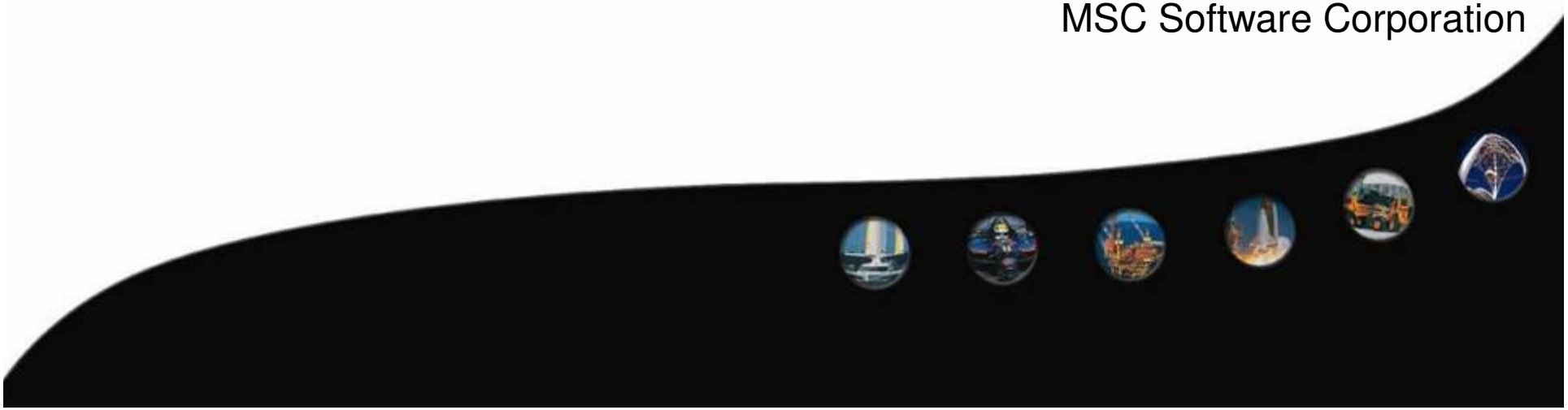
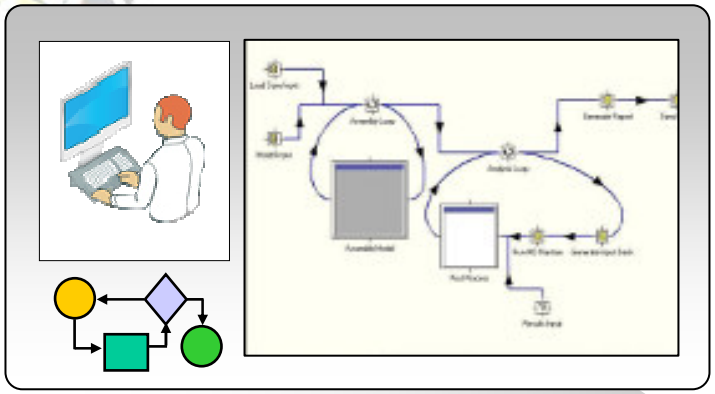
NA Regional Summit 2008 NAFEMS
2020 Vision of Engineering Analysis and Simulation
October 29 - 31, 2008 | Hampton, Virginia

PLASVEE 2020: Driving Success with Digital Simulation

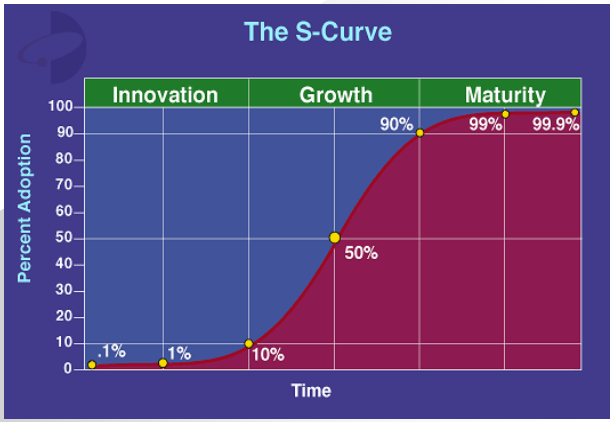
Hal Hikita
Senior Director, Product Development
MSC Software Corporation



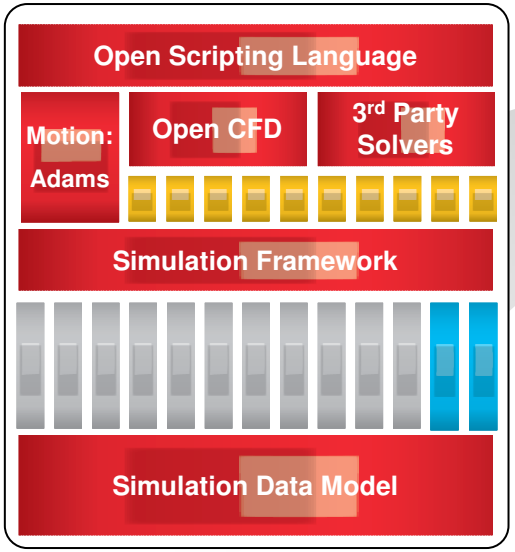
PLASVEE Critical Success Factors



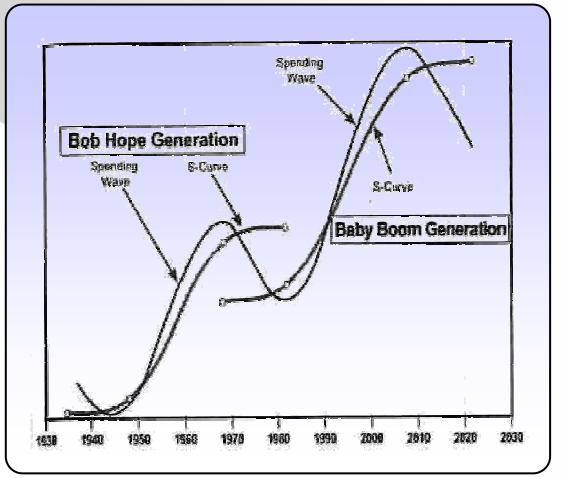
PEOPLE & PROCESSES



SOCIO-ECONOMIC & GOVERNMENT POLICY



TECHNOLOGY

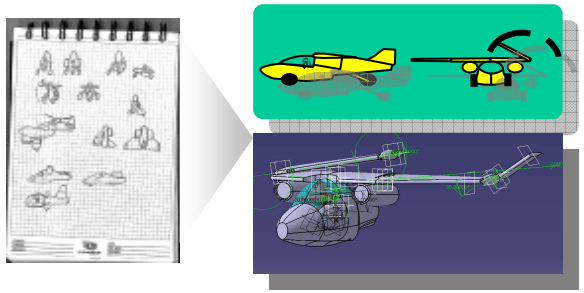


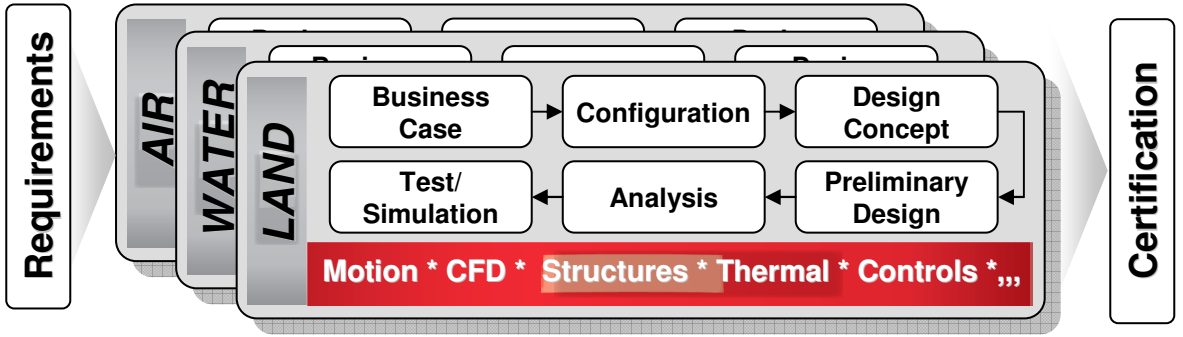
Socio-Economic References

- *The Roaring 2000s*, Harry S. Dent, Jr., Touchstone Books, Simon & Schuster, Inc., 1998.
- *The Great Boom Ahead*, Harry S. Dent, Jr. & James V. Smith, Jr., Hyperion, 1993.

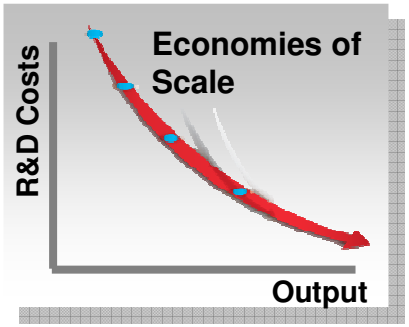
People, Processes, Automation
Operational Efficiency Drives Affordability

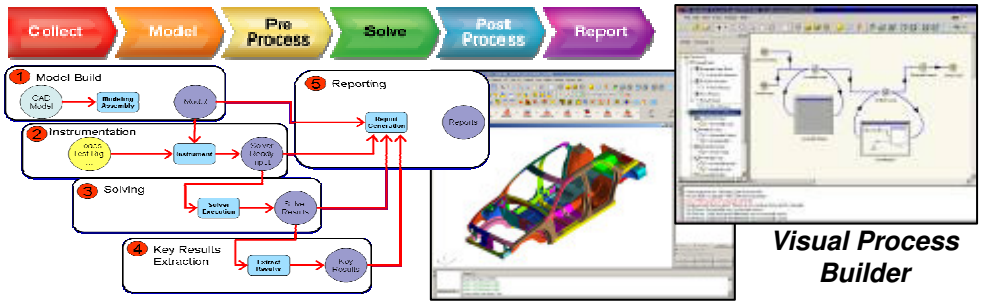
- **Organizational and Operational Design**





- **Lean Process Design and Continuous Improvement**



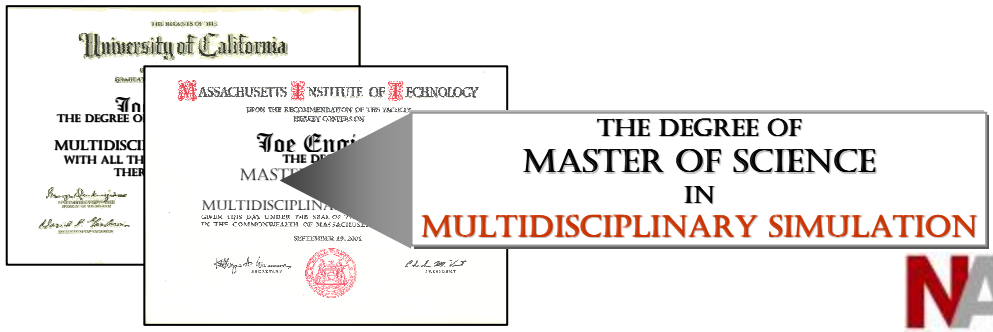


MD Simulation Processes

Modeling/Review Processes

Visual Process Builder

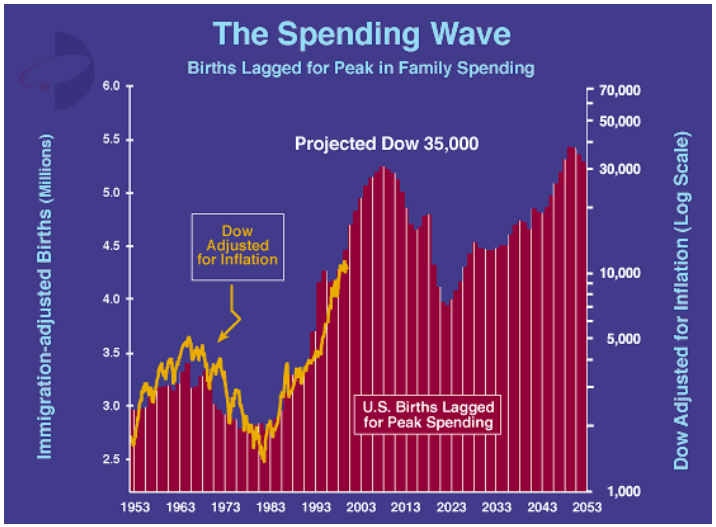
- **Education and Training**



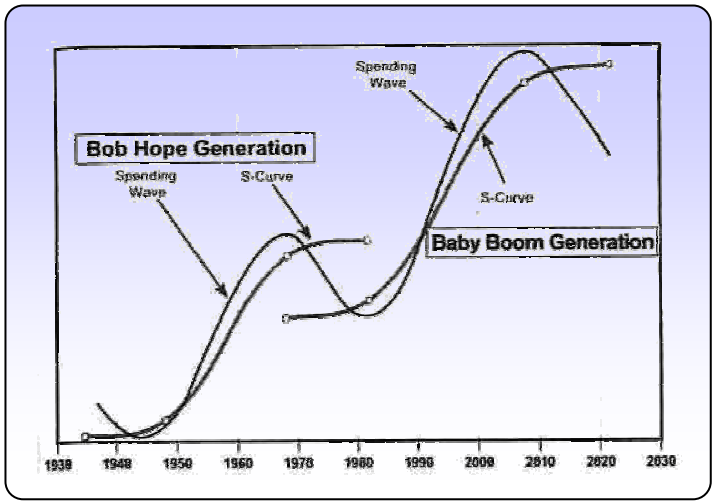
Socio-Economic Factors and Government Policy
Key Enablers

Milner Motors Roadable Light Sport Aircraft

- **"…Thanks to the Light Sport Aircraft and Sport Pilot Rules issued by the FAA in the fall of 2004, the barrier to entry for a small, fully manufactured General Aviation plane was lowered for both pilots and manufacturers.**
- **This new class of airplane introduced the notion of a roadable aircraft versus a flying car, allowing businesses to develop a truly practical air/land vehicle for a reasonable level of capitalization.**
- **The new Sport Pilot category of pilot license also makes it easier for someone to learn how to fly roadable aircraft and other Light-Sport Airplanes..."**



Courtesy of www.hsdent.com



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- *The Great Boom Ahead, Harry S. Dent, Jr. & James V. Smith, Jr., Hyperion, 1993.*

Pathway to Simulation 2020

Personal Land, Air, Sea Vehicles from 2008



Terrafugia "Transition" Roadable Light Sport Aircraft

Courtesy of www.terrafugia.com and www.youtube.com/watch?v=dqA_yTkIEHE

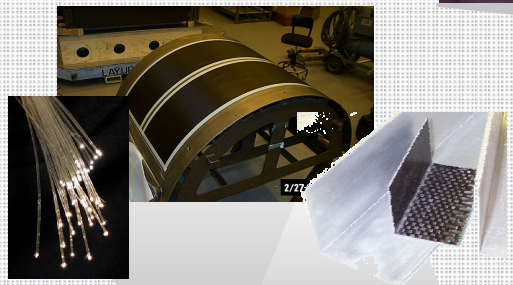


Rinspeed "sQuba" Submersible Concept Car

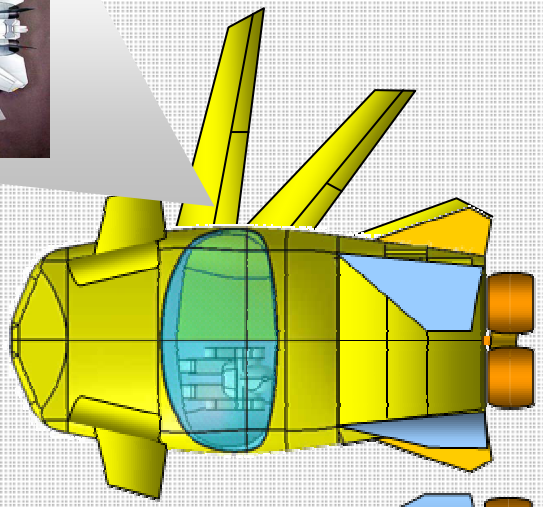
Courtesy of www.rinspeed.com/pages/cars/squba/pre-squba-fotos.htm

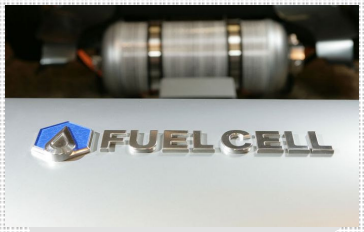
MSC Software Corporation
2020 PLASVEE Platform

- *Recyclable, laminate, Kevlar, and metal matrix modular parts*
- *Pre-wired for sensors, adaptive controls, health monitoring*

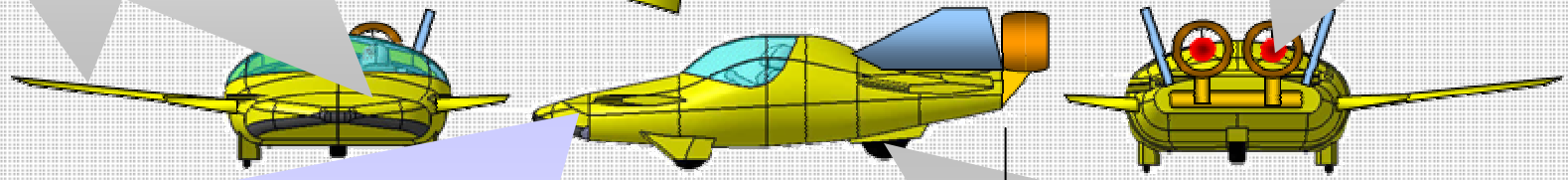


High-lift, variable sweep wing

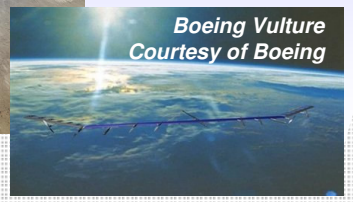




Hybrid Propulsion based on Hydrogen Fuel Cells
Courtesy of www.topnews.in



UAVs Courtesy of www.public.iastate.edu



Embedded autonomous vehicle mechatronics for smart handling in air or water, and on the road.

Toyota Prius

Michelin's innovative airless tire
Courtesy of Michelin Tweel – "T wheel", www.youtube.com/watch?v=xZEc2qdlfrQ www.motorintro.com

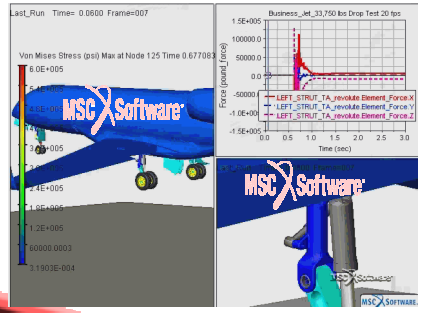
Event Simulation: CAE Revolutionized

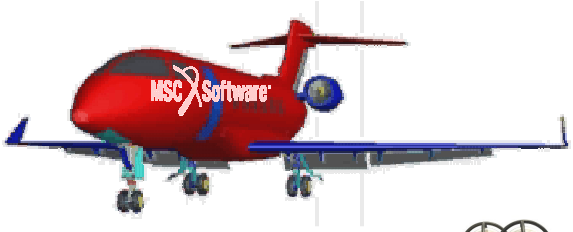
Air/Water Vehicle Events

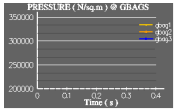
Take-off

Flight Maneuvers/
Fluid Flow

Landing/Ground
Maneuvers

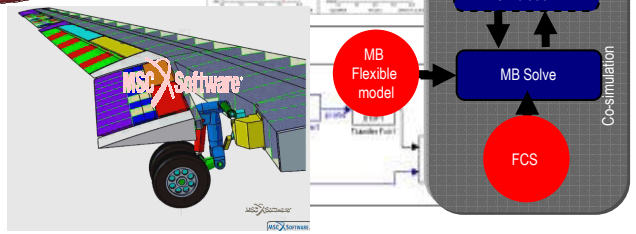






Safety
Simulation

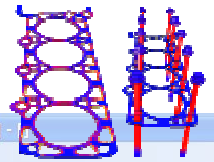
Pressurization
and Seals

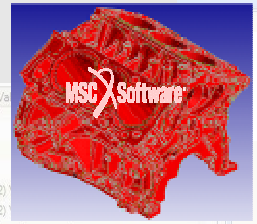


Stability and Controls

Event Simulation: CAE Revolutionized

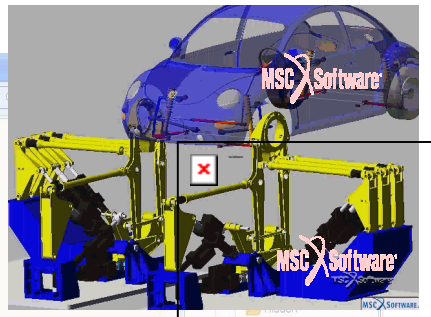
Land Vehicle Events



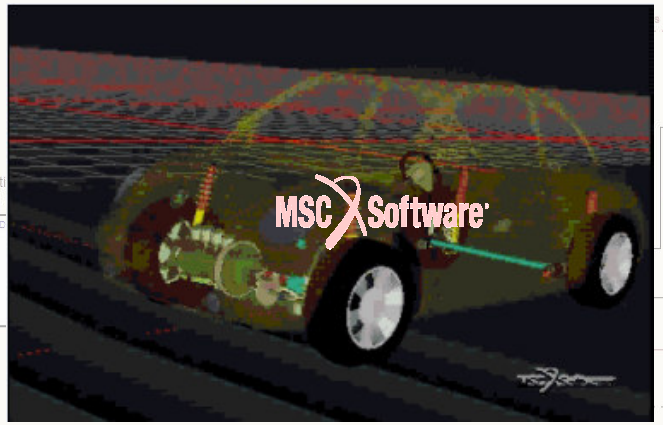


Engine Design

Thermal Management

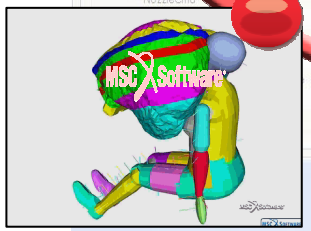


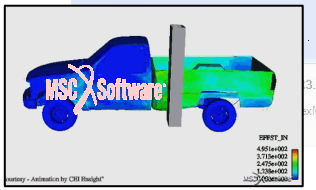
Nonlinear Suspension Systems



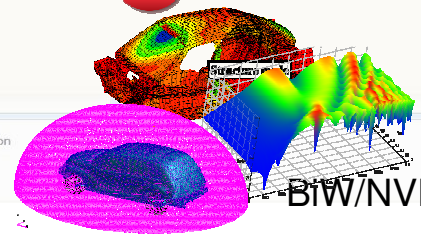
U.S. Department of Transportation
Federal Highway Administration

NHTSA
www.nhtsa.gov



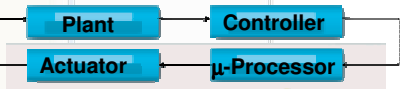


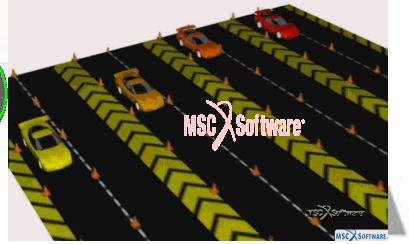
Safety Systems



BIW/NVH

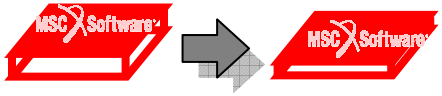
Ride & Handling



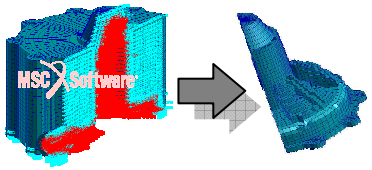


Vehicle Event Optimization Key Enabler
Global, Robust Design Solutions

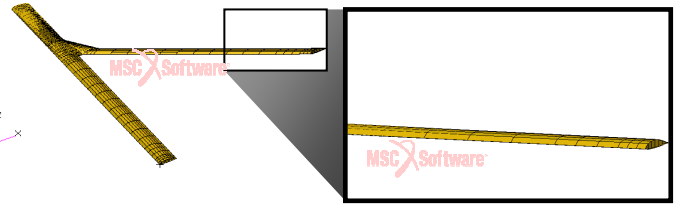
Shape Optimization:
Change in GRID locations



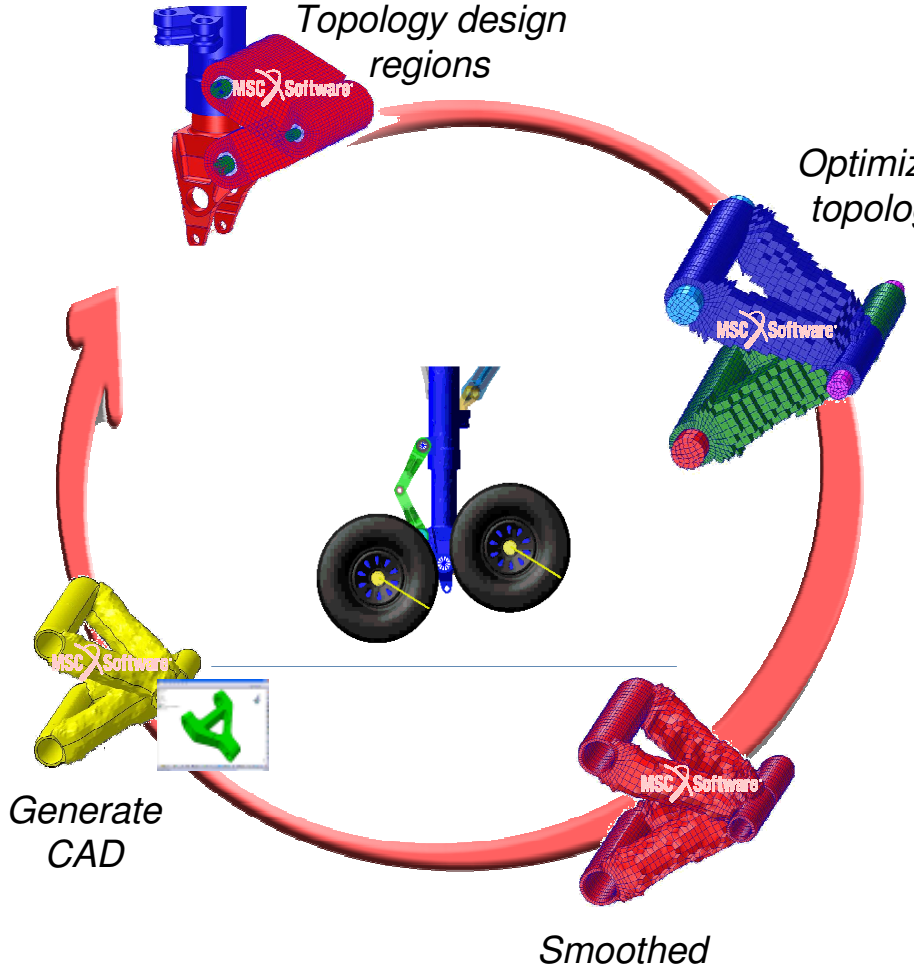
Sizing Optimization:
Changes in property

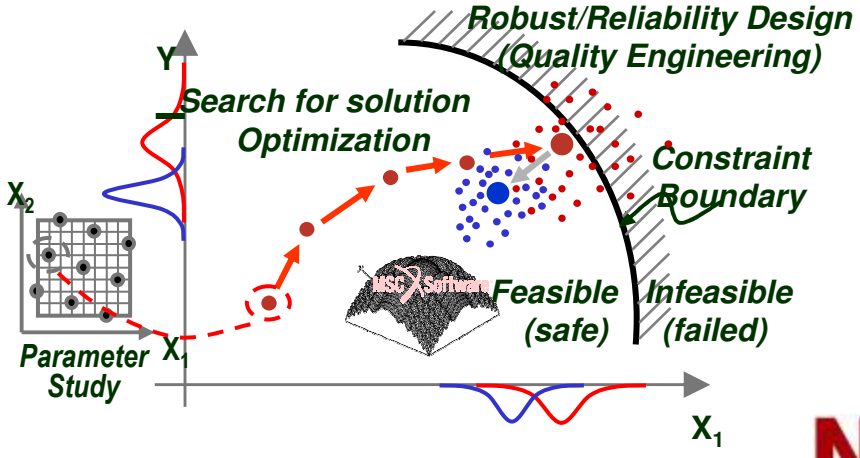


Topology Optimization:
Remove Unneeded Structure



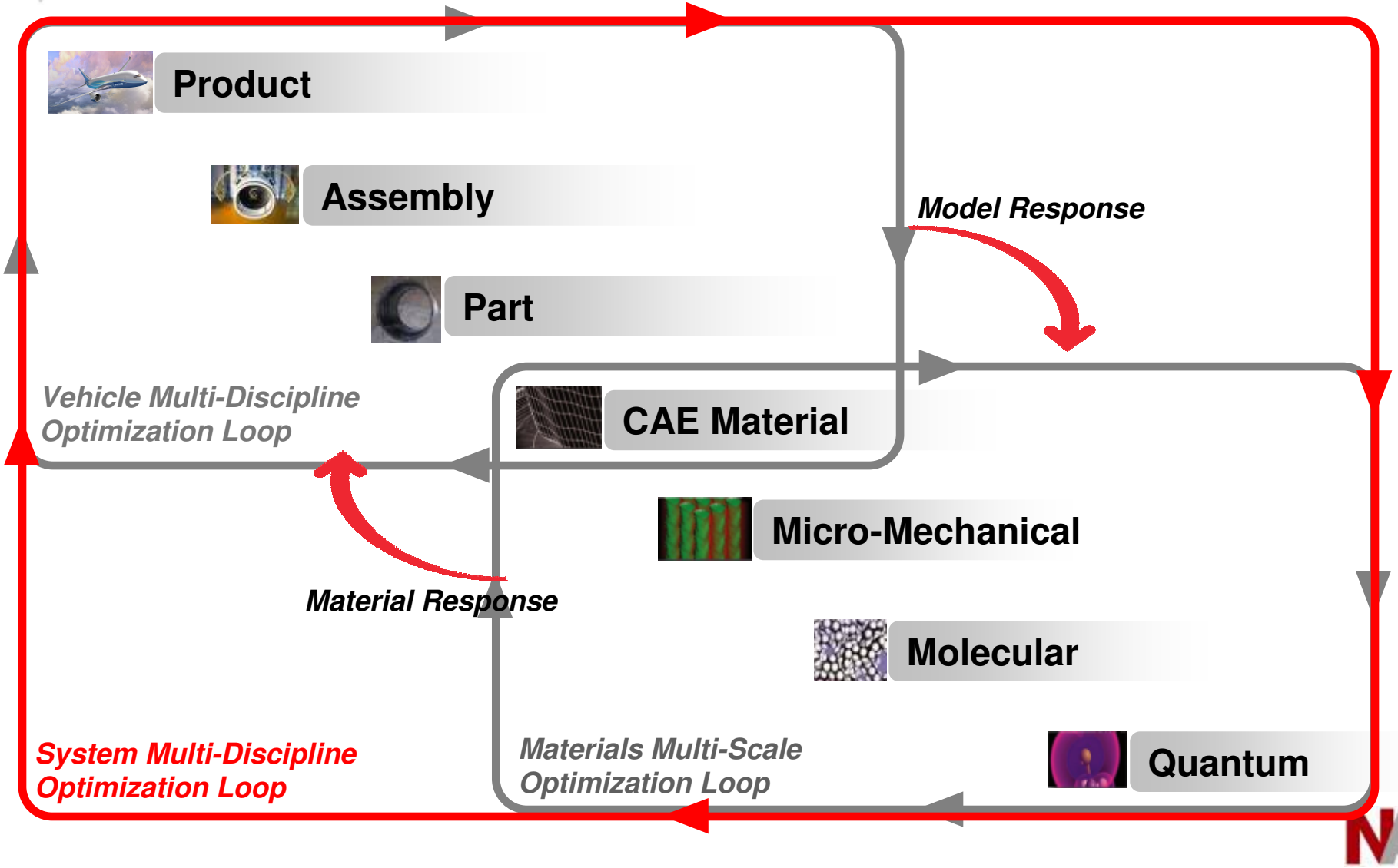
Nonlinear Post-Buckling Optimization





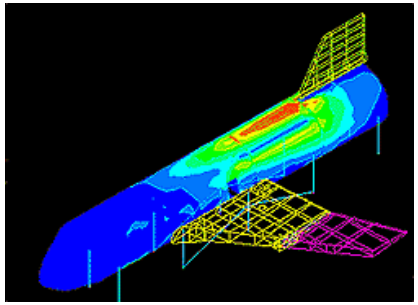
Vehicle Event Optimization Key Enabler

Multi-Discipline / Multi-Scale Optimization

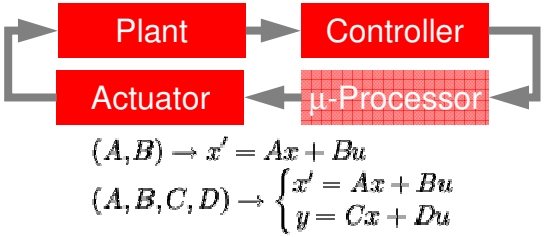


MD Event Simulation Key Enablers
Computational Parts and Assemblies

- **Computational Parts**
  - Contact Body
  - FE Parts
  - FRF Parts
  - Motion Parts
- **Kinematics Elements**
  - Large rotation beam & shells
  - Rigid elements for modeling rotations

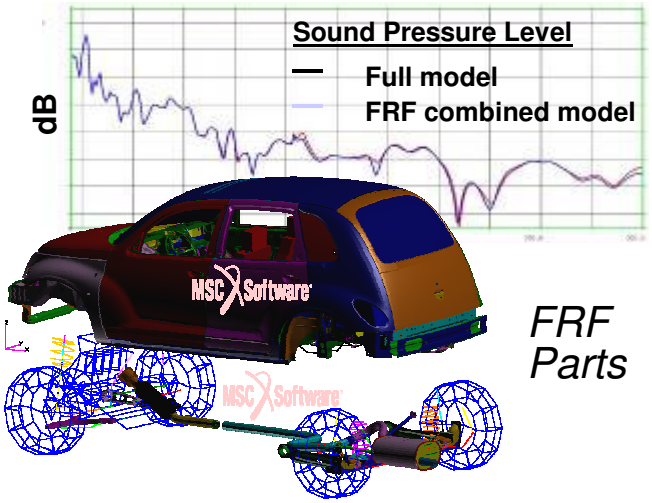


FE Parts

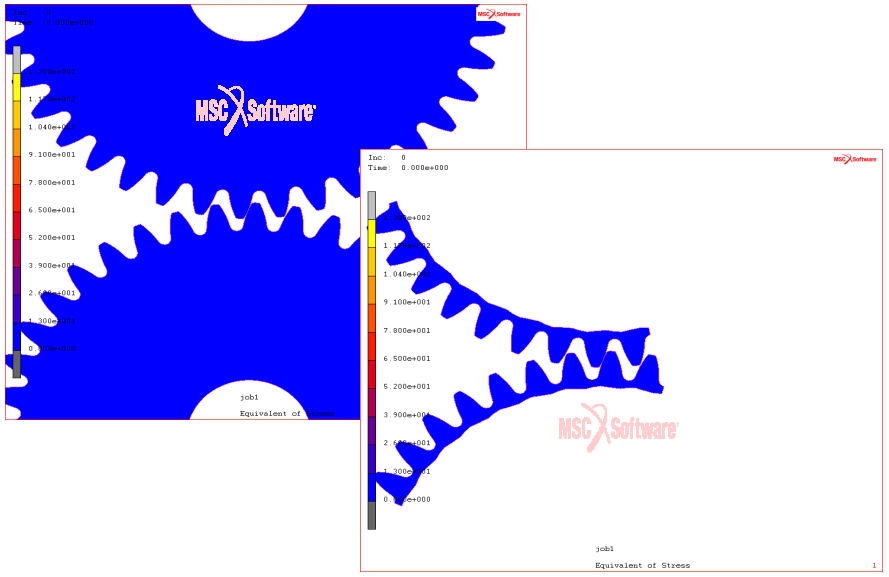


$$(A,B) \rightarrow x' = Ax + Bu$$
$$(A,B,C,D) \rightarrow \begin{cases} x' = Ax + Bu \\ y = Cx + Du \end{cases}$$

Electro-Mechanical Parts
***G**eneral **S**tate **E**quations*

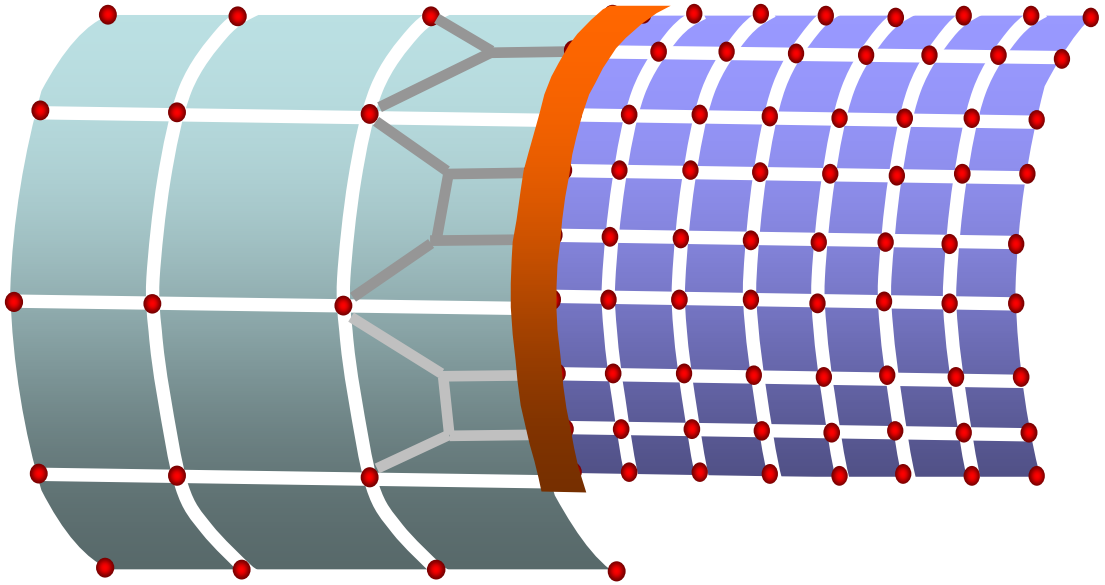


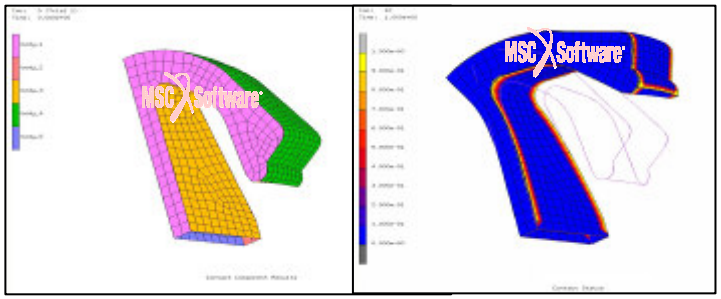
FRF Parts



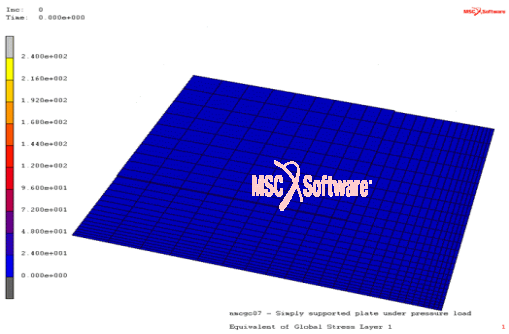
Superelement Contact

MD Event Simulation Key Enablers
Computational Parts and Assemblies

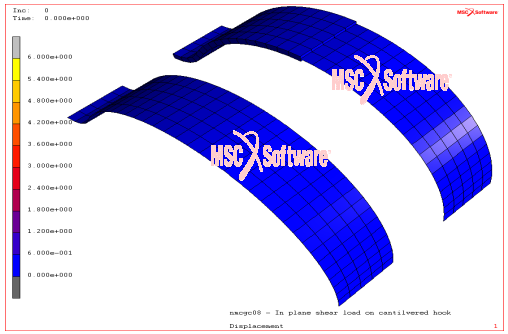




Non-congruent shells joined with Shell Edge-to-Edge Glue



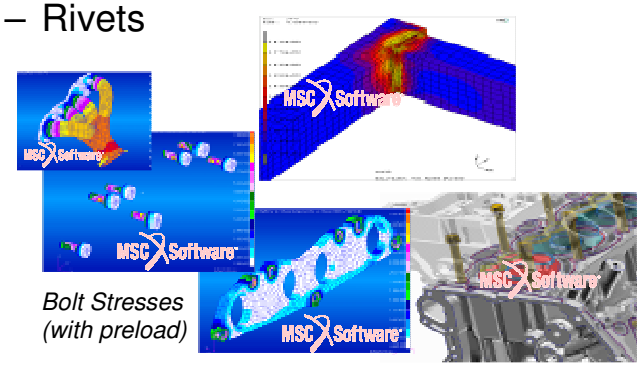
Full Moment-Carrying Glue



Full Moment-Carrying Glue in bending

Computational connectors

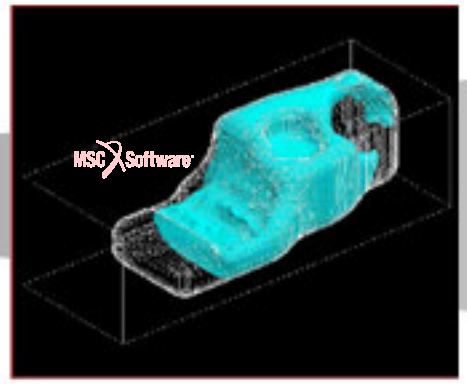
- Spot and seam Welds
- Bolts and Gaskets
- Rivets



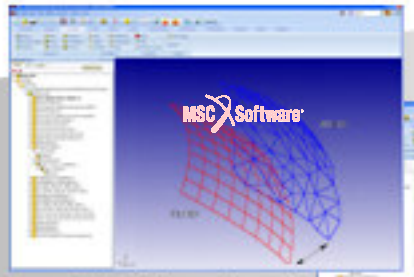
Bolt Stresses (with preload)

Head Stresses

MD Event Simulation Key Enablers
Robust MD Simulation

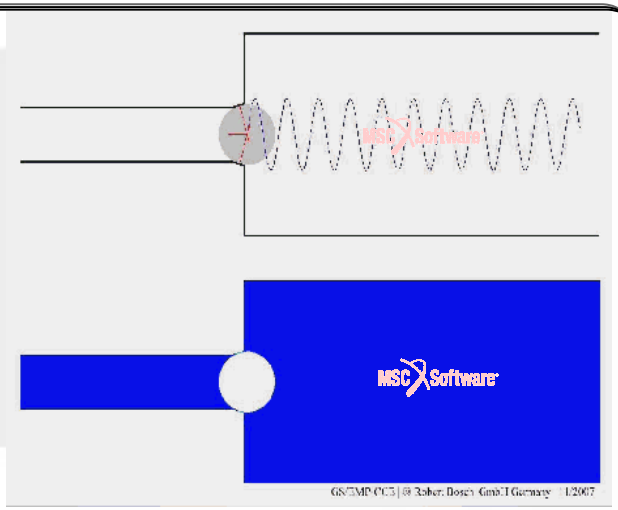


Fuel-Tank Sloshing



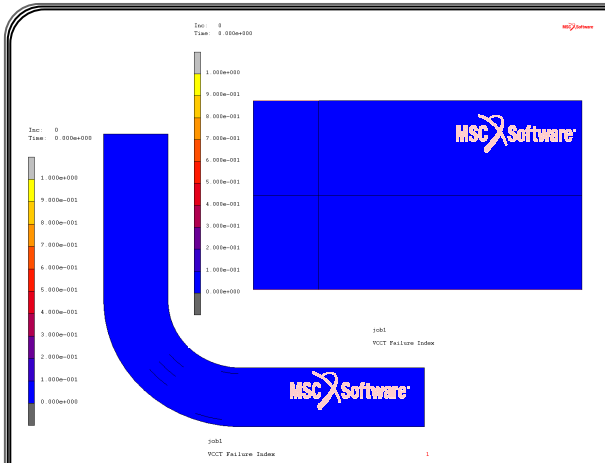
CFD/Structural coupling

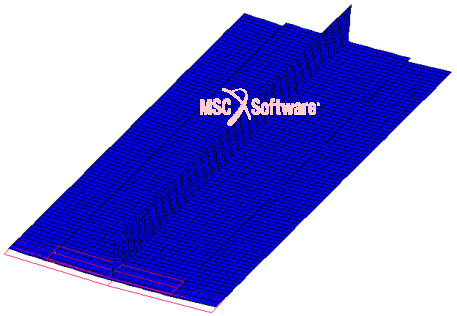
CFD/Structural visualization

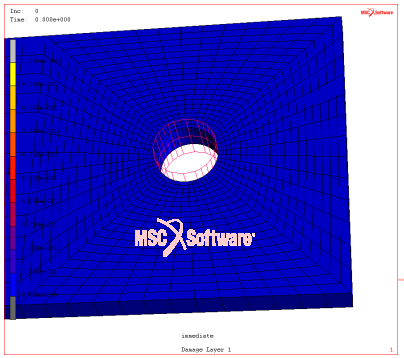


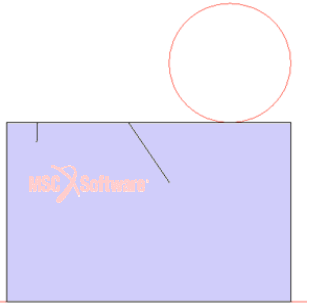
CFD/Structures/Motion
Courtesy of Bosch Germany

Fluid-Structures Interaction



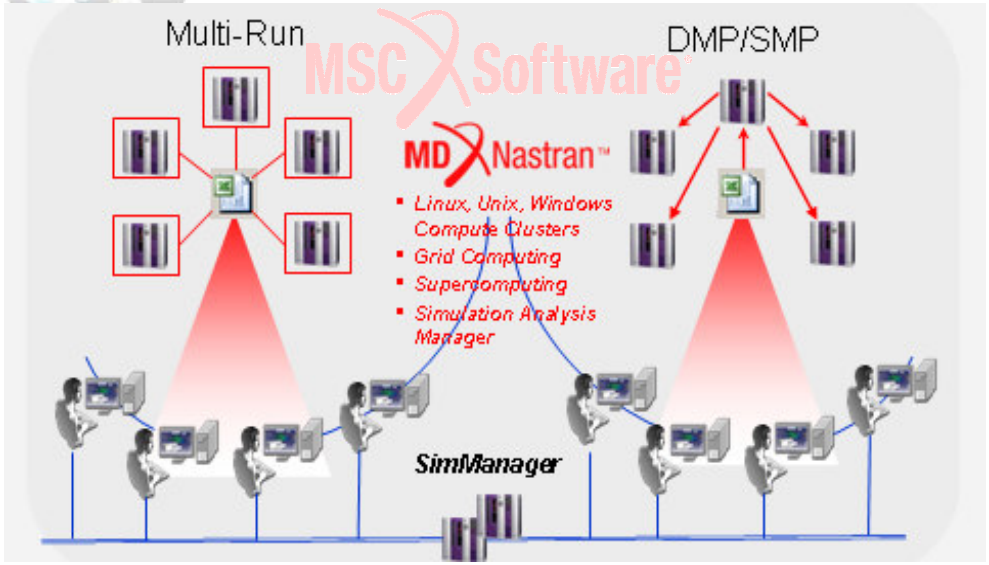


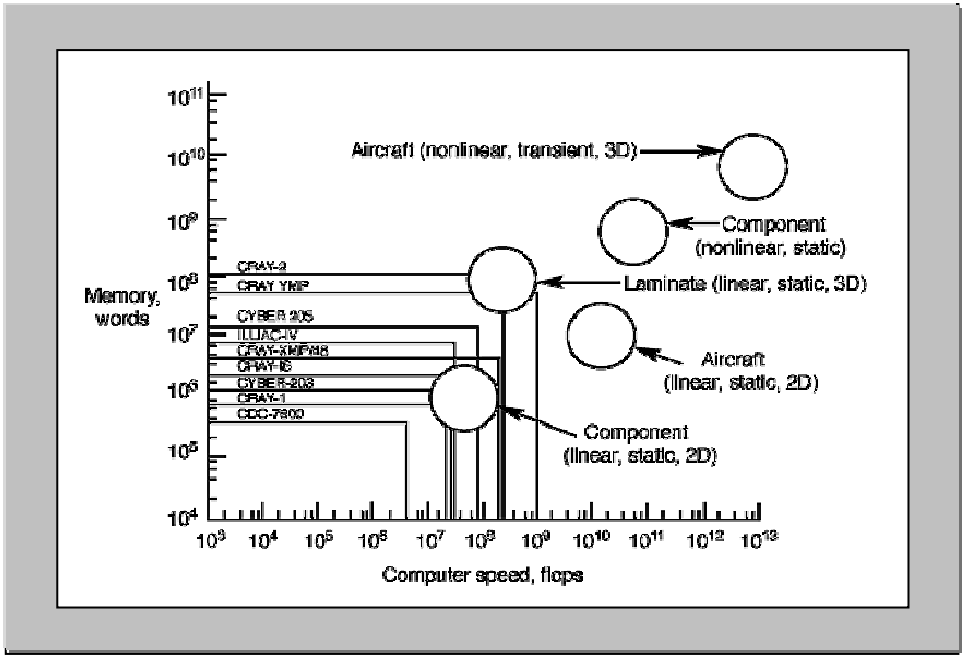




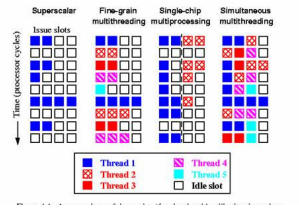
Structural Integrity and Durability

Scalable Simulations
Pervasive HPC





- **Tuned solvers**
  - SMP/DMP enabled
  - Multi-processor/core enabled
  - Cluster/Grid enabled
  - Leading edge numerics
- **Optimized chips**
  - Intel, IBM, HP, …
- **Multi-threaded, Distributed Interactive Solutions**
  - Visualization
  - Pre/Post
  - Model Management
  - Meshing



- **Open Job Management**
  - Desktop and Web-based
  - Compatible with popular job schedulers, LSF, etc

Rich Multidiscipline Modeling and Visualization

Dedicated and CAD-Embedded Modeling Environments

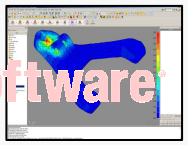
Dedicated Simulation Environment

MSC SimXpert™

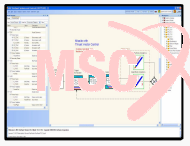
Reuse Expert Simulation Knowledge

MSC SimXpert™

Motion



Structures



Systems/Controls

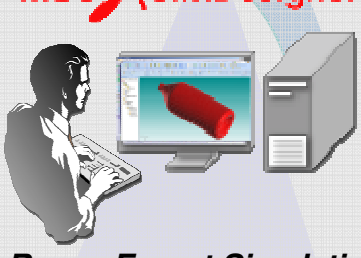
Thermal

Crash/Explicit

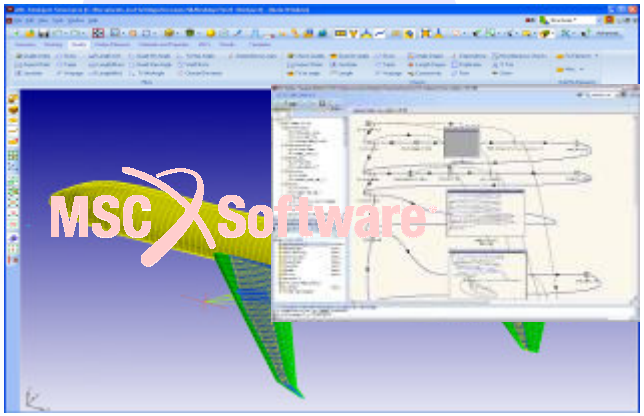
3rd Party / User-Defined

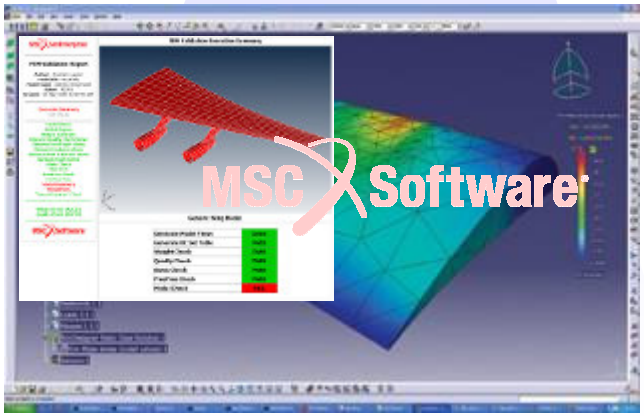
CAD-Embedded Simulation Environment

MSC SimDesigner™



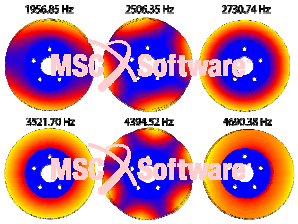
Reuse Expert Simulation Knowledge in CAD Environments

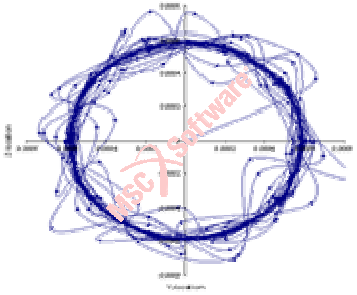


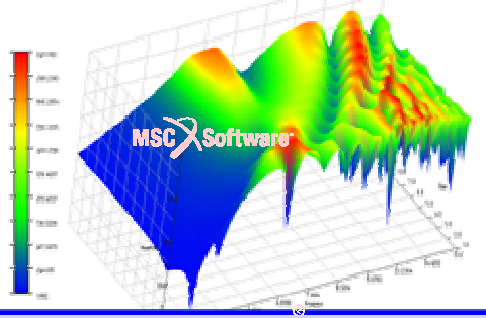


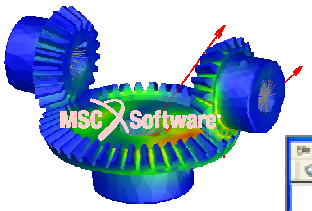
Simulation Intelligence
Knowledge-Processing

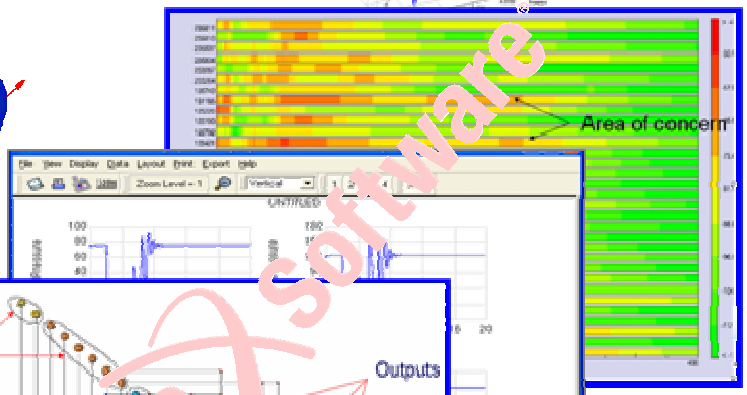
- **Enabling Informed Design Decisions**
  - **Dashboards**
  - **"Search engine" for critical cases**
    - Max-min, envelope, ranking, etc.
  - **Rapid Global-Local Assessments**
    - Using FE results to compute real design metrics
      - Best practices and methods
      - Allowables / criteria
      - Micro-mechanical failure
      - Manufacturing processes
  - **Embedded non-FE analyses**
  - **Auto FE update**
    - Auto remeshing
    - Multiple meshes, surrogate models
    - Shape optimization smoothing
  - **Auto FE ⇨ CAD**

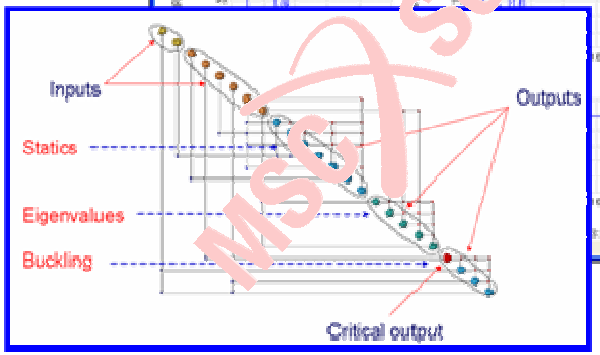






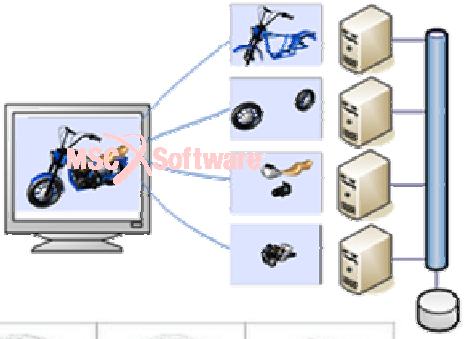






High-Performance Visualization

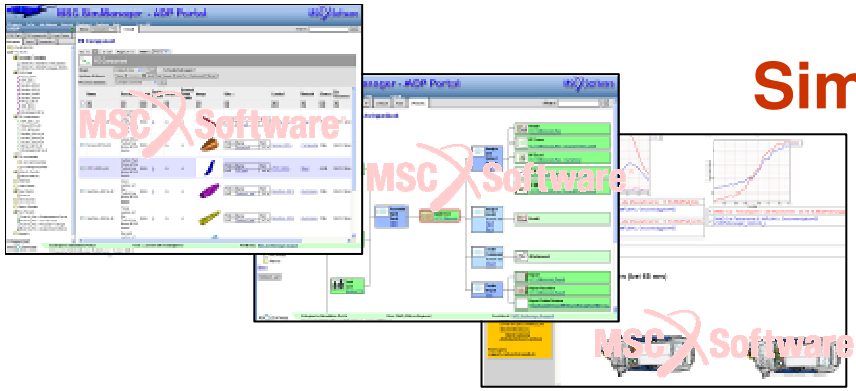
- High-end 3D graphics specialized for visualizing scientific and engineering data
- Scalable desktop and Web-based, Interactive, photo-realistic, visualization of very large data sets
- Large-scale volume rendering enabled by HPC
- Virtual Reality Interactive with "Fly-around" and "Walk-through" inspection modes



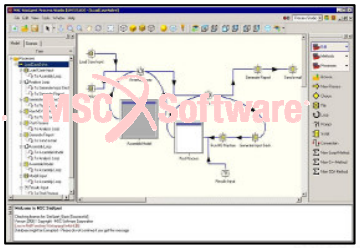
Virtual Reality / Virtual Vehicle

Image					
Vertices	~5500	~2680	~1580	~670	140
Notes	Maximum detail for closeups.				Minimum detail, very far objects.

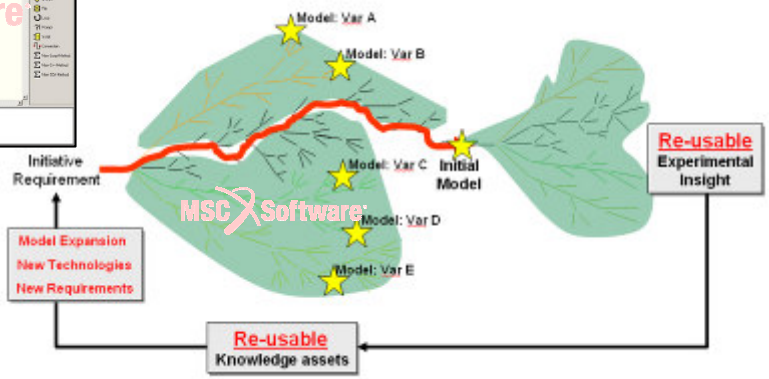
Level-of-Detail Management



Simulation Knowledge Management
Leveraging Simulation Intelligence



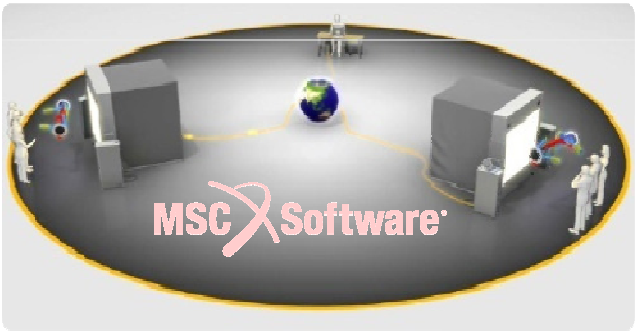
- **Simulation Process and Data Management**
  - Best Practices Capture, Sharing, Integration, Automation
  - Simulation/Modeling workflows
  - Process and data pedigree
  - Dashboards, reports, trend analysis
- **Immersive Real-time Collaboration**
  - Convergence of Virtual Reality, HPC, Remote Conferencing



Simulation Process and Data Management

Immersive Collaboration

Images courtesy of ICIDCO



NA Regional Summit 2008 NAFEMS

2020 Vision of Engineering Analysis and Simulation

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Thank You!