

# Broader Deployment of Simulation Tools: *Addressing the Hidden Issue*

# Broader Deployment of Simulation Tools

- **The use of simulation has seen a continual increase over the last thirty (30) years with a noticeable dramatic increase over the last ten (10) years**
- **We are now at an inflection point in potential growth due to recognition of the use of simulation producing real business benefits**

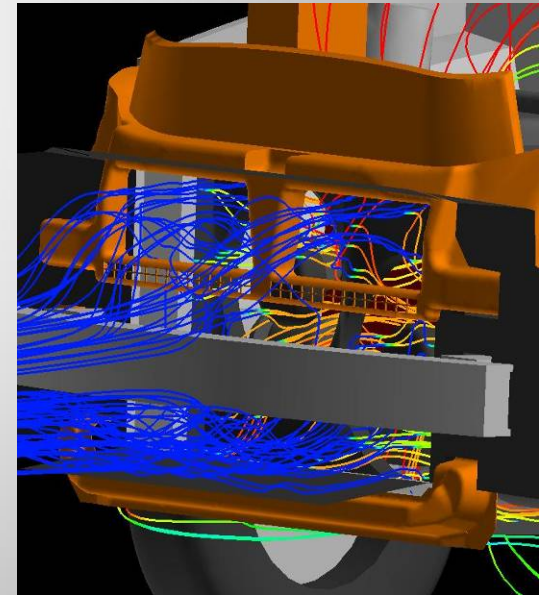
# Broader Deployment of Simulation Tools

## ● Real business benefits from Simulation

- **Virtual Prototyping** = reduced costs for physical prototypes
- **Improved Product Quality** = reduced warranty risk/cost, improved competitiveness
- **Improved Product Performance** = increased innovation, improved competitiveness
- **Support of Early Design Decisions** = reduced committed cost, quicker time to market, improved competitiveness
- **Others** = better, faster, cheaper

# Broader Deployment of Simulation Tools

- This business benefit recognition brings with it the potential for even more rapid growth with its own set of challenges
  - Simulation is not limited to a simple set of specific physics behavior
  - Use of physics simulation as an integral part of the design process
- The ***objective is clearly to use more complex simulations early and often in the design process*** in order to achieve real business benefits

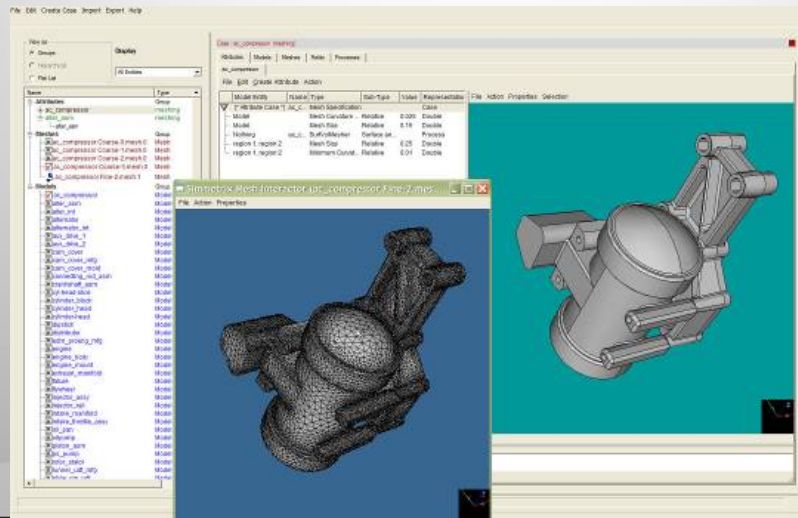


# Broader Deployment of Simulation Tools

- **Software vendors have been addressing integration and process flow control**
  - Process Automation
  - Data & Process Management
- **So life is good and we are all set – right ?**
  - *If you believe that I have a bridge you would love*
  - There's nothing wrong with what the software vendors are doing
  - We need everything that they are doing
  - But there's a significant hidden issue that needs to be addressed

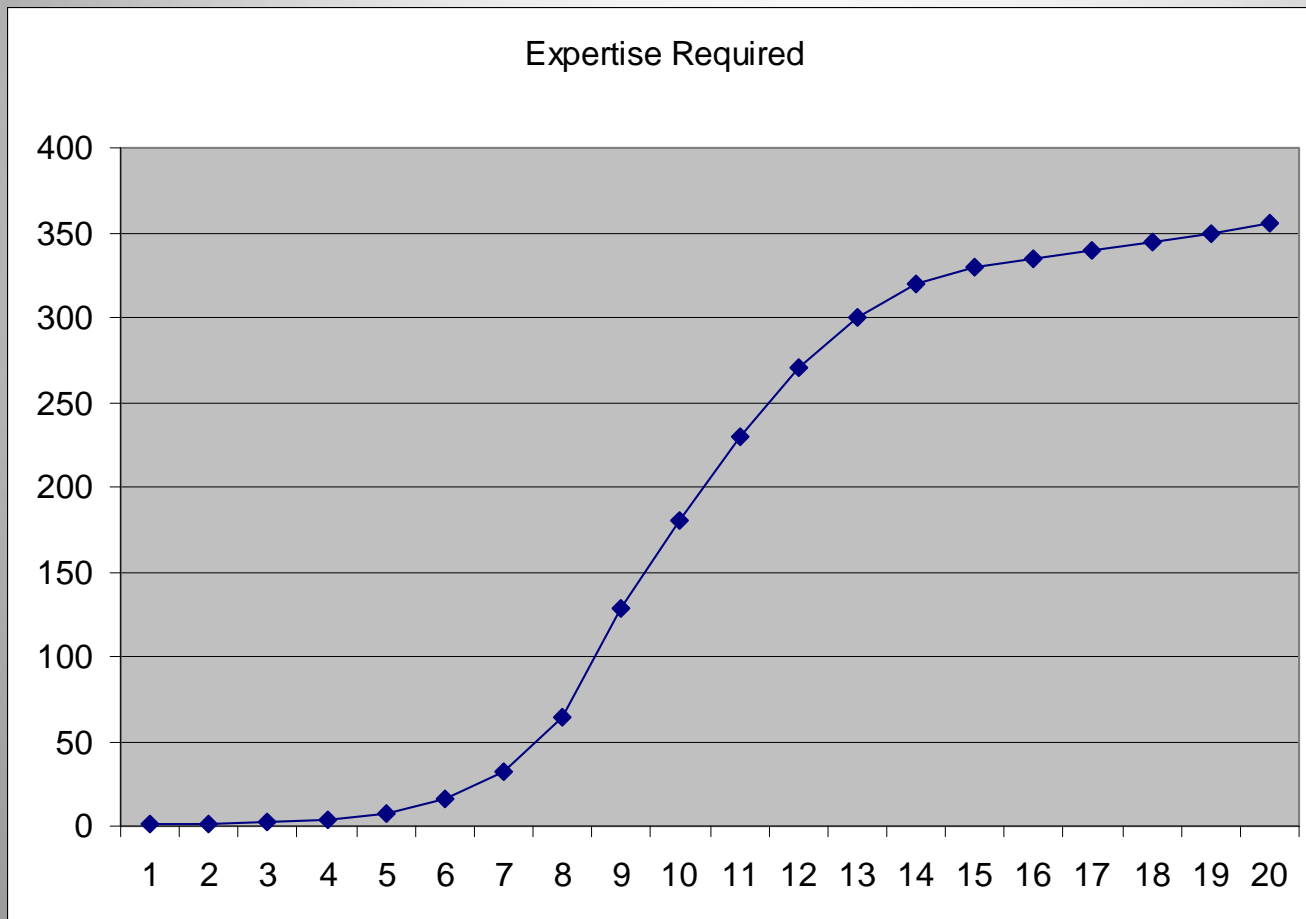
# Addressing the Hidden Issue

- What is the expertise level required to run the simulation tools necessary for the increasing complexity of simulations?
- What is the expertise level available today and in the future ?
- Does the level of expertise exist to support the potential growth ?



# Addressing the Hidden Issue

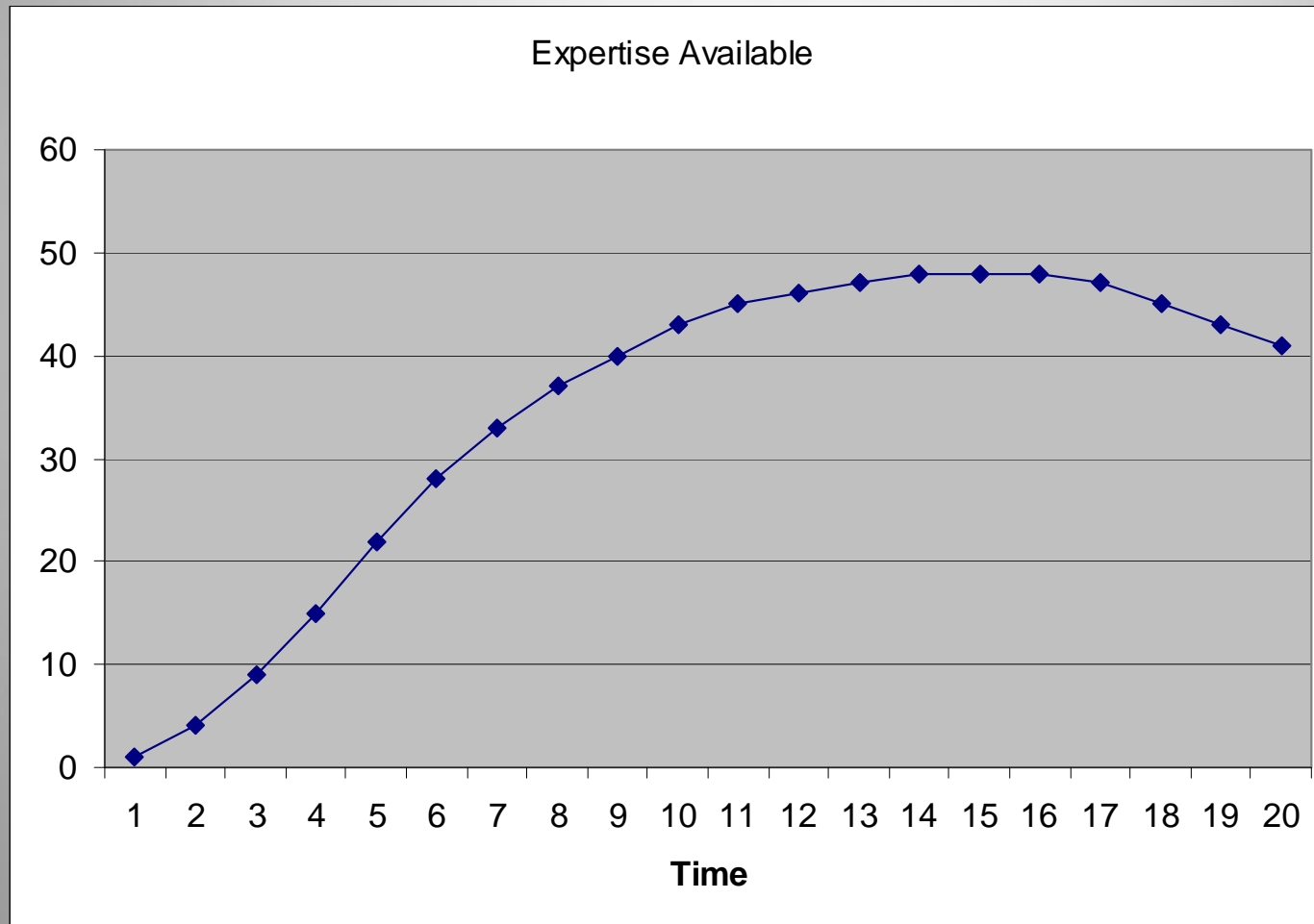
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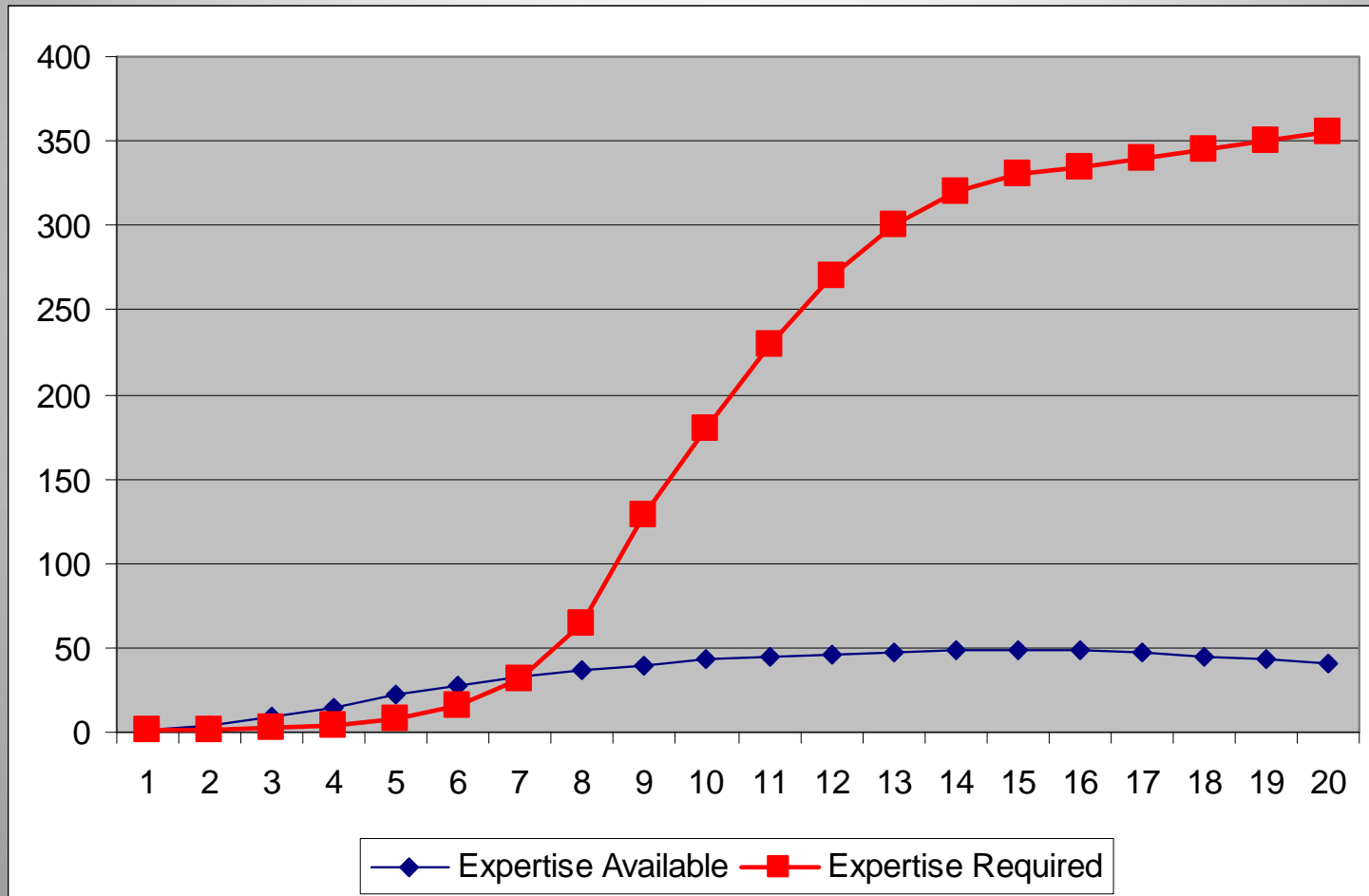


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# Addressing the Hidden Issue

- Does the level of expertise exist to support the potential growth ?



# *Addressing the Hidden Issue*

- **Established simulation users (i.e. automotive, aerospace, ...) have an issue with vanishing expertise**
  - Voluntary and forced retirement
  - Resources not available to replace lost talent
- **Simulation is being considered by companies and industries that have little to no simulation expertise**
  - Some new technologies can only be effective with simulation even though experience is not strong (i.e. alternate energy sources, biomedical ...)
  - One could argue that advanced Simulation seems to be remaining the province of experts at large companies

# *Addressing the Hidden Issue*

- Since the level of available expertise does not exist **we have a real problem** related to growing the deployment of simulation tools
- That means that the future **growth** of simulation deployment will be **limited primarily by the available resources** with the required expertise to run the simulations

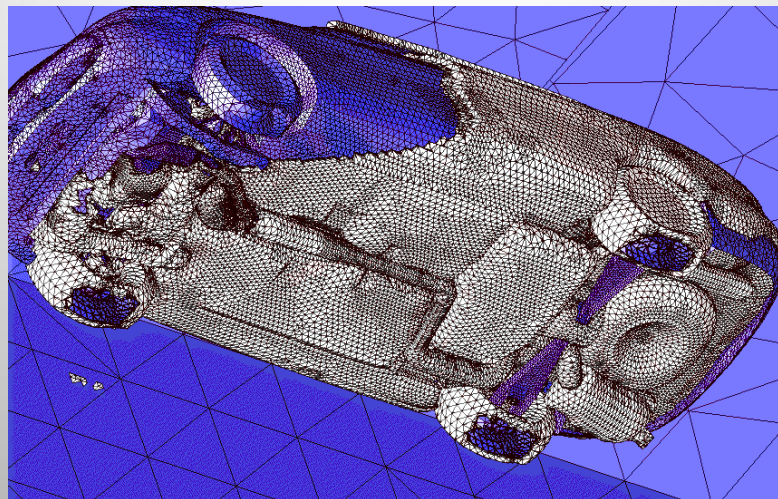
# *Addressing the Hidden Issue*

- **growth limited by available resources**
  - This is not just an ease of use issue
  - “Non-expert” does not mean non-engineer
  - This is an issue for both vendors and users
    - Efforts to drive simulation to less-skilled users at large companies have failed over and over again
    - Some success has been achieved at deployment to smaller companies but expertise and domain knowledge is the key limiting factor

# Addressing the Hidden Issue

## ● From a Vendor Perspective

- Targeted to meet customer demand and reduce effort
- Typically not targeted to significantly reduce required expertise
- Current tools are not leveraged to their capabilities
  - “are users still waiting for a silver bullet?”

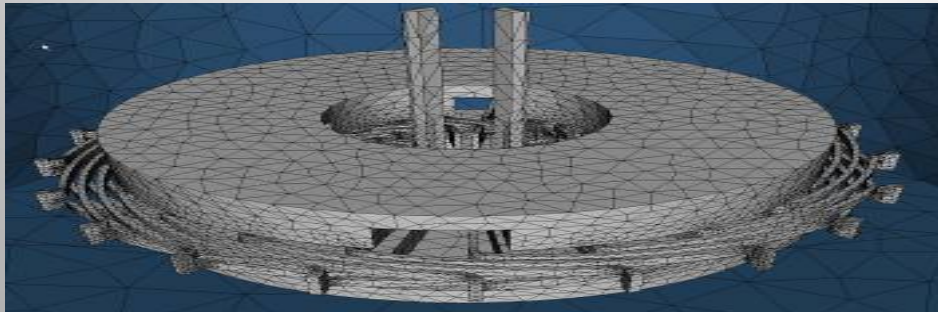


# Addressing the Hidden Issue

- From a User Perspective
  - Technology is not ready to meet my needs
    - Data management, Process Automation, etc ... just looks like more complexity
  - CAE experts generally are really not on board for making broader deployment of simulation a reality
    - Nothing to gain from broader deployment
    - Reluctant to share knowledge
    - Don't understand non-expert needs
  - Change is hard, and this looks like a big change
    - Where's the benefit?
    - Who is the internal champion?

# Addressing the Hidden Issue

- We need to significantly decrease the expertise required by making the simulation tools smarter
  - Not just easier to use
  - Not just automating current processes
  - We will need to think outside the box



# *Addressing the Hidden Issue*

- **The first key is a new wave of automation – “Intelligent Automation”**
  - Leveraging current automation capabilities
  - Leveraging simulation data management capabilities
    - need automated data management for non-experts
  - Desired accuracy and adaptive approaches
  - Application requirements rather than physics
    - i.e. wind turbine performance evaluation



# Addressing the Hidden Issue

## ● “Intelligent Automation” cont.

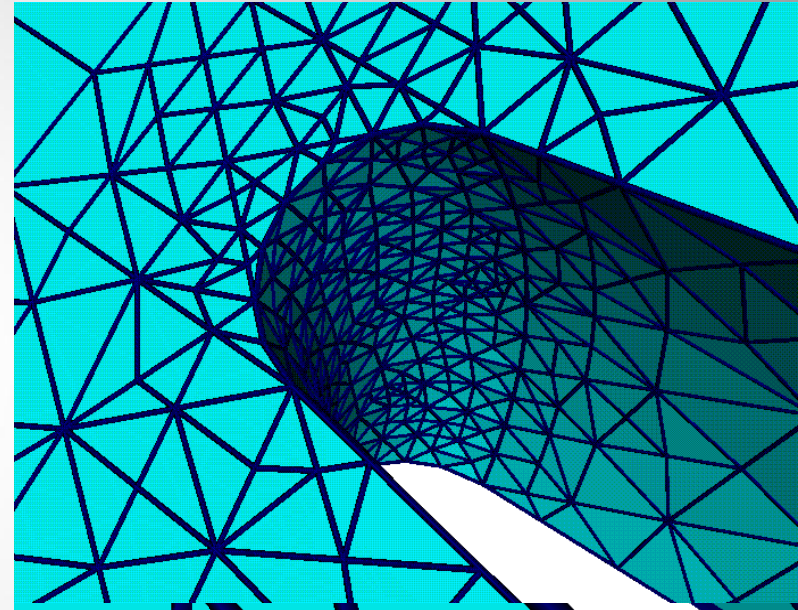
- Support for broader range of design variability
  - Abstract Modeling
  - Heuristics, ...
  - Robust engineering, stochastics, DSE, ...
- Hierarchy of models & model abstractions
  - Systems Engineering type approach
  - Results of one level of abstraction become input for next
  - Capture complexity by dealing with the appropriate level of abstraction
- Integration of multiple/all of the above

# *Addressing the Hidden Issue*

- **Leveraging current automation capabilities**
  - Automatic mesh generation
  - Process Automation
  - Automated simulation assembly modeling
  - Data and process management
  - Design Space exploration
  - Best place to start is “Intelligently automate what we can today”
    - Standard work
    - Straightforward analyses of simple parts and sub-assemblies
  - Then grow capabilities as more “intelligent automation” tools become available

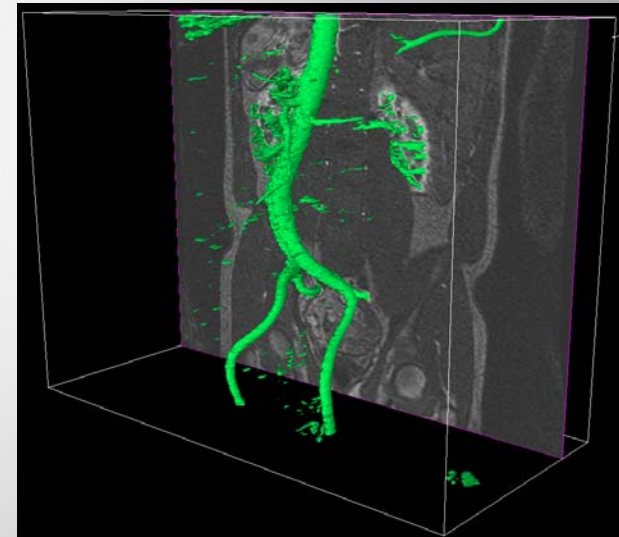
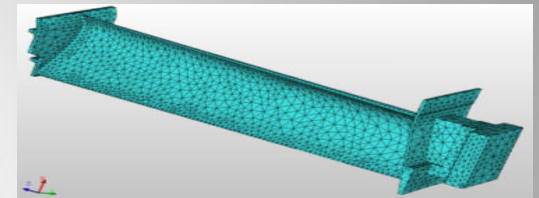
# Addressing the Hidden Issue

- **Desired accuracy and adaptive methods**
  - Required accuracy is a function of the design decision under consideration
  - Mesh adaptivity is a requirement – not a luxury
  - *A-priori element shape metrics generally have little to no correlation with error*
  - Adaptivity needs to be driven by local field errors and not by global “norms”
  - Transient problems and certain physics need more work to effectively support mesh adaptivity



# Addressing the Hidden Issue

- **Application requirements rather than physics based**
  - This is already happening
    - Rotating equipment applications
    - Biomedical applications
    - And many, many more ...
  - Non-traditional simulation applications have little to no choice
  - Traditional simulation applications can gain significant benefit by leveraging domain expertise



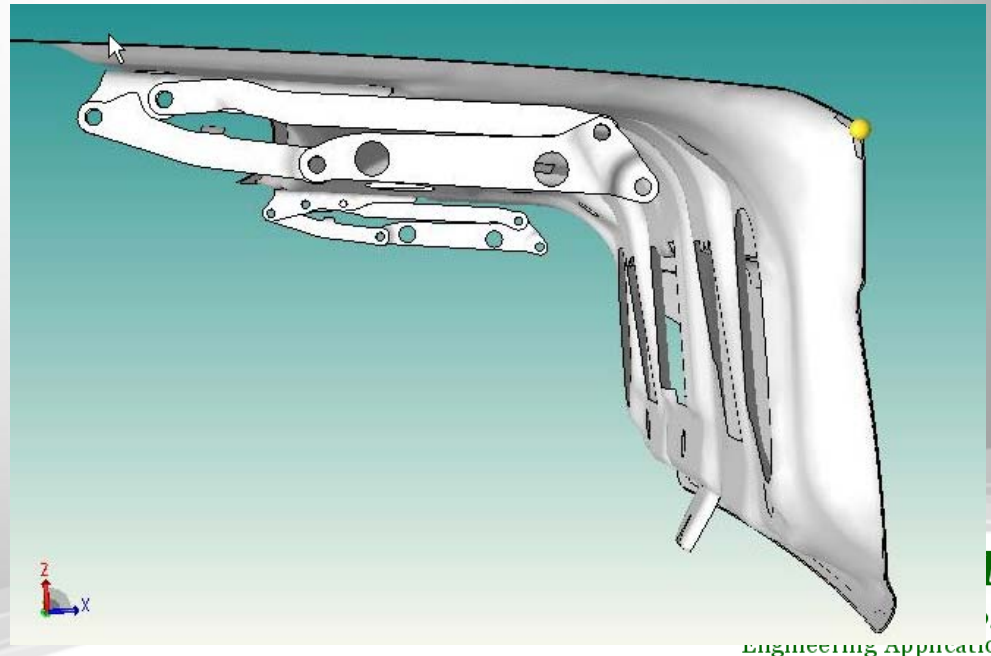
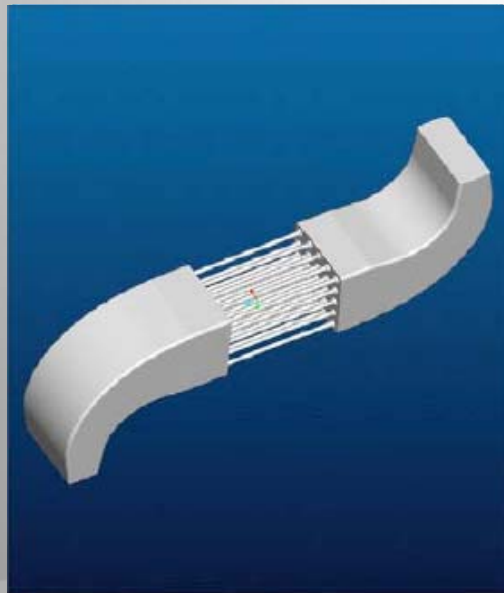
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# *Addressing the Hidden Issue*

- **Support for broader range of design variability**
  - Allow for capture of expertise
  - Allow for reuse through the entire design process
  - Allow for reuse through Design Space Exploration, Stochastics, Robust Engineering
  - Allow for automation of simulation assembly
  - Allow for repeatability
- **Crawl – Walk – Run analogy**
  - Crawl = simulation modeling at mesh level
  - Walk = simulation modeling at geometry level
  - Run = simulation modeling at an Abstract Model level
  - We need to move to the run stage if we want to deploy effectively to “non-experts”

# Addressing the Hidden Issue

- **Abstract Modeling is a persistent simulation representation**
  - Enables persistent analysis attributes throughout the design process that are invariant to design changes
  - Analysis attributes are assigned to the persistent Abstract Model



# Addressing the Hidden Issue

- **The second key is updating processes to support “Intelligent Automation”**
  - Leveraging simulation data management capabilities
    - Enables auditable use by non-experts
  - Remove unfounded focus on a-priori shape metrics
    - Adaptivity is your friend (anything else is a guess)
  - Remove unfounded focus on idealization/simplification
    - Minimizing the need for idealization/simplification is key to reducing required expertise
    - Idealization/simplification are extremely difficult to automate
  - Continue to push vendors for solutions that support “Intelligent Automation”
  - Leverage current automation capabilities now !!
    - Do what can be done now !!!! - Don't wait for a silver bullet
    - Think in terms of applications not physics
- **Become the “Intelligent Automation” champion**

# Addressing the Hidden Issue

## ● Conclusions

- The use of simulation is at an inflection point with potential growth driven by business issues
- There is a simulation expertise issue that will limit the spread of effective use of simulation technologies
  - The level of expertise required for simulation needs to be reduced significantly to attain deployment growth to meet business goals
- “Intelligent Automation” is the means to make a radical reduction in required expertise
  - Most technology exists but in an integrated form
  - Vendors need to focus on integration of disperse technologies with a goal to reduce required expertise
- “Intelligent Automation” means a process change
  - Users need to start with the concept and do what they can today
  - Internal champions have to come forward