SMILE
ALTERNATIVE INPUT LANGUAGE FORMULA

(AND OTHER SOLVERS)

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BMW GROUP THE NEXT 100 YEARS

TEAM.

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CONTENT.

Problems & Vision

CAD vs. CAE

Features of SMILE

100+% model, Democratization of Simulation, LOD, CAD-Support, Object-Orientation, Modelling Guidelines, Hierarchical Structure

Technology

Web Technologies

XML, DTD, XSLT

Examples

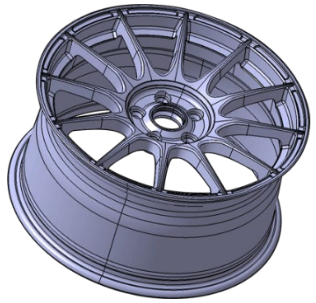
Table &Vase

Airbag

PROBLEMS AND VISION.

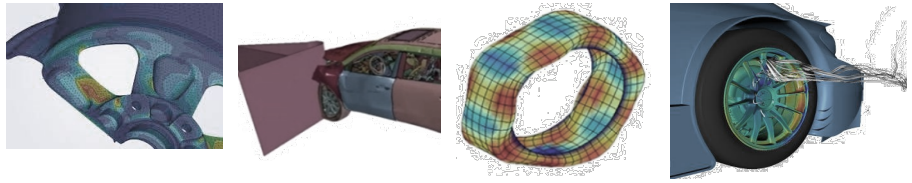
CAD

- One model for the entire geometry (100+% model)
- For all disciplines &tools



CAE

- Many <100 % models
- Every simulation tool or discipline needs his own model



Unified Simulation Modelling Language

- One model describes the physic of the objects (100+% model)
- Simulation models will be derived from it

S.M.I.L.E.
Unified Simulation Modelling LanguagE

Democratization of Simulation

- Model contains physical properties only
- Numerical expert knowledge by machine readable modelling guidelines

SMILE–FEATURES.

Democratization of Simulation

Split into simulation know-how and engineering know-how.
Today, a good engineer has to be a simulation expert.

100+ %model

One simulation model for all simulation disciplines and solvers (similar to CAD).

LoD, CAD-Integration

More than one discretizations per model.
Link to CAD-Geometry → automatic meshing, IGA, …

Object-oriented

Split into object to be investigated and question (load case).

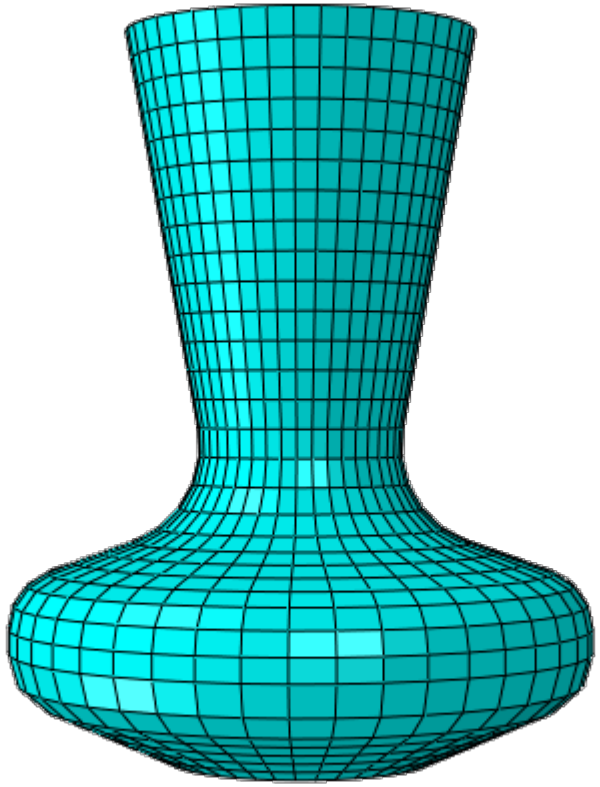
Modelling guideline

Cascading (solver, company, department) modelling guidelines.

Hierarchicalstructure

Hierarchical structure instead of flat input file.

EXAMPLE TABLE & VASE. MODELS.



Vase

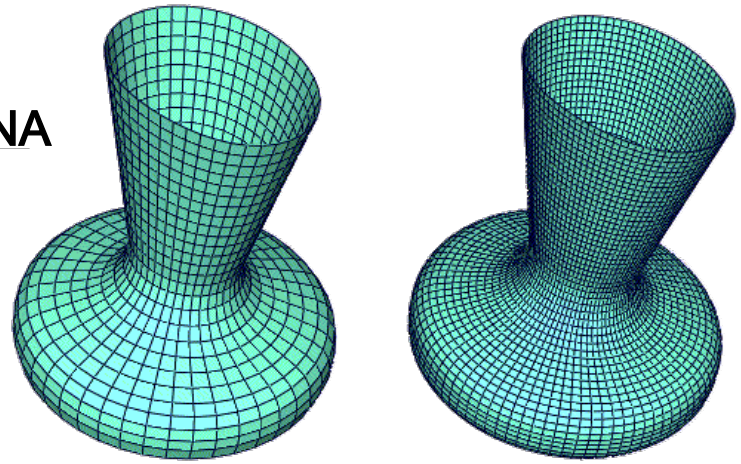
0,2 mm sheet metal

Table

Wood, composed by 5 components (plate, 4x legs)

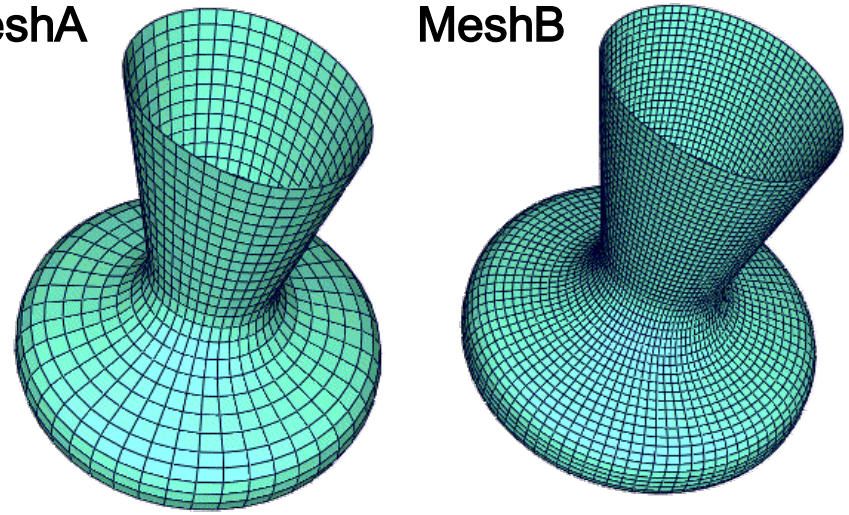
EXAMPLE – TABLE & VASE. FREQUENCY – MODE 1 (+6).

LS-DYNA



MeshA

MeshB



Abaqus

```
<SMILE.INCLUDE>
    <MESH Description="Model from a Vase" Id="MSH-Vase_Mesh"
        Mesh_Discipline="CRASH_MESH" Name="MSH-Test" Resolution="1.0">
        <NODE>
            <NODE.DEFINE NodeId="9357" X="0.33531500000000003" Y="0.2" Z="-0.11423000000000001"/>
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        Mesh_Discipline="CRASH_MESH" Name="MSH-Test" Resolution="2.0">
        <NODE>
            <NODE.DEFINE NodeId="10000001" X="335.315" Y="200.0" Z="-114.23"/>
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```

```
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        <xi:include href="ASSEMBLY/Vase_Model.xml"/>
    </REFERENCE>
</REFERENCES>
```

EXAMPLE TABLE & VASE. MODELLING.

Plate&legs

```
<REFERENCES>
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    </REFERENCE>
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        Resolution="2.0" Complete_Assembly="YES"
        Translate="0.0 0.0 0.0" Orientation="ORI-Global"
        Orientation_Map="ORI-Global"> <xi:include href="ASSEMBLY/Pole_Model.xml"/>
    </REFERENCE>
    <REFERENCE Name ="M3_2" StartId="12100000" Mesh_Discipline="CRASH_MESH"
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        Translate="-1218.0 0.0 0.0" Orientation="ORI-Global"
        Orientation_Map="ORI-Global"> <xi:include href="ASSEMBLY/Pole_Model.xml"/>
    </REFERENCE>
    <REFERENCE Name ="M3_3" StartId="12200000" Mesh_Discipline="CRASH_MESH"
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        Orientation_Map="ORI-Global"> <xi:include href="ASSEMBLY/Pole_Model.xml"/>
    </REFERENCE>
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        Orientation_Map="ORI-Global"> <xi:include href="ASSEMBLY/Pole_Model.xml"/>
    </REFERENCE>
</REFERENCES>
```

EXAMPLE TABLE & VASE. MODELLING.

Plate – element selection

- Plate → bending load case
- One element over thickness

```
<PROPERTY.GLOBAL>
    <USAGE Component_Ref = "COMP-Plate" Value = "Bending Dominated"/>
</PROPERTY.GLOBAL>
```

- Modellierungskatalog

```
<GUIDLINE Solver = "ABAQUS">
    <TEMPLATE.USAGE Id = "Bending Dominated">
        <SOLID Nodes_10="C3D10" Nodes_8="C3D8I" Nodes_6="C3D6" Nodes_4="C3D4" Section="De  ltSolidSection"/>
        <SHELL Nodes_4="S4R" Nodes_3="S3" Section="DefaultShellSection"/>
        <MEMBRANE Nodes_4="M3D4R" Nodes_3="M3D3" Section="DefaultMembraneSection"/>


<GUIDLINE Solver = "LSDYNA">
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        <TEMPLATE.SOLID_SECTION>
            <LSDYNA.SECTION_SOLID Space="10">
                <COMMENT Value="   Secid  Elform     aet"/>
                <LINE   Secid= "$Pid" Elform= "2"  aet = "0"/>
            </LSDYNA.SECTION_SOLID>
```
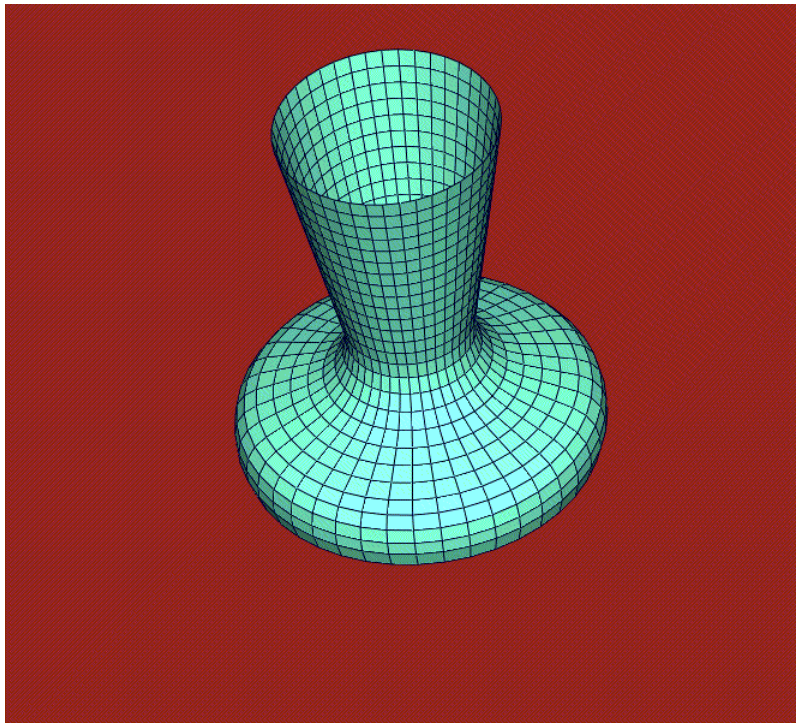
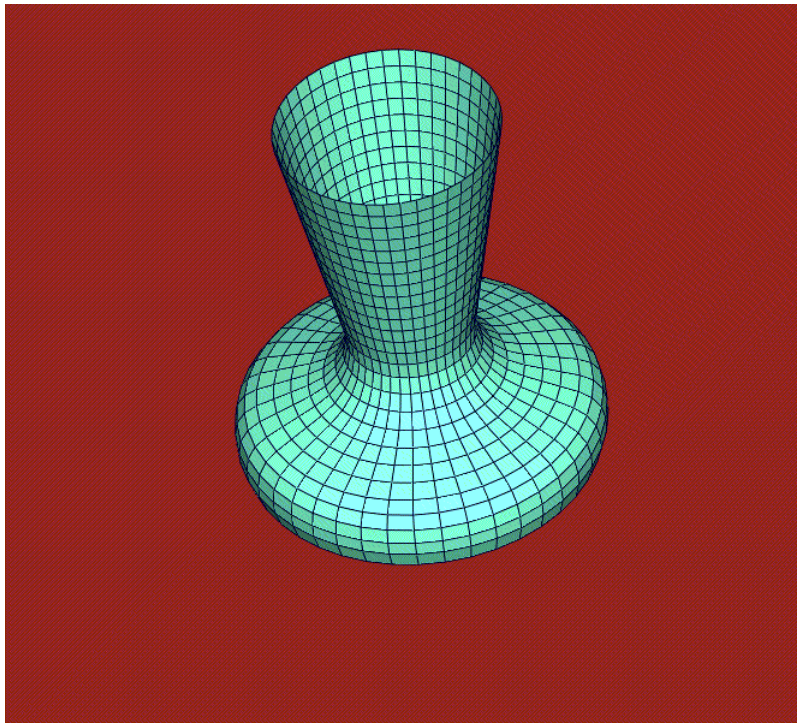

EXAMPLE – TABLE & VASE. IMPACT – MESH A.

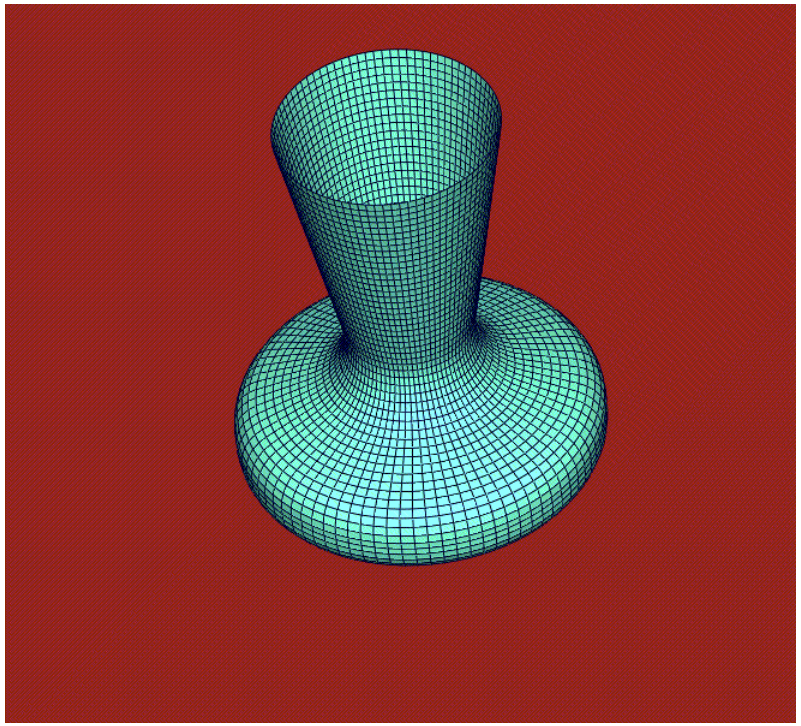


Abaqus

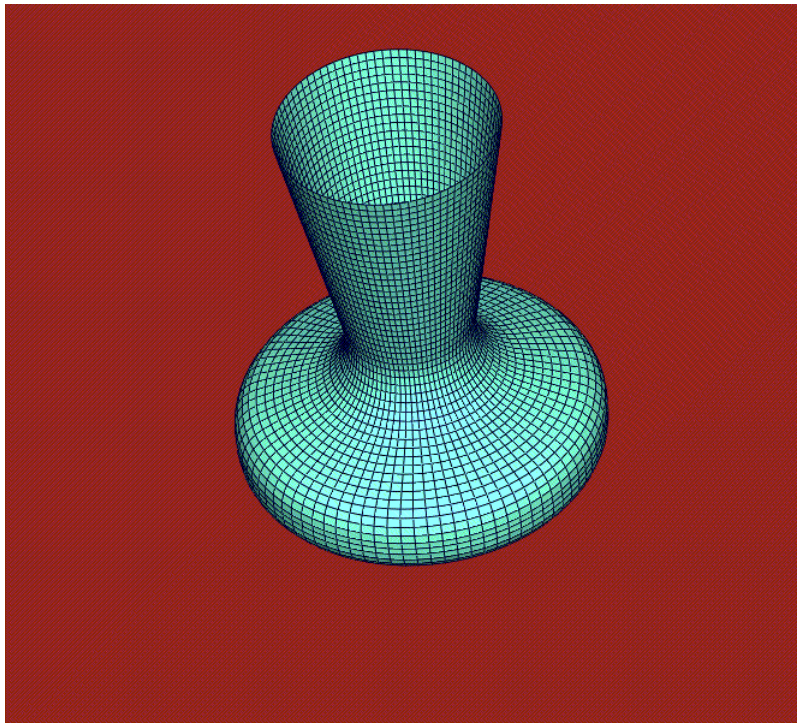


LS-DYNA

EXAMPLE – TABLE & VASE. IMPACT – MESH B.



Abaqus



LS-DYNA

EXAMPLE TABLE & VASE.
SMILE STRUCTURE.

Model file

Vase

Configuration File

Frequency analysis

Modelling Guideline

Abaqus/Standard

Model file

Vase

Table (Plate)

Table (Leg)

Configuration File

Impact analysis

Modelling Guideline

LS-DYNA

EXAMPLE TABLE & VASE.
SMILE STRUCTURE.

Model file

Vase

Configuration File

Frequency analysis

Modelling Guideline

LS-DYNA

Model file

Vase

Table (Plate)

Table (Leg)

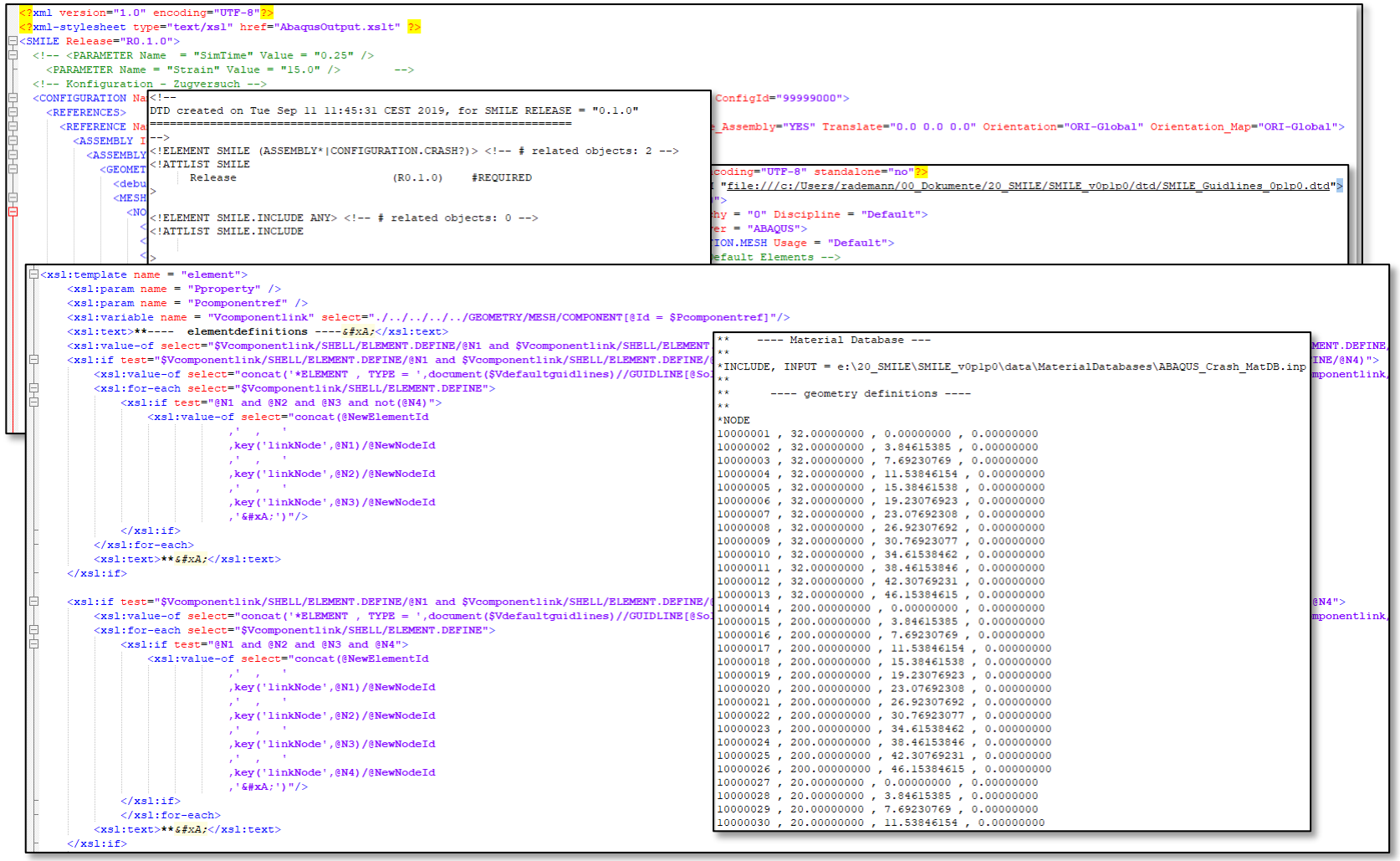
Configuration File

Impact analysis

Modelling Guideline

Abaqus/Explicit

TECHNOLOGY.



XML

Machine and human readable markup language for hierarchical structures.

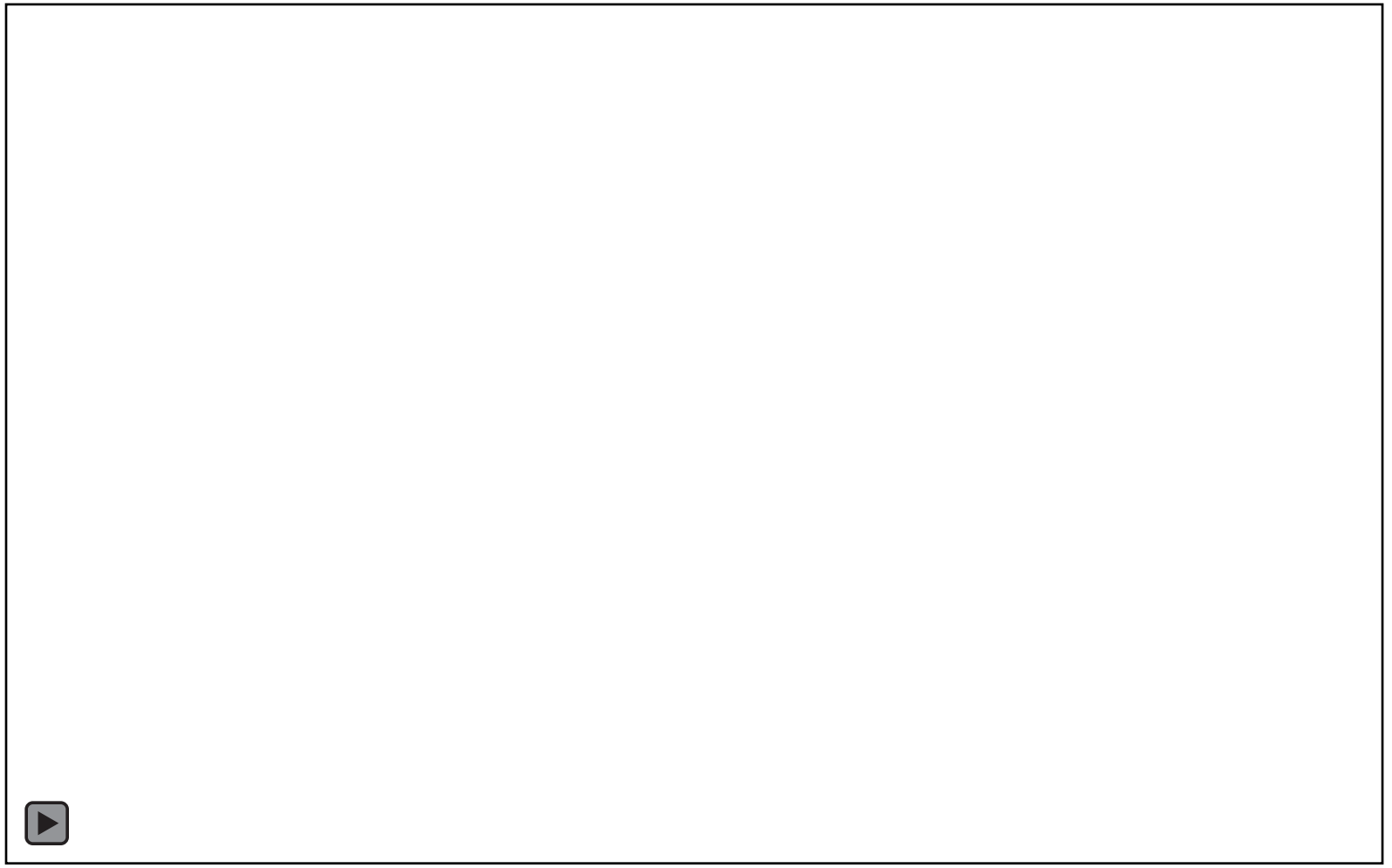
DTD

Document type definition as rules to define document types.

XSLT

Turing-complete language for transforming XML-documents in alternative formats.

TECHNOLOGY.



XML

Machine and human readable markup language for hierarchical structures.

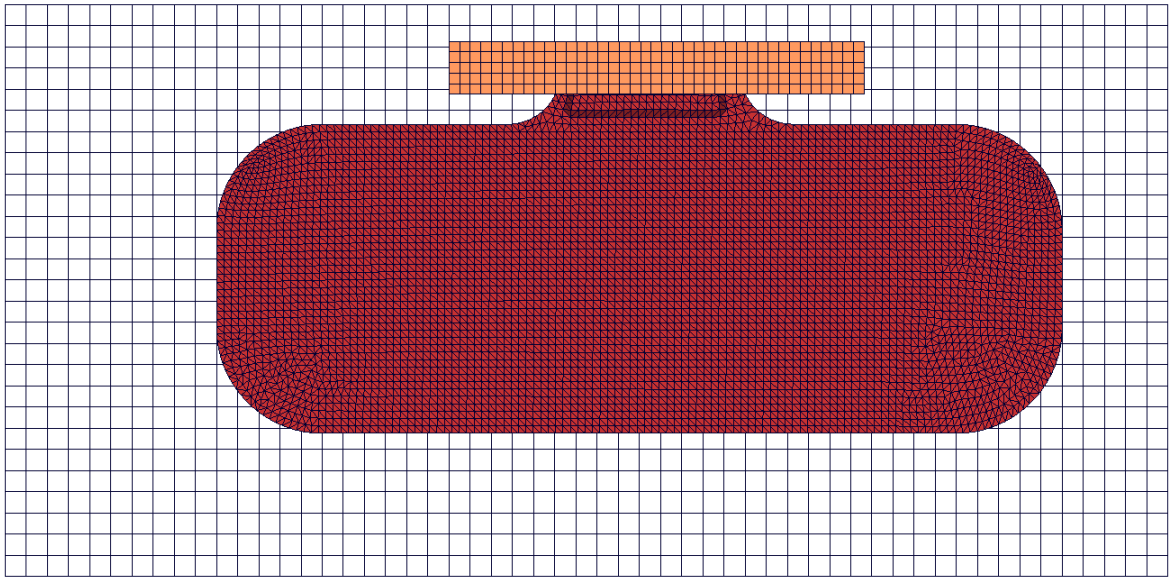
DTD

Document type definition as rules to define document types.

XSLT

Turing-complete language for transforming XML-documents in alternative formats.

EXAMPLE AIRBAG. MODEL.



Airbag model

- Flat airbag (unfolded)
- Membrane elements (7 mm, triangular)

Simulation

- Deployment: 25 ms
- Different inflator types
  - Uniform ressure method (UPM)
  - Particle methods

    LS-DYNA: Corpuscular Method (CPM)

    Abaqus: Lumped Kinetic Molecular (LKM)
  - Coupled Eulerian Lagrange (CEL)

```
<MODELINGGUIDLINE Discipline="AIRBAG_UPM"
    File="file:///../data/ModellingGuidlines/Default-ModellingGuidlines.xml"/>

<MODELINGGUIDLINE Discipline="AIRBAG_PCL"
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<MODELINGGUIDLINE Discipline="AIRBAG_CEL"
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```
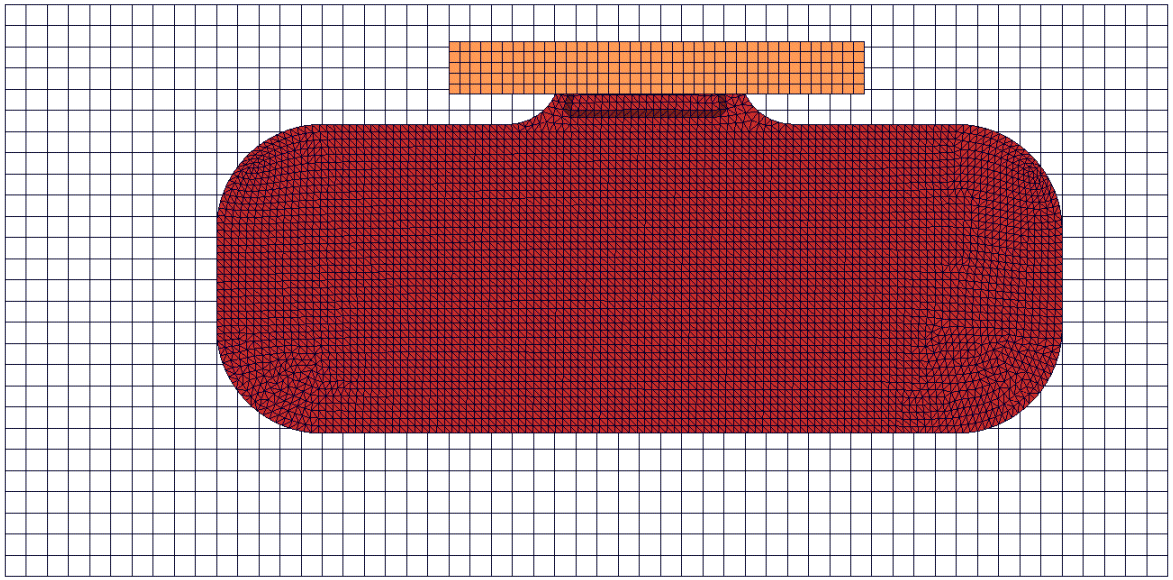
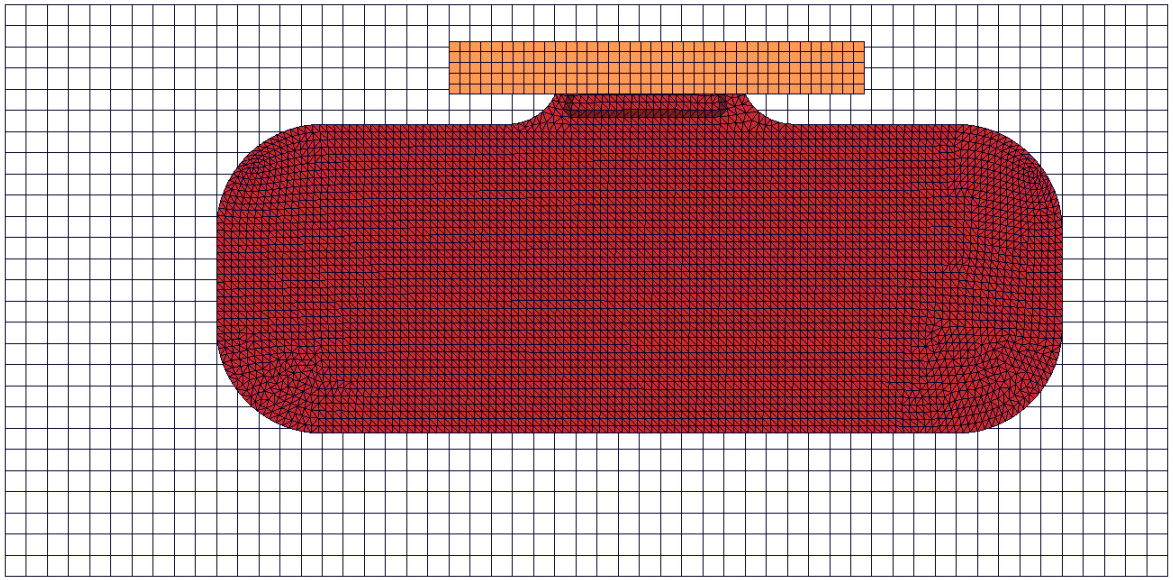

EXAMPLE – AIRBAG.
SIMULATION – UPM.

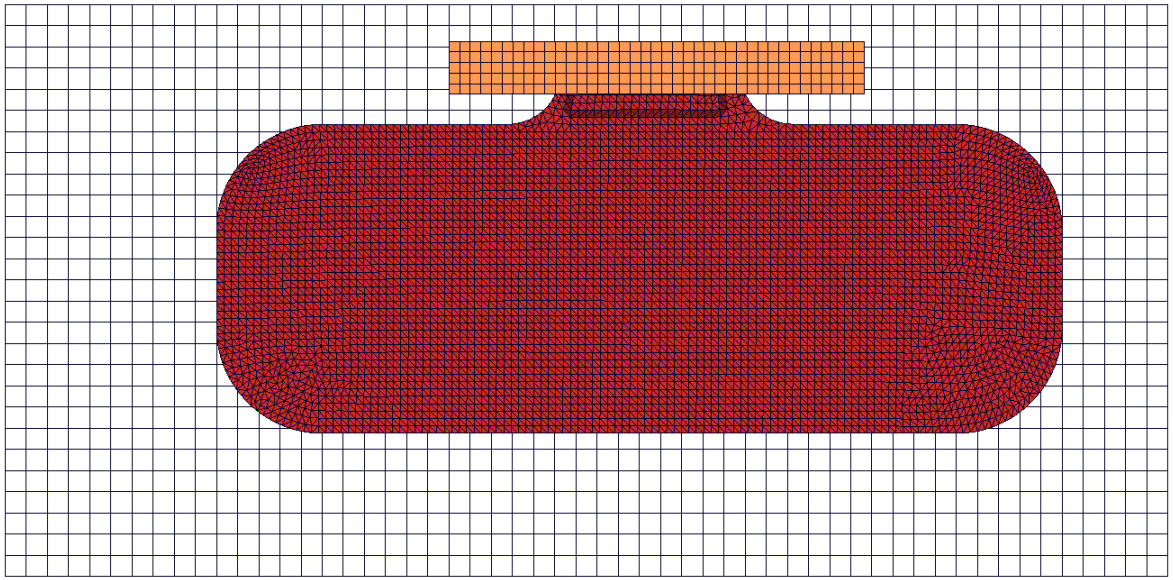


LS-DYNA

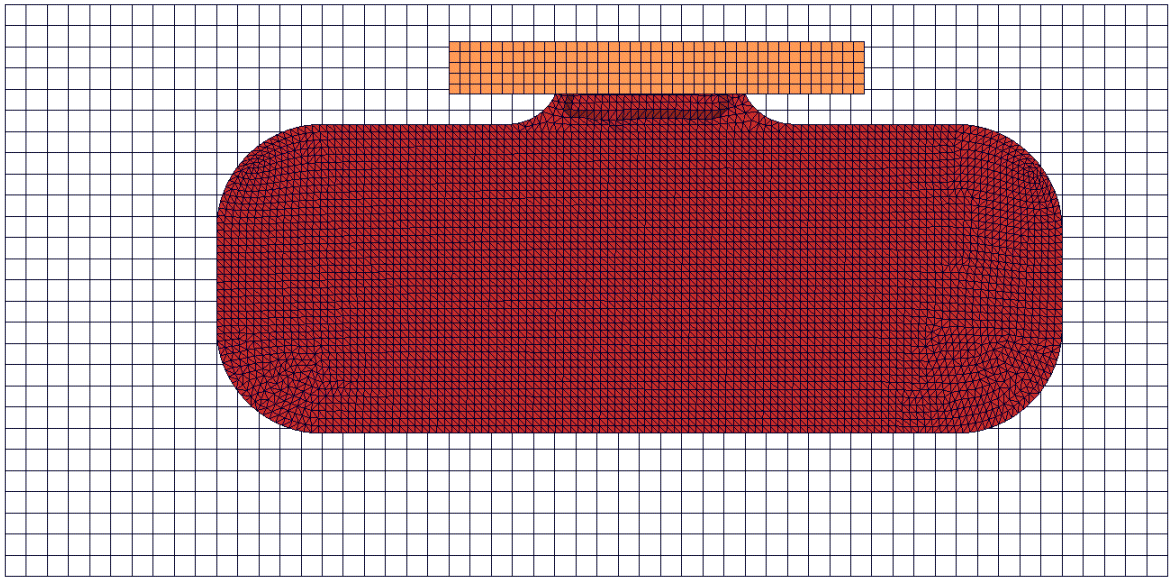


Abaqus

EXAMPLE AIRBAG. SIMULATION PARTICEL METHOD.

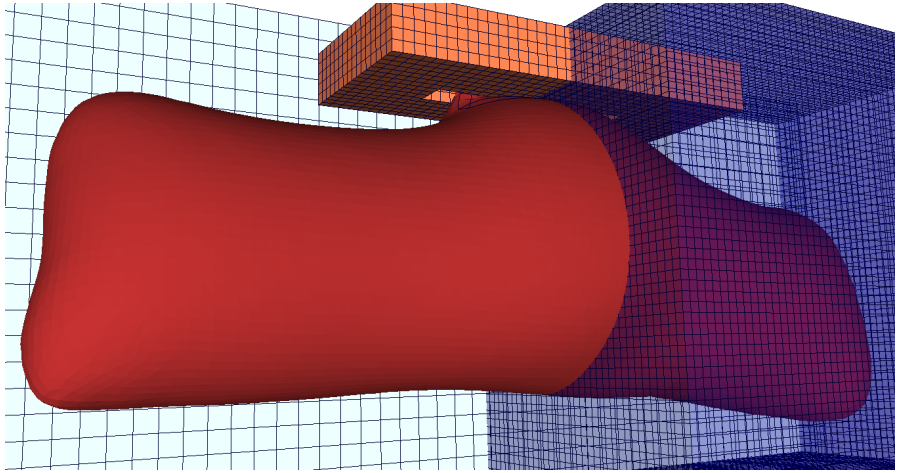


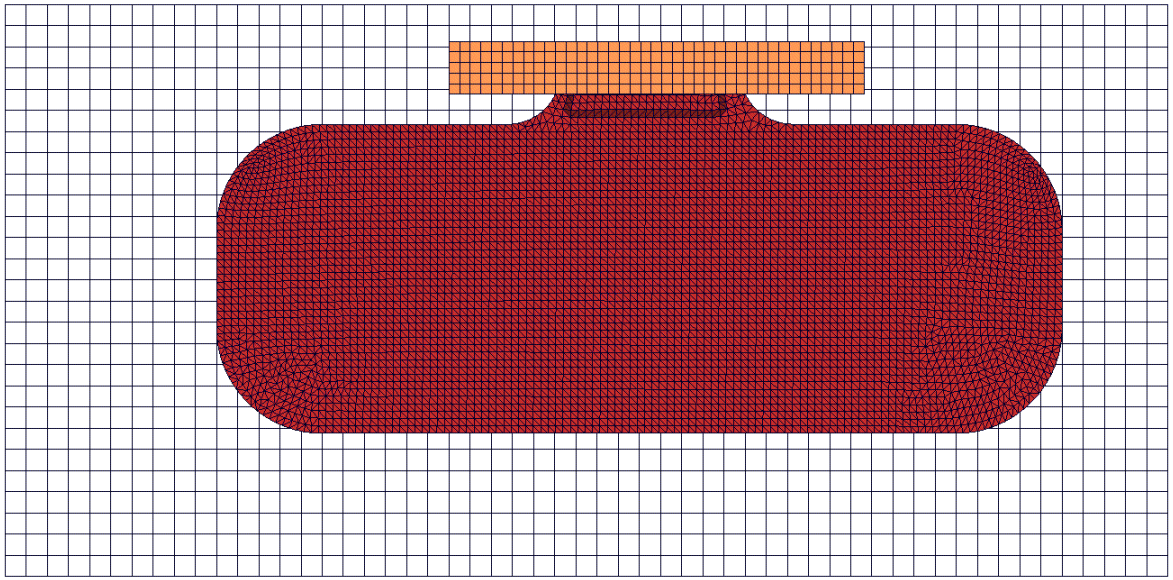
LS-DYNA



Abaqus

EXAMPLE AIRBAG. SIMULATION CEL.





Abaqus

CEL-Domain

- Mesh fixed in space, volume of fraction method
- approx. 230.000 elements (8 mm)
- Automatic mesh generation
- Keywords: `*NCOPY`, `*NFILL`, `*ELGEN`

EXAMPLE AIRBAG.
SMILE STRUCTURE.

Model file	Configuration File	Modelling Guideline
Airbag	Deployment	LS-DYNA (UPM)

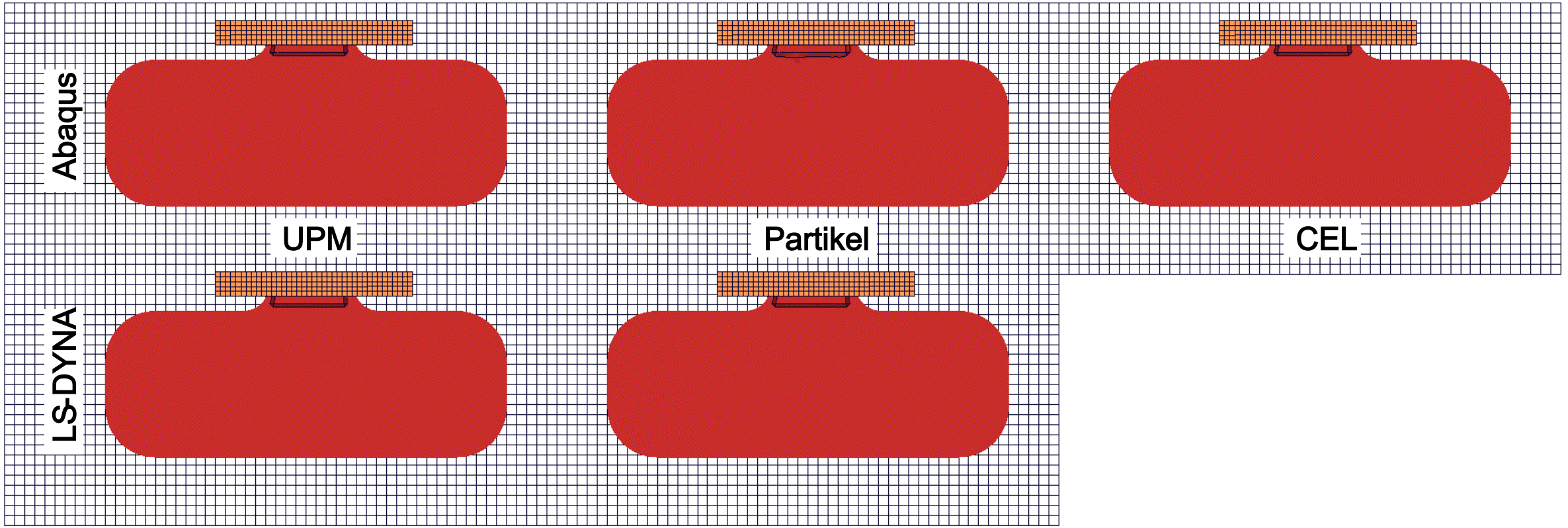
Model file	Configuration File	Modelling Guideline
Airbag	Deployment	Abaqus/Explicit (UPM)

EXAMPLE AIRBAG.
SMILE STRUCTURE.

Model file	Configuration File	Modelling Guideline
Airbag	Deployment	LS-DYNA (Particle - CPM)

Model file	Configuration File	Modelling Guideline
Airbag	Deployment	Abaqus/Explicit (CEL)

EXAMPLE AIRBAG. SIMULATION OVERVIEW.



SUMMARY & OUTLOOK.

Summary

- 100+% Modell
  - one CAE-model → many simulation models, different disciplines
- Democratization of Simulation
  - Modelling guideline
- Example: table &vase
  - natural frequency extraction
  - impact analysis
  - different levels of discretisation
  - two solver
- Example: airbag
  - deployment simulation
  - three different modelling techniques
  - two solver

Outlook

- Standardization (with partner)
- Extend language (POC)
- Support new solver
- Support additional simulation disciplines (e.g. CFD, MKS)
- Link to CAD geometry