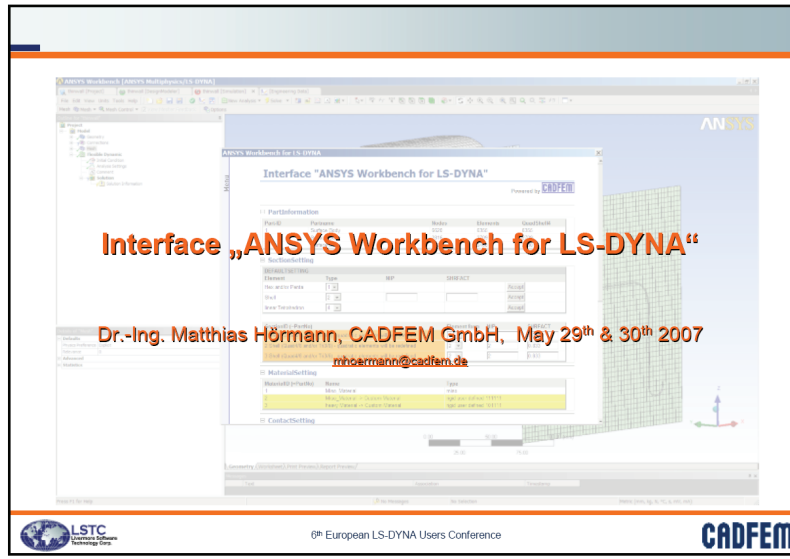


Motivation and Applications

Motivation to develop the Interface "Workbench LS-DYNA"

- Use of FE-software which fits best for physical problem → more efficient in terms of simulation time
- Allow WB users to simulate large nonlinear and transient dynamic problems with LS-DYNA
- LS-DYNA with LS-PrePost lacks preprocessor with CAD-Interfaces, mid-surface generation and meshing functionalities

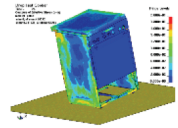
Typical examples for application

- Drop-test simulations (short time dynamic range, high frequencies)
- Problems including complex contact situations (large geometrical nonlinearities)
- Problems including sophisticated material damage and failure (large nonlinearities, element erosion)
- Load limit analyses (large deformations, large nonlinearities)

Benefits for Users – Win-Win-Situation

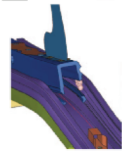
ANSYS Workbench Users

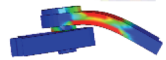
- Limited extra costs for step into explicit world
  → no preprocessor needed, only LS-DYNA solver
- Use of existing WB model → previous invested work,
  e.g. with DesignModeler, not wasted
- Basically one environment (Workbench) for implicit
  and explicit simulations



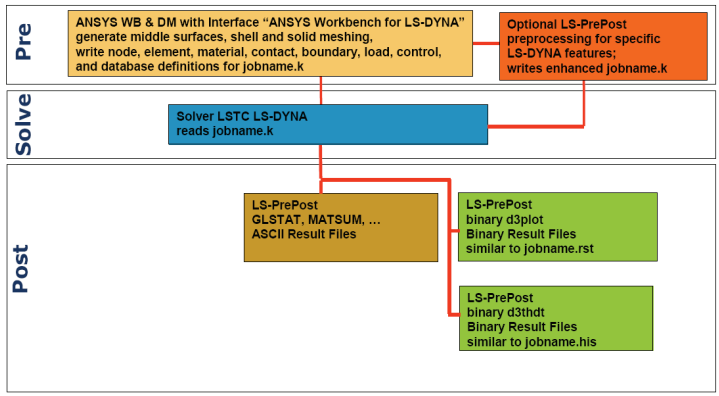
LS-DYNA Users with ANSYS Workbench on site

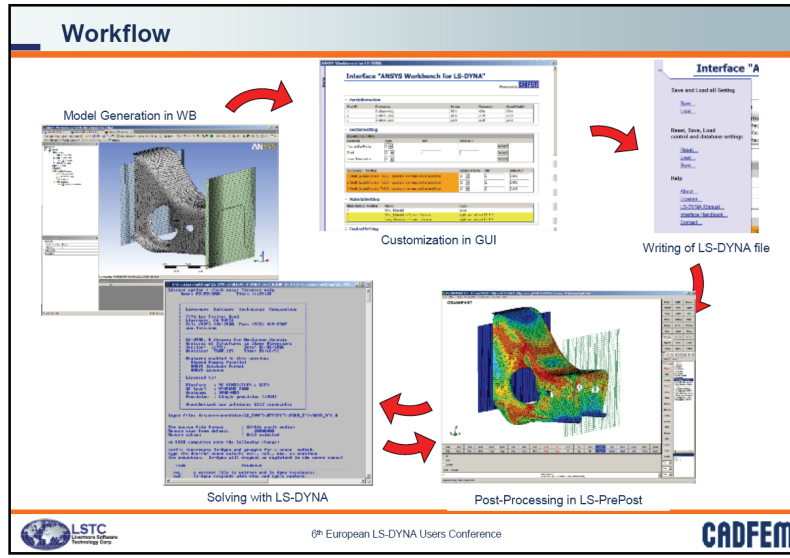
- Saving additional preprocessor
- Closely linked to other simulation departments using already
  ANSYS Workbench
- Closer link to design engineering departments through
  CAD-Interfaces of ANSYS WB





Abstract Workflow





Supported Features – Elements

Following Workbench Elements are supported:

Solid Elements:

- Linear Tetrahedron with 4-Nodes
- Linear Hexahedron with 8-Nodes
- Linear Pentahedron with 6-Nodes
- Linear Pyramids with 5-Nodes
- Quadratic Tetrahedron with 10-Nodes
- Quadratic Hexahedron with 20-Nodes → Linear Hexahedron with 8-Nodes
- Quadratic Pentahedron with 15-Nodes → Linear Pentahedron with 6-Nodes
- Quadratic Pyramids with 13-Nodes → Linear Pyramids with 5-Nodes

Shell Elements:

- Linear Triangle with 3-Nodes
- Quadratic Triangle with 6-Nodes → Linear Triangle with 3-Nodes
- Linear Quadratic with 4-Nodes
- Quadratic Quadratic with 8-Nodes → Linear Quadratic with 4-Nodes

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Supported Features – Elements

SectionSetting

DEFAULTSETTING				
Element	Type	NIP	SHRFACT	
Hex and/or Pentra	1			Accept
Shell	2			Accept
linear Tetrahedron	4			Accept

SectionID (=PartNo)	Element form
1 Hexahedron (20-Nodes) and/or Pentahedron (15-Nodes) - will be redefined	1
2 Hexahedron (20-Nodes) and/or Pentahedron (15-Nodes) - will be redefined	1
3 Hexahedron (20-Nodes) and/or Pentahedron (15-Nodes) - will be redefined	1
4 Hexahedron (20-Nodes) and/or Pentahedron (15-Nodes) - will be redefined	1
5 Hexahedron (20-Nodes) and/or Pentahedron (15-Nodes) - will be redefined	1

- The table "SectionSetting" allows to set element formulation for all parts or every part independently, e.g. reduced or fully integrated elements
- For shell elements the user can change number of integration points across shell thickness (NIP) and shear correction factor (SHRFACT)
- Highlighting syntax shows warning whenever quadratic elements are redefined (highlighted in orange)

Supported Features – Materials

Following Workbench Materials are supported:

Isotropic linear elastic	→ *MAT_ELASTIC (#1)
Orthotropic linear elastic	→ *MAT_ORTHOTROPIC_ELASTIC (#2)
BISO	→ *MAT_PIECEWISE_LINEAR_PLASTICITY (#24)
MISO	→ *MAT_PIECEWISE_LINEAR_PLASTICITY (#24)
BKIN	→ *MAT_PLASTIC_KINEMATIC (#3)

- All materials which are not defined as ortho, biso or miso are defined as linear elastic. True stress-strain curves for MISO are translated as well.
- User can switch any material model within Worbench GUI to rigid and can apply support conditions in global directions for center of gravity.
- Any LS-DYNA material model which is not directly supported by Workbench GUI can be added using comments with LS-DYNA Keyword commands; Material IDs will be automatically changed and reported in the *MAT-definition
- Hourglass and Equation of State definitions for each part can be added with comments as well; IDs and part definitions will be automatically adjusted

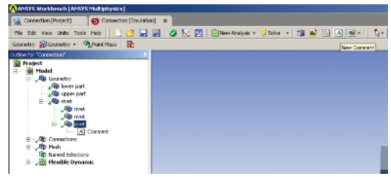
Supported Features – Materials

MaterialSetting

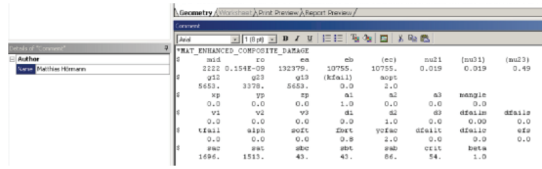
MaterialID (=PartNo)	Name	Type
1	Custom Material -> Structural Steel - MISO 2	rigid user defined 111000
2 (orig. ID: 3)	Rigid	*MAT_RIGID_TITLE
3	Structural Steel - MISO	miso
4	Structural Steel - MISO	miso
5 (orig. ID: 2222)	Custom Material	*MAT_ENHANCED_COMPOSITE_DAMAGE

- The table "MaterialSetting" gives information on materials selected from Workbench Engineering Data and on additional defined materials using comments (highlighted in yellow)
- To define rigid materials a quick definition in the comment is possible:
  `mat_rigid 111000`
  where the latter input corresponds to the support condition CON2 flag (CMO=-1). Modification is highlighted in yellow. Density, Young's modulus and Poisson ratio will be taken from Workbench Engineering Data of that part
- Any material model available in LS-DYNA can be input via comments using LS-DYNA Keyword commands. The original material ID is listed and added in the keyword definition for clarity

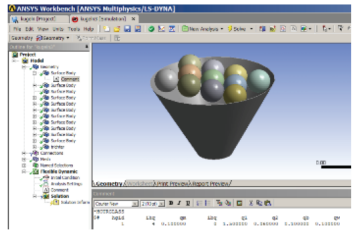
Supported Features – Materials



- New comment is added for the desired part
- Comment is composed of LS-DYNA Keyword; use proper unit system



Supported Features – EOS & Hourglass



EosSetting

EOSID	PartID	Name
1	3	*EOS_IDEAL_GAS
2	4	*EOS_LINEAR_POLYNOMIAL
3	6	*EOS_LINEAR_POLYNOMIAL
4	7	*EOS_IDEAL_GAS
5	8	*EOS_IDEAL_GAS

HourglassSetting

HGID	PartID	IHQ	QM
1	1	4	0.100000
2	2	5	0.100000
3	5	1	0.100000
4	7	4	0.050000
5	8	4	0.050000

Preview of LS-DYNA file

(This information is not complete)

```
$#
$#############################################################################
$#
$#####  DEFINE PARTS
$#
$#############################################################################
$#
$#...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....8
$#
*PART
$#    pid     sid     mid    eosid    hgid    adpopt
Surface Body
         1       1       1                1
Surface Body
         2       2       2                2
Surface Body
         3       3       3       1
Surface Body
         4       4       4       2
Surface Body
         5       5       5                3
Surface Body
         6       6       6       3
Surface Body
```

- *HOURGLASS and *EOS definition for each part can be added as well
- Define comment for part with corresponding LS-DYNA Keyword command; can be combined with *MAT definition
- IDs and part definitions will be automatically adjusted

Supported Features – Contacts

Following Workbench Contacts are supported:

Bonded	→ *CONTACT_TIED_SURFACE_TO_SURFACE_OFFSET
Frictional	→ *CONTACT_AUTOMATIC_SURFACE_TO_SURFACE

- All other contact types are redefined to Frictional
- For asymmetric contact definition *CONTACT_ONE_WAY_ is written
- Slave-Master flipping is supported
- Contact definitions are part based (SSTYP=MSTYP=3), if part to part is supposed in contact. Part-set definitions are also available if several parts are defined on slave or master side. SOFT=1 is used by default
- Input for LS-DYNA optional contact cards A, B and C can be defined as well (e.g. SOFT, SBOPT, DEPTH)
- Any LS-DYNA contact definition which is not directly supported by Workbench GUI can be added using comments with LS-DYNA Keyword commands; care has to be taken for proper numbering

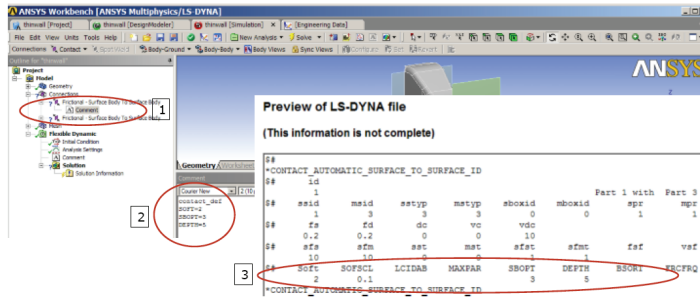
Supported Features – Contacts

ContactSetting

ID	Name	Part-IDs Slave	Part-IDs Master	Type
1	Bonded - lower part To upper part	1	2	Bonded
2	Frictional - Solid To Solid	1	3	Frictional
3	No Separation - upper part To rivet	2	3	will be changed to Frictional
4	Frictional - Solid To Solid	1	4	Frictional
5	Frictional - Solid To Solid	2	5	Frictional

- The table shows the Part-IDs for master and slave side as well as the contact type.
- Bonded and frictional contact types are supported. All other contact types will be automatically changed to "Frictional" (warning highlighted in orange).
- Contact definitions are part based (SSTYP=MSTYP=3), if part to part is supposed in contact. Part-set definitions are also available if several parts are on slave or master side

Supported Features – Contacts

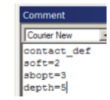


- Input for LS-DYNA optional contact cards A, B and C can be defined as well (e.g. SOFT, SBOPT, DEPTH)
- Define comment for corresponding contact definition with `contact_def` and define input for `SOFT=2` or any other variable

Supported Features – Contacts

- Below is a list of supported optional contact commands of LS-DYNA
- Input must not be case sensitive
- Define one variable per line

Card A	SOFT	SOFSCL	LCIDAB	MAXPAR	SBOPT	DEPTH	BSORT	FRCFRQ
Card B	PENMAX	THKOPT	SHLTHK	SNLOG	ISYM	I2D3D	SLDTHK	SLDSTF
Card C	IGAP	IGNORE	DPRFAC	DTSTIF			FLANGL	



Supported Features – Boundaries & Loads

Following Workbench Boundary Conditions are supported:

- translational and rotational fixed boundary conditions on solids and shells

Following Workbench Initial Conditions are supported:

- initial velocity conditions
- gravity loading (always for all parts)

Following Workbench Loads and Prescribed Motions are supported:

- transient single loads
- prescribed motions in terms of displacements;
  switching to velocity or acceleration possible within Interface GUI

Supported Features

Other important interface features:

- Any LS-DYNA command can be added using Comments in WB
- Check on non-supported elements in the mesh and non-supported contact definitions → automatic switching possibilities are partly offered
- Check on "no Density" input
- Highlighting syntax for warnings and errors
- Automatic end-time calculation based on time step sizes and number of time step
- Named selections, which are defined in WB, are automatically written into the *.k file (currently as *SET_NODE_LIST)
- Definition of control and output settings for LS-DYNA; default values are given, changeable and savable by user (template.rc)
- Project related GUI settings can be saved and reloaded
- User manual for interface available
- Generation of log-file during translation; added into keyword-file (version information of interface and Workbench as well as warnings)
- Hot link to LS-DYNA Keyword User's Manual

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Additional Information and Contact

World Wide Web

http://www.cadfem.de/Workbench-LS-DYNA.3622.0.html

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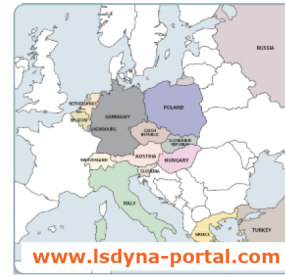

CADFEM booth at exhibition

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