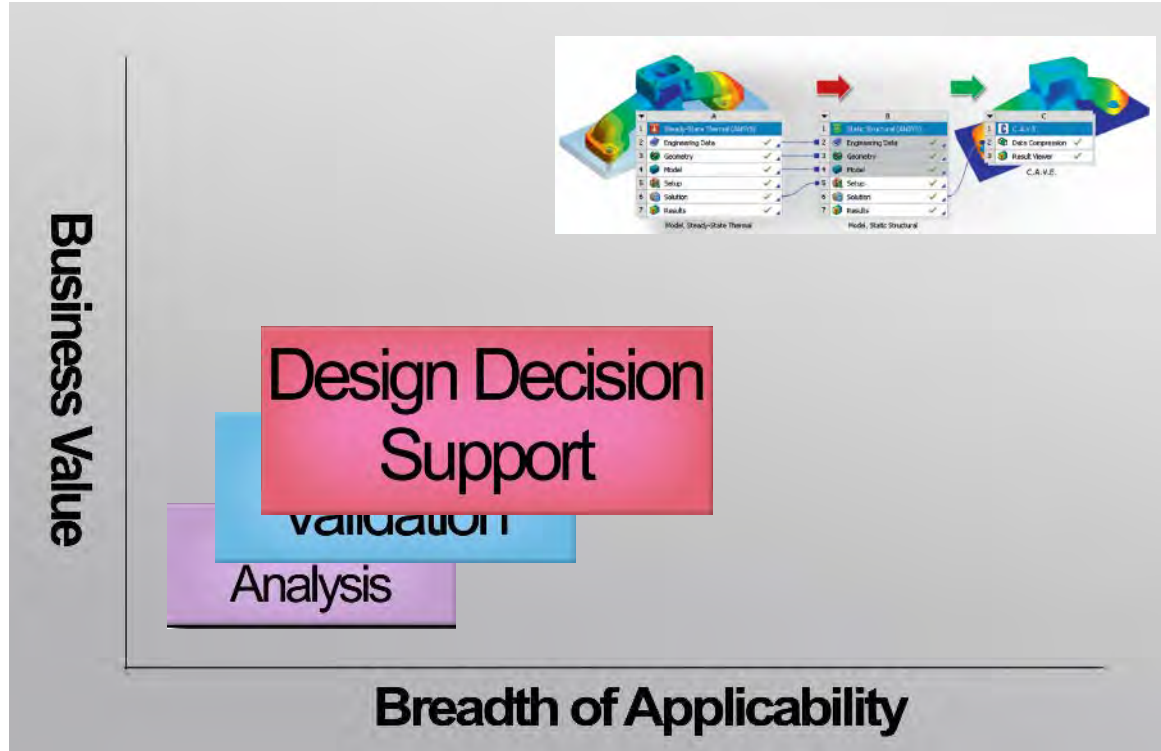
Understanding the Simulation Revolution



- **Design Validation**
- Checking before it fails
- The dawn of Virtual Prototyping
- Broader use of simulation

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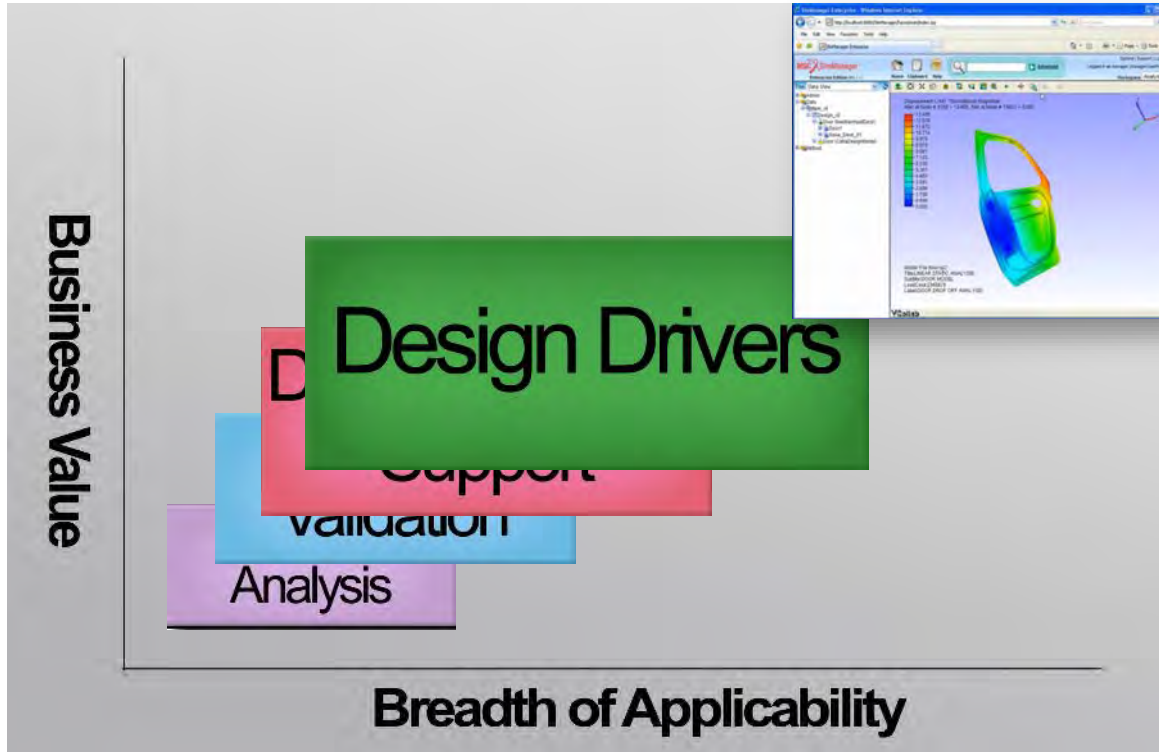
Understanding the Simulation Revolution



- **Design Decision Support**
- Why not use simulation to make better design decisions
- Why not ask designers to run simulations

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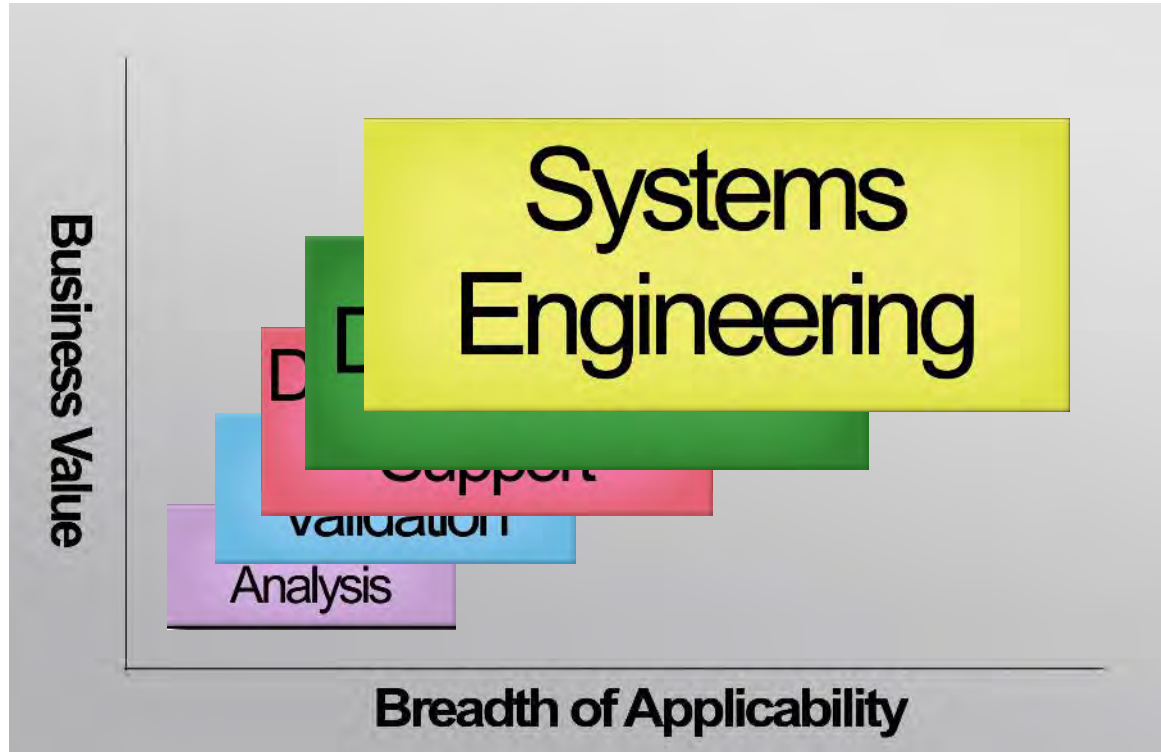
Understanding the Simulation Revolution



- **Design Drivers**
- Simulation Driven Design
- Simulation making design decisions

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Understanding the Simulation Revolution



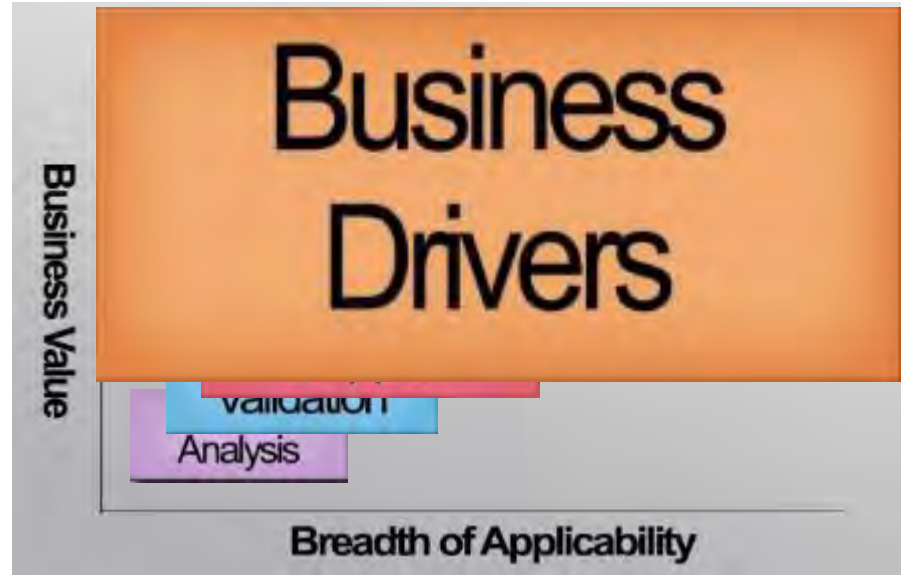
- **Systems Engineering**
- Driven by growth of embedded software
- Heavily used in EDA world
- Design drivers extended to systems

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Understanding the Simulation Revolution

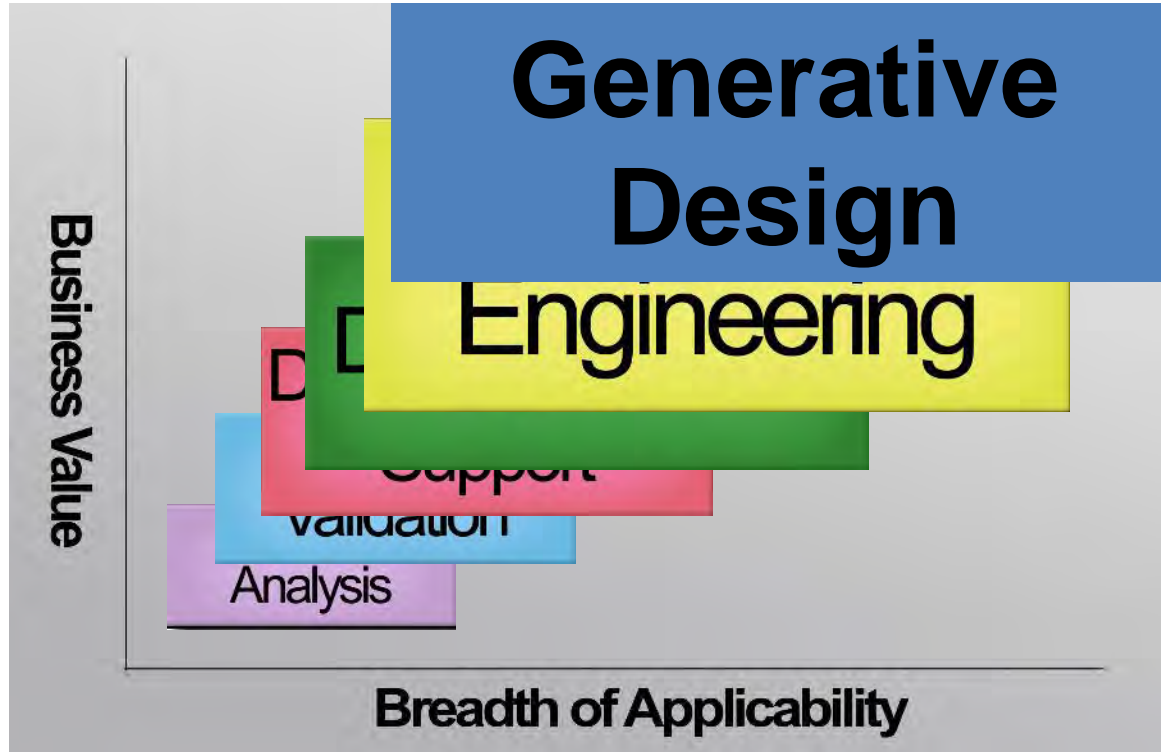
The Changing Role of Engineering Simulation is really about becoming a major key to strategic goals for improving competitiveness

- Increase Innovation
- Increase Quality
- Reduce Risk
- Reduce Time
- Reduce Cost



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Understanding the Simulation Revolution



- **Generative Design**
- Software developing design options accounting for:
 - Requirements
 - Constraints
 - Manufacturing
 - Uncertainty
 - Available design space

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Understanding the Simulation Revolution

- “**Generative Design**” will dramatically increase the amount, breadth and complexity of Engineering Simulation that is required
 - More on Generative design later

Understanding the Simulation Revolution

- The “**Digital Twin**” approach will dramatically increase the demand for Engineering Simulation
 - “What good is a digital twin if you cannot evaluate its performance virtually?” - Fouad El Khaldi, ESI Group
 - Digital Twins will generate a significant amount of data
 - Machine Learning can play a role in managing the data and working with Systems Engineering to determine what simulations are needed

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Understanding the Simulation Revolution

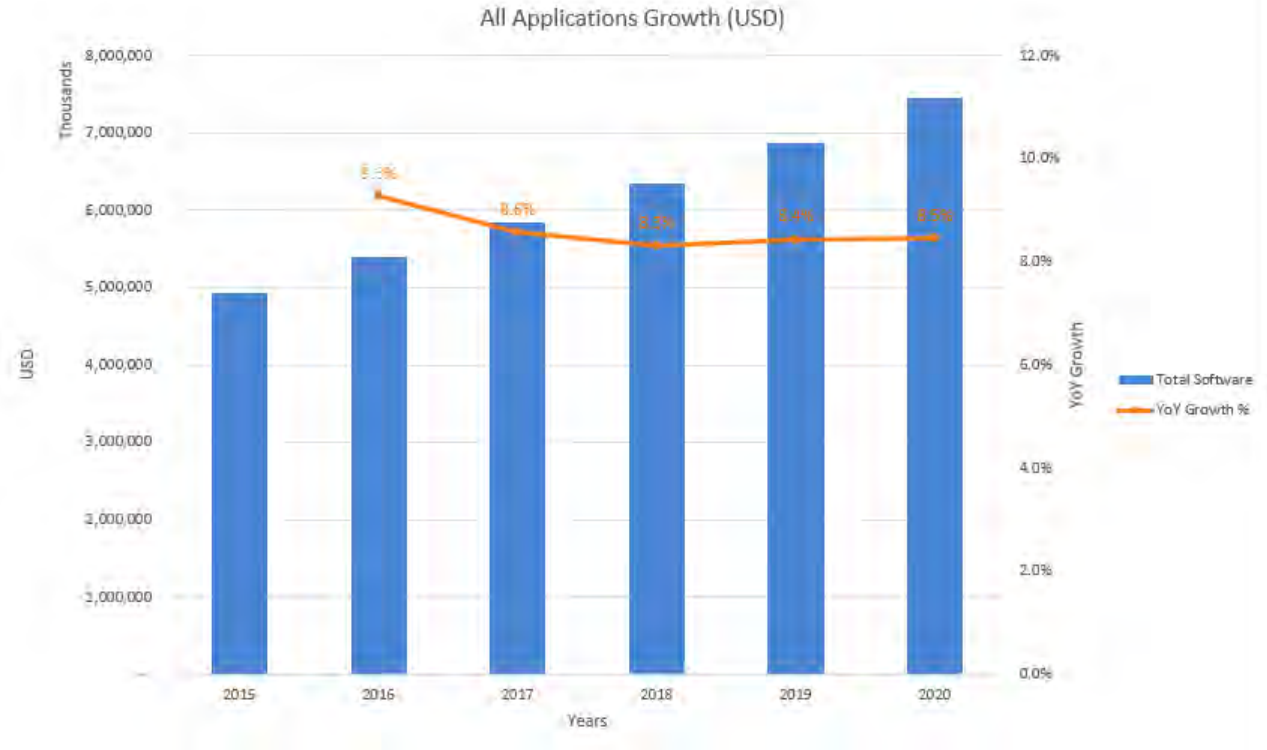
- The demand for software tools for Engineering Simulation is exploding to support the demand for increased competitiveness and to deal with the rapidly growing complexity of products, processes, and systems.
- At the same time, we are struggling to keep up with our current demand for experts who are able to use these tools effectively.

Understanding the Simulation Revolution

- Growth of the Engineering Simulation market is tempered due to lack of expertise available
- **Engineering Simulation** is **still** done primarily **by specialized Analysts**

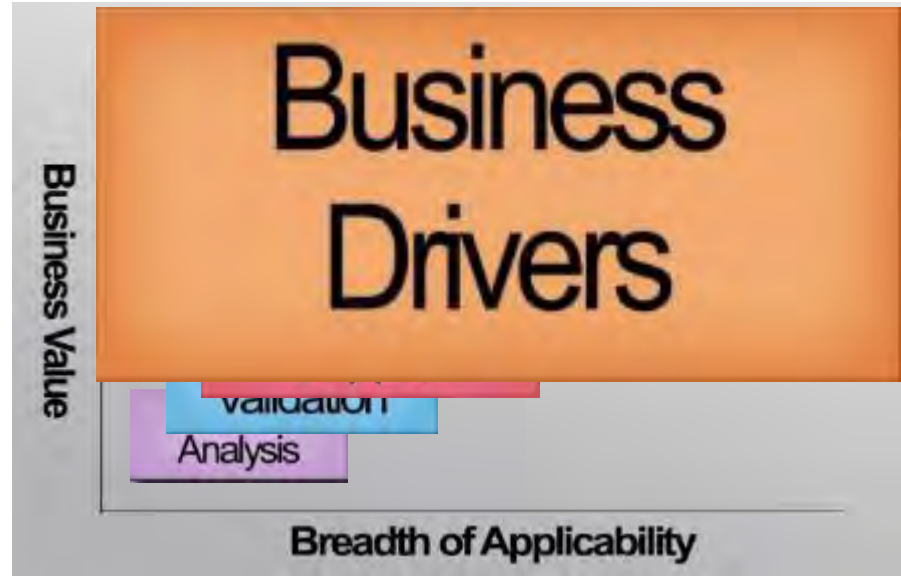
Understanding the Simulation Revolution

- Engineering Simulation Market Continues to grow and is over \$ 5 Bn annually
- But growth rate is slowing to ~ 8.5%
- Data courtesy of Cambashi CAE Observatory



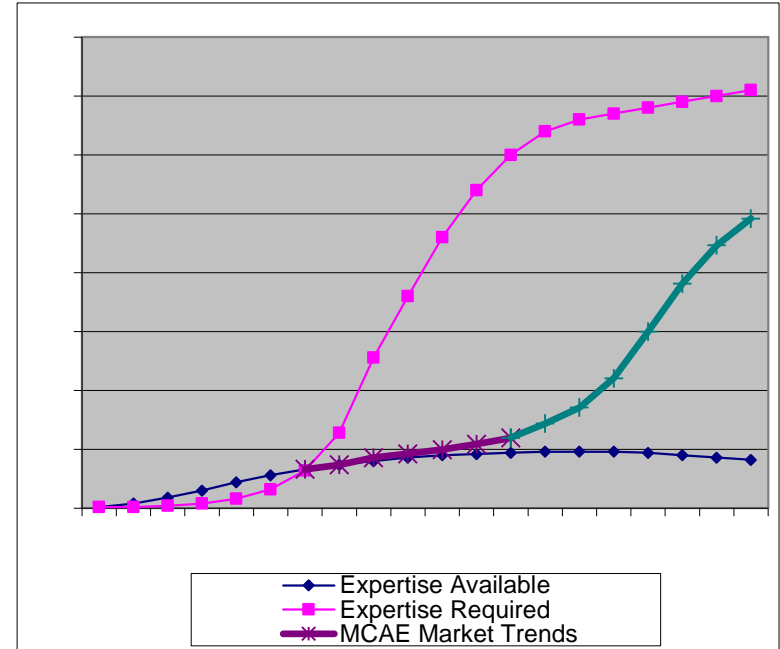
Understanding the Simulation Revolution

- Business Drivers are going to force a “**revolution**” to overcome the expertise based limitation
- Engineering Simulation will be forced to find a way



Understanding the Simulation Revolution

- The demand is not going away
- A **Simulation Revolution** will occur:
 - “Model-Based”
 - “Fit for purpose”
 - “Integrated”
 - “Smart”
 - “Transparent” / “Invisible”
 - “Generative”
 - “Machine Learning”
 - CULTURE CHANGE

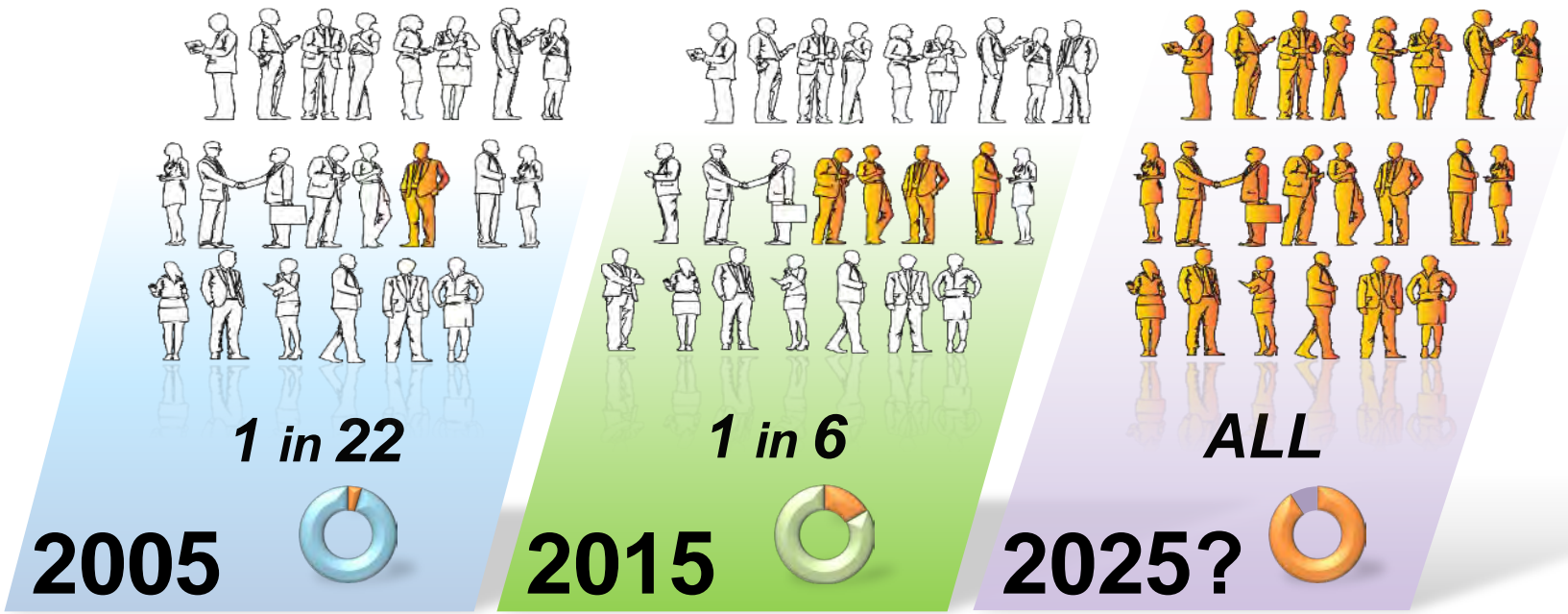


Understanding the Simulation Revolution

- **Engineering Simulation is rapidly being recognized as a key enabler to Increased Competitiveness**

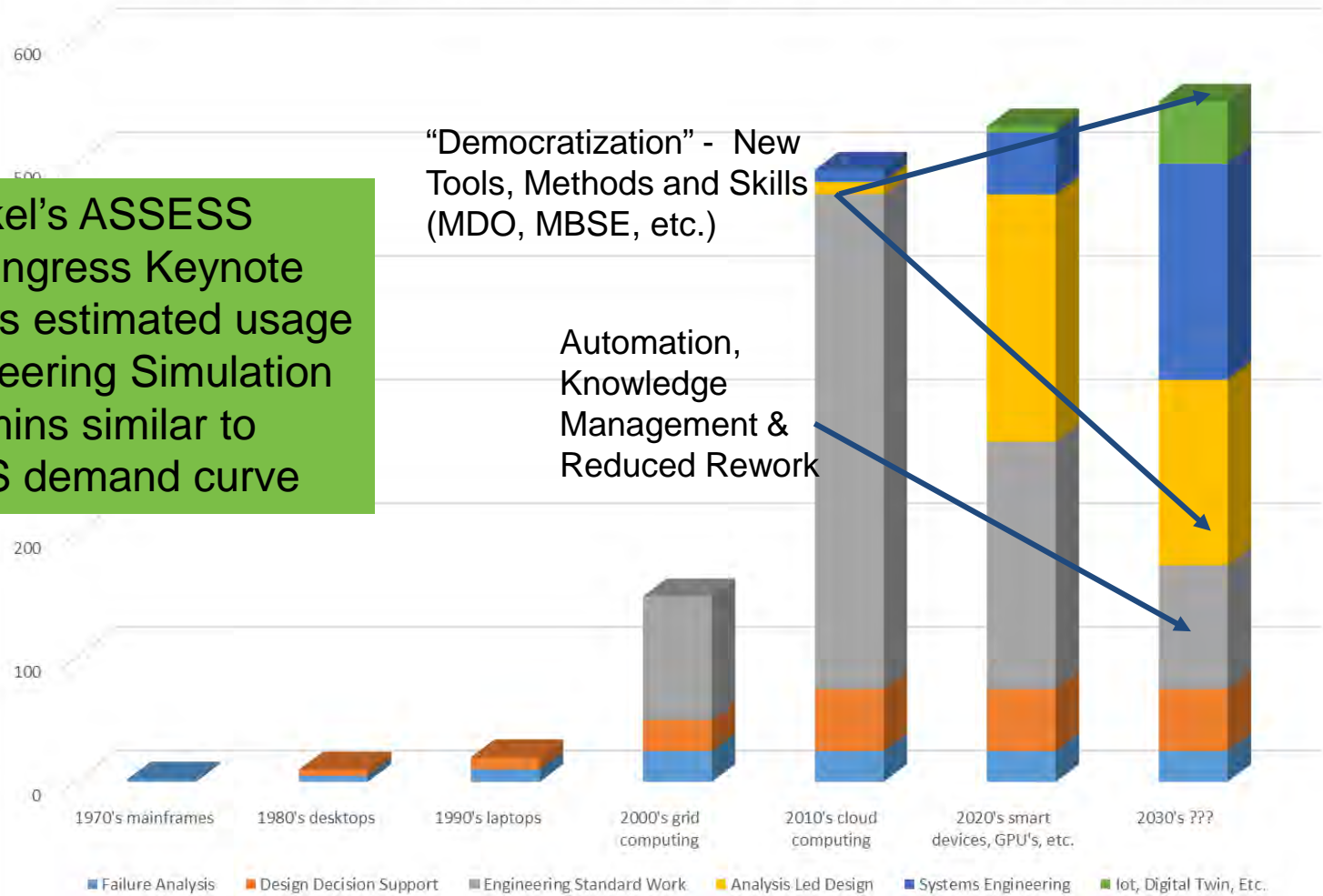
Potential for Growth in Engineering Simulation Use

Estimated Ratio of Engineers Performing Simulation to Total Engineers



CMI Global Full Time Equivalents for Modeling and Simulation (Estimates)

Bob Tickel's ASSESS 2017 Congress Keynote illustrates estimated usage of Engineering Simulation at Cummins similar to ASSESS demand curve



"Democratization" - New Tools, Methods and Skills (MDO, MBSE, etc.)

Automation, Knowledge Management & Reduced Rework

Understanding the Simulation Revolution

- The Simulation Revolution is about making **Engineering Simulation widely available & appropriate** to support improved decision making throughout the entire life-cycle of engineered products and processes

Understanding the Simulation Revolution

- Rod Dreisbach (formerly of Boeing) set the goal for the Simulation Revolution at the ASSESS 2016 Congress

Strategic Direction: Revolutionizing the Future is Now!
--- An Immersive Design Environment ---



...through Realistic Digital Simulation of Multi-Physical Phenomena at the Speed of Human Thought!

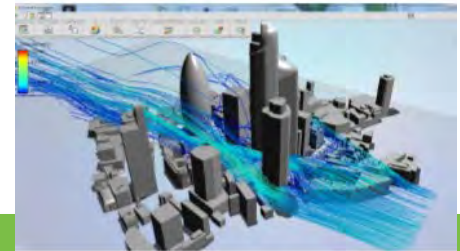
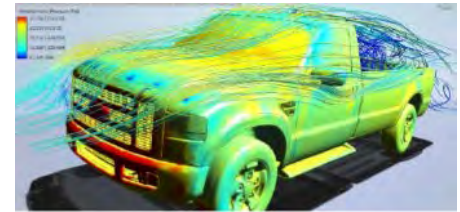
Enabling the Simulation Revolution



Enabling the Simulation Revolution

• Technologies

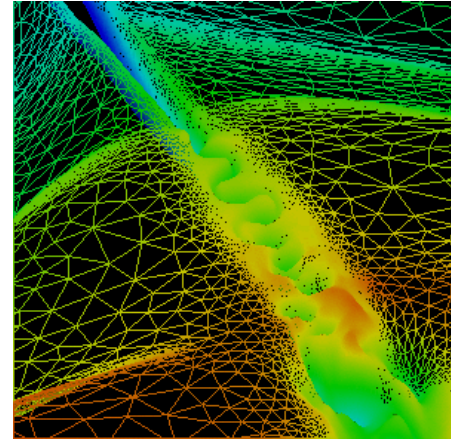
- Increased emphasis on purpose built applications
- Model Based Systems Engineering
- Emergence of simulation knowledge capture & reuse (KARREN)
- Emergence of near real time / near physics approaches
- Emergence of Generative Design
- IoT access to “real” data / Digital Twins
- Machine Learning



Enabling the Simulation Revolution

- **Approaches**

- Focusing on automation for appropriate accuracy for effective decision support
- Focusing on accuracy driven methods
- Focusing on application related engineering rather than physics
- Increasing the emphasis on Model Based Systems Engineering
- Leveraging Machine learning



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Enabling the Simulation Revolution

- **Approaches**

- Accounting for Variability and Uncertainty
- Leveraging Surrogate Models
- Coupling Systems Models with more detailed models for better system level decisions
- Optimizing the system rather than the components
- Spawning simulations from “real-time” data automatically
- Enabling a viable business model

Enabling the Simulation Revolution

- **We need a broad multi-industry initiative to raise awareness and develop/promote strategies to enable the Simulation Revolution**
 - **Analysis, Simulation, and Systems Engineering Software Strategies (ASSESS) Initiative**

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The ASSESS Initiative



The ASSESS Initiative

The **ASSESS Initiative** was formed to bring together key players to guide and influence strategies for software tools for model-based analysis, simulation, and systems engineering.

The ASSESS Initiative

Key drivers behind the ASSESS Initiative

1. Growing demand on “How to be more competitive”
2. Exponentially growing complexity of products & processes
3. Available computing power is rapidly removing the computing bottlenecks
4. New world of 3D printed objects and light weighting
5. Entirely new applications are creating a rapidly growing demand for simulation to enable breakthroughs
6. Simulation is used almost exclusively by a limited number of expert analysts
7. Simulation efforts have three key but disjointed vectors – Commercial / Government / Research

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The ASSESS Initiative

The ASSESS Vision

“To significantly expand the use and benefit of software tools for model-based analysis, simulation, and systems engineering in the engineering applications domain.”

The ASSESS Initiative

- ASSESS will interact and collaborate with multiple activities and organizations including: NAFEMS, INCOSE, and others.



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The ASSESS Initiative

- ASSESS Advisory Committee
 - 58 Industry Thought leaders
 - 7 Working Groups focused on defining the future directions, activities and deliverables of the ASSESS Initiative
 - 6 Working Groups aligned with “actionable” themes

The ASSESS Initiative Themes



The ASSESS Initiative

- Current ASSESS Themes
 - Alignment of Government / Research/ Commercial Activities
 - Engineering Simulation Business Challenges
 - Engineering Simulation Credibility
 - Democratization of Engineering Simulation (DoES)
 - Generative Design
 - Integration of Systems and Detailed Sub-System Simulations

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The ASSESS Initiative - Align

- **Align Working Group Next Step**

- **ASSESS Theme Positioning Paper**

Oveview of the current status of alignment (or lack thereof) across Government / Research / Commercial Engineering Simulation

- **ASSESS Research Paper**

Deeper understanding the current status of alignment (or lack thereof) and associated issues.

The ASSESS Initiative - Business

- **Business Working Group Key Factors**
 - Value proposition of Engineering Simulation
 - Communication with non-technical executives
 - Role of untapped Subject Matter Experts (SMEs)
 - Addressing the Small-Medium Business (SMB) Market
 - Business impact of web cloud/mobile
 - Licensing models

The ASSESS Initiative - Business

- **Business Working Group Next Step**

- **ASSESS Research Paper**

Understanding and explaining the Engineering Simulation value proposition

- All other Business Challenge issues are a function of clear understanding of achievable and realistic Engineering Simulation value propositions
 - Varies by customers
 - Large company / SMB / Industry Consortium

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The ASSESS Initiative - Credibility

- **“All Engineering Simulation should be done to support a design decision made or to be made”**
- No good metrics today for target or actual model appropriateness
- Engineering Simulation is done as “good” as the Analyst thinks he can do in a given timeframe
 - Decisions are being made without knowing appropriateness of simulations or models – heavy reliance on experts experience
 - Not transferrable to new users
 - Not scalable for DoES

The ASSESS Initiative - Credibility

- **Credibility Working Group Scope**
 - Appropriate Model Fidelity
 - Verification & Validation
 - Uncertainty Quantification
 - Risk Management
 - Deployment & Governance
 - Unsexy stuff (hygiene)

The ASSESS Initiative - Credibility

- **Credibility Working Group Next Steps**
 - **ASSESS Research Paper (referencing NASA Standards on Modeling & Simulation)**
 - Understanding why/how to develop an Engineering Simulation Risk Management Model
 - Sensitivity determines Importance
 - Probability determines Uncertainty
 - Risk defines Consequence
 - Quantifying results in Confidence
 - Managing results in Governance
 - Governance results in ROI

The ASSESS Initiative - DoES

- **DoES Goals**

- Make it possible for people who could benefit from using Engineering Simulation to be able to use Engineering Simulation
- Get Engineering Simulation into the hands of current non-users
- Address Engineering Simulation ease of use issues
- **Grow Engineering Simulation use by 10x in 5 years**

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The ASSESS Initiative - DoES

Mission statement for DoES Working Group

“To advocate for a significant expansion of the use of Engineering Simulation by all users, for whom access to the power of Engineering Simulation would be beneficial. This group’s advocacy is aimed at broader accessibility and use of Engineering Simulation, and includes education; understanding of technologies, methods, processes, organizational impacts; promotion of successes; identification of challenges; facilitation of partnerships; and providing access to resources.”

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The ASSESS Initiative - DoES

- DoES increases the need for Governance to maintain Confidence & establish Credibility
 - Organizations must understand the role and place for simulation
 - Non-expert users need guidance and control
 - Applicability of models
 - Problem definition
 - Uncertainty
 - Risk assessment & management

The ASSESS Initiative - DoES

- **DoES Working Group Next Step**

- **ASSESS Research Paper**

Understanding the different forms of Implementation for Democratization of Engineering Simulation (DoES) and their related benefits, activities, requirements and issues

- Different levels (scope) of Democratization
 - Product-Project / PD Process / Enterprise / Industry
 - Different types of organizations
 - Large company / SMB / Industry Consortium
 - Consumer Centric or Vendor Centric

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Generative Design

- After considerable discussion at the ASSESS 2017 Congress, the ASSESS Initiative defines Generative Design as follows:
“Generative Design is the use of algorithmic methods to quickly and automatically, or iteratively, transform requirements, constraints, uncertainties, and design space to create/drive viable designs or outcomes. Requirements, constraints, and uncertainties may include factors from multiple areas including: design, performance, manufacturing, usability, aesthetics, ergonomics, and cost.”

Generative Design

- Driving design from requirements, constraints, uncertainty and the available design space
- Inputs
 - Requirements (performance, cost, ...)
 - Constraints (connections, design rules, manufacturability, ...)
 - Available design space
 - Uncertainty Information (loads, materials, ...)
 - Manufacturing information (additive, subtractive, ...)
 - Objectives (stiffness, stress, durability, vibration, cost)

Generative Design

- Driving design from requirements, constraints, uncertainty and the available design space
- Outputs
 - Range of possible designs within the available design space and specified manufacturing processes that address
 - Requirements (performance, cost, ...)
 - Constraints (connections, design rules, manufacturability, ...)
 - Uncertainty (loads, materials, ...)
 - Objectives (stiffness, stress, durability, vibration, cost)

The ASSESS Initiative – Generative Design

- Generative Design should become the use of algorithmic methods to transform requirements into product geometry and design including optimizations within constraints and uncertainty.
- Generative Design is a prime candidate for leveraging machine learning
 - Requires the ability to define similarity between different simulations

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The ASSESS Initiative - Systems

- Integration of **Systems** simulation and detailed sub-system simulations
- **Systems Working Group Goals**
 - Explore & improve integration methods
 - Incorporate VV&A, UQ (component-based)
 - Move toward libraries of accredited components
 - Aspire to find a well-integrated approach to support a broad range of models

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The ASSESS Initiative - Systems

- **Systems Working Group Next Step**

- **ASSESS Research Paper**

Understanding why integration of Systems and detailed Sub-System simulations is not easy and how to move forward

- Starting with classification of Engineering Simulation Models

The ASSESS Initiative Membership Program



The ASSESS Initiative Membership Program

- **Membership Program Launched January 2018**
 - Access to all ASSESS initiative “deliverable documents” at no charge, including:
 - Research Papers as available
 - Survey research
 - Others as appropriate
 - Access to ASSESS Theme status and update reports
 - Working Group Notes
 - Congress Working Session Notes
 - Access to previous ASSESS Congress presentations
 - Access to ASSESS Members Only LinkedIn Group
 - ASSESS Members Only newsletter

The ASSESS Initiative Membership Program

- **Membership Program Launched January 2018**
 - Individual memberships
 - Group Memberships
 - Three
 - Five
 - Ten
 - Active ASSESS Initiative members receive a discount on ASSESS Annual Congress Fees

ASSESS Annual Congress



ASSESS Annual Congress

- **ASSESS Summit**

(January 2015, Sante Fe, NM)

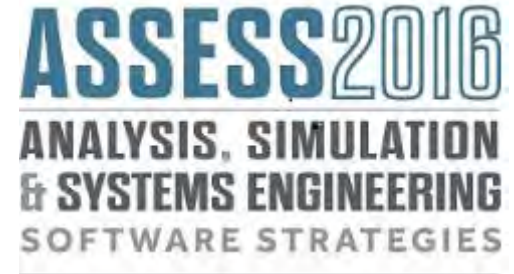
- 40 Industry leading Ambassadors
- 1 Keynote presentation (Richard Riff – retired from Ford)
- 5 Working Groups
- 8 key issues were highlighted
 - Design Centered Workflow
 - Ease of Use & Usability
 - Pre-CAD Analysis & Optimization
 - Impact of Web/Cloud/Mobile
 - Knowledge Capture & Reuse
 - Ability to Combine Heterogeneous Models in a Systems Approach
 - Appropriate Model Fidelity and role of Unsexy Stuff
 - Licensing Models Need to be Revisited



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ASSESS Annual Congress

- **ASSESS 2016 Congress**
(January 2016, Potomac, MD)
 - 85 Industry leading participants
 - 4 Keynote presentations
 - Jesse Citizen – DMSCO
 - Roger Burkhart – John Deere
 - Zack Eckblad – Intel
 - Rod Dreisbach – formerly with Boeing
 - 26 Technology Briefings
 - 7 Working Groups each with a particular ASSESS related theme



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ASSESS Activities



- **ASSESS 2017 Congress**
(November 1-3 2017, Potomac, MD)
 - 80 industry leading participants
 - 2 Keynote presentations
 - Tina Morrison – US FDA
 - Bob Tickel – Cummins Engine
 - 10 Technology Briefings
 - 16 Working Groups focused on a particular ASSESS related Themes



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The ASSESS Initiative

- **ASSESS 2018 Congress**
(October 28-30, Chateau Elan Winery & Resort – Braselton, GA)
 - Capped at 115 industry leading participants
 - 2 Keynote presentations
 - 10 “quick” Notes From the Front presentations
 - 12 Working Sessions focused on the ASSESS related themes



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