Infowebinar
ANSYS Workbench LS-DYNA

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ANSYS Competence Center FEM

Introduction to ANSYS Workbench LS-DYNA

§ Motivation for explicit solver

§ ANSYS Workbench LS-DYNA in a Nutshell

§ Key Functionalities

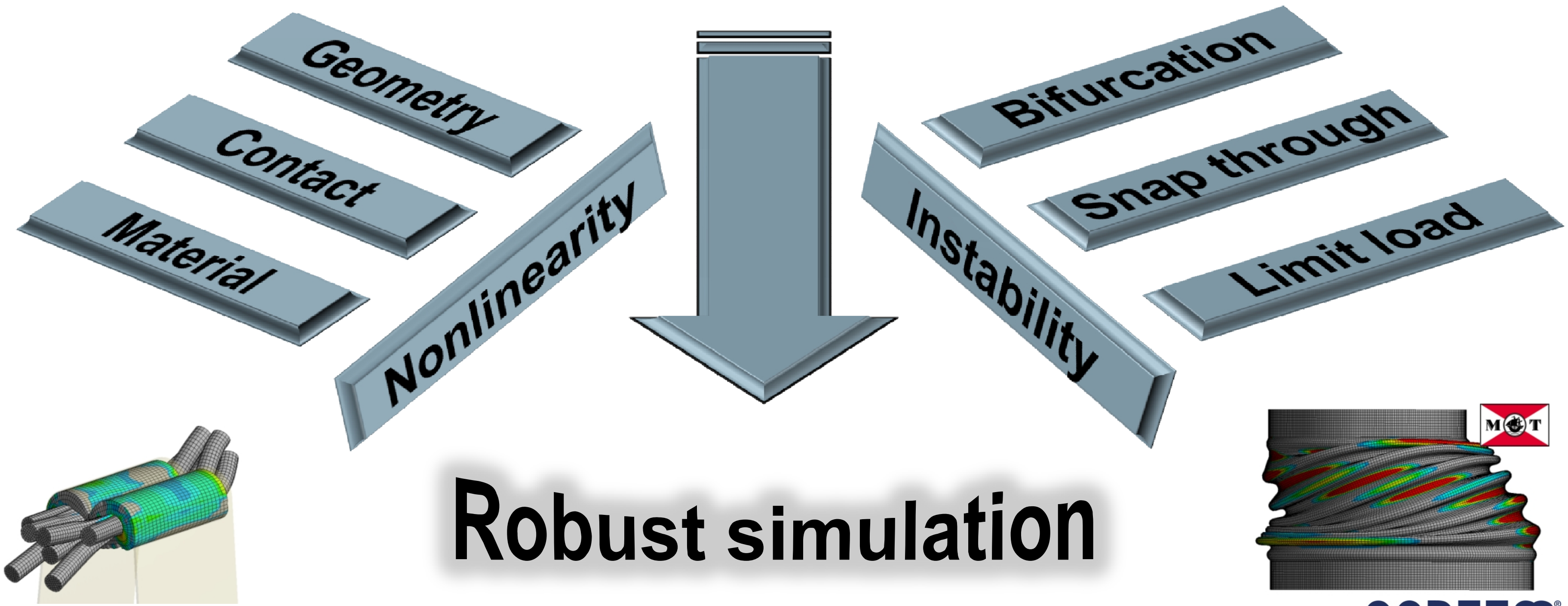
§ Live Demonstration

§ Summary

Motivation for Explicit Solver

Does Your Real World Problem …

- … deal with large nonlinearities?
- … include instability issues?
- … need a robust simulation process?



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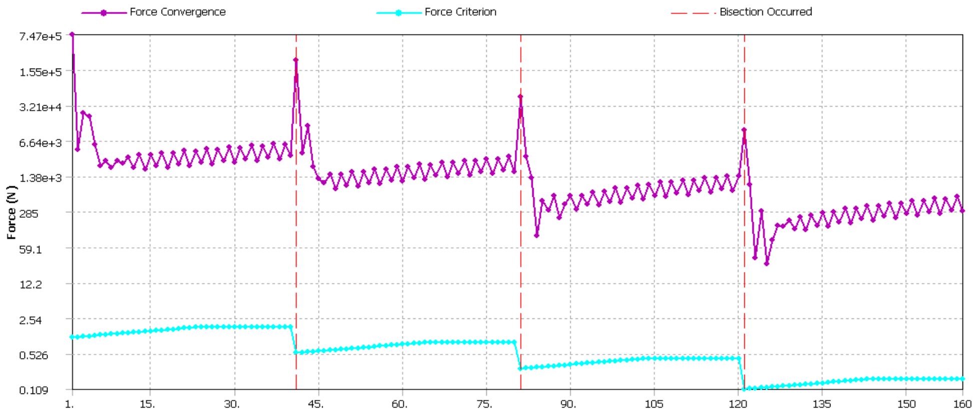
Robust Simulation Process

- § More nonlinearities (or rigid motion) ó more difficulties to achieve solution
- § Maybe no equilibrium can be found



- § With an explicit solver a solution is guaranteed
  - § Save engineering time / money

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Robust Simulation Process

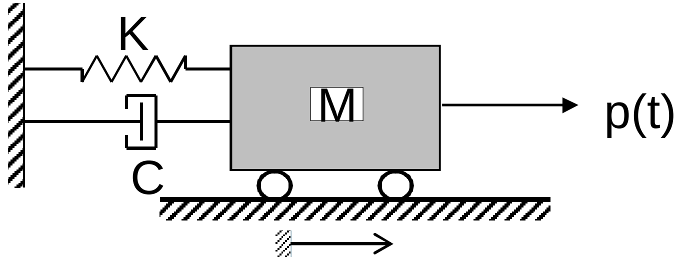
- With an implicit solution you jump on a mountain and try to find the way how to come there
  - If the mountain is to high and very rough you will find a way only by trial and error
  - Appropriate for moderate nonlinearities
- With an explicit solution you climb up the mountain step by step
  - If you make a step which is too big you will fall down
  - Appropriate for large nonlinearities

Behind the Scenes

- Implicit solution:
  - Solution of large system of equations
  - Iteration within time step
  - Convergence not always guaranteed

- Explicit solution:
  - No large system of equation to be solved
  - No convergence problems
  - Low computation time in each time step

Behind the Scenes



- Single Degree-of-Freedom System
  - Equation of Motion:

$$M \cdot \ddot{u}(t) + C \cdot \dot{u}(t) + K \cdot u(t) = p(t)$$

→ Function of time → time discretization needed

- Implicit time integration
  - The equation of motion is set up for new time t_{n+1}

$$M_{n+1} \cdot \ddot{u}_{n+1} + C_{n+1} \cdot \dot{u}_{n+1} + K_{n+1} \cdot u_{n+1} = p_{n+1}$$

- Explicit time integration
  - The equation of motion is set up for current time t_n (extrapolation to t_{n+1})

$$M_n \cdot \ddot{u}_n + C_n \cdot \dot{u}_n + K_n \cdot u_{n+1} = p_n$$

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Behind the Scenes

- A solution of a equation of motion can be used for static problems? How should that work?

$$M \cdot \ddot{u}(t) + C \cdot \dot{u}(t) + K \cdot u(t) = p(t)$$

- Just imagine you apply a load very very slowly to a body. What would happen?

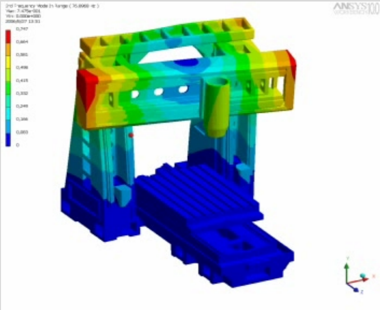
$$\cancelto{0}{M \cdot \ddot{u}(t)} + \cancelto{0}{C \cdot \dot{u}(t)} + K \cdot u(t) = p(t)$$

- So you get a solution which is equivalent to the static one!

$$K \cdot u = p$$

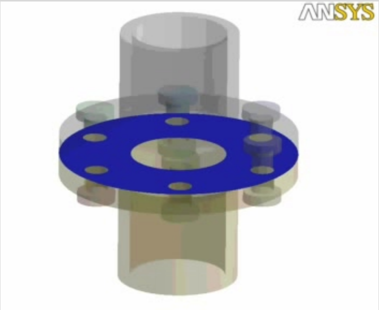
Fields of Application for Explicit Solver

Linear Dynamics



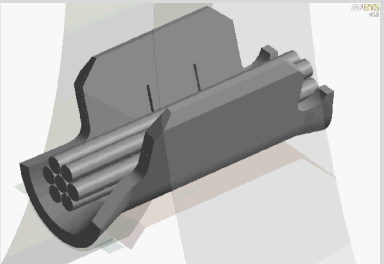
Modal Based

Statics



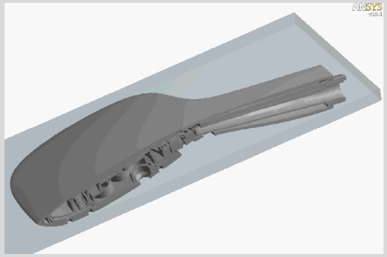
Structures

Quasi-Statics



Metal Forming

Nonlin. Dynamics



Impact

IMPLICIT METHODS

EXPLICIT METHODS

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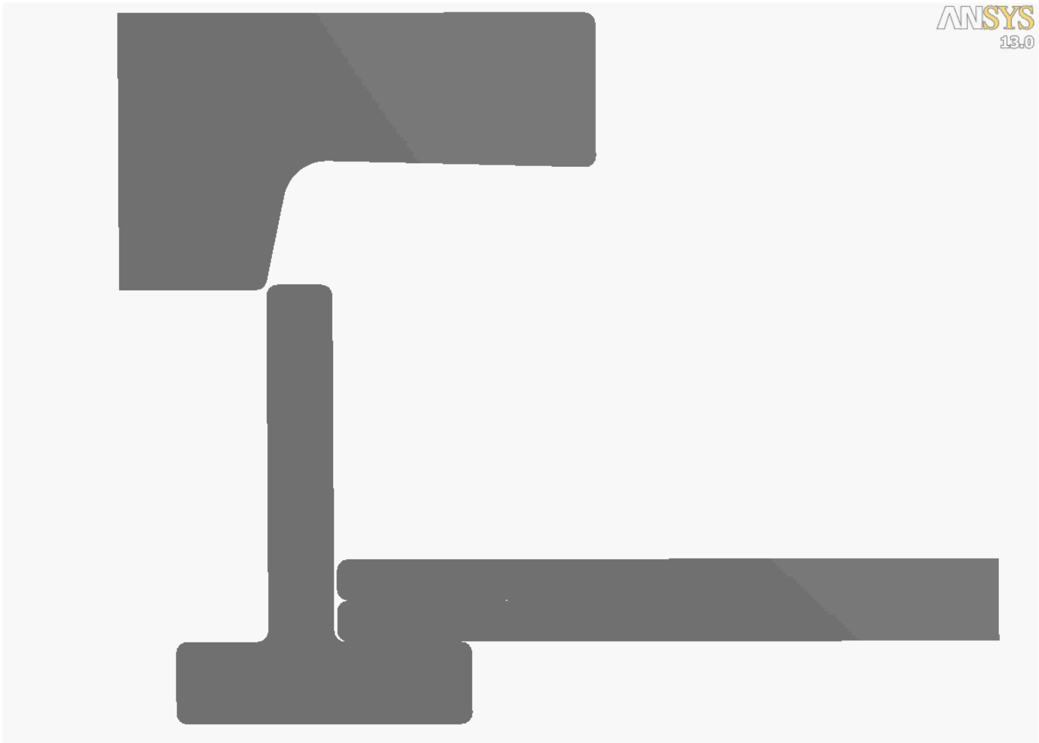
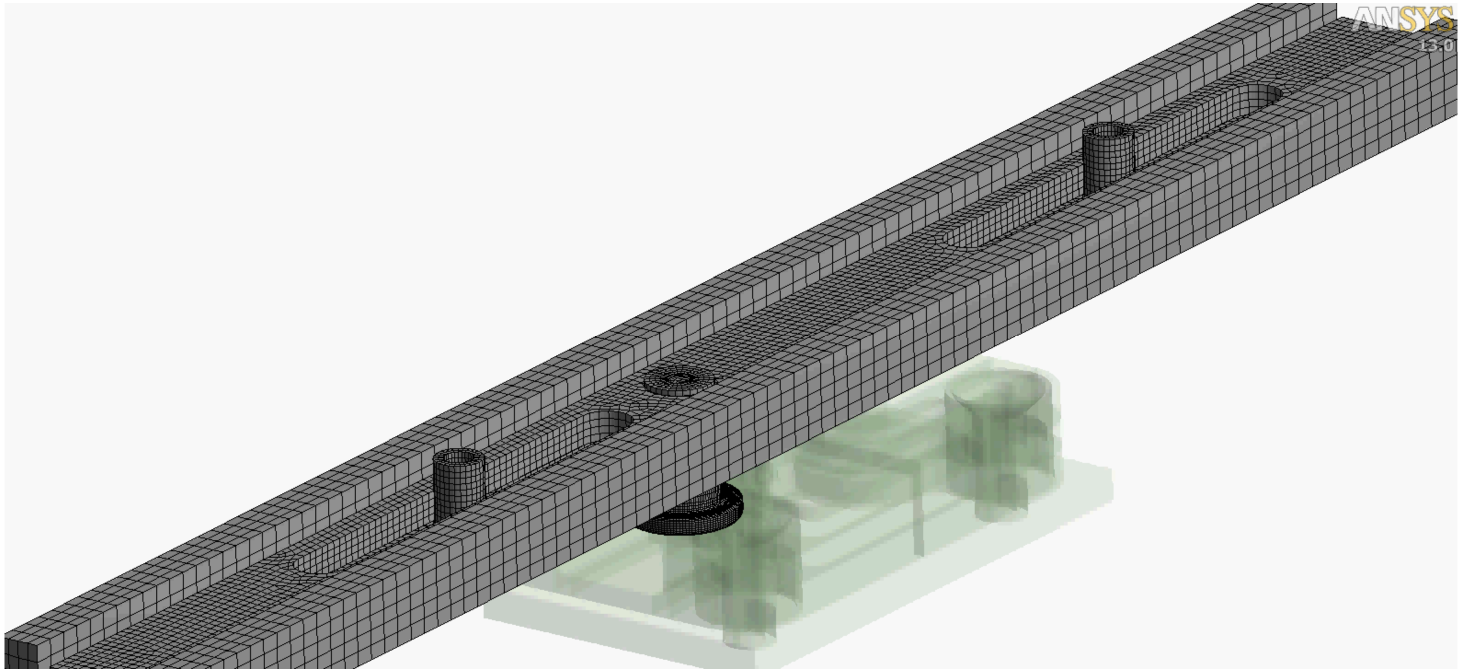
Fields of Application for Explicit Solver

Quasi-Static – Crimping



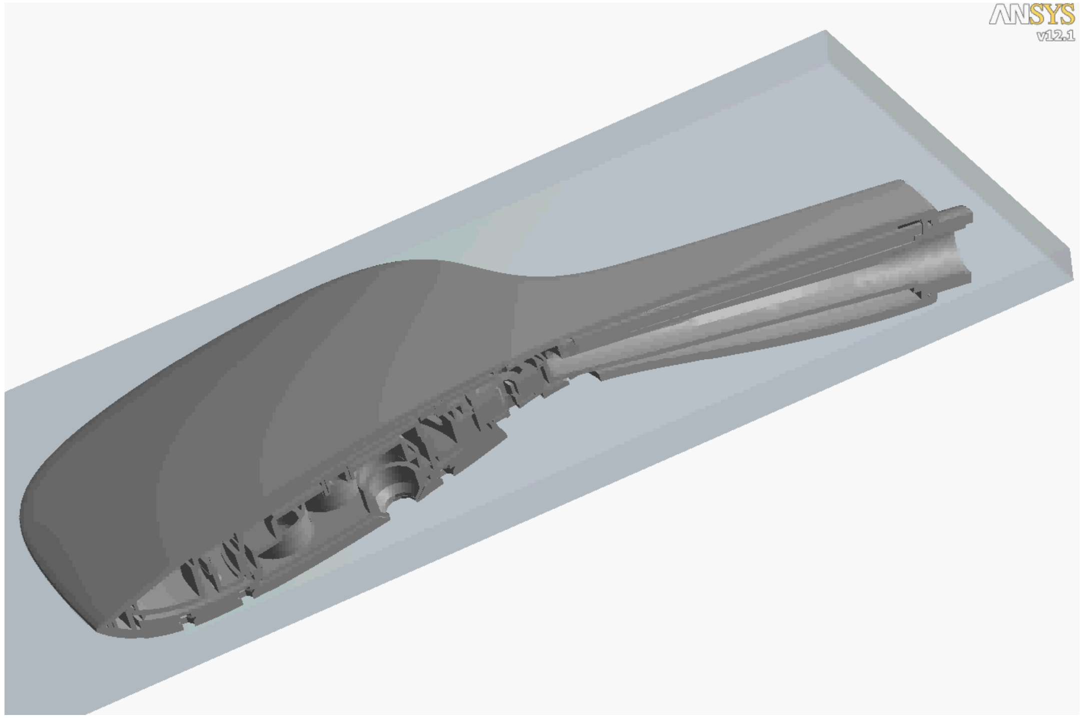
Fields of Application for Explicit Solver

Change-Over to Dynamic – Pull out



Fields of Application for Explicit Solver

Dynamic – Drop test



ANSYS Workbench LS-DYNA in a Nutshell

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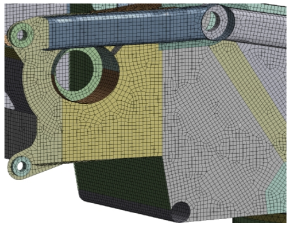
Two Worlds Become One

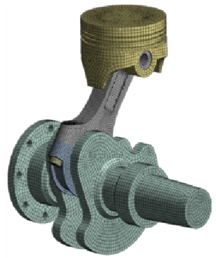
- A new interface is created through a collaboration between LSTC & ANSYS with assistance from CADFEM. The aim is to link both tools to get the best of both.
- On one hand an outstanding explicit solver with more then 25 years of experience is provided to ANSYS users through the Workbench environment.
- And on the other hand all Workbench features like CAD connectivity, meshing capabilities or parameterisation are provided to LS-DYNA users.

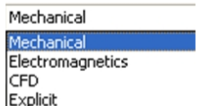
Advantage of ANSYS Workbench

- Interfaces to all common CAD-Tools

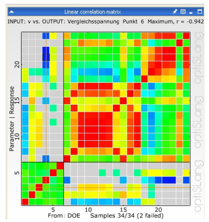
- Strong “physics” based meshing capabilities

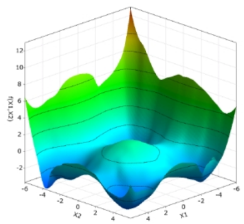






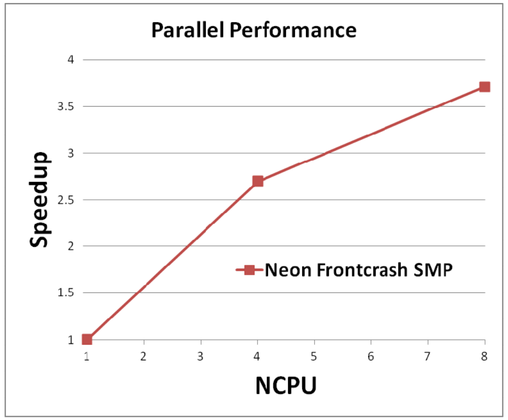
- Use of fully parameterised models



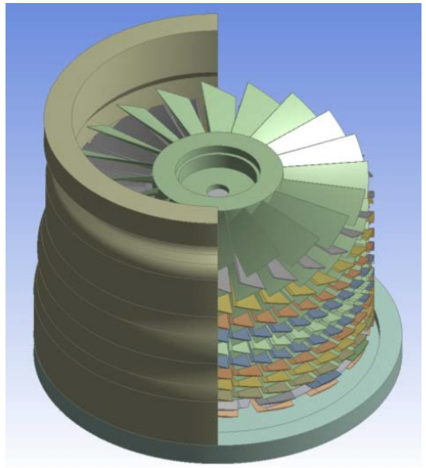


Advantage of LS-DYNA

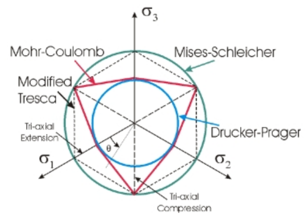
- Solution of large highly nonlinear dynamic and quasi-static problems (world leading robust explicit solver)
- Strong parallel performance
- Extended material models (plasticity, strain rates, failure...)

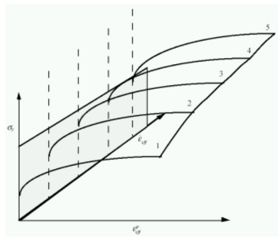


Parallel performance of:
HP Z800, Intel Sandy-Bridge E5-2687W 3.1 GHz



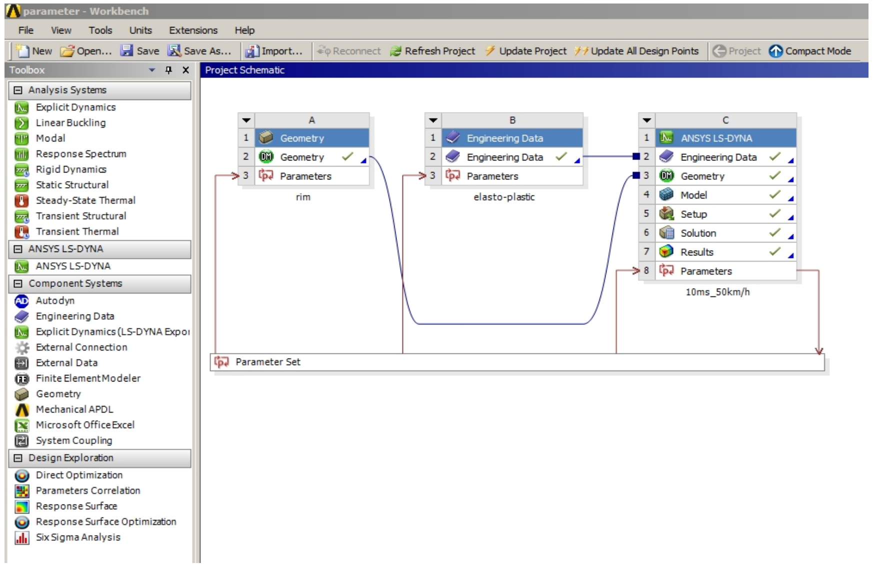
Source: CADFEM Consulting Flyer "Containment analysis"

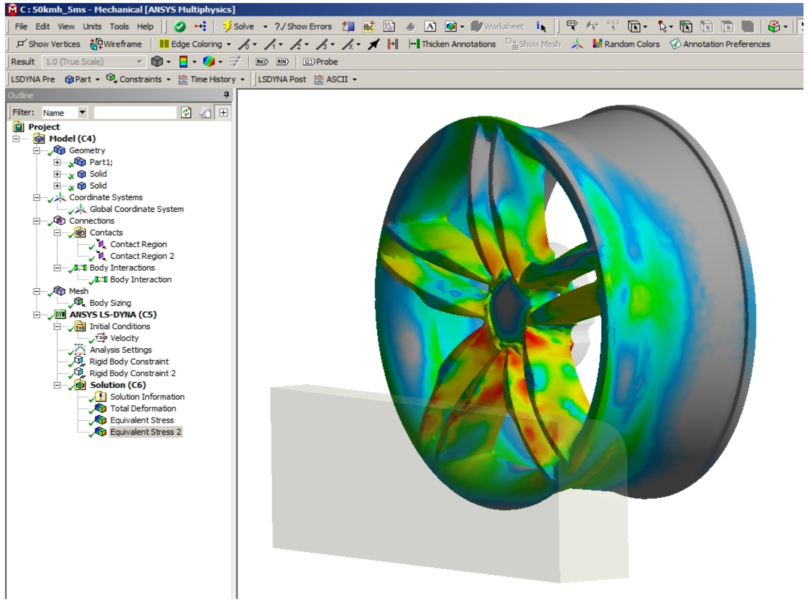




Advantage of ANSYS Workbench LS-DYNA

- Fully integrated and fully parameterized
- Easy to use
- Use of parallel processing





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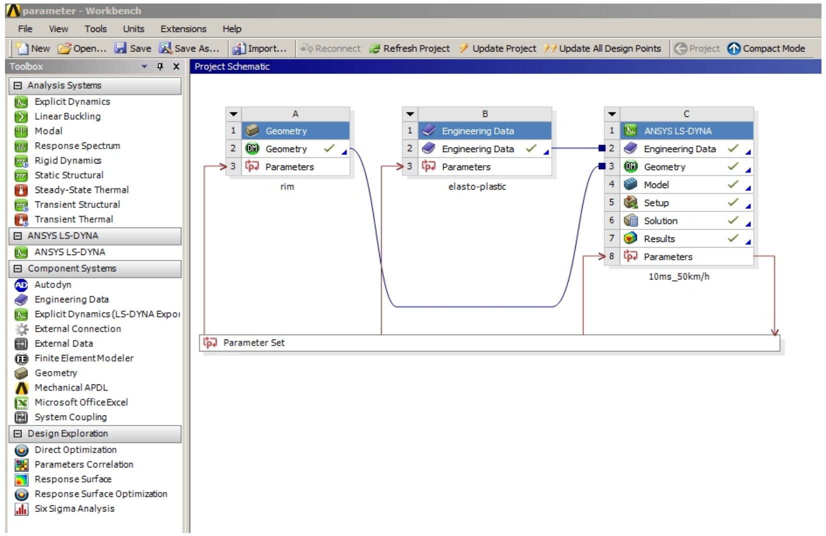
Advantage of ANSYS Workbench LS-DYNA

- § Fully integrated and fully parameterized
  - § Bidirectional interface to CAD
  - § Material database within Engineering Data
  - § Parameterise everything you want to (geometry, material, mesh, boundaries)
  - § Find better designs of your model by using parameter variation



Advantage of ANSYS Workbench LS-DYNA

- Easy to use – Same environment as other analysis

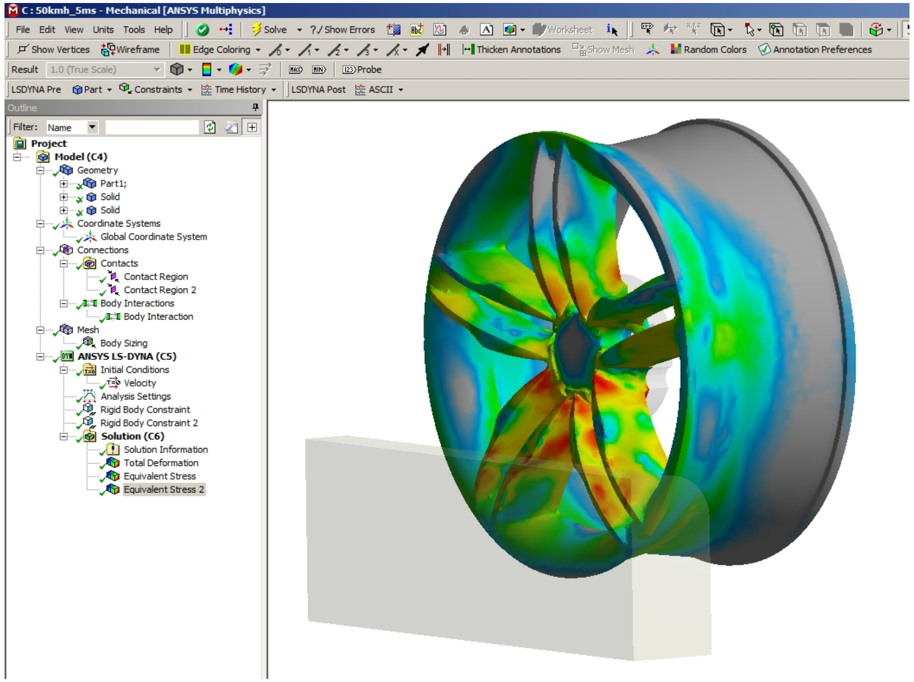
  - Short learning curve

  - Suitable for beginners as well as experts

  - Use wide range of meshing capabilities of ANSYS Workbench

  - Full access to parallel processing

  - Post-processing in Workbench



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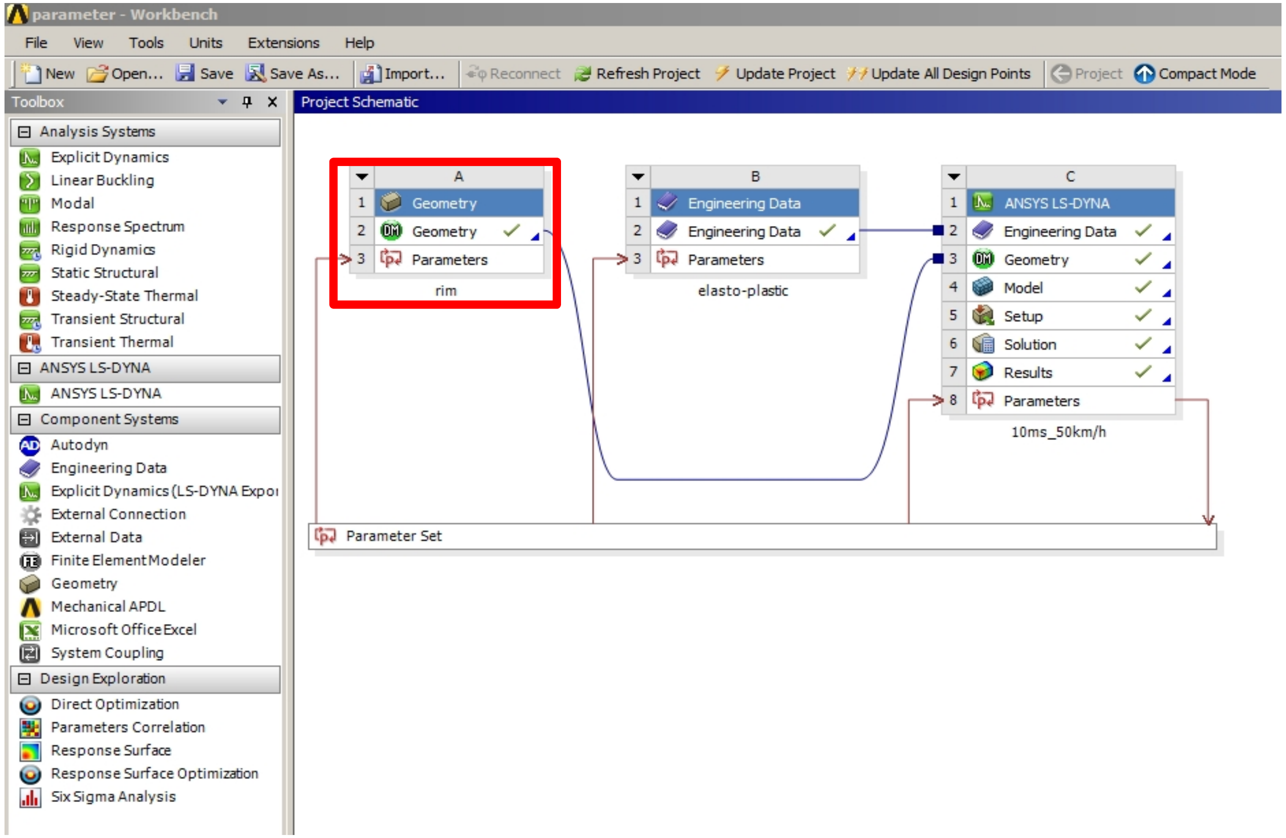
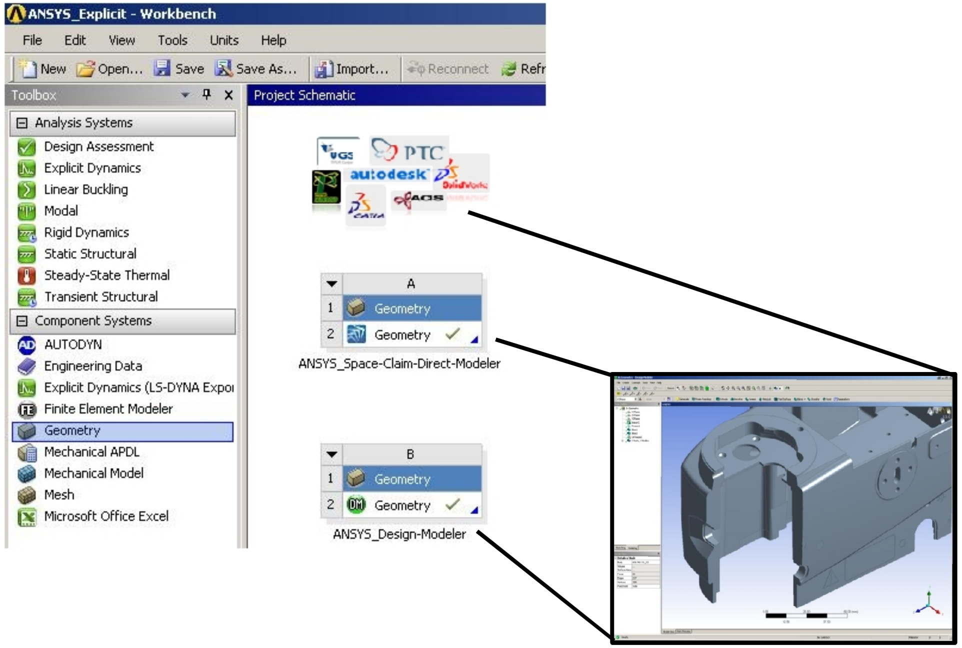
Key Functionalities

Key Functionalities – Geometry



Key Functionalities – Geometry

- Access to bi-directional CAD-Interfaces of Workbench
- Preparation of simulation suitable geometry
  - Design Modeler
  - Space Claim Direct Modeler



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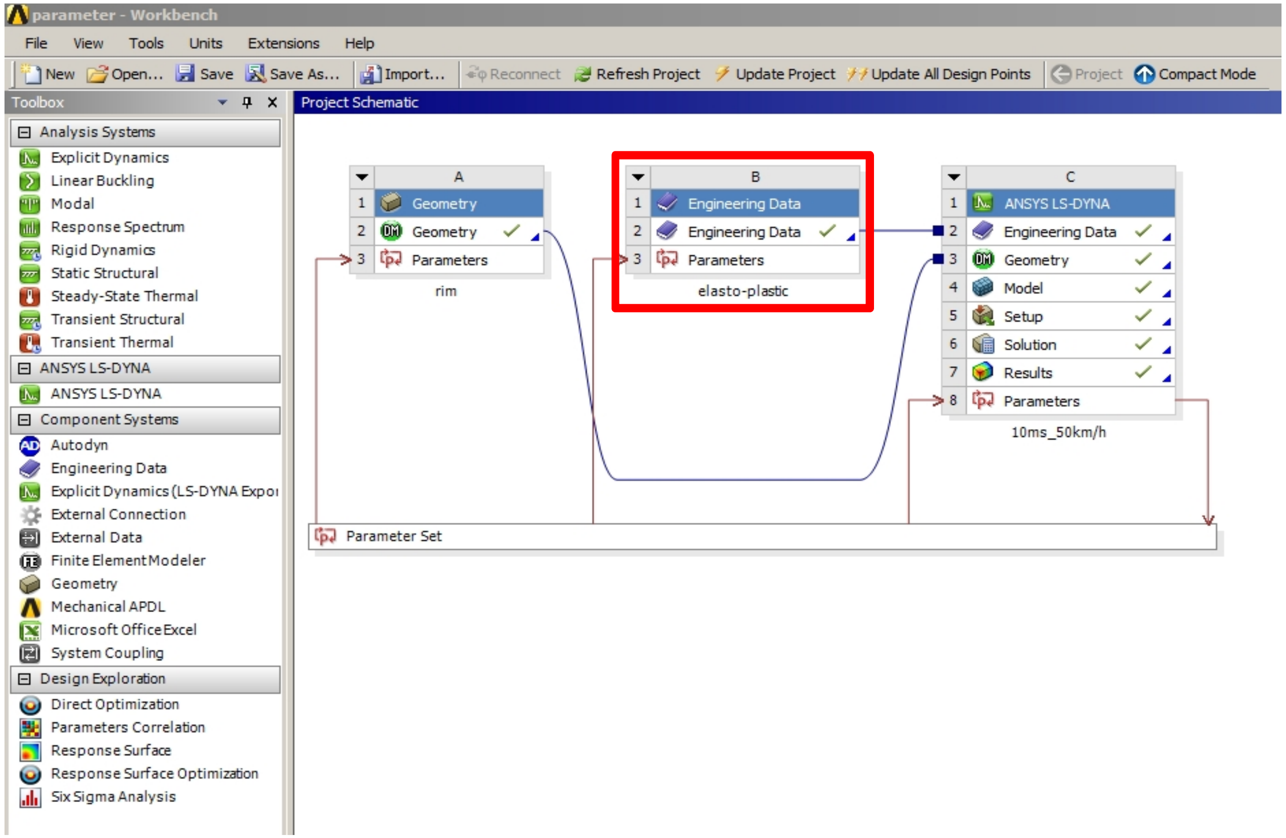
Key Functionalities – Material



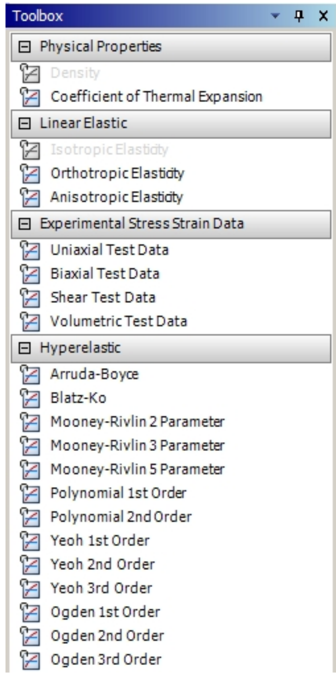
Key Functionalities – Material

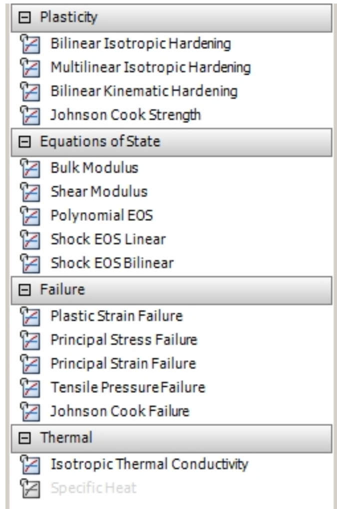
§ Workbench user can define materials as usual in the material-section

§ Chose material properties you want to include

§ Only materials which can be translated are accessible

§ The interface creates material cards depending on the chosen material model and material properties





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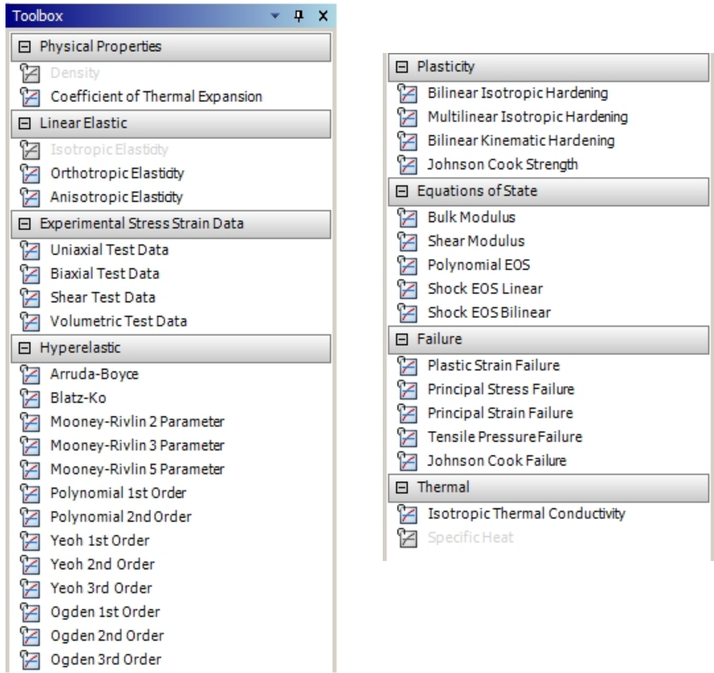
Key Functionalities – Material

§ LS-DYNA user can create materials cards by choosing corresponding Workbench materials

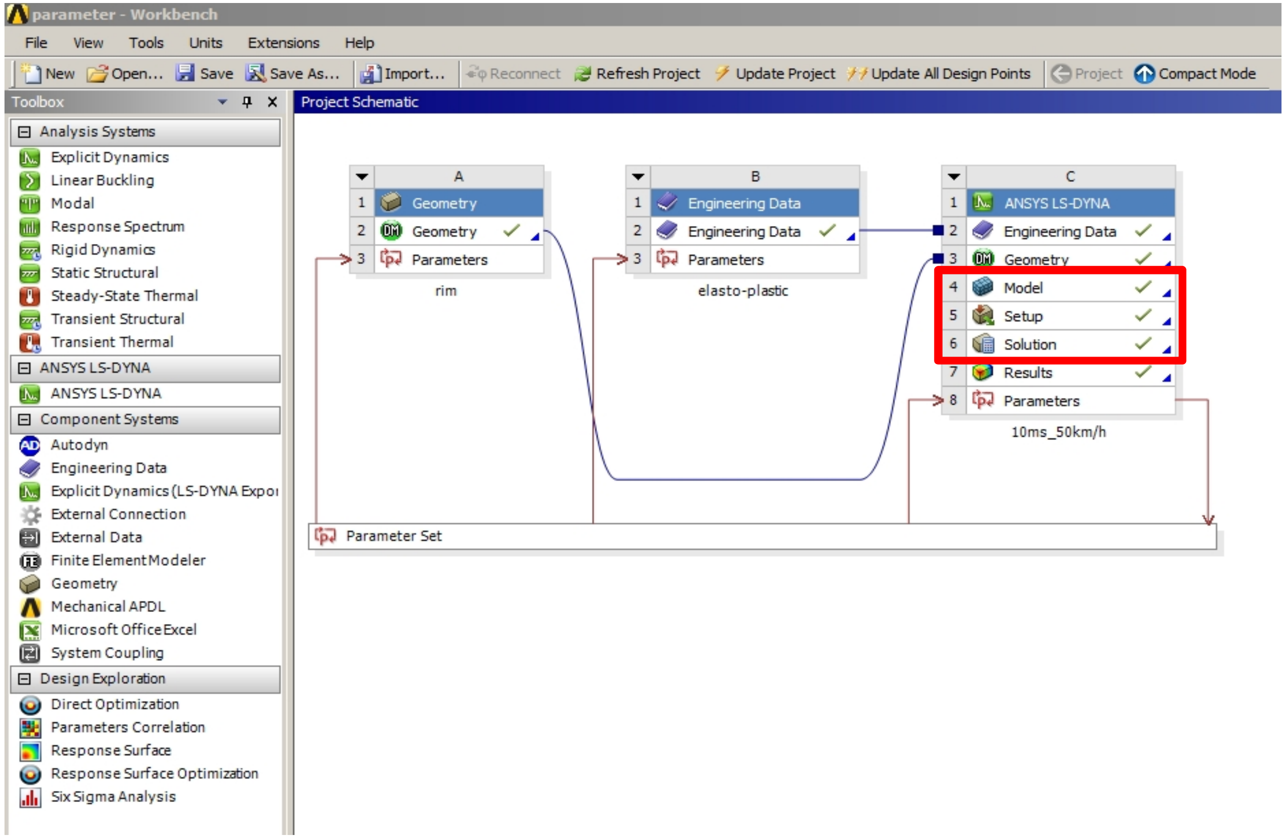
§ Material failure is either written to material card (if supported) or *MAT_ADD_ERROSION is created

§ Command objects can be used to write own material cards

```
*MAT_JOHNSON_COOK
        19  8.45E-09     37400         0         0         0         0         0
       112       505      0.42     0.009      1.68      1189         0         1
 385000000         0         0         0         0         0         0         0
         0         0
*MAT_ADD_EROSION
        19         0         0         0       0.8         0         0         0
         0         0         0         0         0         0         0         0
```



Key Functionalities – Model Setup



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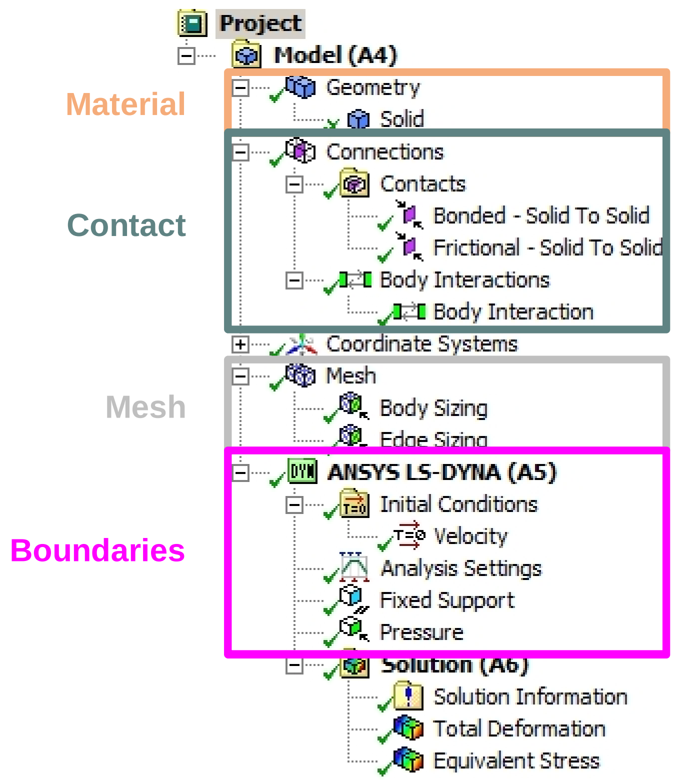
Key Functionalities – Model Setup

§ Workbench user can set up model as done before in other analysis

§ Interface creates corresponding cards

§ In general default settings are used, based on many years of experiences. Additional options can be chosen.

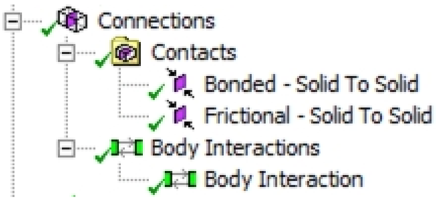
§ LS-DYNA user can create specific cards by choosing several options



Key Functionalities – Model Setup

- Body Interactions
  - Frictionless and Frictional

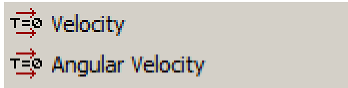
- Manual Contact Regions
  - Bonded
  - Bonded Breakable
  - Frictionless and Frictional

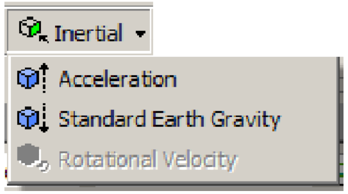


- Spot welds
  - Breakable and Non-Breakable

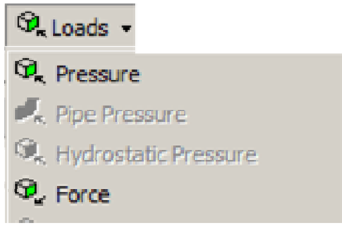
Key Functionalities – Model Setup

- Initial conditions
  - Velocity
  - Angular Velocity
  - Both

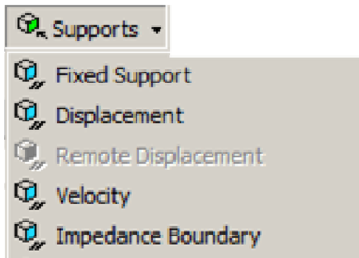




- Loads
  - Inertial: Acceleration and Standard Earth Gravity
  - Pressure
  - Force



- Supports
  - Fixed Support
  - Displacement.
  - Velocity
  - Impedance Boundary
  - Simply Supported
  - Fixed Rotation



Key Functionalities – Model Setup

- At least simulation time has to be chosen by user
- Make global settings here (local settings by the additional buttons)
- For example:
  - Chose number of CPU’s
  - Set Mass scaling
  - Set global Hourglass control
  - Output frequency of d3plot
  - Output frequency of ASCII data
  - ...

mass scaling

number of CPU

global hourglass control

output format and frequency (d3plot)

output frequency (ASCII)

Details of "Analysis Settings"	
Step Controls	
End Time	1e-03
Automatic Mass Scaling	Yes
Time Step Size	1E-07
CPU and Memory Management	
Memory Allocation	Program Controlled
Number Of CPUS	6
Solver Controls	
Solver Type	Program Controlled
Solver Precision	Program Controlled
Unit System	nmm
Damping Controls	
Global Damping	No
Hourglass Controls	
Hourglass Type	Program Controlled
LS-DYNA ID	0
Default Hourglass Coefficient	0.1
ALE Controls	
Continuum Treatment	Lagrangian
Cycles Between Advection	1
Advection Method	Donor Cell + Half Index Shift
Output Controls	
Output Format	Program Controlled
Stress	Yes
Strain	No
Plastic Strain	Yes
Calculate Results At	Equally Spaced Point
--- Value	100
Time History Output Controls	
Calculate Results At	Equally Spaced Point
--- Value	1000
Output	Global Data
Output	Material energies Data
Output	Rigid Body Data
Output	No
Analysis Data Management	

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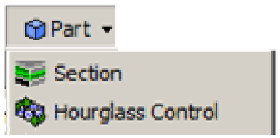
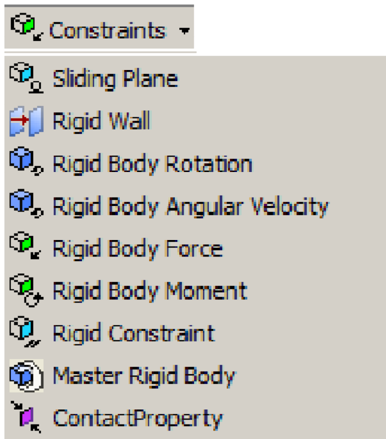
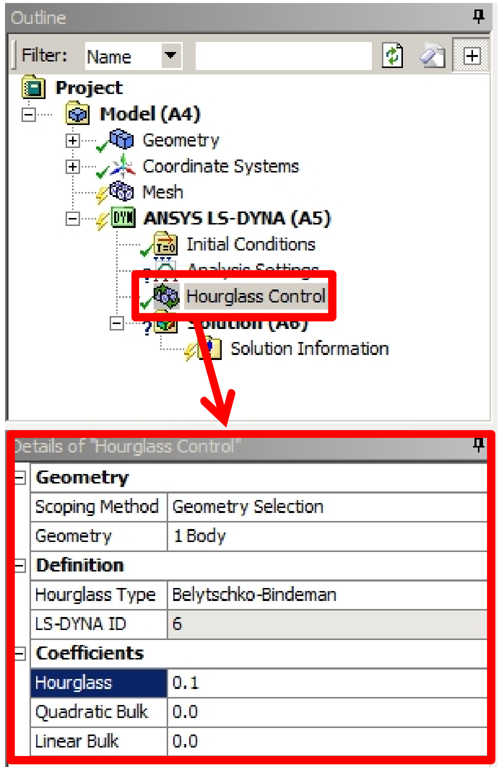
Advanced Functionalities – Model Setup

- § Additional cards for local settings like Section, Hourglass Control or Contact Settings are available
- § Accessible through general GUI
- § Name and ID of entity is given



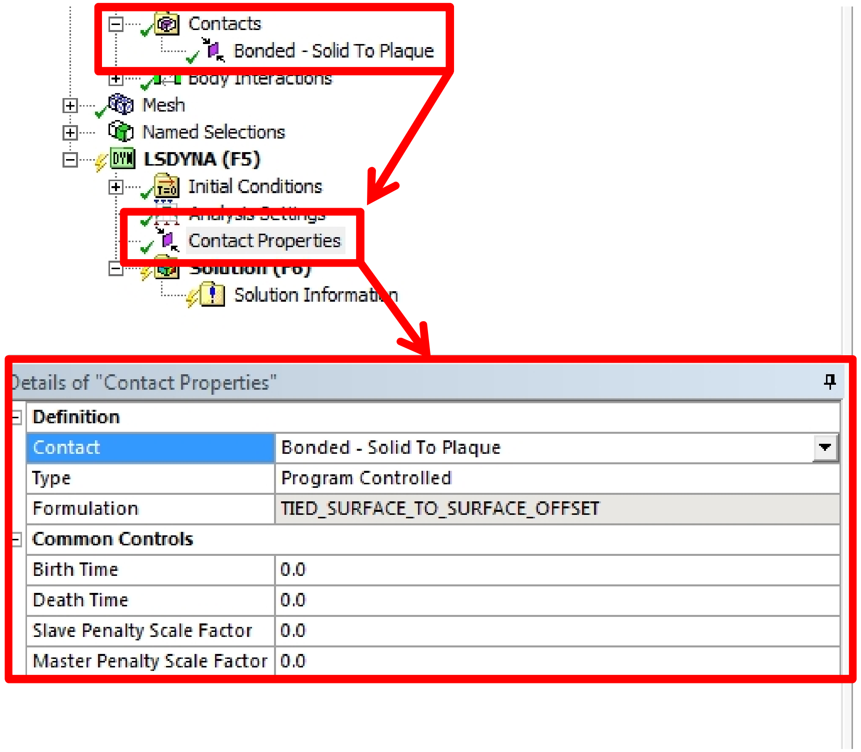




Advanced Functionalities – Model Setup

- LS-DYNA users can set options to achieve specific cards

- If no option is set Interface chooses default options (not necessarily the DYNA default options)



Advanced Functionalities – Model Setup

Details of "Contact Properties"

Definition	
Contact	Frictional - Solid To Plaque
Type	Program Controlled
Formulation	AUTOMATIC_SURFACE_TO_SURFACE
Common Controls	
Birth Time	0.0
Death Time	0.0
Slave Penalty Scale Factor	0.0
Master Penalty Scale Factor	0.0

Details of "Contact Properties"

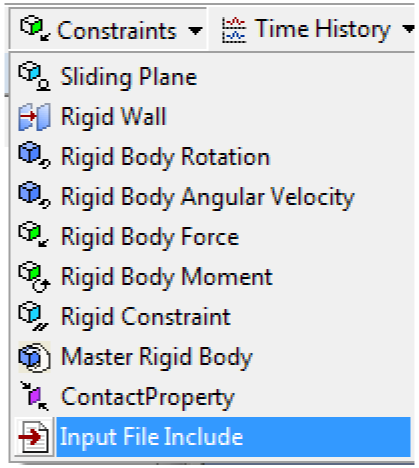
Definition	
Contact	Frictional - Solid To Plaque
Type	Forming
Formulation	FORMING_SURFACE_TO_SURFACE

Details of "Contact Properties"

Definition	
Contact	Frictional - Solid To Plaque
Type	Eroding
Formulation	ERODING_SURFACE_TO_SURFACE
Common Controls	
Birth Time	0.0
Death Time	0.0
Slave Penalty Scale Factor	0.0
Master Penalty Scale Factor	0.0
Eroding Controls	
Symmetry Plane Option	Program Controlled
Erosion Interior Node Option	Program Controlled
Solid Elements Treatment	Program Controlled

Advanced Functionalities – Model Setup

- Advanced user can add unsupported features by including the content of a text file to the input File
- Model containing command snippets would not be supported, the feature (inclusion) is supported
- Regular Commands snippets at the environment level (even with the LS-DYNA solver Target) are not supported in ANSYS Workbench LS-DYNA)



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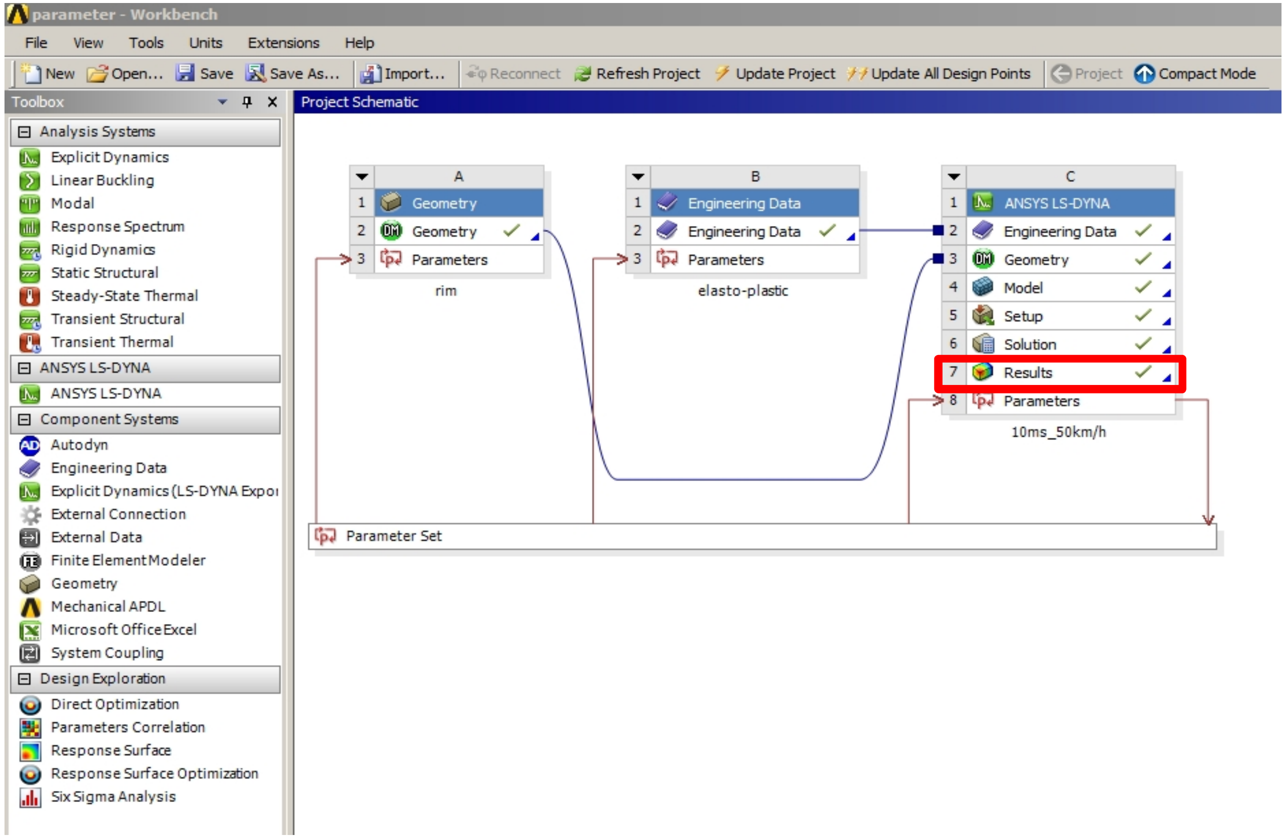
Key Functionalities – Postprocessing

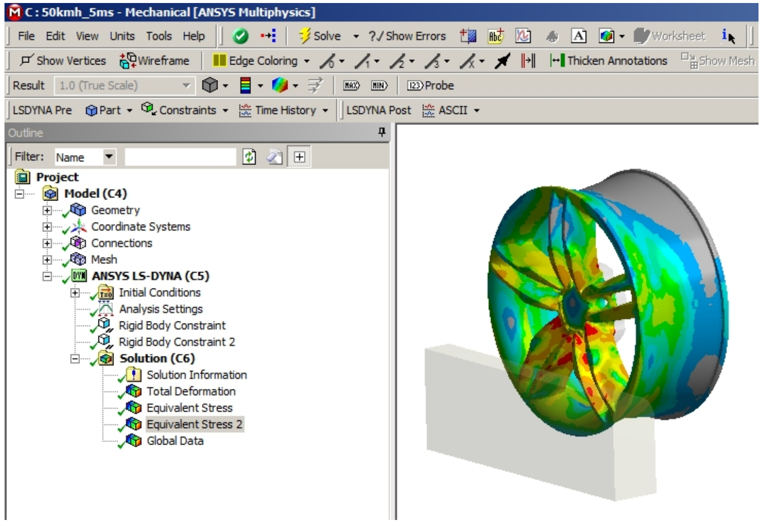


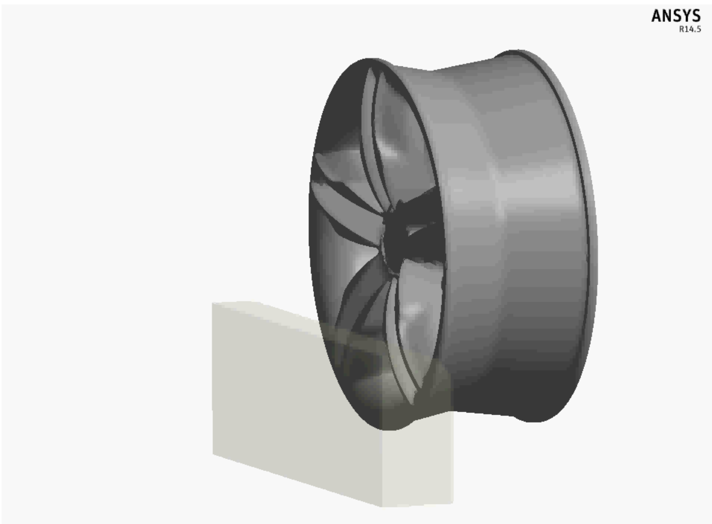
Key Functionalities – Postprocessing

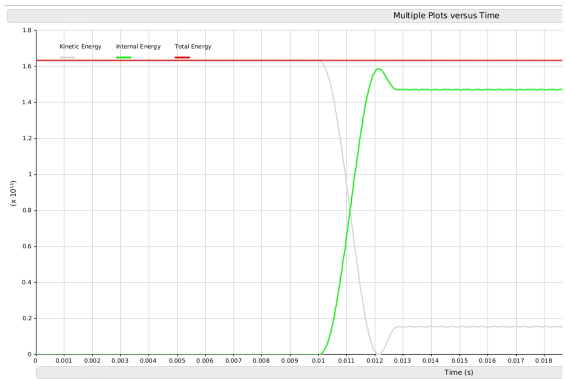
§ General post-processing of contour data

§ Animation of results

§ Plot of ASCII data

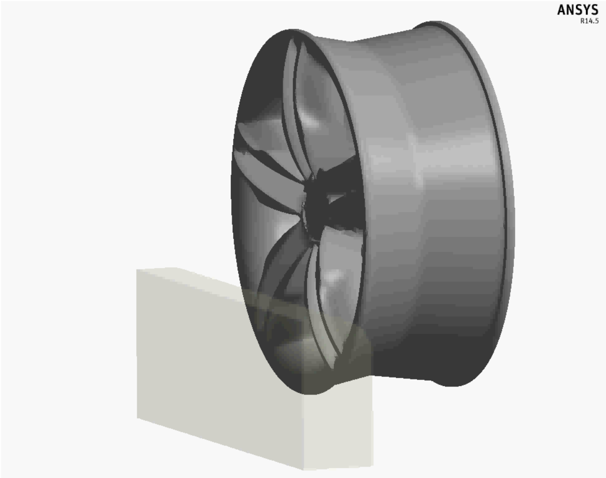




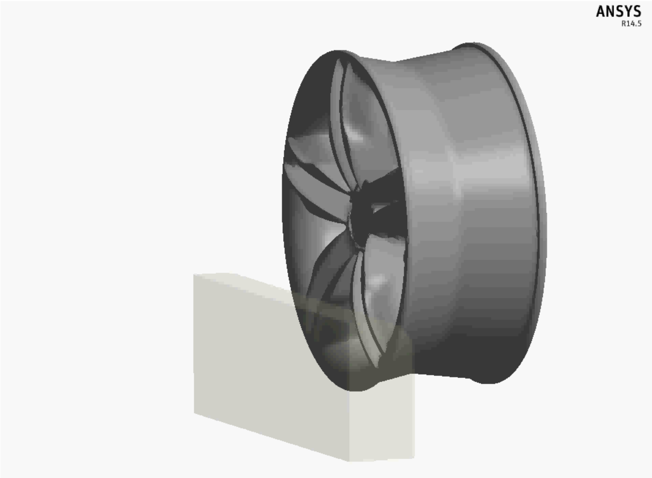


CADFEM

Example – Rim Impact (Load Variation)



v = 25 km/h



v = 50 km/h

- Challenges
  - Large deformations
  - Plastic material
  - Frictional sliding

- Outcome & Benefits
  - Max. misuse to fail
  - Material failure
  - Fast design investigation

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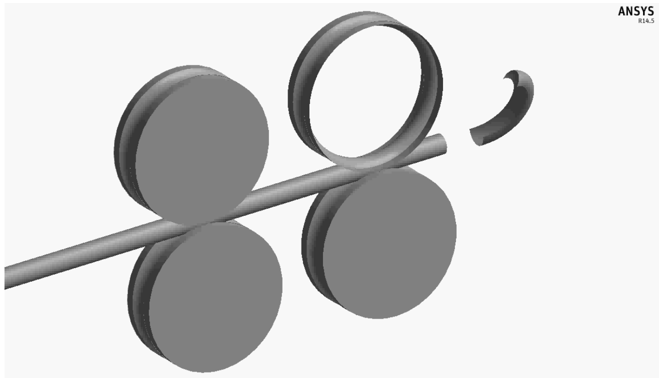
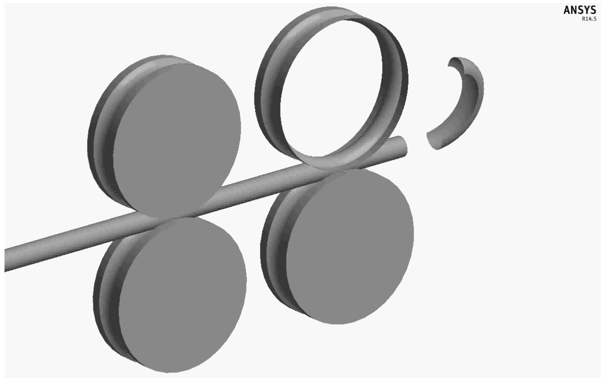
Example – Spring (Tool Variation)



0.4 turns



1 turn

- Challenges
  - Large deformations
  - Plastic material
  - Frictional sliding

- Outcome & Benefits
  - Tool geometry
  - Get process running
  - Fast design investigation

ANSYS Workbench LS-DYNA Installation

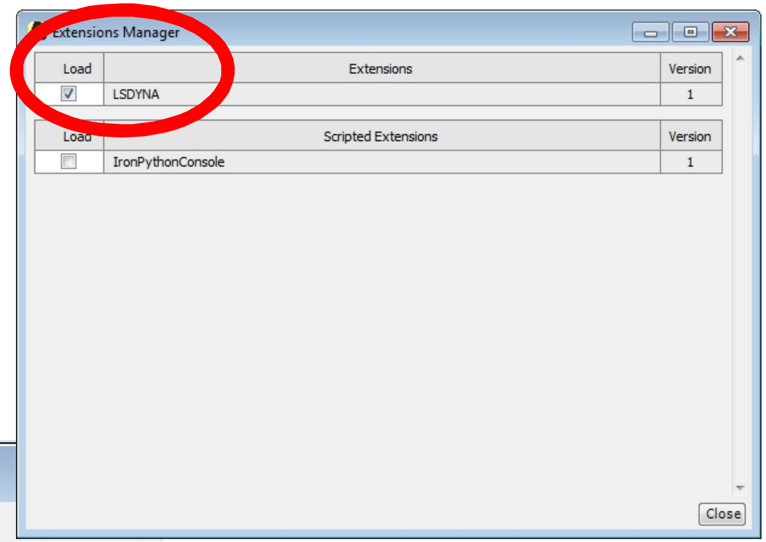
ANSYS

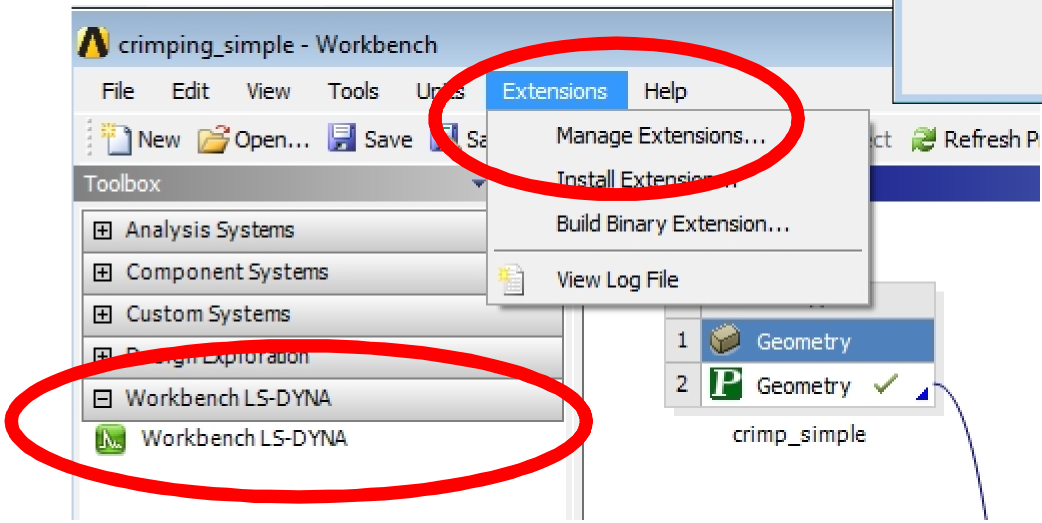
ANSYS Competence Center FEM

CADFEM

ANSYS Workbench LS-DYNA

- Workbench LS-DYNA is a ACT extension
- Requires installation of the extension
- Extension has to be turned on in Extension Manager
- It requires a ANSYS/LS-DYNA or ANSYS/LS-DYNA PC license
- Available for ANSYS 14.5 and 14.5.7





ANSYS Workbench LS-DYNA

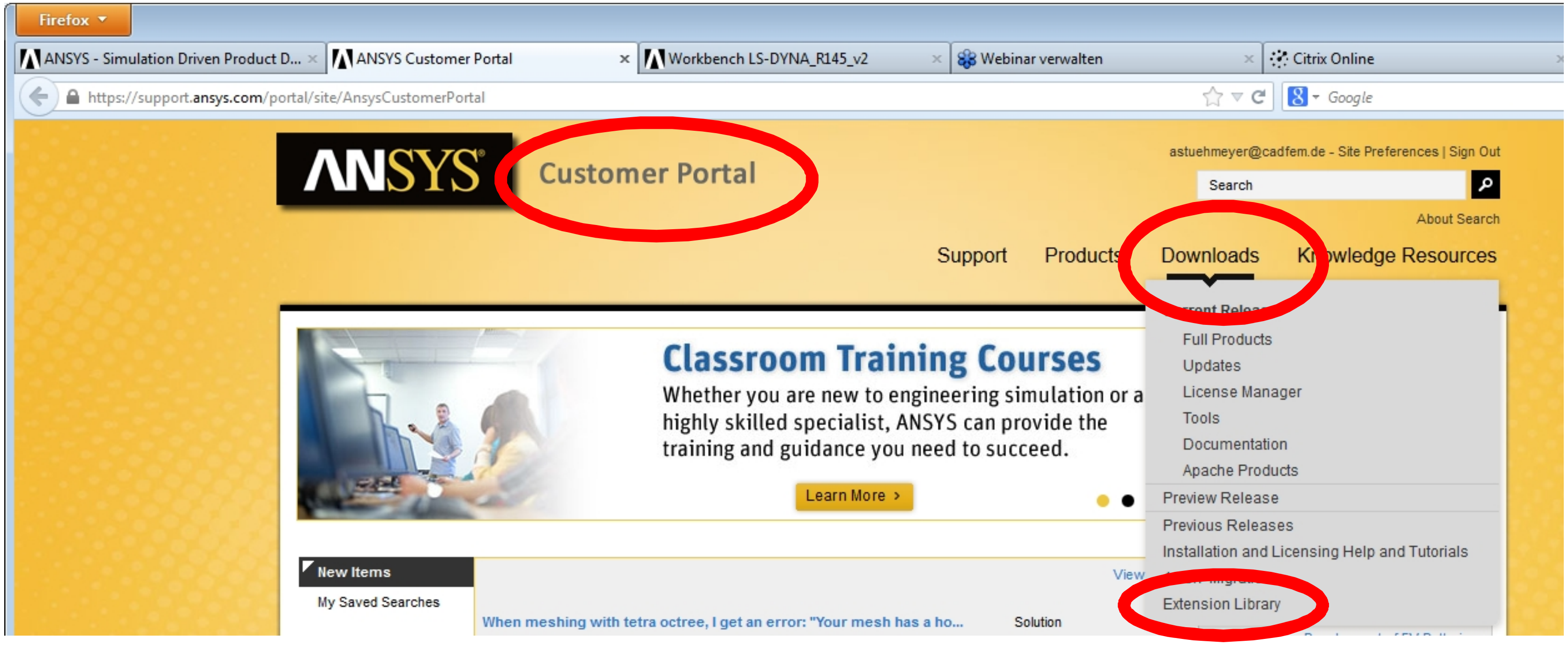
§ Download from Customer Portal: http://www.ansys.com

§ Go to Support Customer Portal

ANSYS Workbench LS-DYNA

§ Select „Extension Library“ from the „Downloads“

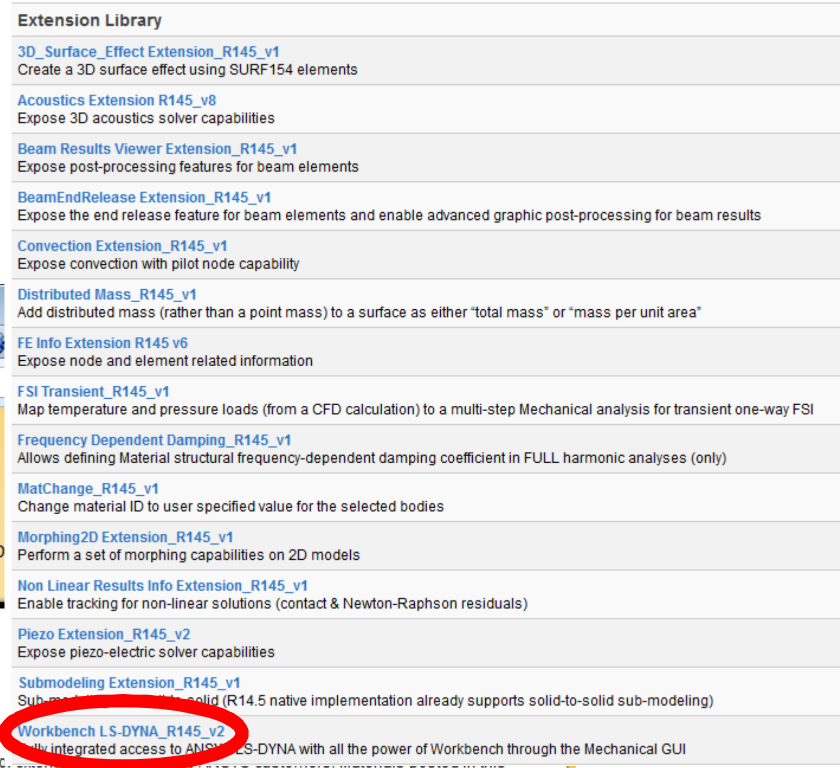
§ Workbench LS-DYNA is a „ACT Library“

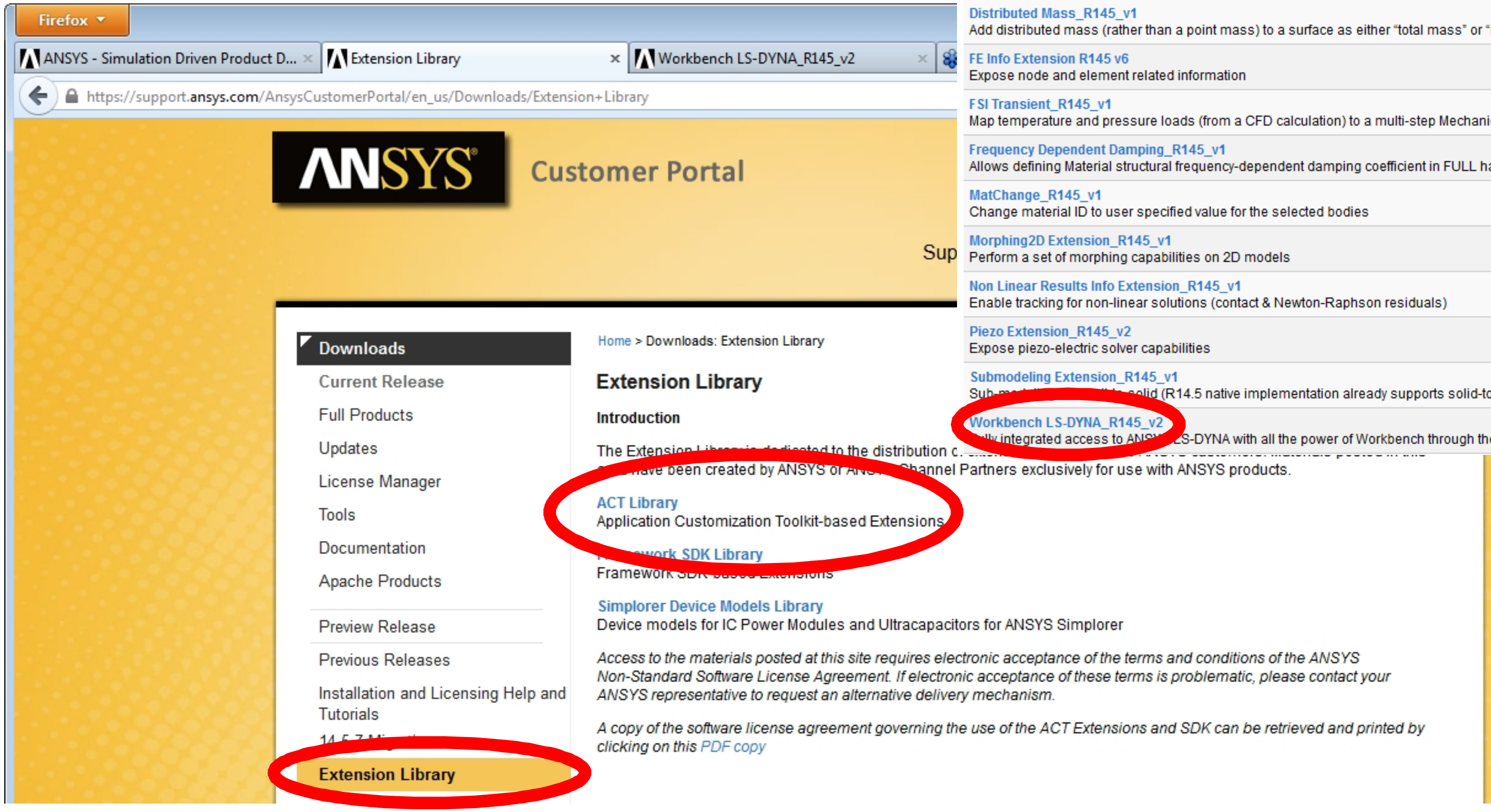


ANSYS Workbench LS-DYNA

§ Workbench LS-DYNA is a „ACT Library“

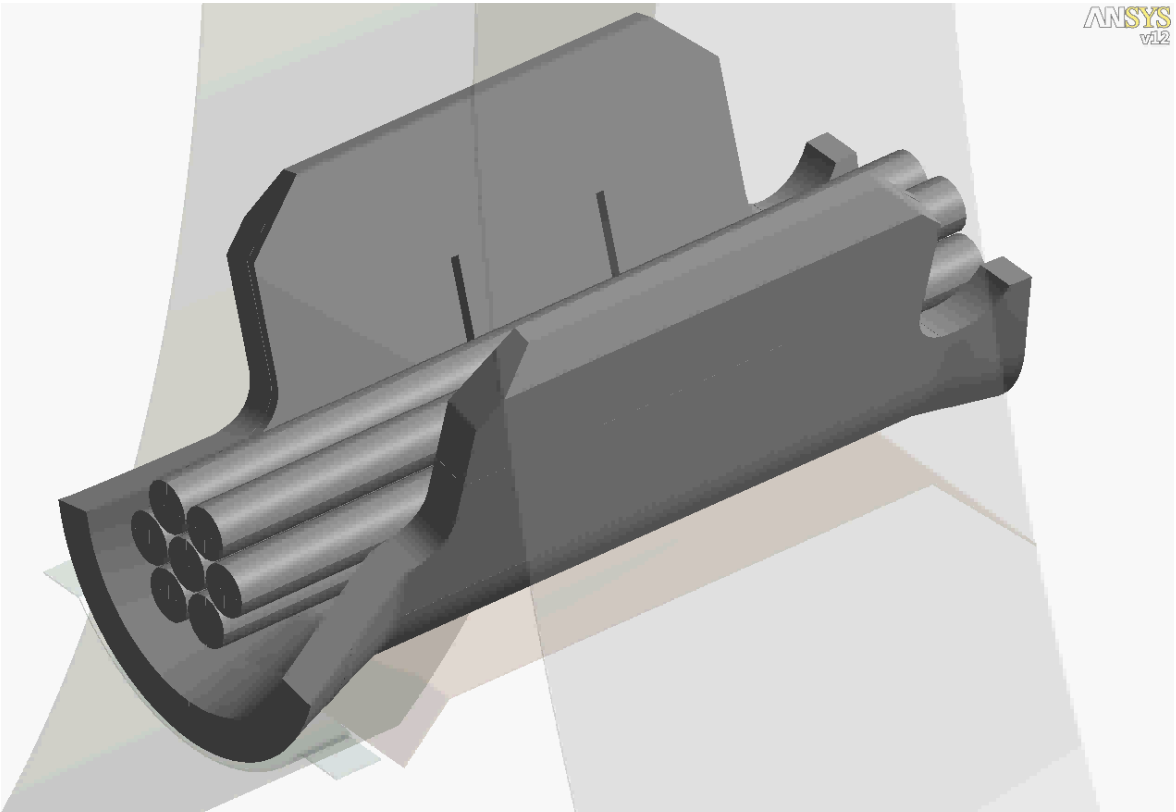
§ Look for „Workbench LS-DYNA“





Live Demonstration

Live Demonstration




$\overline{\Pi} = \frac{1}{2}\sum_e \{u\}^T \cdot [K] \cdot \{u\} - \{u\}^T \cdot \{F\}$
FEM SOFTWARE AND SERVICES
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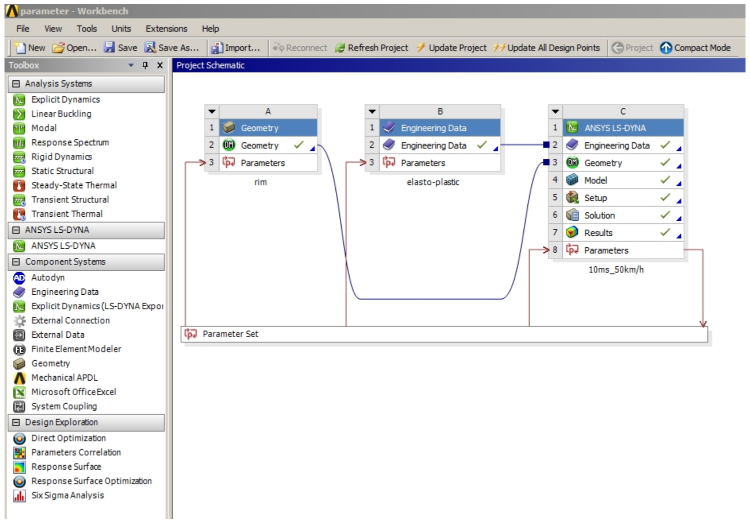
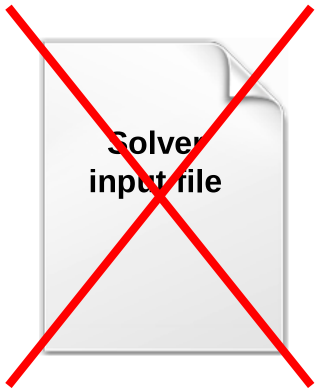
Summary

Advantages of Workbench LS-DYNA

- § Preprocessing, solving and postprocessing within one environment
  - § Bi-directional connection to CAD systems
  - § Fully parametric workflow
  - § Integrated powerful mesher
  - § Workbench based monitoring during the solve process
- § No manual data handling necessary (e. g. solver input file)



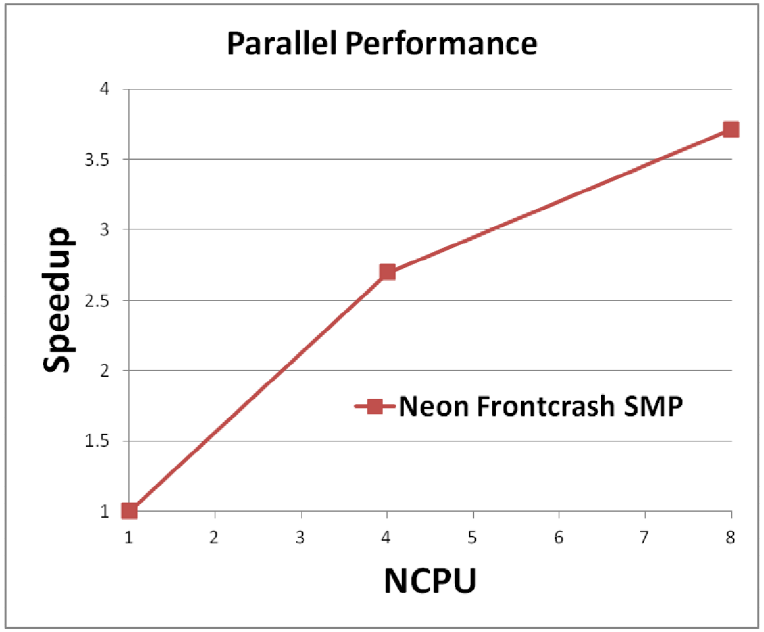


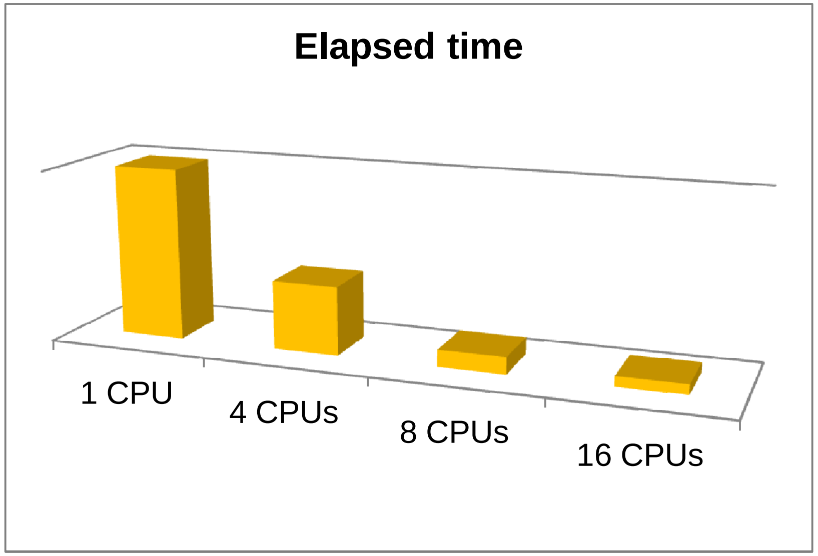
Advantages of Workbench LS-DYNA

§ High-performance explicit solver including parallel processing

§ Parallel processing enhances design variations due to time saving

§ Advanced simulation capabilities





Advantages of Workbench LS-DYNA

§ Workbench integrated solution for explicit calculation

§ Access to a powerful and robust explicit solver

§ Robust calculation of large non-linearities possible

§ Common Graphical User Interface (GUI)