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MultiDisciplinary Simulation of a Climate Control System

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MSC Software

MultiDisciplinary Simulation of a Climate Control System

Challenge: Validate a Manufacturing Tool
Change to Door Substrate Tool

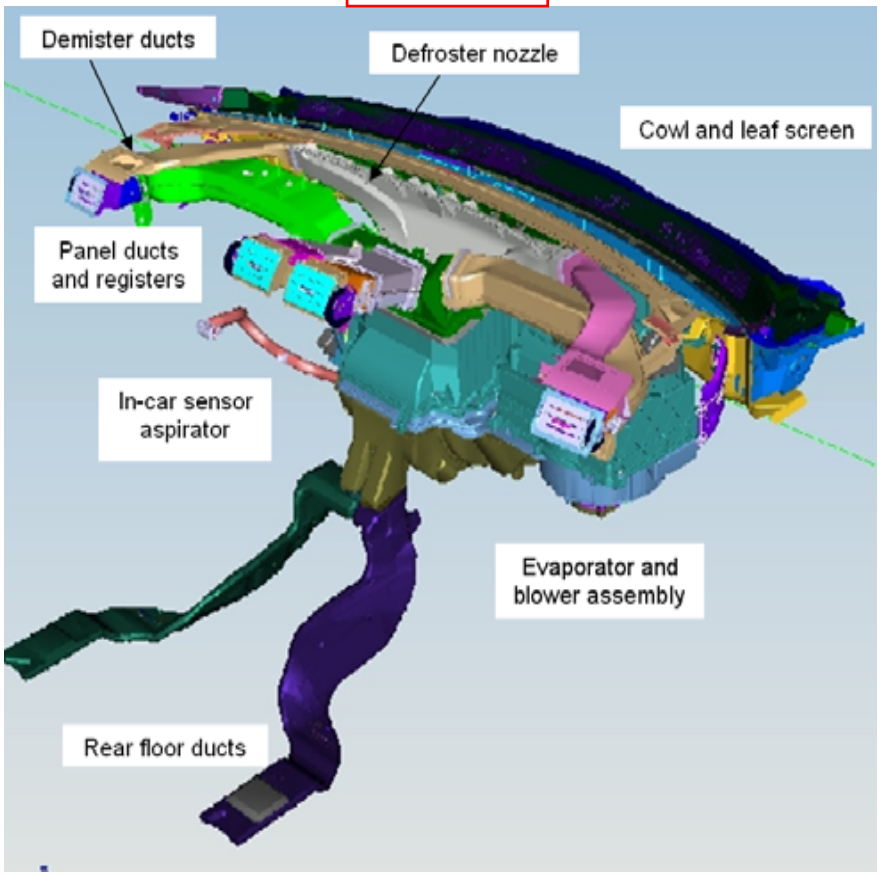
A door component of a climate control system is tested with Adams and MD Nastran using the template approach in SimXpert. The solution combines both dynamics and nonlinear implicit FEA with process automation in mind.

Trent Meehan – Automotive Components Holdings
Fouad Hafiani, Patrick J. O'Heron – MSC.Software

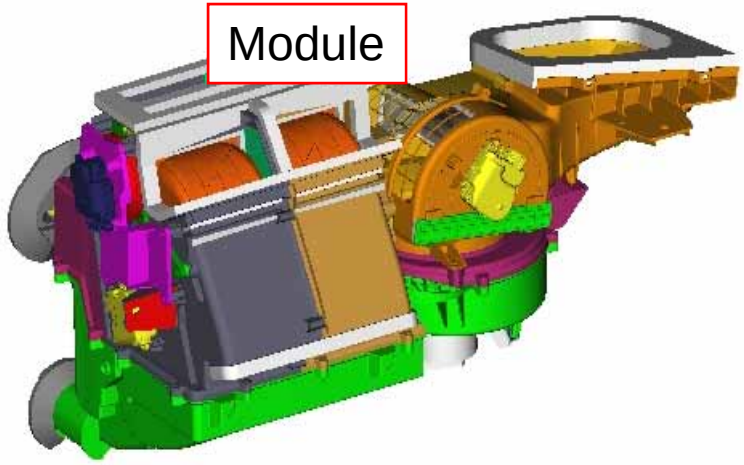
Who we are…
ACH & Sheldon Road Plant

HVAC Pieces and Parts

System

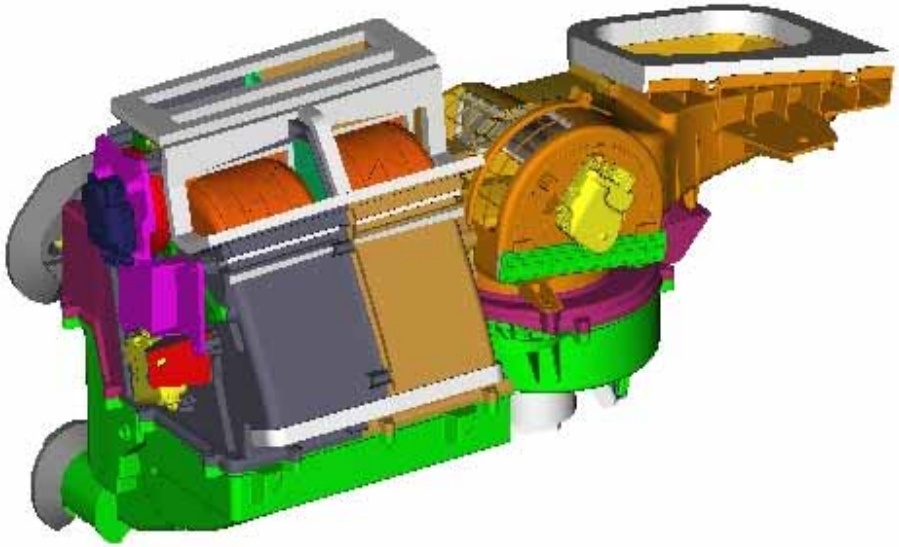


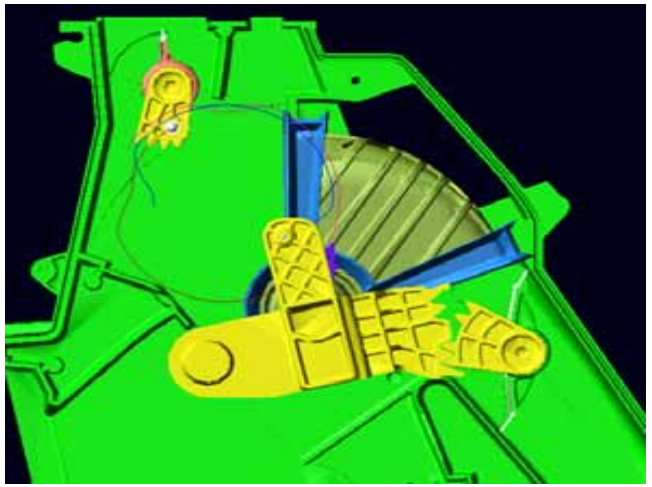
Module



Component

Which part is the door?



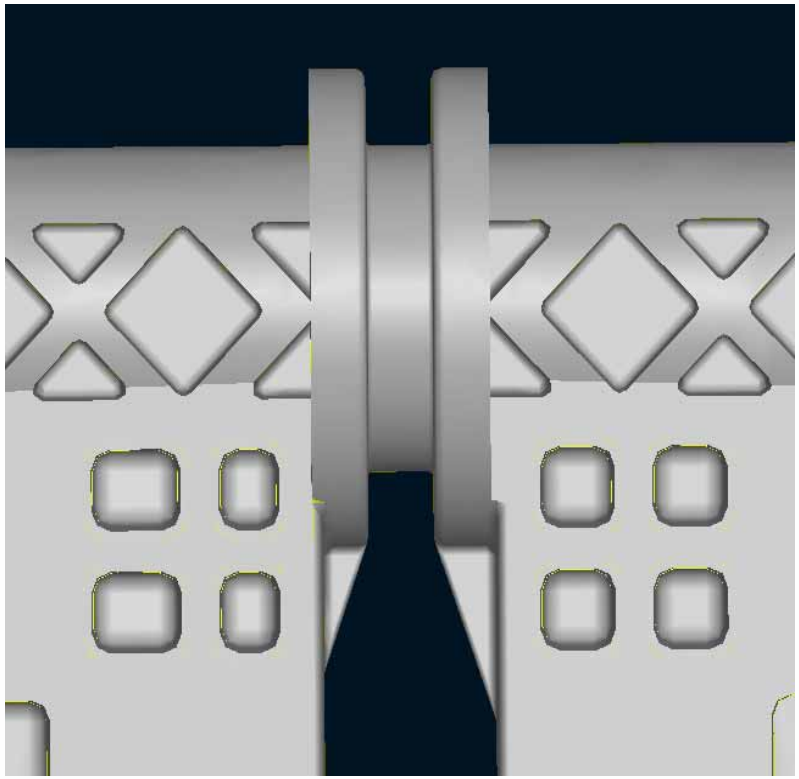


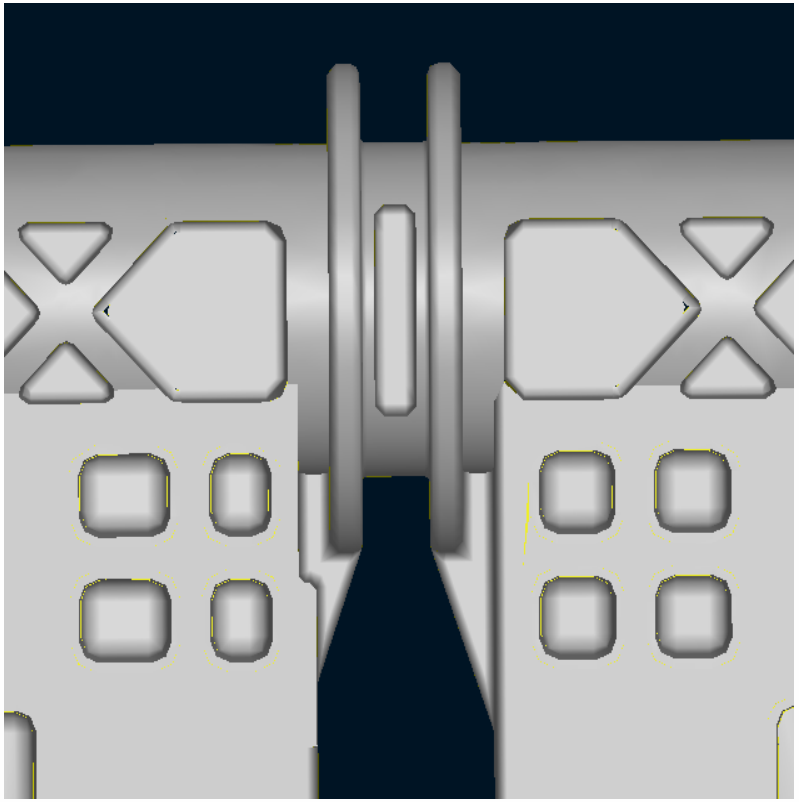
HVAC Door Design CAE Challenges

- *Design Stage*
  - **Preliminary Design Exploration**
  - **Validate Designs against Requirements**

- *Manufacturing Stage*
  - **Identify Root Causes**
  - **Validate Changes**

Challenge: Validate a Manufacturing Change to the Door Substrate Tool

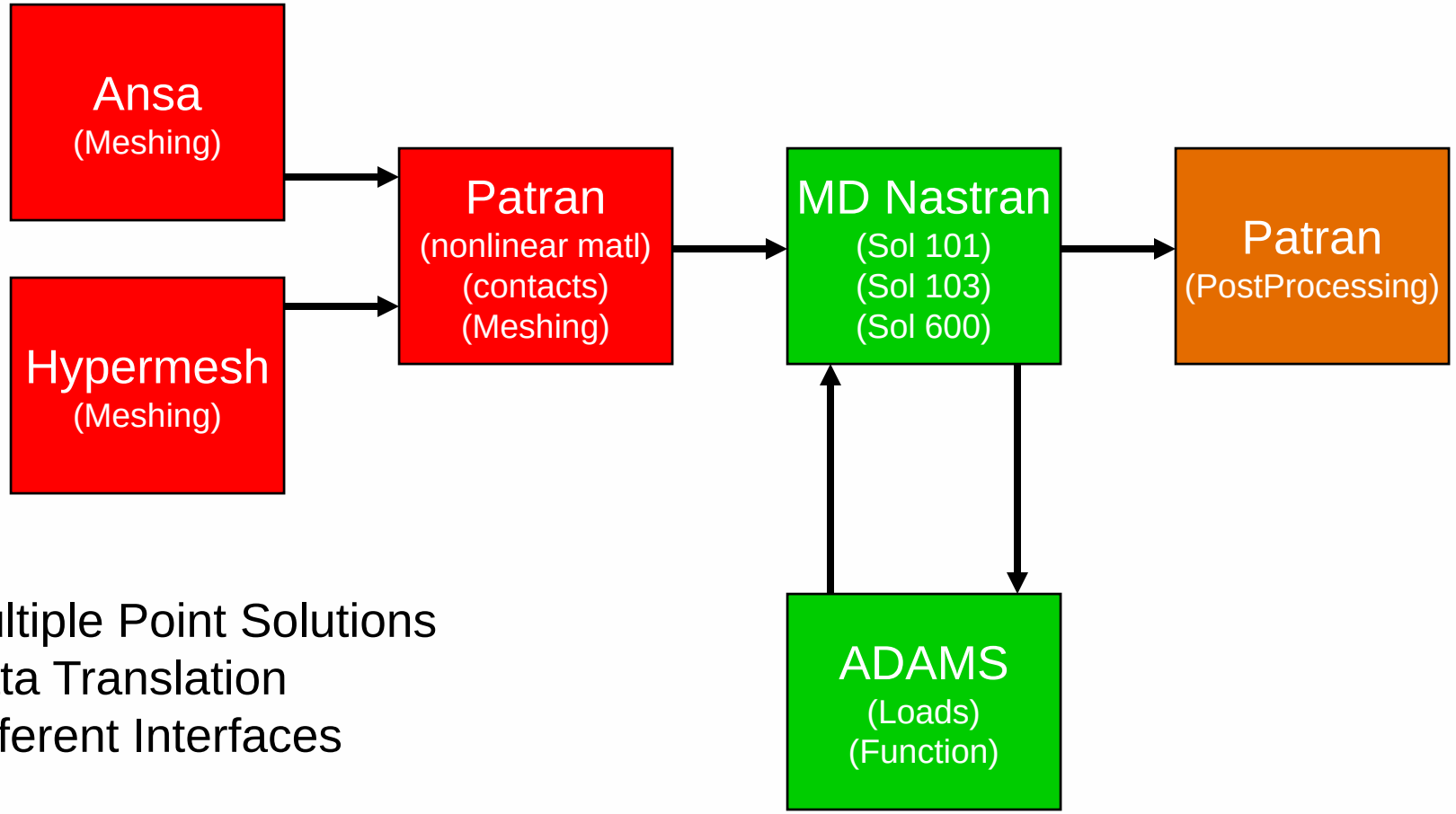




CAE Tools Applied

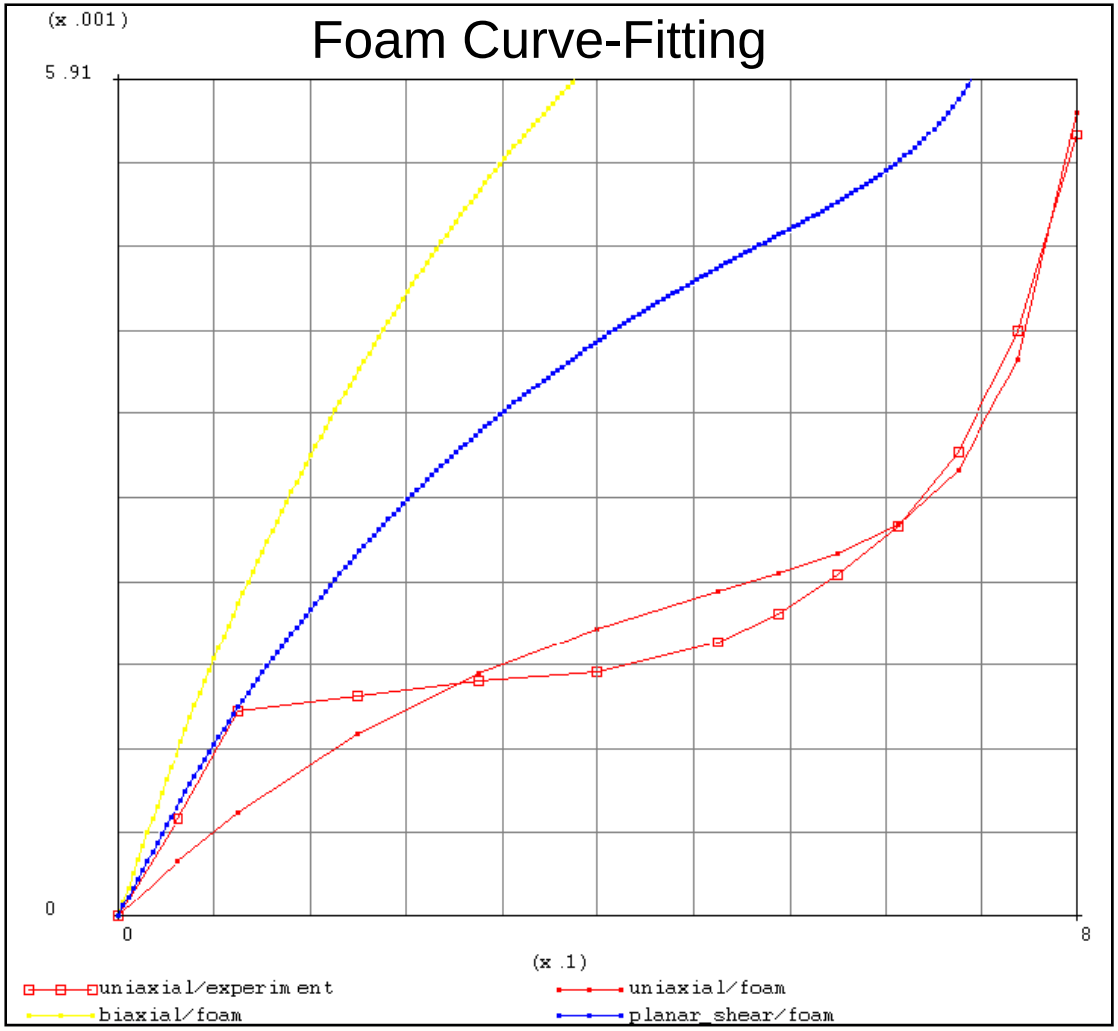
- *ADAMS with Flex Bodies and Contacts*
- *MD Nastran Solution 101*
- *MD Nastran Solution 600*
- *SimXpert*

Analysis Process



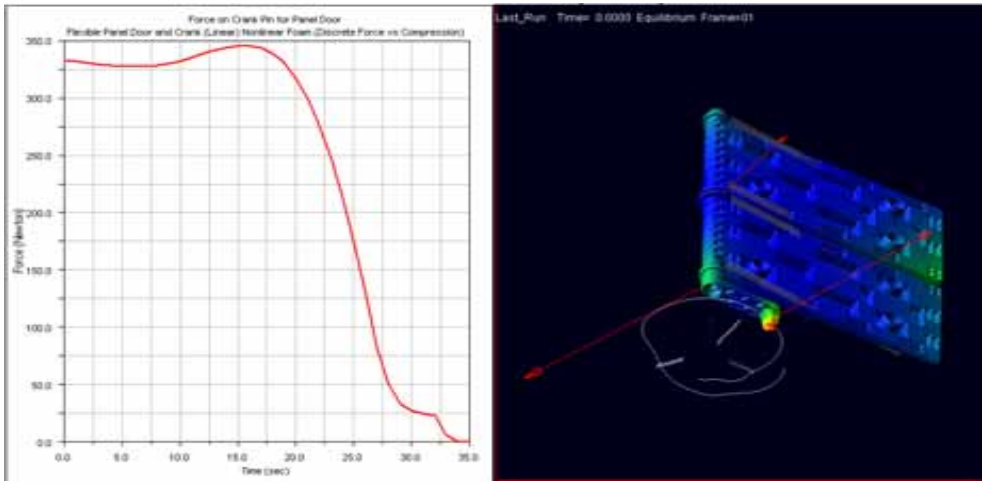
Multiple Point Solutions
Data Translation
Different Interfaces

Non Linear Material Characterization

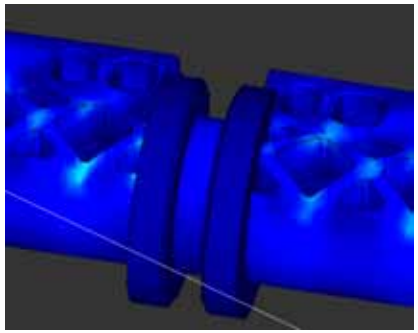


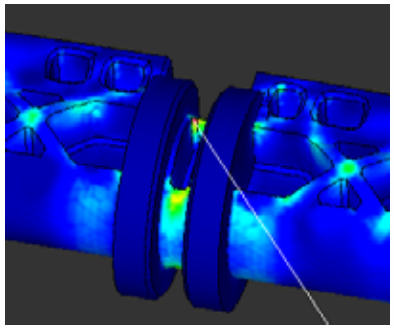
Kinematics and Linear Structural with ADAMS and MD Nastran Sol 101

ADAMS with Flex Bodies and Contacts

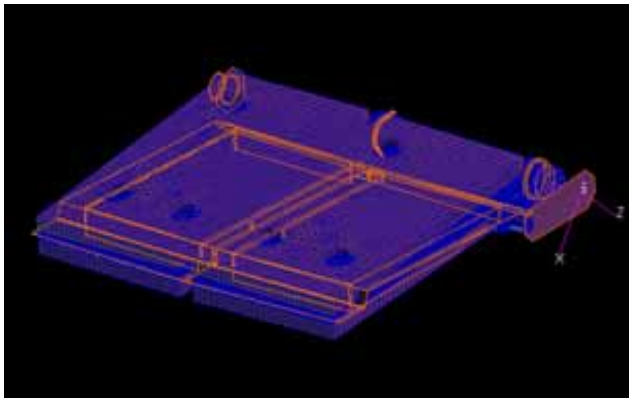


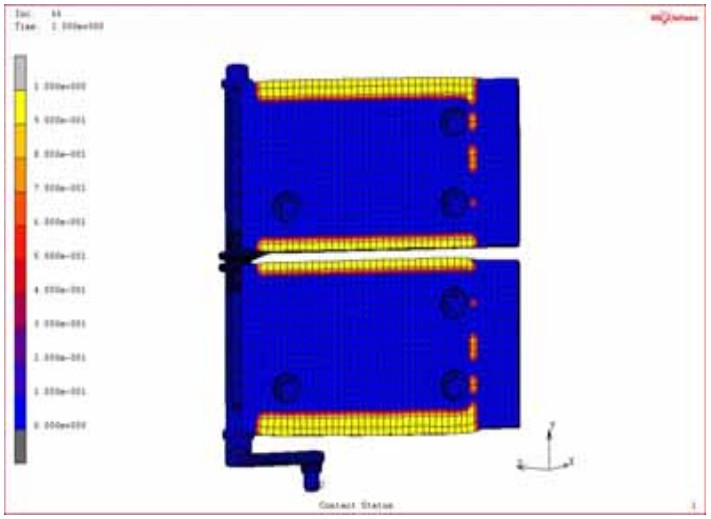
MD Nastran Solution 101

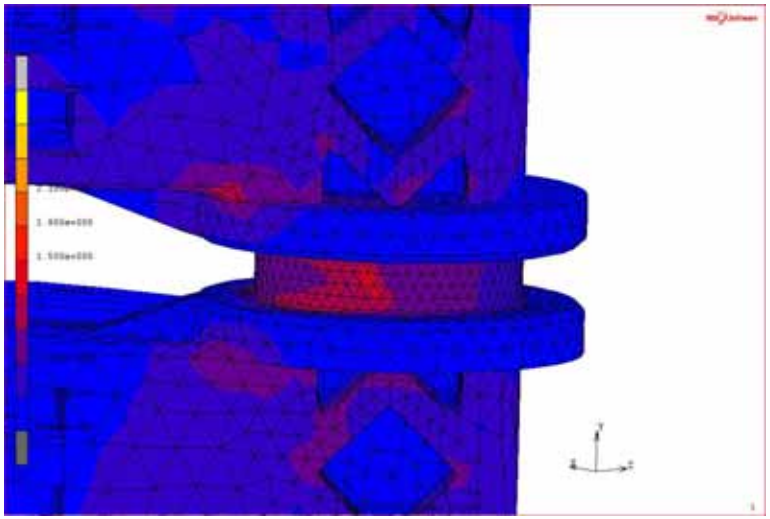


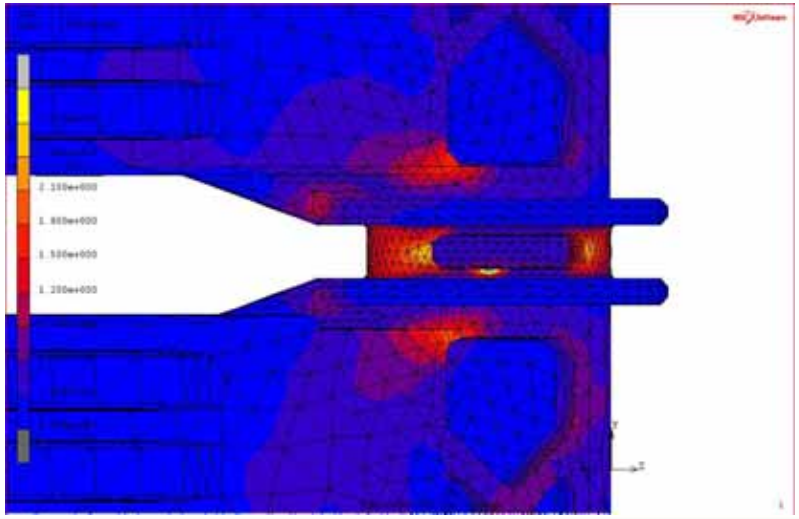


Nonlinear Structural with MD Nastran Sol 600

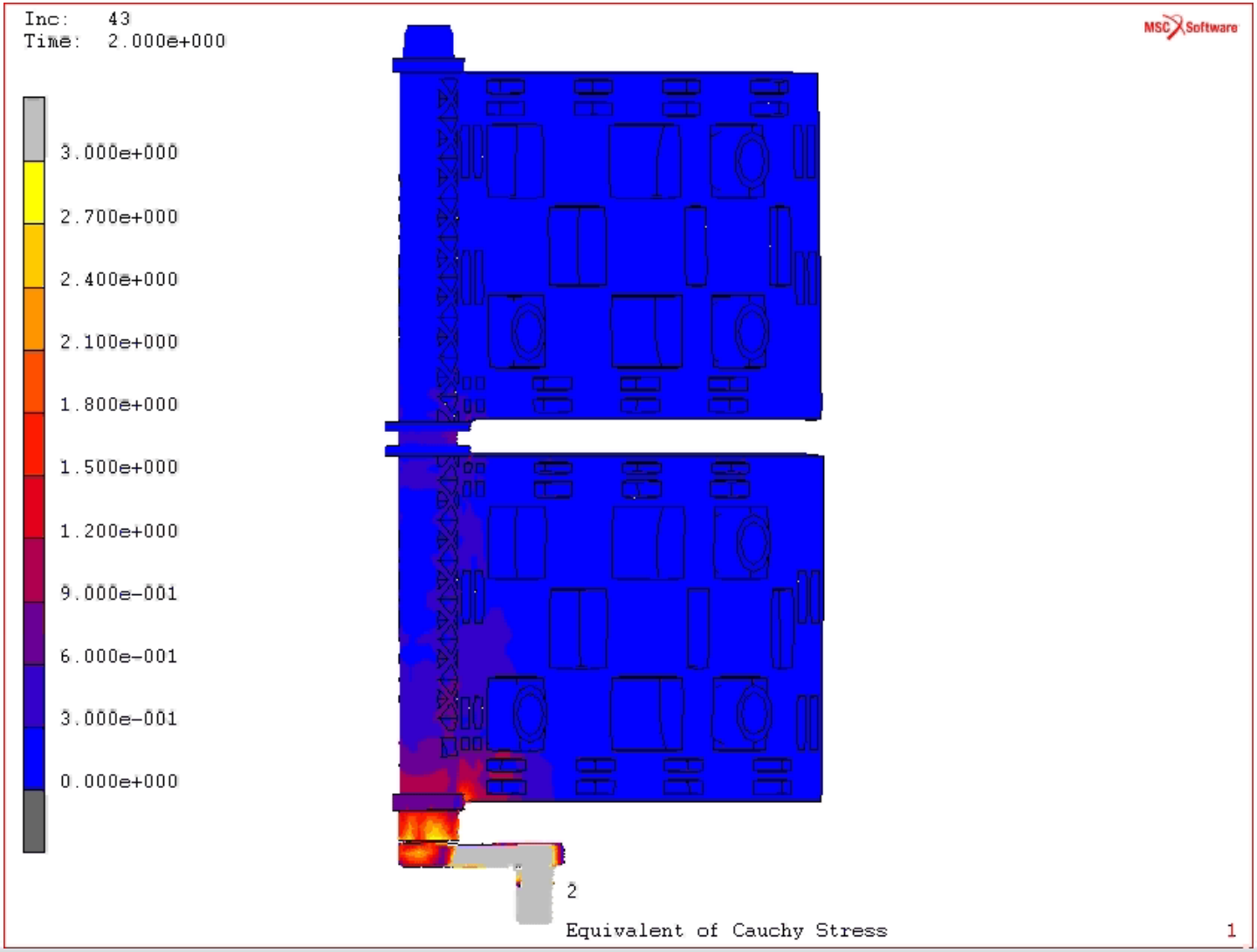




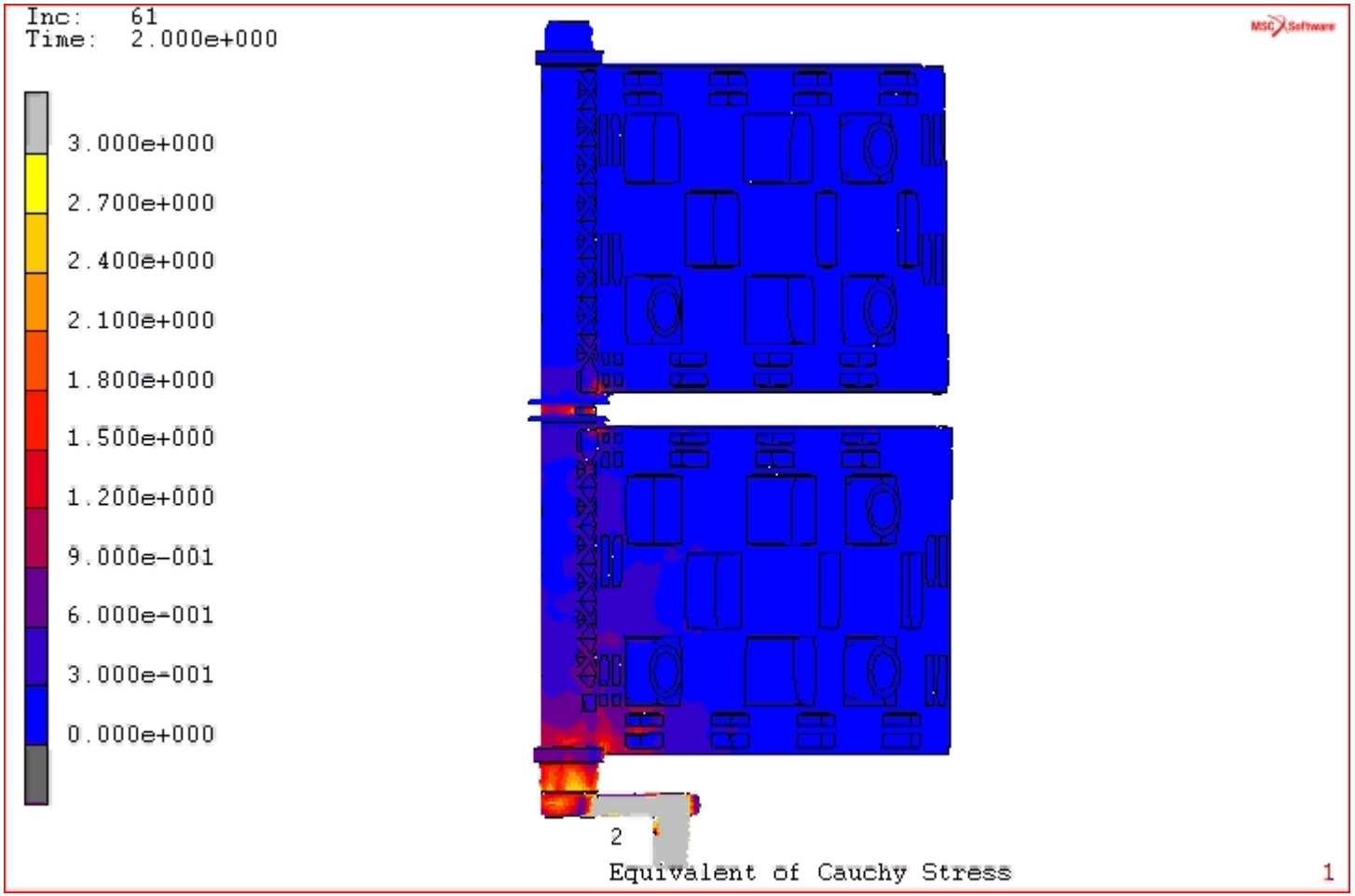




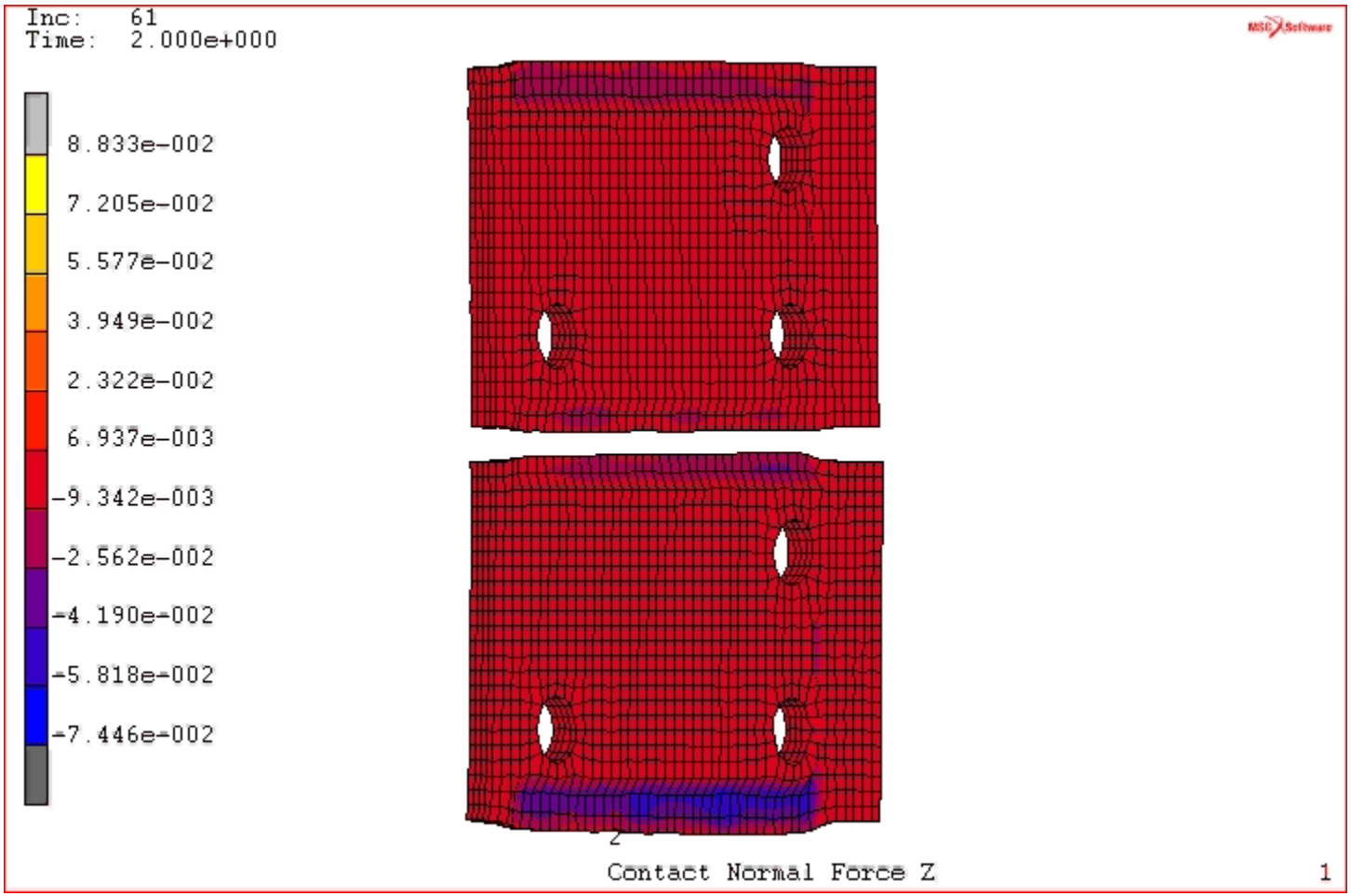
Old door


Inc: 43
Time: 2.000e+000
3.000e+000
2.700e+000
2.400e+000
2.100e+000
1.800e+000
1.500e+000
1.200e+000
9.000e-001
6.000e-001
3.000e-001
0.000e+000
MSC Software
2
Equivalent of Cauchy Stress
1

New door


Inc: 61
Time: 2.000e+000
3.000e+000
2.700e+000
2.400e+000
2.100e+000
1.800e+000
1.500e+000
1.200e+000
9.000e-001
6.000e-001
3.000e-001
0.000e+000
2
Equivalent of Cauchy Stress
1

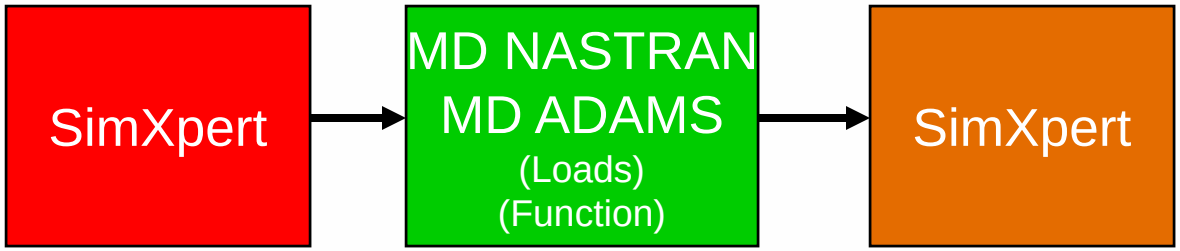
New door


Inc: 61
Time: 2.000e+000
8.833e-002
7.205e-002
5.577e-002
3.949e-002
2.322e-002
6.937e-003
-9.342e-003
-2.562e-002
-4.190e-002
-5.818e-002
-7.446e-002
Z
Contact Normal Force Z
1

TEMPLATE CONCEPTS

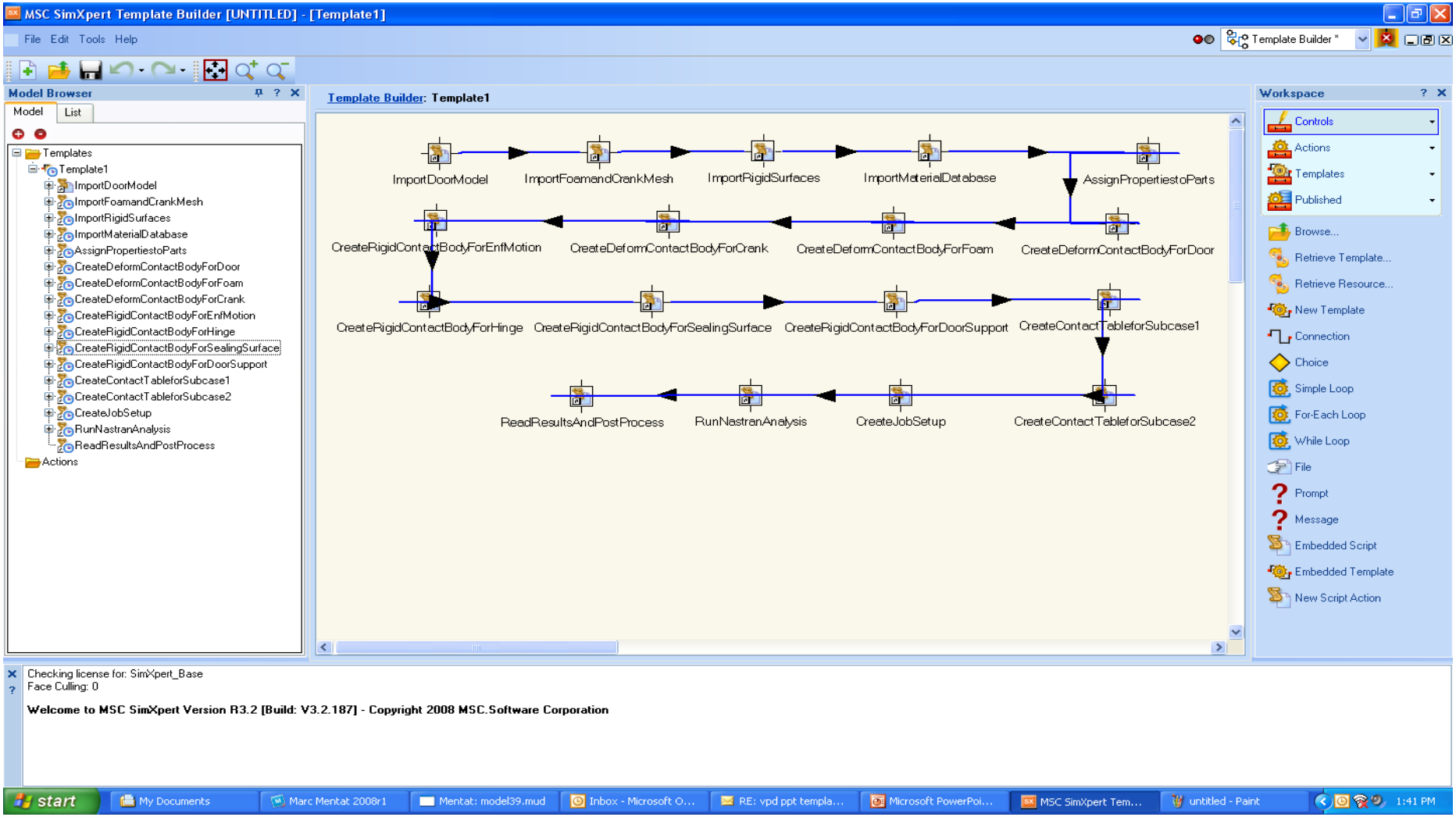
- Templates automate simulation processes
  - All SimXpert functionality can be used
  - External programs and applications can also be accessed
  - Multi-disciplinary - Processes can span multiple workspaces
- Templates enable simulation knowledge capture & re-use
  - Experts author templates
  - End-users re-use templates
- Benefits:
  - Expert knowledge and best practices are shared
  - Productivity is improved
  - Errors and variation are reduced or eliminated
  - Repetitive tasks can be automated

Analysis Process

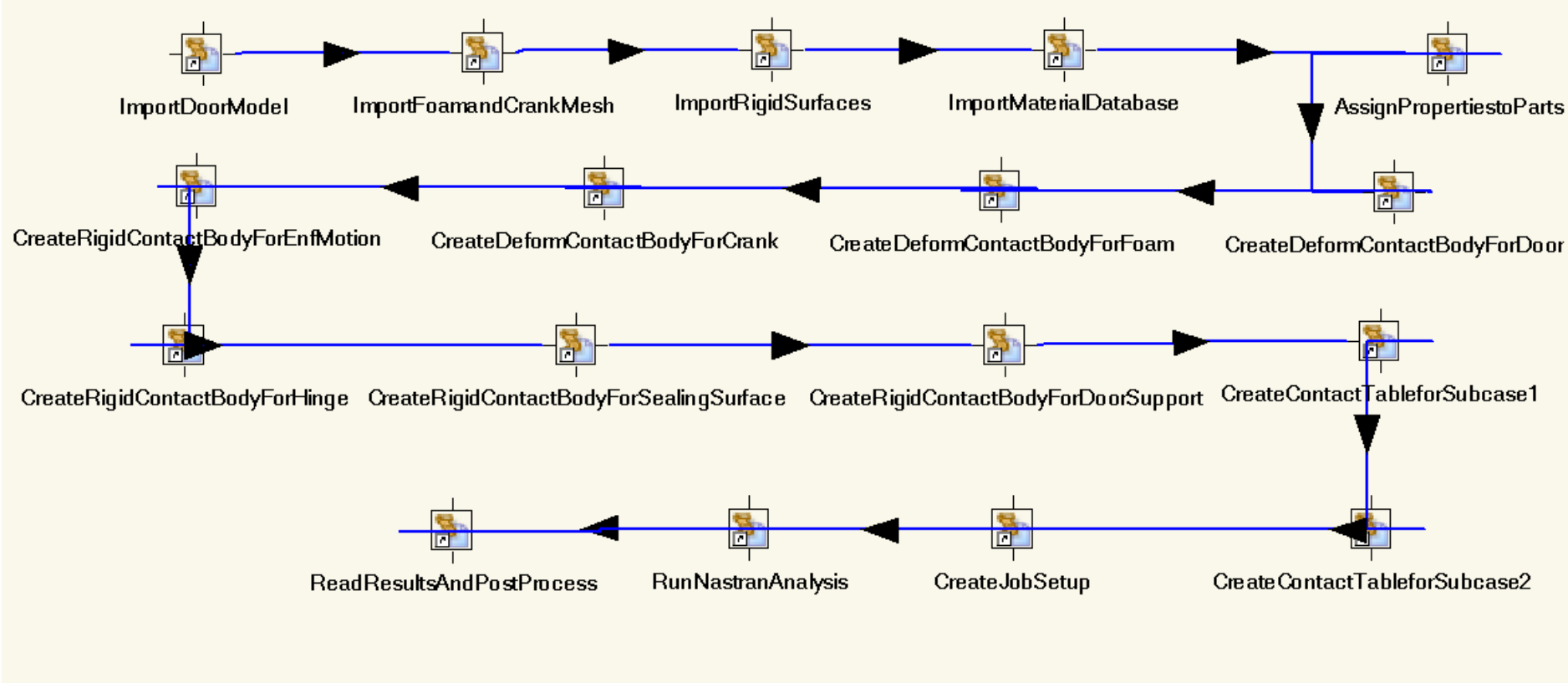


Single Solution
Minimal Data Translation
Single Interfaces
Automated Process

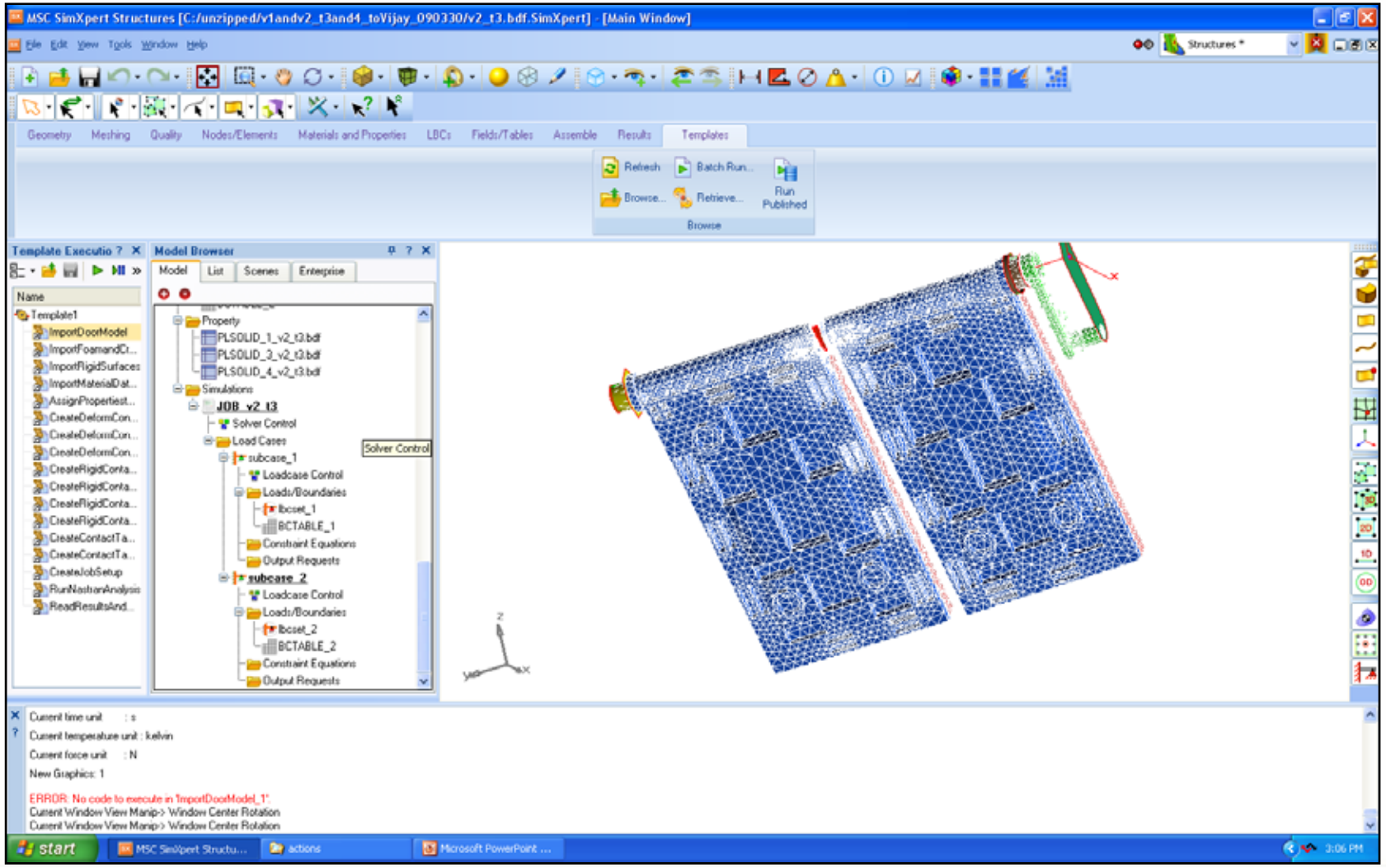
SimXpert Template For a Door Analysis



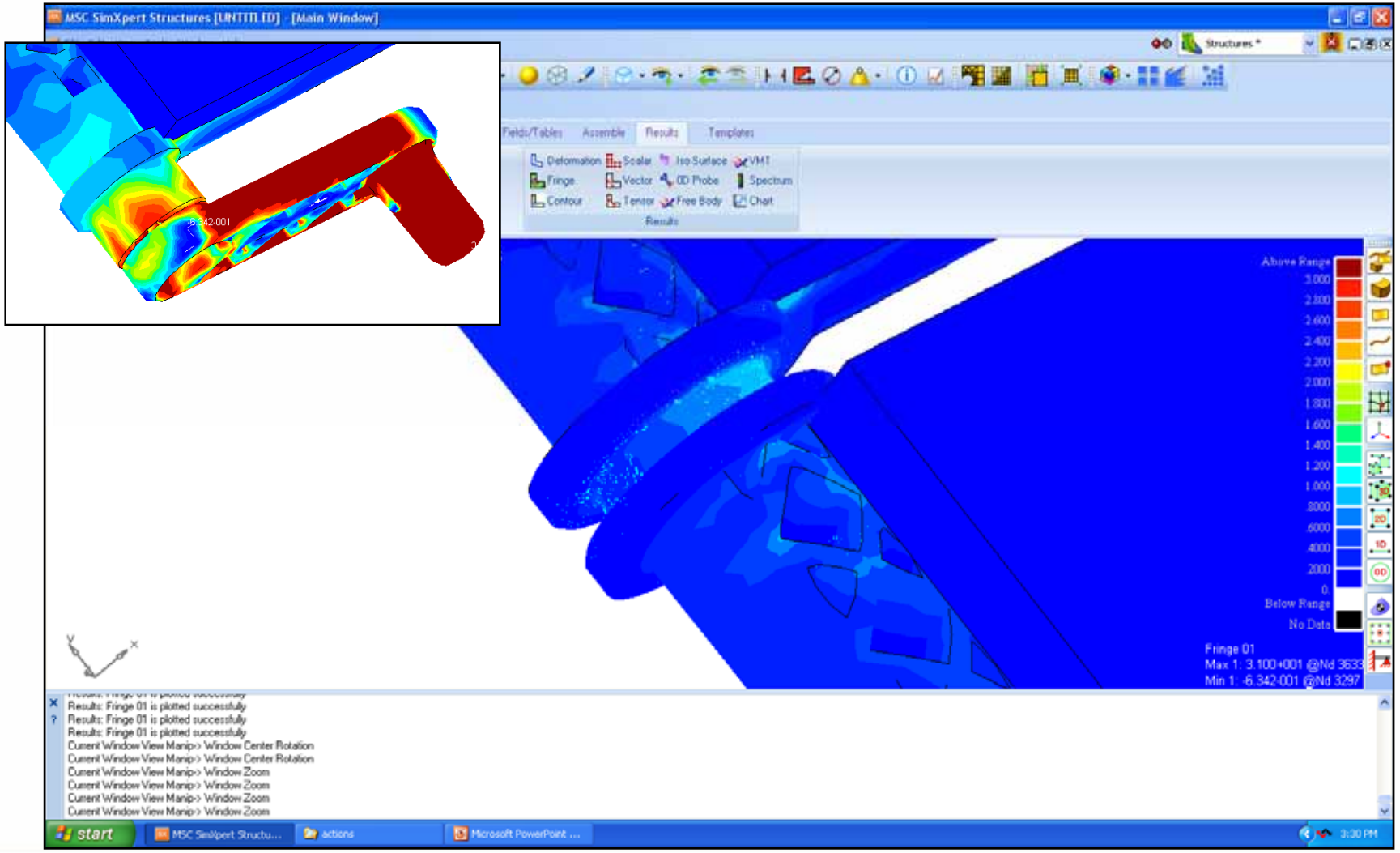
SimXpert Template Details



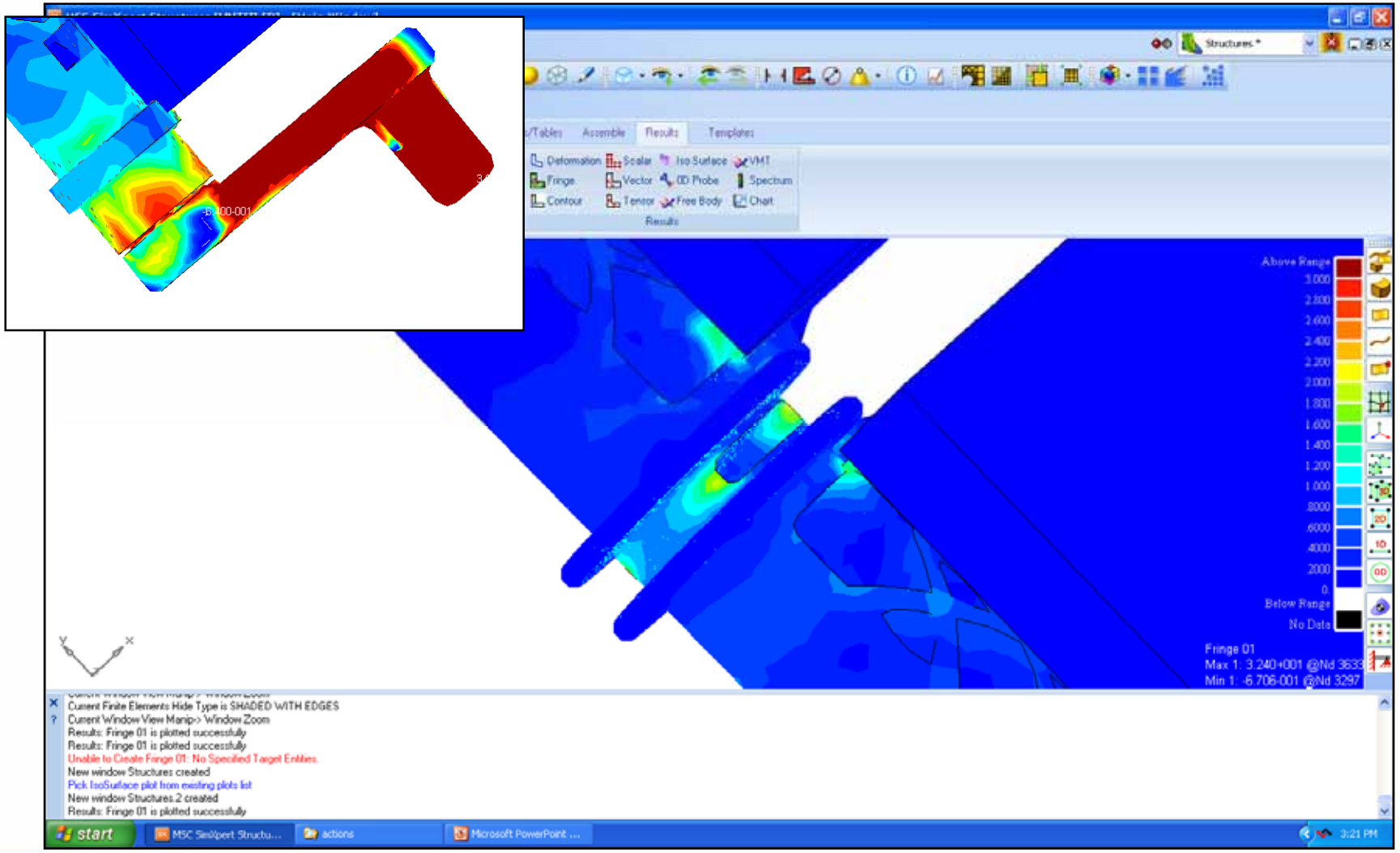
SimXpert Analysis Set up using a Template



Results: Stress Concentration for Door # 1



Results: Stress Concentration for Door # 2



Template Results & Comments

- Setting up the door analysis using a template reduced the analysis setup time by ~34% and eliminated potential error conditions.
- The SimXpert Analyses correlated with the Patran analyses to a very high degree.
- MD NASTRAN SOL600 contact analysis has proven to be very robust and accurately captures the nonlinear effects of the material properties and contacts.
- The simulated results agree quantitatively with the standardized ACH test protocols.

Comparison and Conclusions

- Linear structural properties in the ADAMS Flex Body over-predict the loads (real materials are nonlinear)
- MD Nastran Solution 101 only provides A-B comparisons with simplified loading assumptions
- MD Nastran Solution 600 provides the non-linear material behavior and loading necessary for stress predictions
- For Solution 600 material properties are critical and book-keeping is expensive and error prone
- SimXpert provides the templating approach that is necessary for design studies and automation

THANK YOU

Q & A

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