

SMILE ALTERNATIVE INPUT LANGUAGE FOR YNA

(AND OTHER SOLVERS)



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Chaitanya Pillala on Unsplash

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TEAM.

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- Product Owner Crash Simulation Tool Chain

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



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PROBLEMS AND VISION.

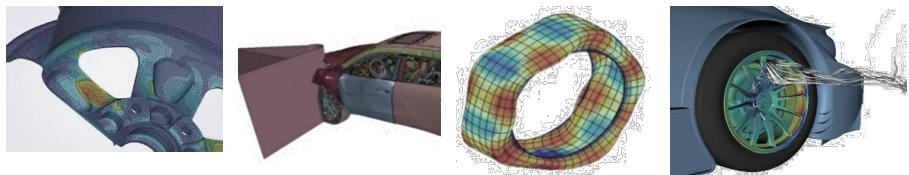
CAD

- 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



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).

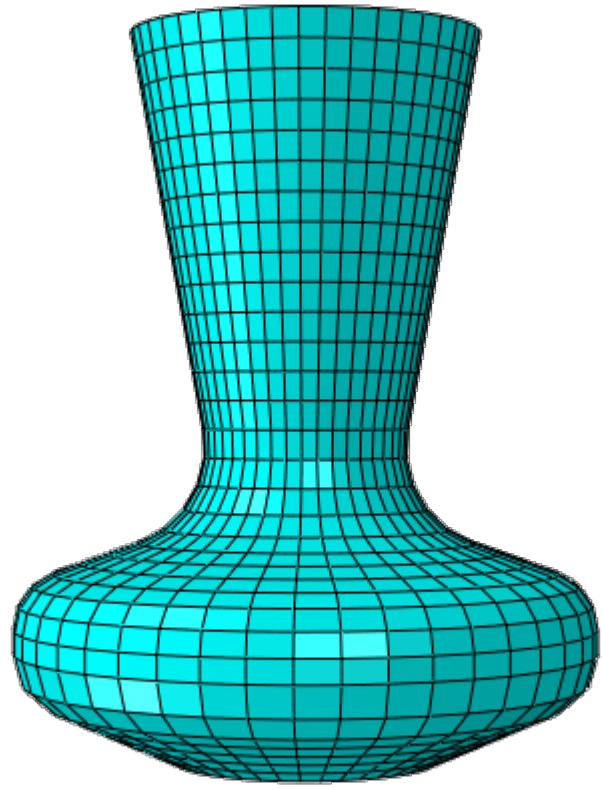
Modelling guideline

Cascading (solver, company, department) modelling guidelines.

Hierarchical structure

Hierarchical structure instead of flat input file.

EXAMPLE TABLE & VASE. MODELS.



Vase

0,2 mm sheet metal

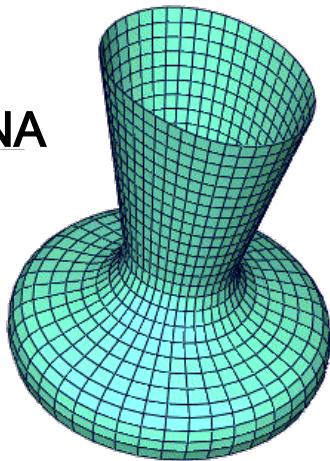


Table

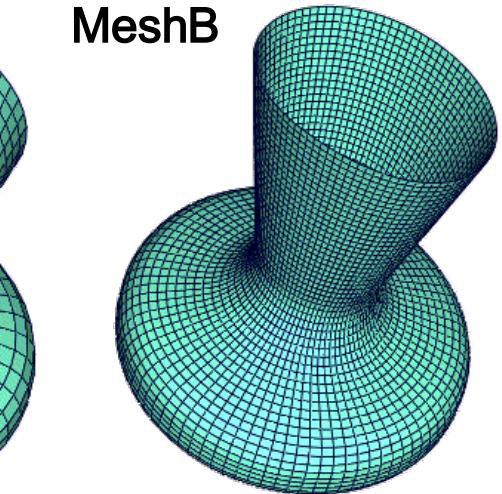
Wood, composed by 5 components
(plate, 4xlegs)

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

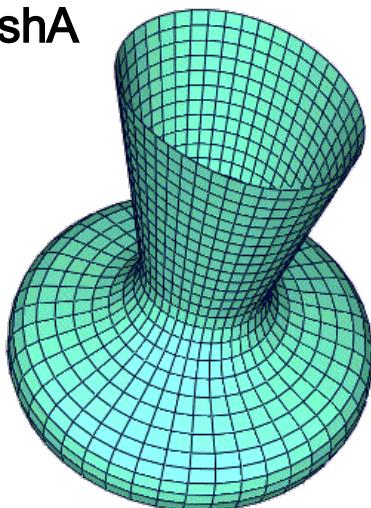
LS-DYNA



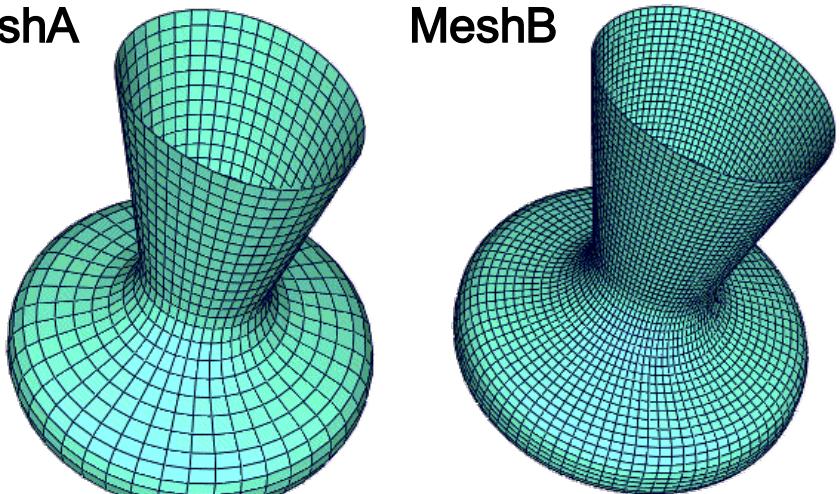
MeshA



Abaqus



MeshA



```
<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="-0.1142300000000001"/>
        <NODE.DEFINE NodeId="9407" X="0.334938" Y="0.194858" Z="-0.1142300000000001"/>

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  <MESH Description="Model from a Vase" Id="MSH-Vase_Mesh"
        Mesh_Discipline="CRASH_MESH" Name="MSH-Test" Resolution="2.0">
    <NODE>
        <NODE.DEFINE NodeId="10000001" X="335.315" Y="200.0" Z="-114.23"/>
        <NODE.DEFINE NodeId="10000002" X="335.22" Y="197.422" Z="-114.23"/>

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        Mesh_Discipline="CRASH_MESH" Name="MSH-Test" Resolution="3.0">
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        <NODE.DEFINE NodeId="9357" X="0.33531500000000003" Y="0.2" Z="-0.1142300000000001"/>
        <NODE.DEFINE NodeId="9582" X="0.33530000000000004" Y="0.198982" Z="-0.1142300000000001"/>

<REFERENCES>
  <REFERENCE Name ="M1" StartId="0" Mesh_Discipline="CRASH_MESH" Resolution="1.0"
             Complete_Assembly="YES" Translate="0.0 0.0 0.0"
             Orientation="ORI-Global" Orientation_Map="ORI-Global">
    <xi:include href="ASSEMBLY/Vase_Model.xml"/>
  </REFERENCE>
</REFERENCES>
```

EXAMPLE TABLE & VASE. MODELLING.

Plate&legs

```
<REFERENCES>
    <REFERENCE Name ="M2" StartId="11000000" Mesh_Discipline="CRASH_MESH"
        Resolution="2.0" Complete_Assembly="YES"
        Translate="0.0 0.0 0.0" Orientation="ORI-Global"
        Orientation_Map="ORI-Global"> <xi:include href="ASSEMBLY/Plate_Model.xml"/>
    </REFERENCE>
    <REFERENCE Name ="M3_1" StartId="12000000" Mesh_Discipline="CRASH_MESH"
        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"
        Resolution="2.0" Complete_Assembly="YES"
        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"
        Resolution="2.0" Complete_Assembly="YES"
        Translate="0.0 -922.333 0.0" Orientation="ORI-Global"
        Orientation_Map="ORI-Global"> <xi:include href="ASSEMBLY/Pole_Model.xml"/>
    </REFERENCE>
    <REFERENCE Name ="M3_4" StartId="12300000" Mesh_Discipline="CRASH_MESH"
        Resolution="2.0" Complete_Assembly="YES"
        Translate="-1218.0 -922.333 0.0" Orientation="ORI-Global"
        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>
```

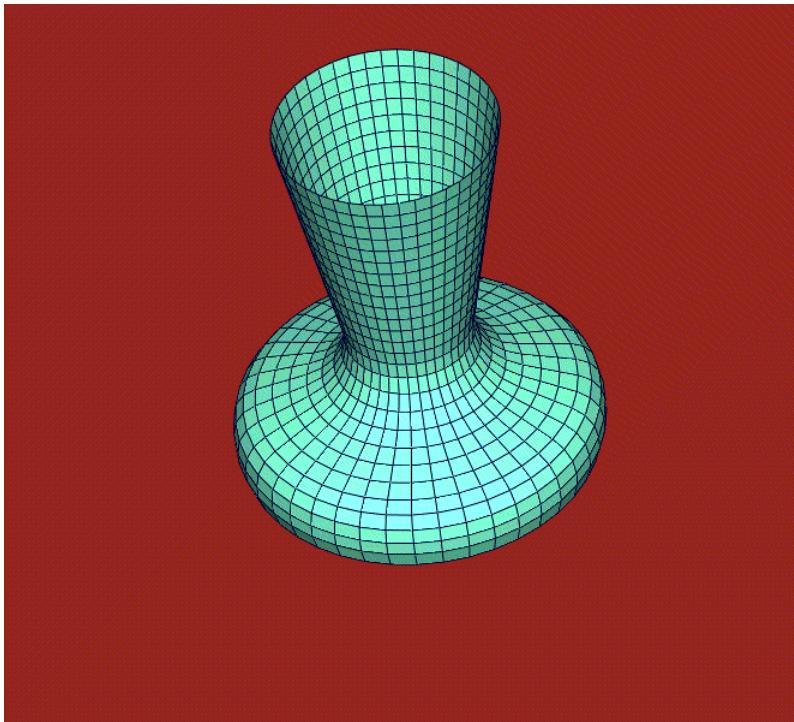
- Modellierungskatalog

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

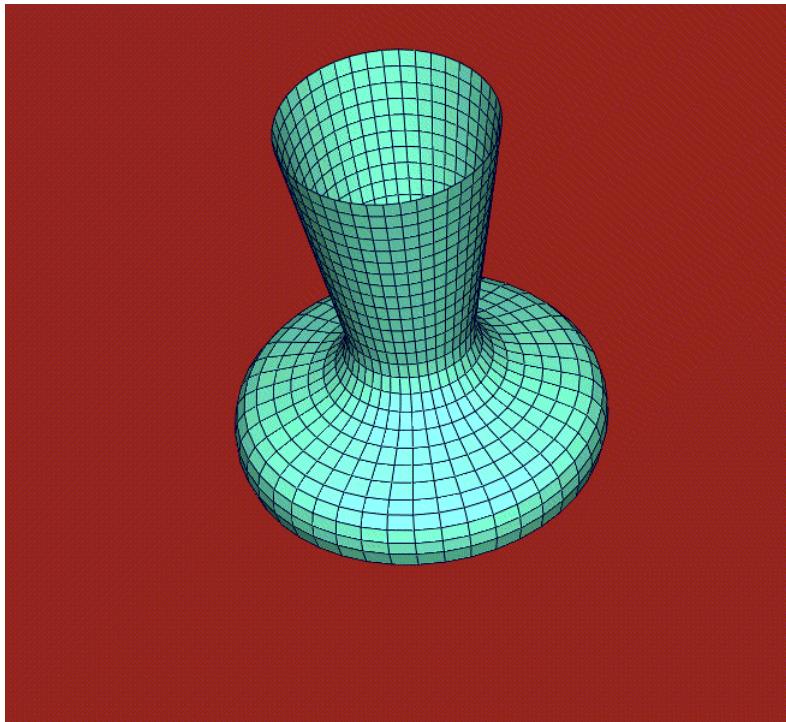
<GUIDLINE Solver = "LSDYNA">
  <TEMPLATE.USAGE Id = "Bending Dominated">
    <TEMPLATE.SOLID_SECTION>
      <LSDYNA.SECTION_SOLID Space="10">
        <COMMENT Value="" Secid Elform aet"/>
        <LINE Secid= "$Pid" Elform= "2" aet = "0"/>
      </LSDYNA.SECTION_SOLID>
```



EXAMPLE TABLE & VASE. IMPACT-MESH A.



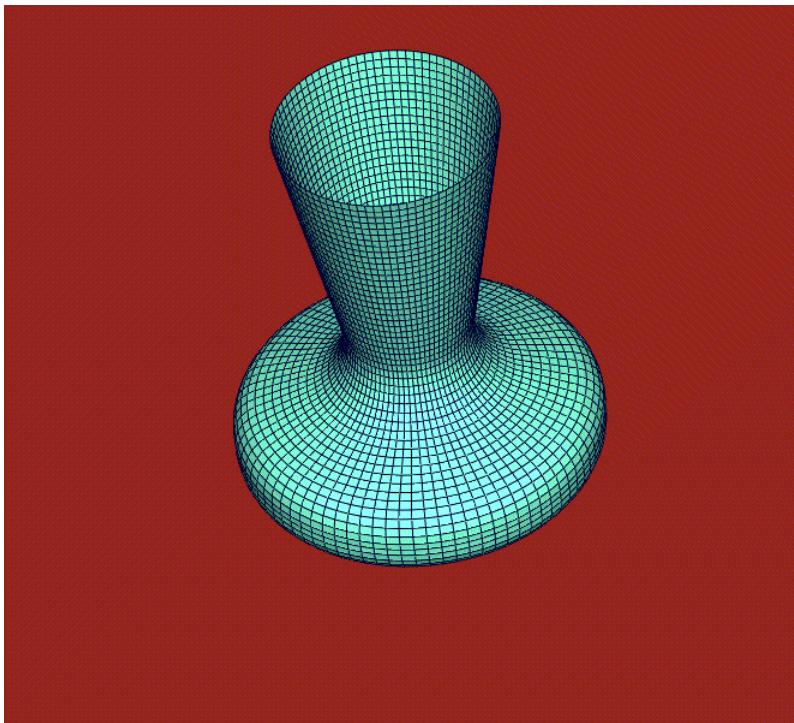
Abaqus



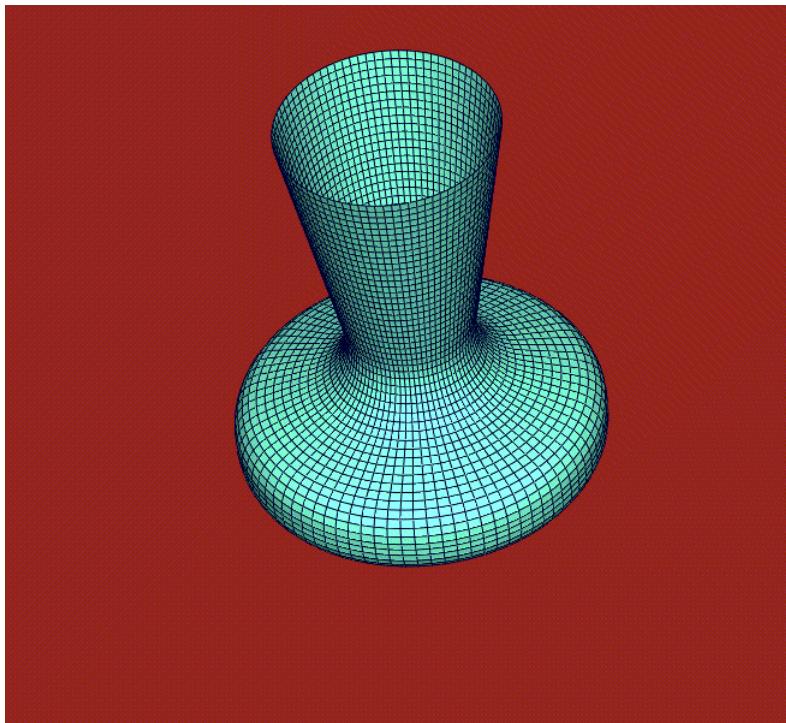
LS-DYNA



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 version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="AbaqusOutput.xslt"?>
<SMILE Release="R0.1.0">
  <!-- <PARAMETER Name = "SimTime" Value = "0.25" />
      <PARAMETER Name = "Strain" Value = "15.0" />    -->
<!-- Konfiguration - Zugversuch -->
<CONFIGURATION Name="Zugversuch">
  <REFERENCES>
    <REFERENCE Name="MaterialDatabase">
      <ASSEMBLY ID="1">
        <ASSEMBLY>
          <!-- ELEMENT SMILE (ASSEMBLY|CONFIGURATION.CRASH?) > <!-- # related objects: 2 -->
          <!ATLIST SMILE
            <GEOMETRY> Release (R0.1.0) #REQUIRED
            <debu>
            <MESH>
            <NO>
            <ELEMENT SMILE.INCLUDE ANY> <!-- # related objects: 0 -->
          </!ATLIST SMILE.INCLUDE
        </ASSEMBLY>
      </ASSEMBLY>
    </REFERENCE>
  </REFERENCES>
  <ConfigId="99999000">
    <_Assembly="YES" Translate="0.0 0.0 0.0" Orientation="ORI-Global" Orientation_Map="ORI-Global">
    <coding="UTF-8" standalone="no"?>
      <file:///c:/Users/rademann/00_Dokumente/20_SMILE/SMILE_v0plp0/dtd/SMILE_Guidelines_0plp0.dtd?>
    <*>
      hy = "0" Discipline = "Default"
      er = "ABAQUS"
      ION.MESH Usage = "Default"
      default Elements -->
  </ConfigId>
</CONFIGURATION>

<xsl:template name = "element">
  <xsl:param name = "Property" />
  <xsl:param name = "Pcomponentref" />
  <xsl:variable name = "Vcomponentlink" select="#{$x1}/$Pcomponentref"/>
  <xsl:text>**** elementdefinitions -----#xA;</xsl:text>
  <xsl:value-of select="$Vcomponentlink/SHELL/ELEMENT.DEFINE/@N1 and $Vcomponentlink/SHELL/ELEMENT.DEFINE/@N2 and $Vcomponentlink/SHELL/ELEMENT.DEFINE/@N3 and $Vcomponentlink/SHELL/ELEMENT.DEFINE/@N4">
  <xsl:value-of select="concat('*ELEMENT , TYPE = ',document($Vdefaultguidelines)//GUIDLINE[@S0])"/>
  <xsl:for-each select="$Vcomponentlink/SHELL/ELEMENT.DEFINE">
    <xsl:if test="#@N1 and @N2 and @N3 and not(@N4)">
      <xsl:value-of select="concat(@NewElementId
        ,'
        ,'
        ,key('linkNode',@N1)/@NewNodeId
        ,'
        ,'
        ,key('linkNode',@N2)/@NewNodeId
        ,'
        ,'
        ,key('linkNode',@N3)/@NewNodeId
        ,'
        ,#xA;')"/>
    </xsl:if>
  </xsl:for-each>
  <xsl:text>**#xA;</xsl:text>
</xsl:if>

<xsl:if test="$Vcomponentlink/SHELL/ELEMENT.DEFINE/@N1 and $Vcomponentlink/SHELL/ELEMENT.DEFINE/@N2 and $Vcomponentlink/SHELL/ELEMENT.DEFINE/@N3 and $Vcomponentlink/SHELL/ELEMENT.DEFINE/@N4">
  <xsl:value-of select="concat('*ELEMENT , TYPE = ',document($Vdefaultguidelines)//GUIDLINE[@S0])"/>
  <xsl:for-each select="$Vcomponentlink/SHELL/ELEMENT.DEFINE">
    <xsl:if test="#@N1 and @N2 and @N3 and @N4">
      <xsl:value-of select="concat(@NewElementId
        ,'
        ,'
        ,key('linkNode',@N1)/@NewNodeId
        ,'
        ,'
        ,key('linkNode',@N2)/@NewNodeId
        ,'
        ,'
        ,key('linkNode',@N3)/@NewNodeId
        ,'
        ,'
        ,key('linkNode',@N4)/@NewNodeId
        ,'
        ,#xA;')"/>
    </xsl:if>
  </xsl:for-each>
  <xsl:text>**#xA;</xsl:text>
</xsl:if>

**** Material Database ****
** INCLUDE, INPUT = e:\20_SMILE\SMILE_v0plp0\data\MaterialDatabases\ABAQUS_Crash_MatDB.inp
** ----- geometry definitions -----
** NODE
10000001, 32.00000000, 0.00000000, 0.00000000
10000002, 32.00000000, 3.84615385, 0.00000000
10000003, 32.00000000, 7.69230769, 0.00000000
10000004, 32.00000000, 11.53846154, 0.00000000
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10000006, 32.00000000, 19.23076923, 0.00000000
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10000008, 32.00000000, 26.92307692, 0.00000000
10000009, 32.00000000, 30.76923077, 0.00000000
10000010, 32.00000000, 34.61538462, 0.00000000
10000011, 32.00000000, 38.46153846, 0.00000000
10000012, 32.00000000, 42.30769231, 0.00000000
10000013, 32.00000000, 46.15384615, 0.00000000
10000014, 200.00000000, 0.00000000, 0.00000000
10000015, 200.00000000, 3.84615385, 0.00000000
10000016, 200.00000000, 7.69230769, 0.00000000
10000017, 200.00000000, 11.53846154, 0.00000000
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10000029, 20.00000000, 7.69230769, 0.00000000
10000030, 20.00000000, 11.53846154, 0.00000000

```

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.

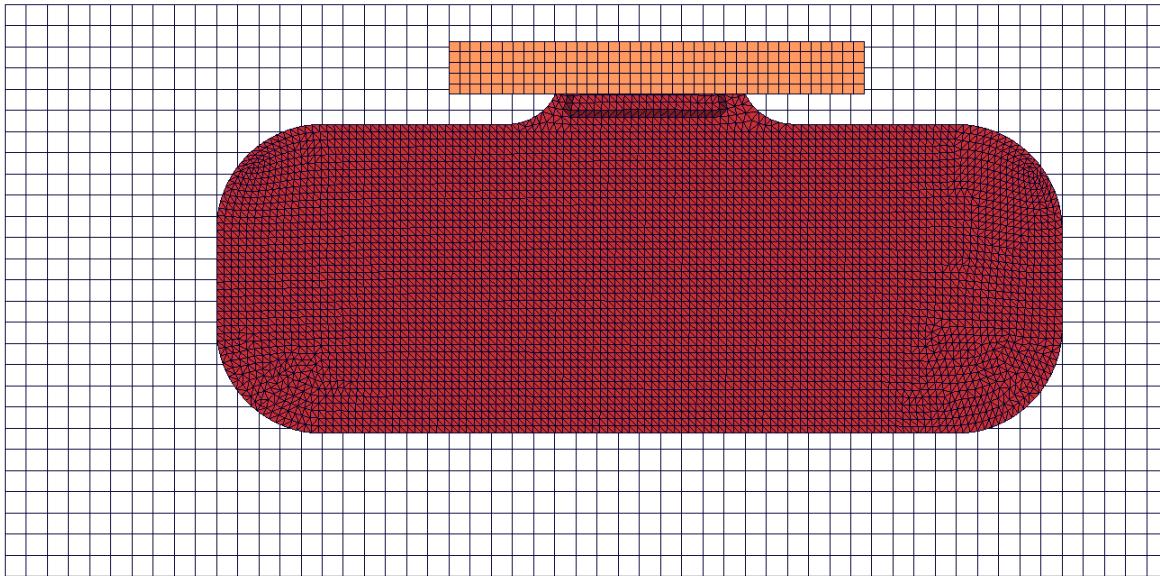
DTD

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

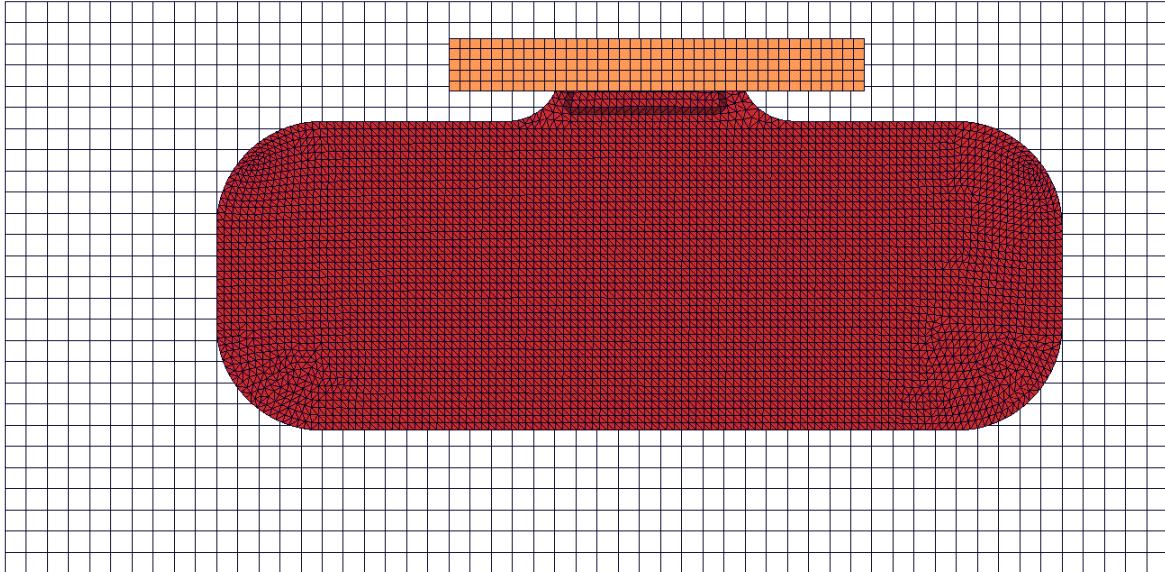
- Flat airbag (unfolded)
- Membrane elements (7 mm, triangular)

Simulation

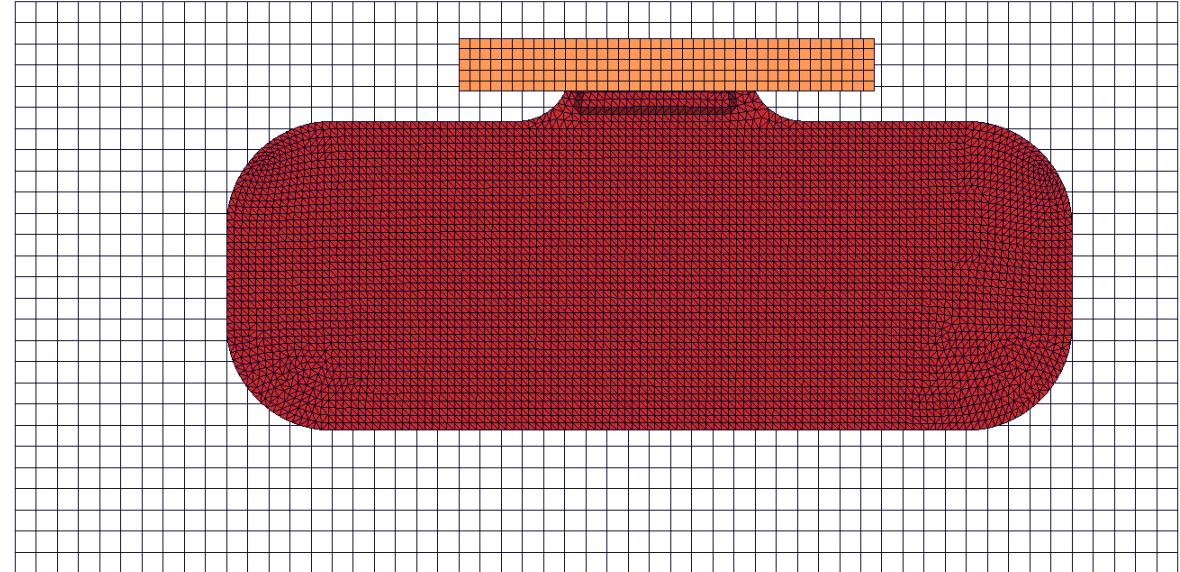
- Deployment: 25 ms
- Different inflator types
 - Uniform pressure method (UPM)
 - Particle methods
 - LS-DYNA: Corpuscular Method (CPM)
 - Abaqus: Lumped Kinetic Molecular (LKM)
- Coupled Eulerian Lagrange (CEL)

```
<MODELINGGUIDLINE Discipline="AIRBAG_UPM"  
File="file:///.../data/ModellingGuidelines/Default-ModellingGuidelines.xml"/>  
  
<MODELINGGUIDLINE Discipline="AIRBAG_PCL"  
File="file:///.../data/ModellingGuidelines/Default-ModellingGuidelines.xml"/>  
  
<MODELINGGUIDLINE Discipline="AIRBAG_CEL"  
File="file:///.../data/ModellingGuidelines/Default-ModellingGuidelines.xml"/>  
  
<CONFIGURATION Name ="airbag_ABAUS_UPM" Usecase="CRASH" Solver="ABAQUS">  
  
<CONFIGURATION Name ="airbag_LSDYNA_UPM" Usecase="CRASH" Solver="LSDYNA">
```

EXAMPLE AIRBAG. SIMULATION UPM.

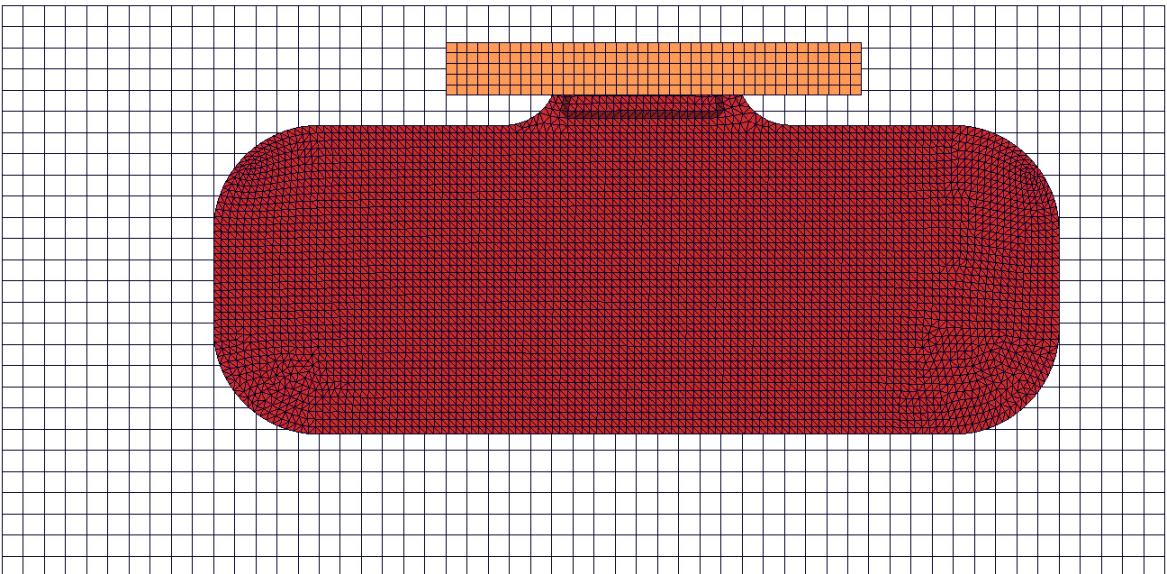


LS-DYNA

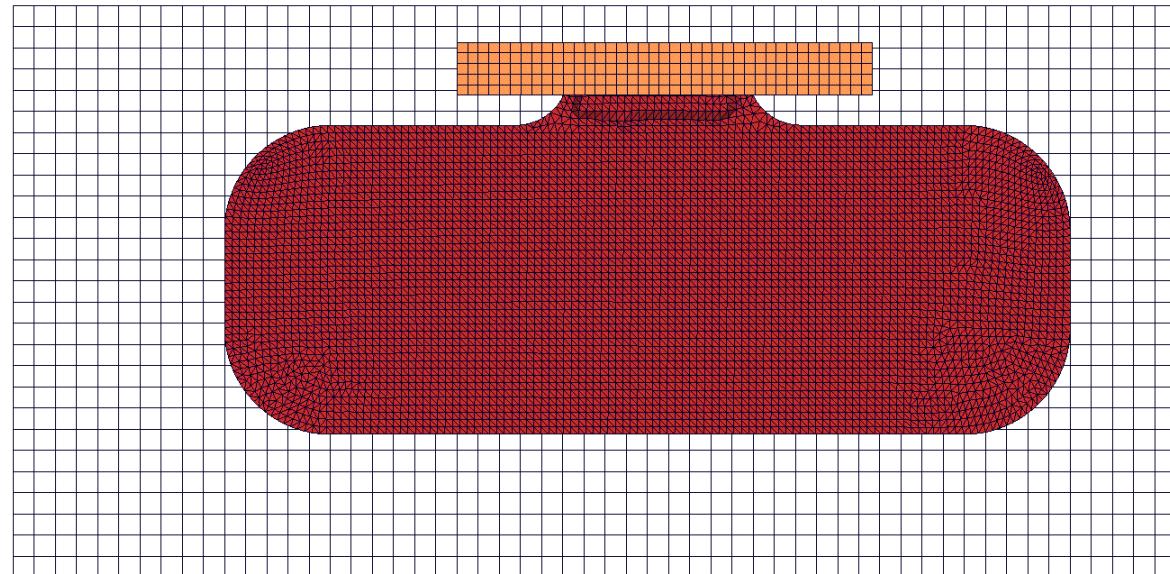


Abaqus

EXAMPLE AIRBAG. SIMULATION PARTICLE METHOD.

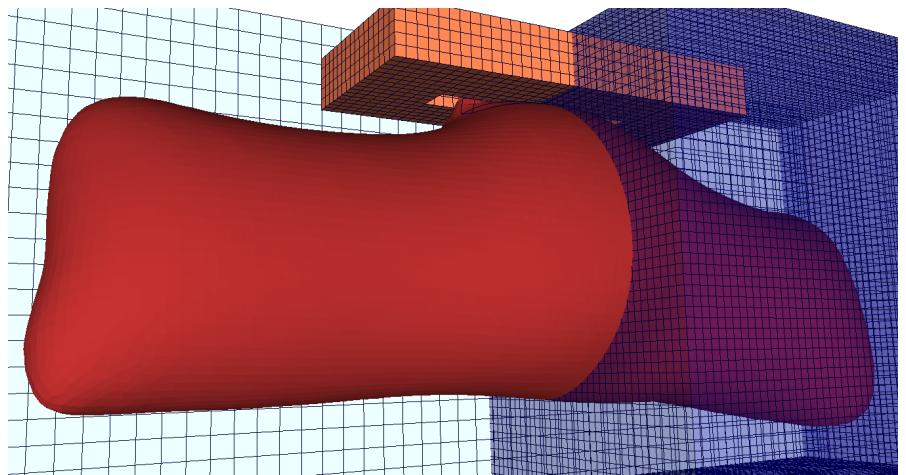


LS-DYNA



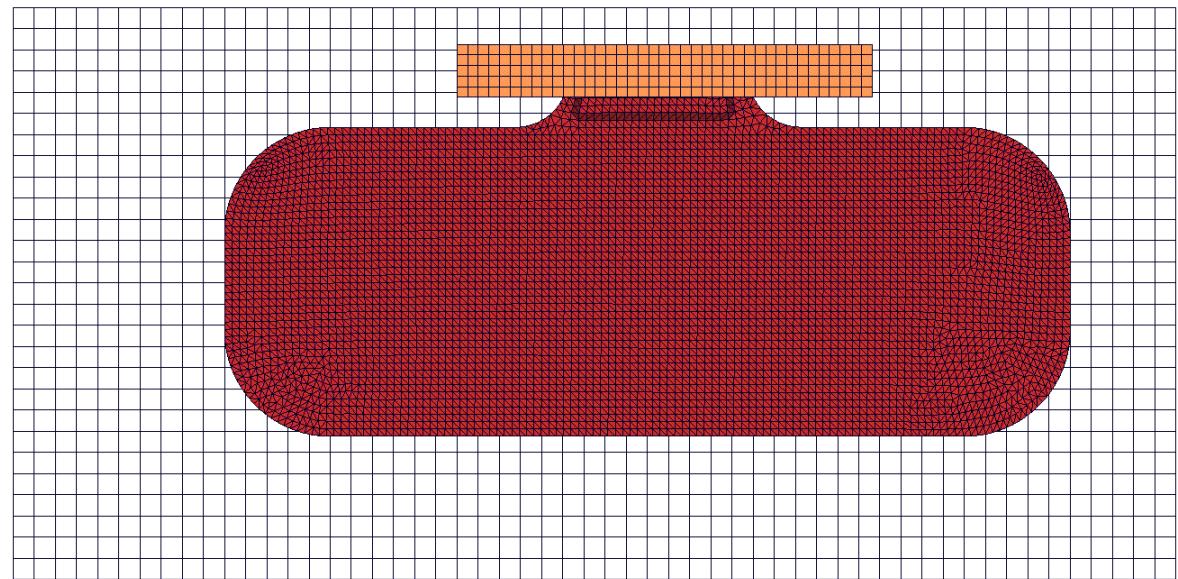
Abaqus

EXAMPLE AIRBAG. SIMULATION CEL.



CEL-Domain

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



Abaqus

EXAMPLE AIRBAG. SMILE STRUCTURE.

Model file

Airbag

Configuration File

Deployment

Modelling Guideline

LS-DYNA
(UPM)

Model file

Airbag

Configuration File

Deployment

Modelling Guideline

Abaqus/Explicit
(UPM)

EXAMPLE AIRBAG. SMILE STRUCTURE.

Model file

Airbag

Configuration File

Deployment

Modelling Guideline

LS-DYNA
(Particle - CPM)

Model file

Airbag

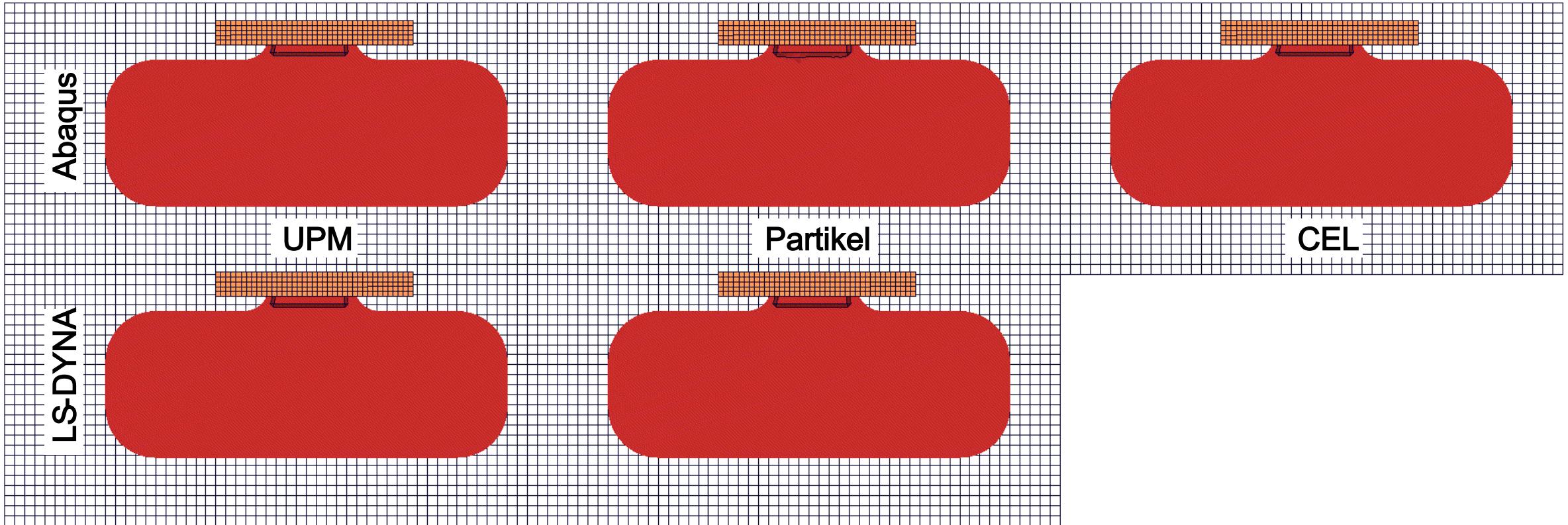
Configuration File

Deployment

Modelling Guideline

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