



Regional Summit

2008  NAFEMS

2020 Vision of Engineering Analysis and Simulation

October 29 - 31, 2008 | Hampton, Virginia

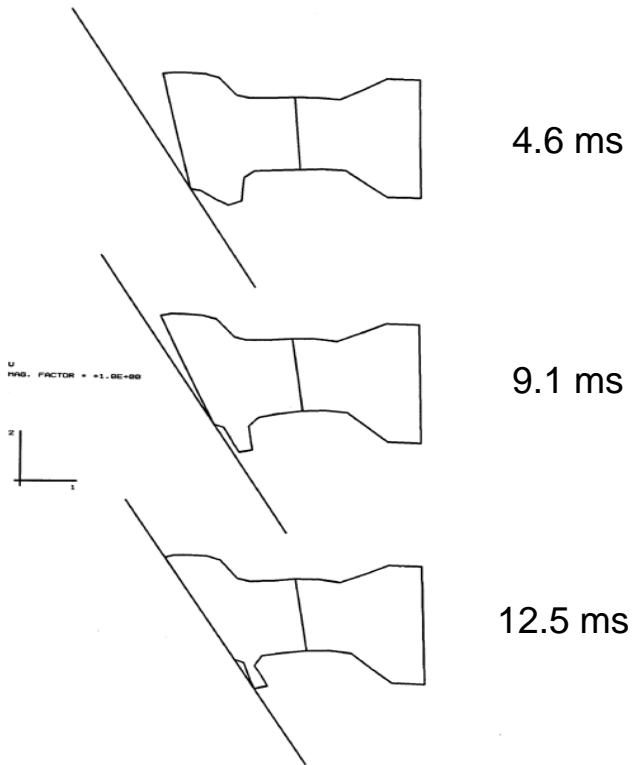
Designer Simulation: Utopia or Catastrophe?

Roger Keene
Dassault Systemes Simulia Corp

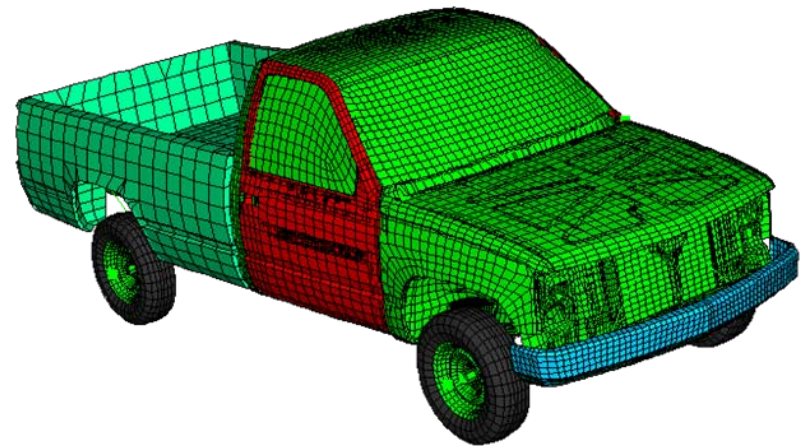


30 years ago...

- ...simulation was a fringe activity
 - Performed by a few researchers in large companies



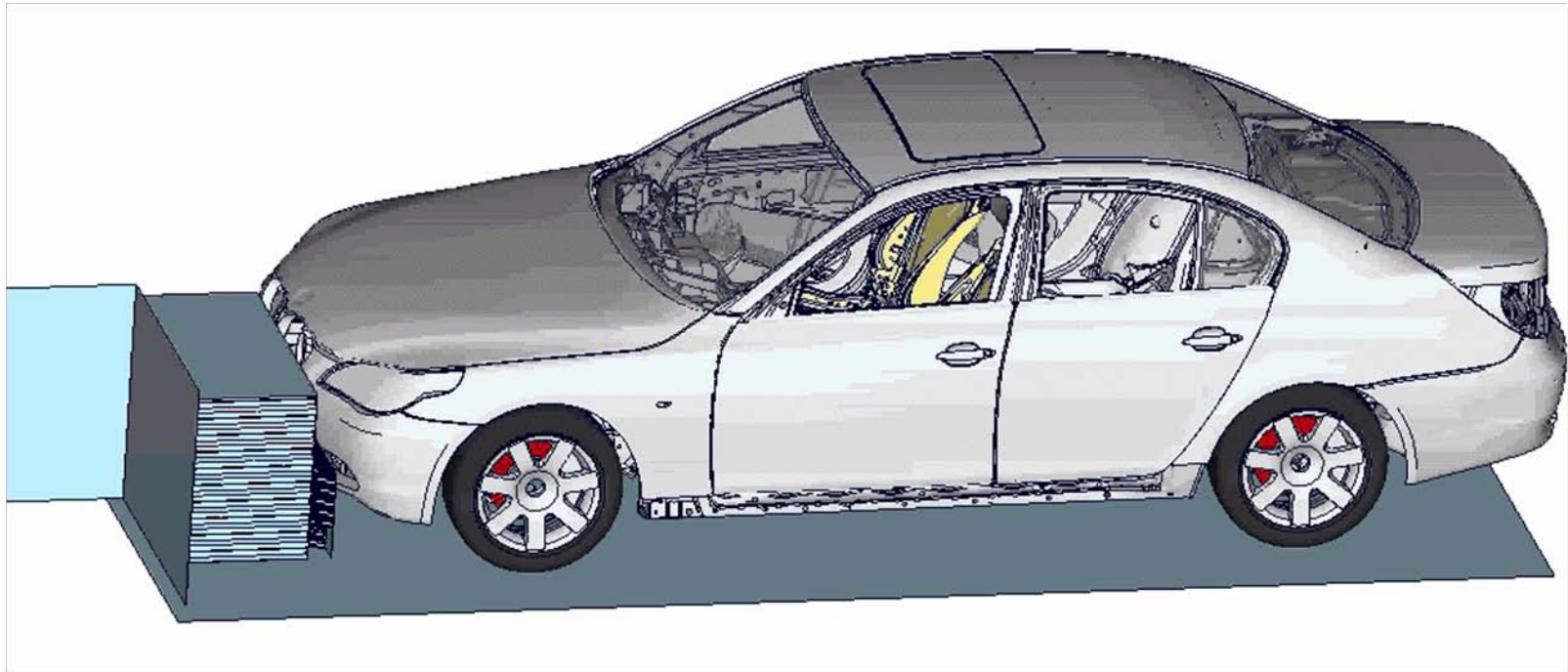
Crash model: Early 1980s



Crash model: Late 1980s

Today...

- ...CAE is increasingly mainstream



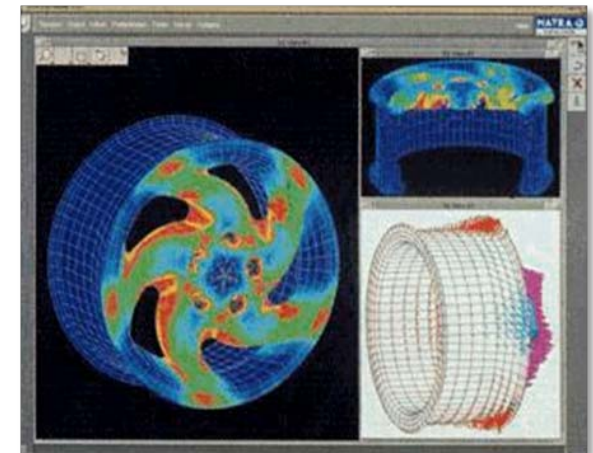
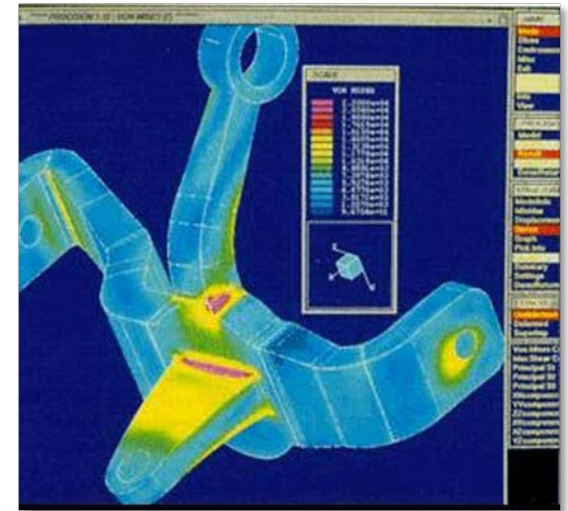
Problem

- Analysis is a skilled endeavor
- Not enough skilled analysts
 - All the analysts in the world would probably fit in a football stadium



Solution 1: Designers

- Tried in the 90's
- Largely failed
 - Still required simulation knowledge
 - Simulation took too long
 - Not realistic enough



Solution 2: Outsourcing

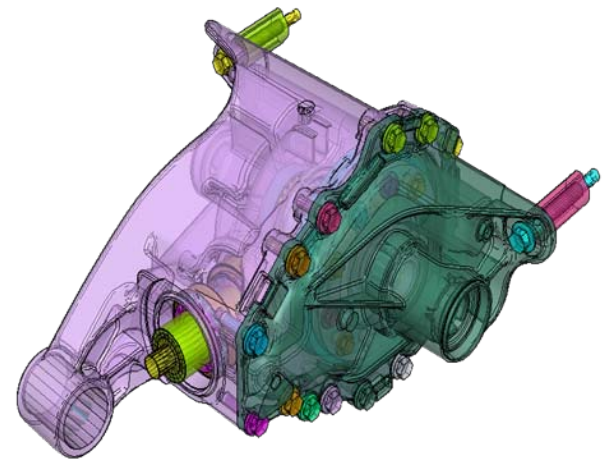
- Lots of cheap engineers in India and China
- Somewhat successful, but still issues:
 - Communication
 - Intellectual property
 - Lack of standardization
 - Staff turnover
 - Salary inflation



Time to try designer simulation again?

- Much has changed
 - Software requires less skill
 - Computers and software are much faster
 - Greater realism (multi-physics, contact...)

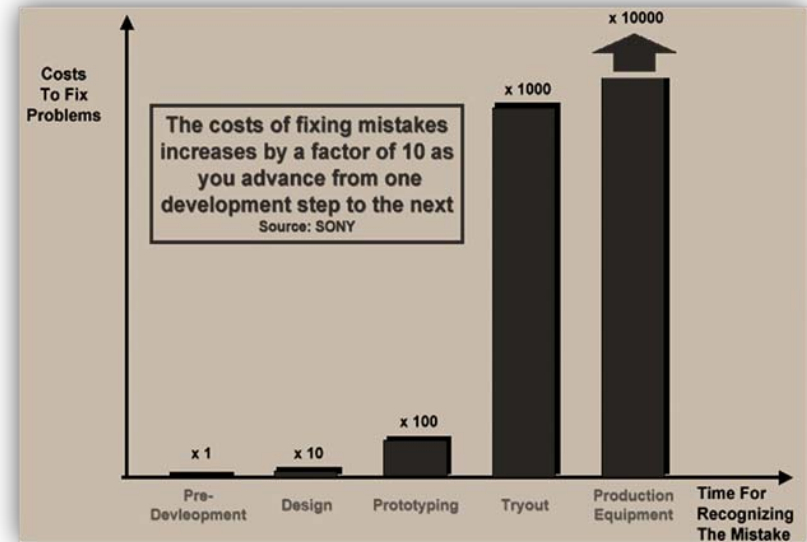
- Rear axle assembly
 - 9 million dof
 - Nonlinear
 - 4 hours on 128 cores



Courtesy of DANA Corporation

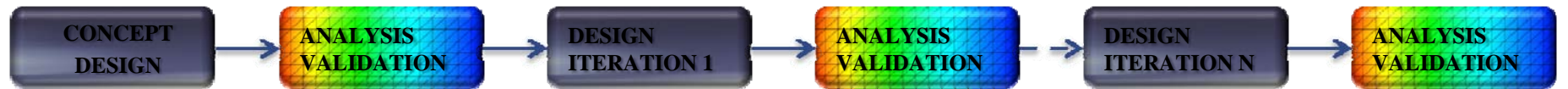
Designer simulation

- Help size designs and understand how design behaves
 - Replace hand calculations and design tables
 - Get design right the first time
 - Few design-analysis iterations
- Current simulation remains as a “virtual test”



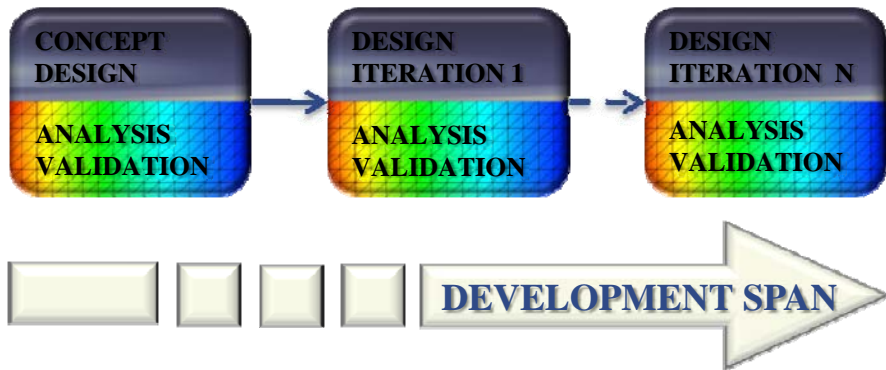
Designer simulation

- Traditional approach:
 - Design and analysis performed in serial by different groups
 - Development time is long
 - Different tools used for design and analysis
 - Associativity to geometry lost
 - Geometry translation and clean-up required



Designer simulation

- Designer simulation
 - Design and analysis in a single environment.
 - Associativity between geometry and analysis model
 - Design iterations can be validated rapidly
 - Productivity gains due to fewer design-analysis iterations





Requirements

- Embedded in CAD tool
 - Fully associative with design specification
- Appropriate user interface
 - Interpret design spec – minimal additional info

Requirements

The screenshot displays the Abaqus/CAE software interface. The main window shows a 3D model of a mechanical part, likely a flange or a similar component, with a red cylindrical feature in the center. A coordinate system (X, Y, Z) is visible on the right side of the model. The 'Create Load' dialog box is open, showing the following details:

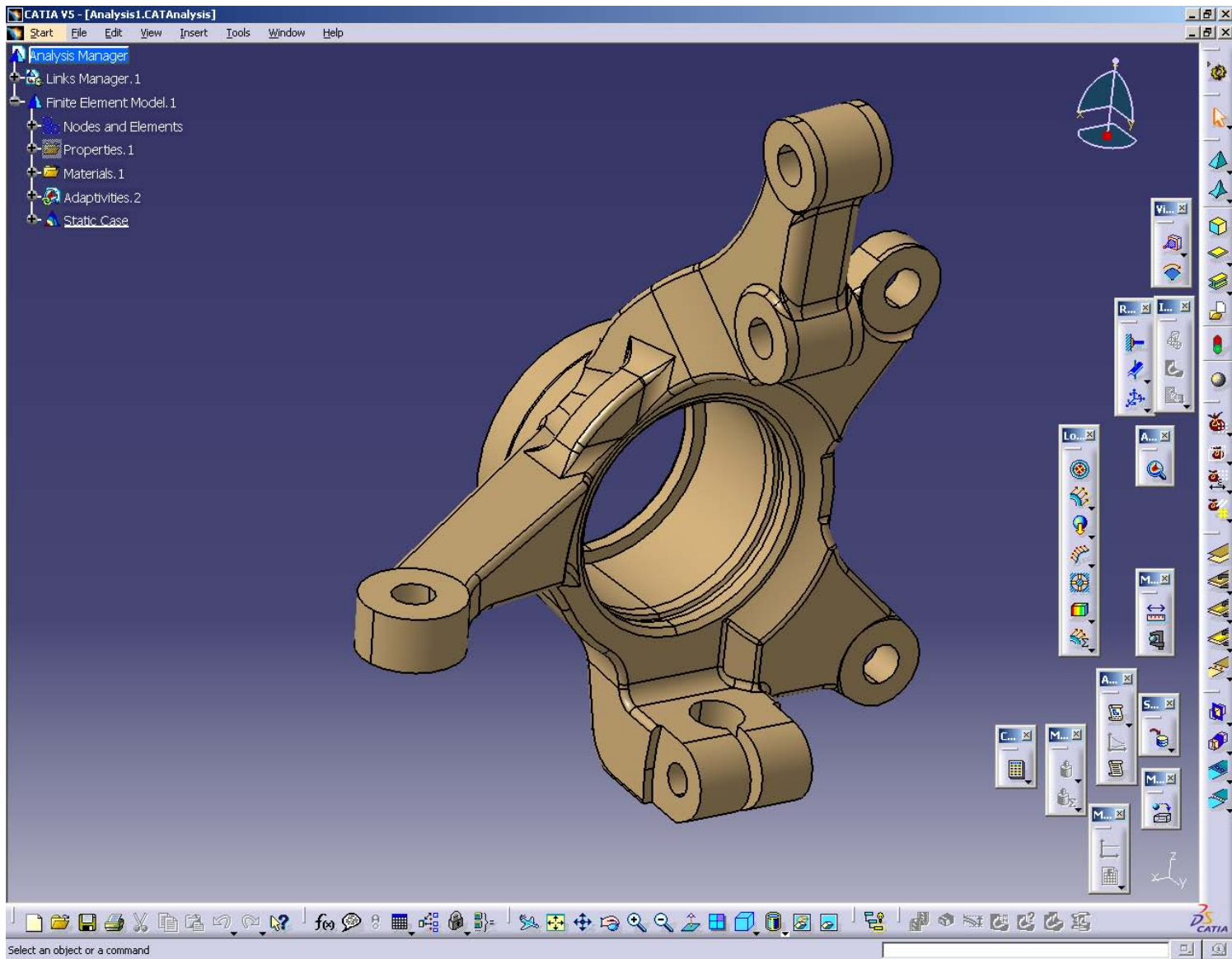
- Name: Load-2
- Step: Step-1
- Procedure: Static, General
- Category: Mechanical (selected)
- Types for Selected Step: Concentrated force (selected), Moment, Pressure, Shell edge load, Surface traction, Pipe pressure, Body force, Line load, Gravity, Bolt load, Generalized plane strain, Rotational body force, Coriolis force, Connector force, Connector moment, Inertia relief.

The left sidebar shows the Model Database tree, including Models (1), Model-1, Parts (4), Materials (2), Sections (2), Profiles, Assembly, Steps (2), Field Output Requests (1), History Output Requests (1), Time Points, ALE Adaptive Mesh Constrain, Interactions, Interaction Properties, Contact Controls, Constraints (16), Connector Sections, Fields, Amplitudes, Loads (1), BCs (2), Predefined Fields, Remeshing Rules, Sketches, Annotations, Analysis, Jobs (1), and Adaptivity Processes.

The bottom status bar shows the following text:

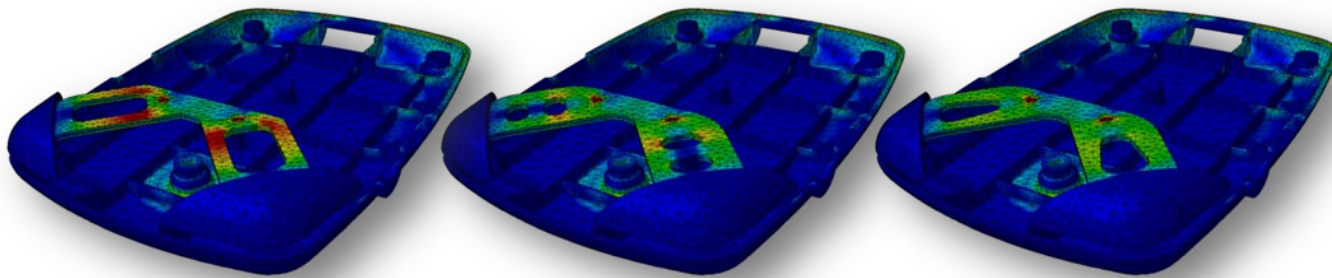
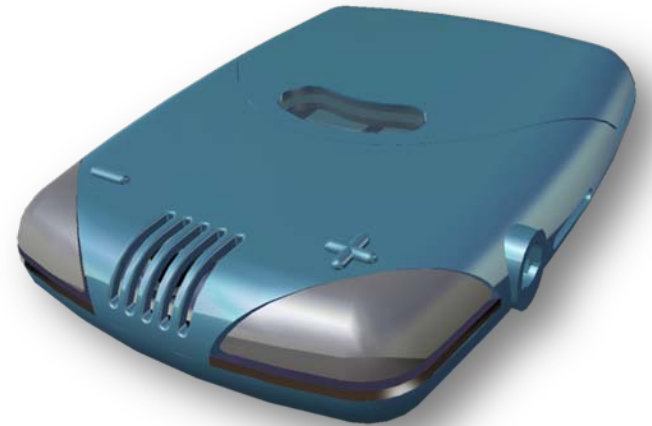
```
executing "onCaeStartup()" in the site directory ...  
Executing "onCaeStartup()" in the home directory ...  
Executing "onCaeStartup()" in the local directory ...  
The model database "d:\wdir\gqn\abq_work\68-DEV\SpinergerFrontHub.cae" has been opened.  
Running macro "makeFine"  
The macro "makeFine" has completed.
```

Requirements



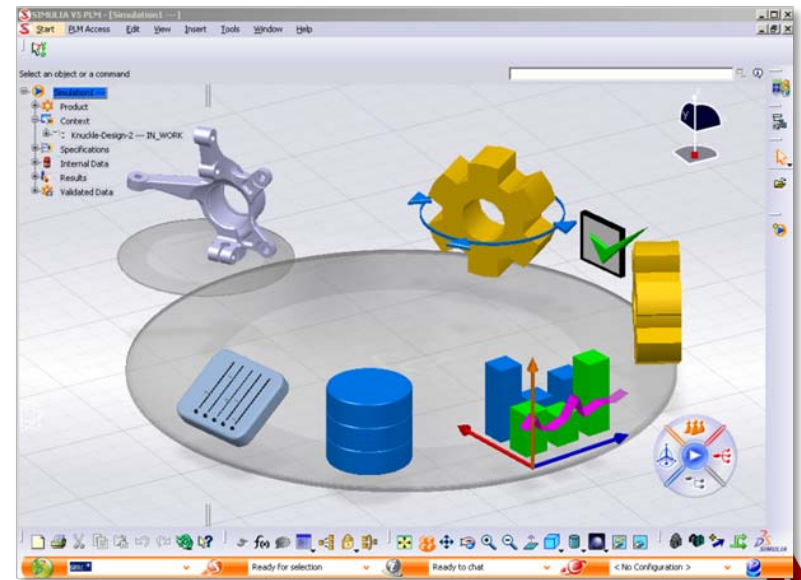
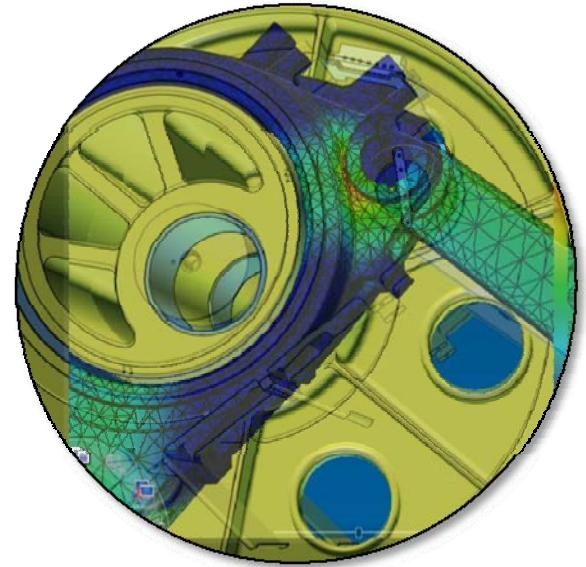
Requirements

- Realistic
 - Contact
 - Large deformations
 - Engineering materials (metals, plastics, rubber, composites...)



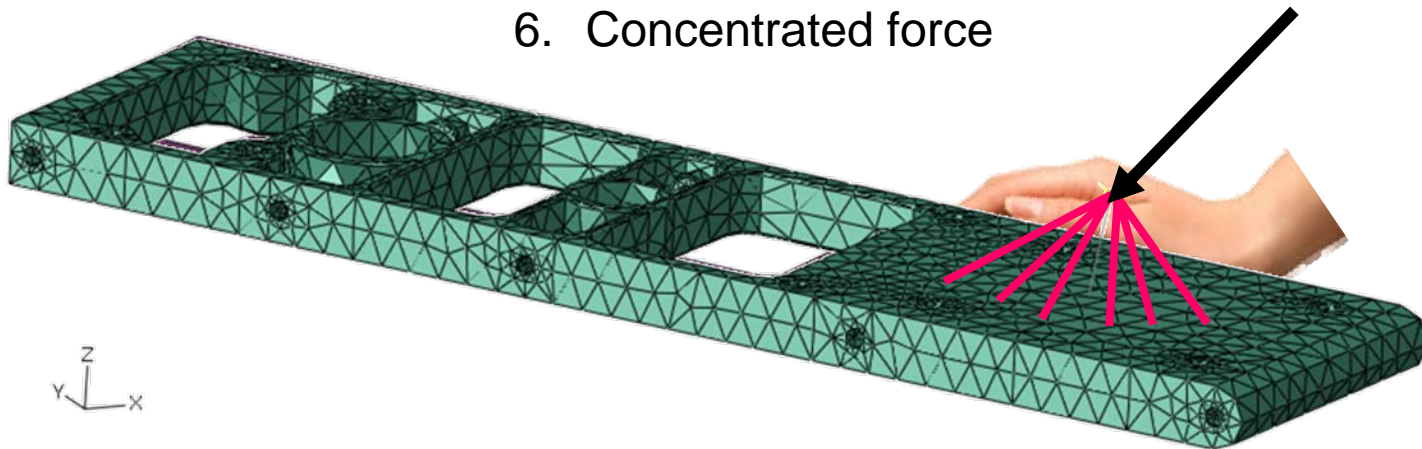
Requirements

- Design guidance
 - How can I improve my design?
- Collaboration with analysts and other designers
 - Collaboration tools
 - Scalable technology
- Managed in PLM



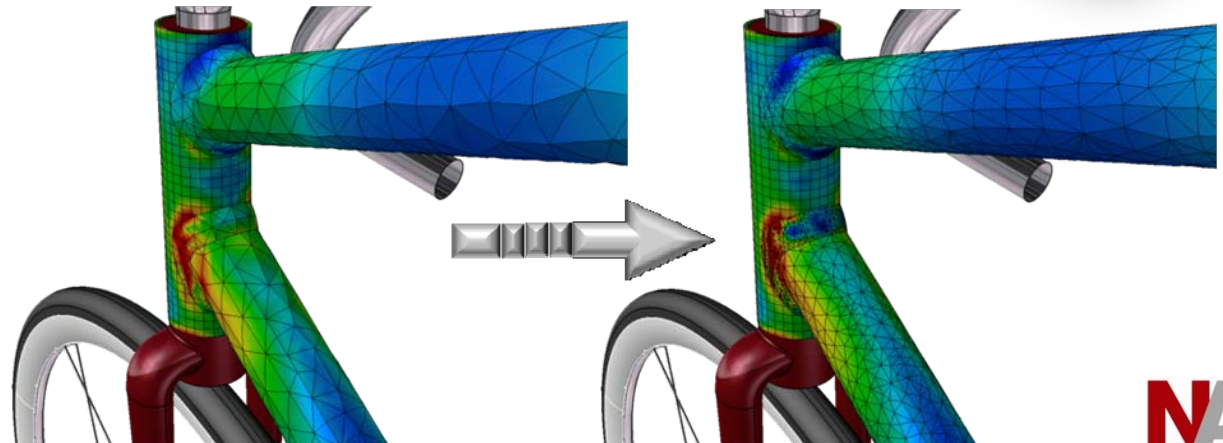
Hide the “FE fiddlybits”

1. Partitioned geometry
2. Region selection
3. Datum point
4. Reference point
5. Coupling
6. Concentrated force



Challenges: Technology

- Key technology mostly exists
 - Robust meshing
 - Adaptivity
 - Automated convergence
 - General contact
 - Design exploration & optimization
 - Data management
- Integration
- User interface





Challenges: People

- Natural resistance to change
- Simulation is increasingly important
 - “If it ain't broke, don't fix it”
- Designers see it as one more thing they don't have time to do
- Analysts fear for their status and independence

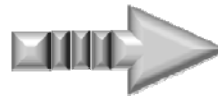


Challenges: People

- Designers
 - Analysis is an integral part of what they do
 - Saves time since less iterations required
- Analysts
 - Develop standard processes
 - Deploy processes to designers
 - Focus on more sophisticated, interesting and value-added simulation

Will it happen?

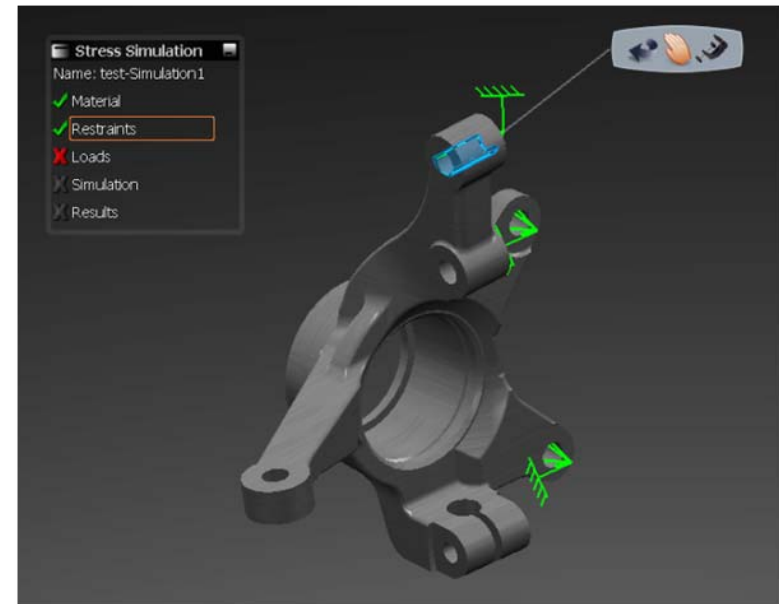
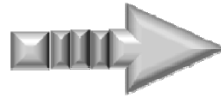
- All technology moves from the domain of the expert to the mass user
 - Electric starters
 - Fuel injection
 - Radial tires



Will it happen?

- The democratization of simulation is inevitable
 - Virtual topology
 - Adaptive meshing
 - Automatic contact

```
>> vi snap.inp
*HEADING
  SNAP
*NODE
  1, 0., 4.
  11, 28., 0.
*NGEN, LINE=C
  1, 11, 1, ,0.,-96.
*ELEMENT, TYPE=B21
  1, 1, 2
*ELGEN, ELSET=SNAP
  1, 10
```



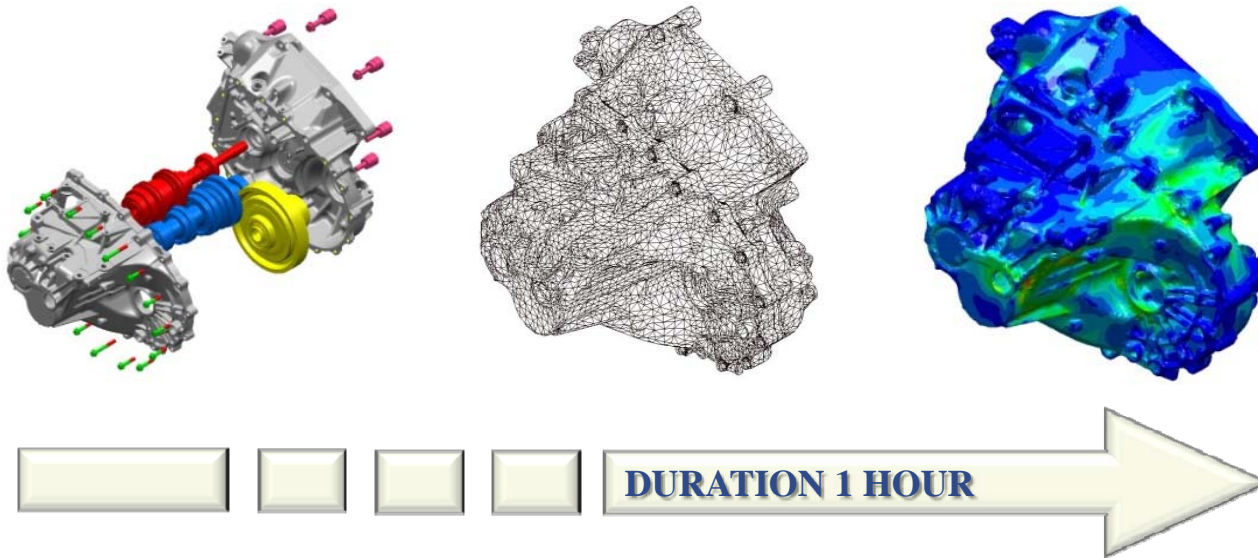
Will it happen?

“Using CATIA Analysis, a designer rather than an expert is now able to perform an analysis on an automobile transmission gear assembly. In the past, such an analysis would only take place if serious problems requiring design modification occurred... With today’s improved CAE tools, however, all analysis conditions for the gear assembly can be set within 30 minutes.”

- Dr. Takanao Uchida, leader of the CATIA V5 project at Honda Automotive R&D and one of the pioneers of “Designer CAE” in Japan.



HONDA



Designer Simulation: Utopia or Catastrophe?

- Hopefully neither
- Next stage of the evolution of simulation to be a key business practice

