

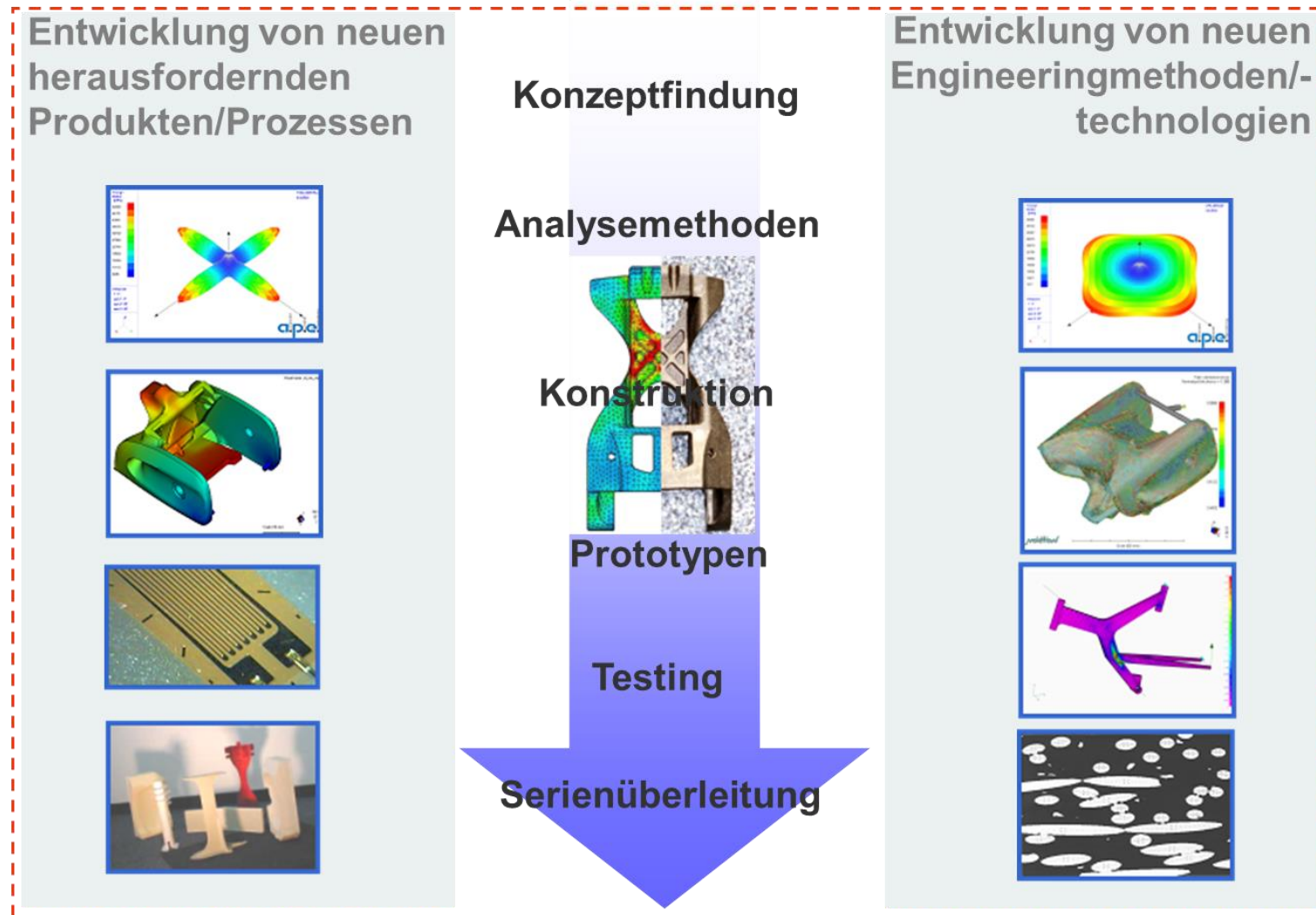
15 Jahre

Produkt-, Software- und Methodenentwicklung

Ch. Weinberger, P. Reithofer (4a engineering GmbH)

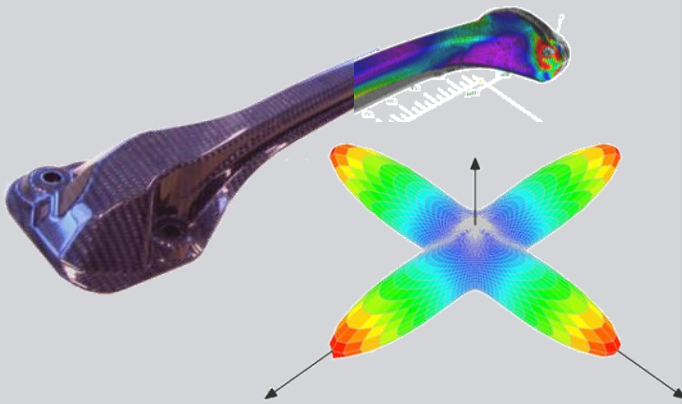
28.2.2018 Schladming

2004 - Dienstleistungsangebot



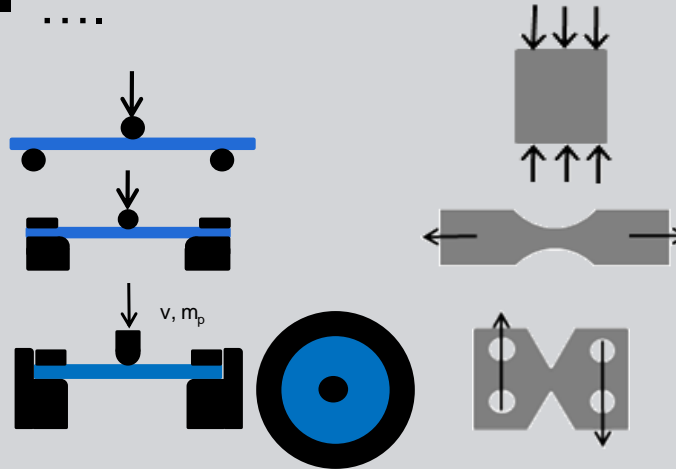
R&D Services

- Konzept- und Produktentwicklung
- Numerische Simulationsmethoden
- Methoden- und Softwareentwicklung



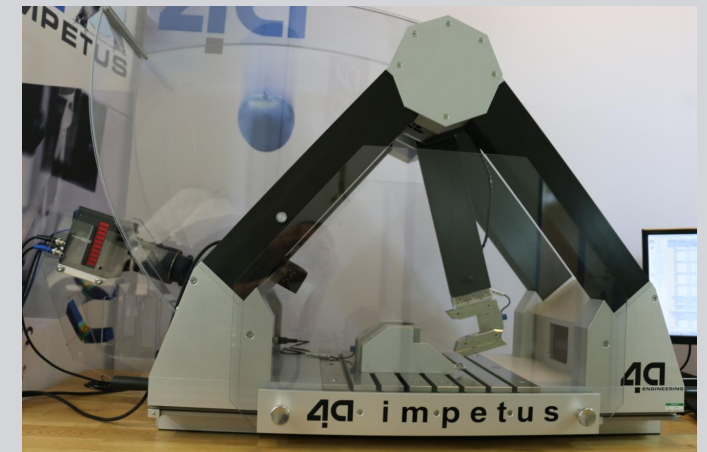
Testing & Material- charakterisierung

- Kunststoffe
- SFRT/LFRT
- Composites
- Metalle
- Schäume/Elastomere
- Komponenten
-



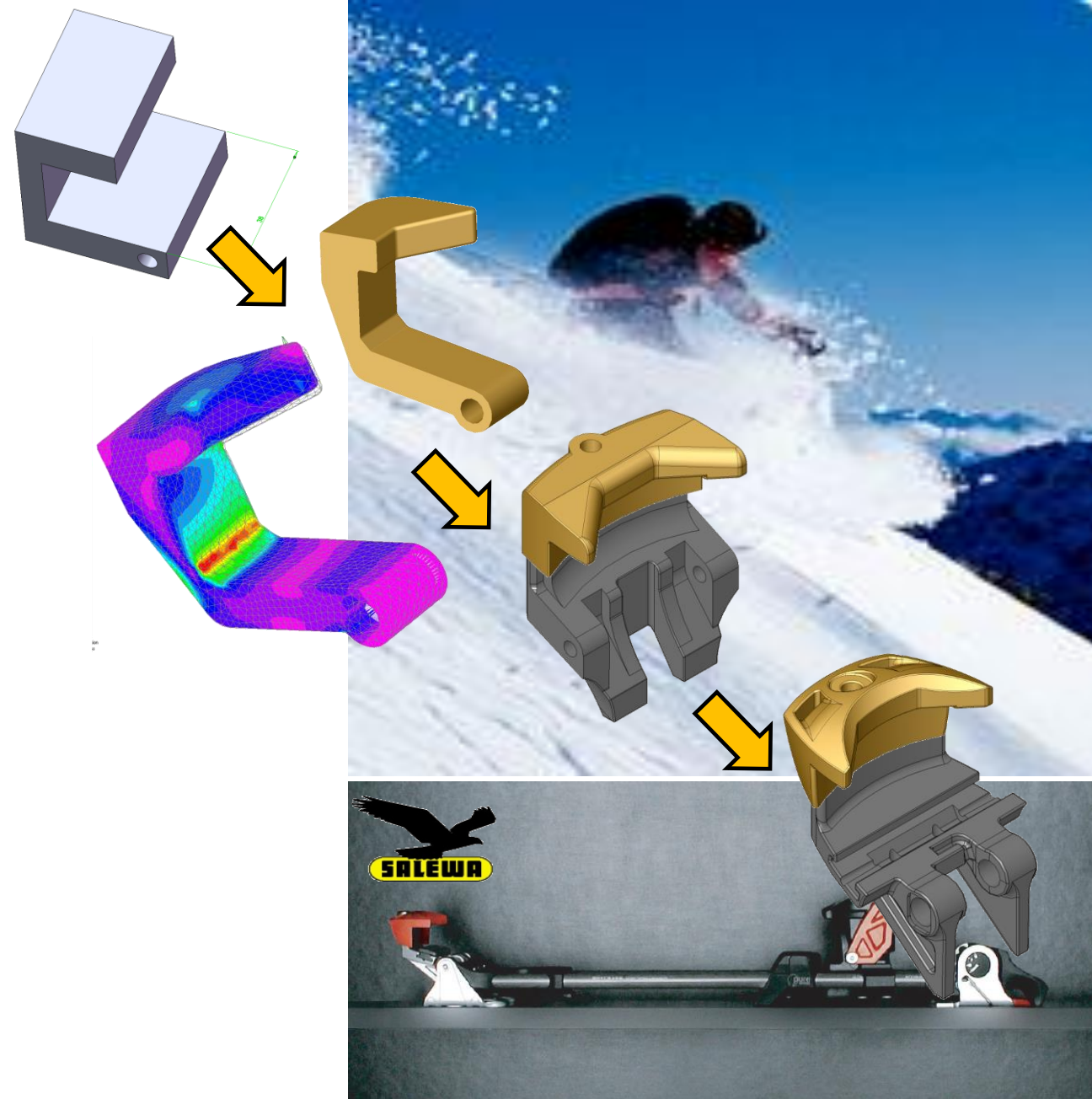
4a impetus

- Vertrieb, R&D
- Aftersales & Wartung
- Konstruktion & Fertigung
- Software & Elektronik
- Training & Support



Produktentwicklung

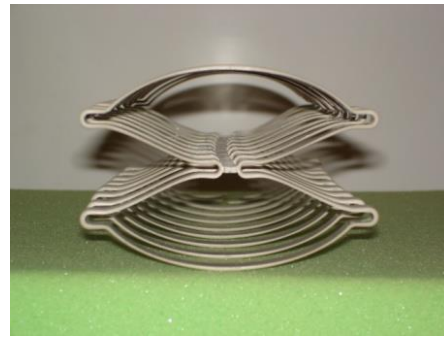
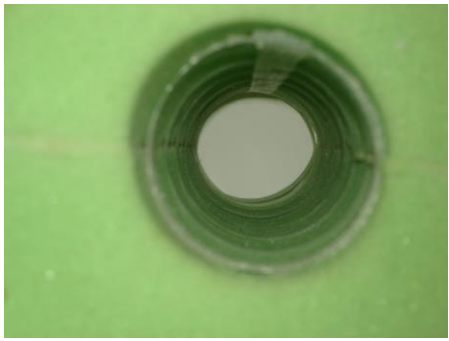
engineering plastics production
concepts **excellence in simulation** testing
lightweight prototypes



Kunststoff statt Metall Matratzenfeder



FLEXIMA[®]
feel the comfort

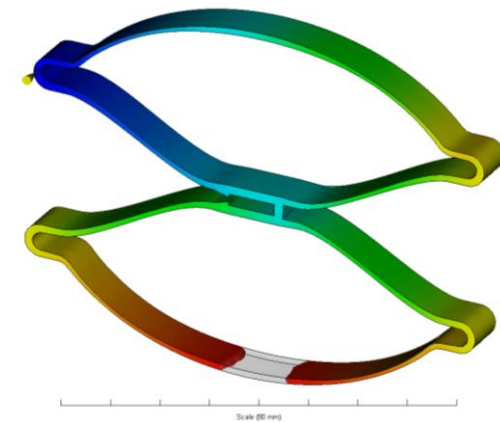
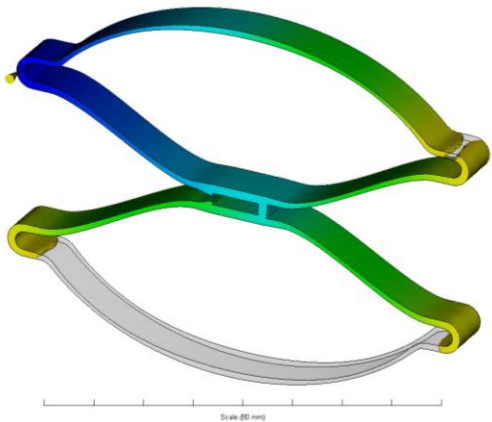


FLEXIMA[®]
feel the comfort



FLEXIMA – Projektinhalt

- Zusammenarbeit seit **2009**
- Zeitstandverhalten von Matratzenfedern
- Substitution einer bestehenden handgefertigten endlosfaserverstärkten Feder durch SG-Bauteil (Stückzahlen, Kosten, Assemblierung,...)
- **ZIEL:**
 - Ideale Geometrie hinsichtlich Langzeitverhalten
 - Prozessoptimierung
 - Materialauswahl

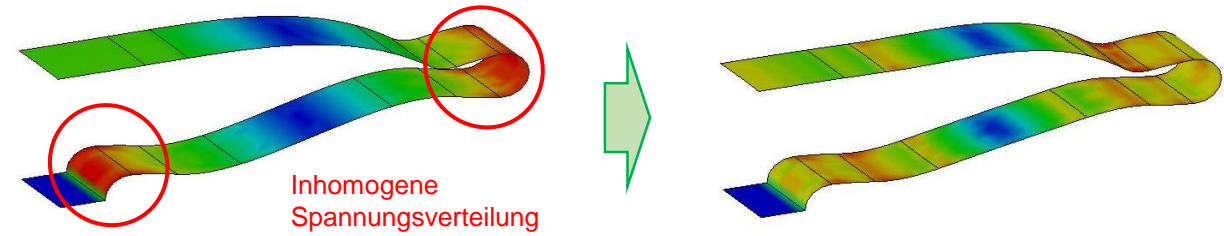


FLEXIMA - Lösungsweg

■ Technische Untersuchungen:

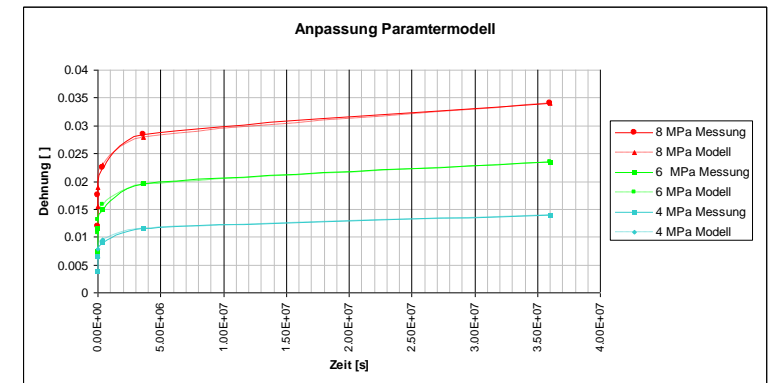
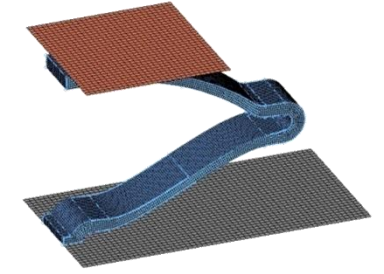
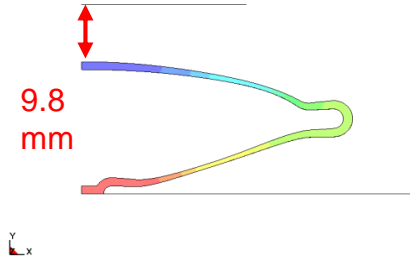
- Simulationen, Kurzzeitverhalten, Dauerlasten
- Geometrieoptimierung
- Prototypen + Tests
- 2016 – „in House“ Fertigung

■ Innovation Award 2016

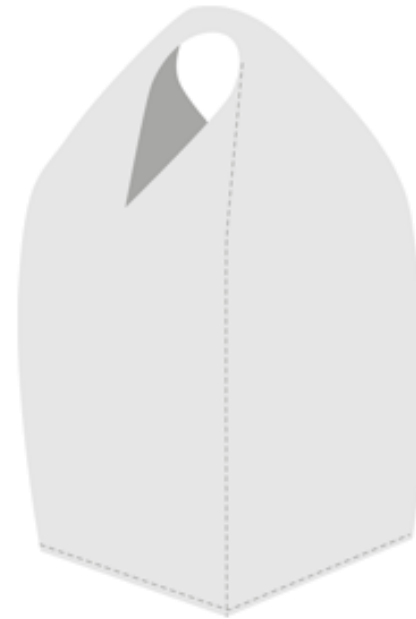
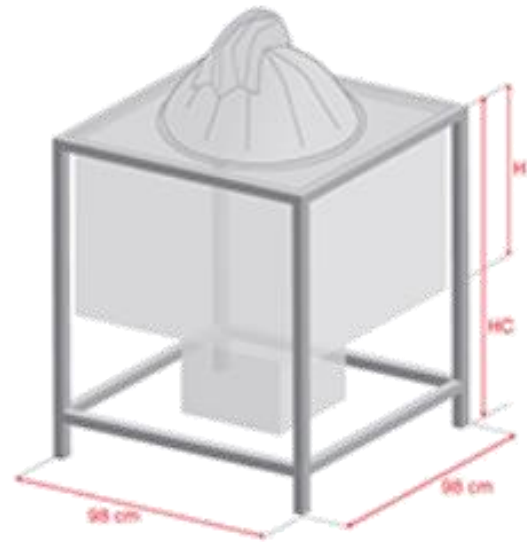


LS-DYNA KEYWORD DECK BY LS-PRE
Time = 2.072e+006
Contours of Y-displacement
min=-0.86675, at node# 651334
max=0.00616652, at node# 652416

3 Tage



Alternative Anwendung vom Airbag Tool Big Bag



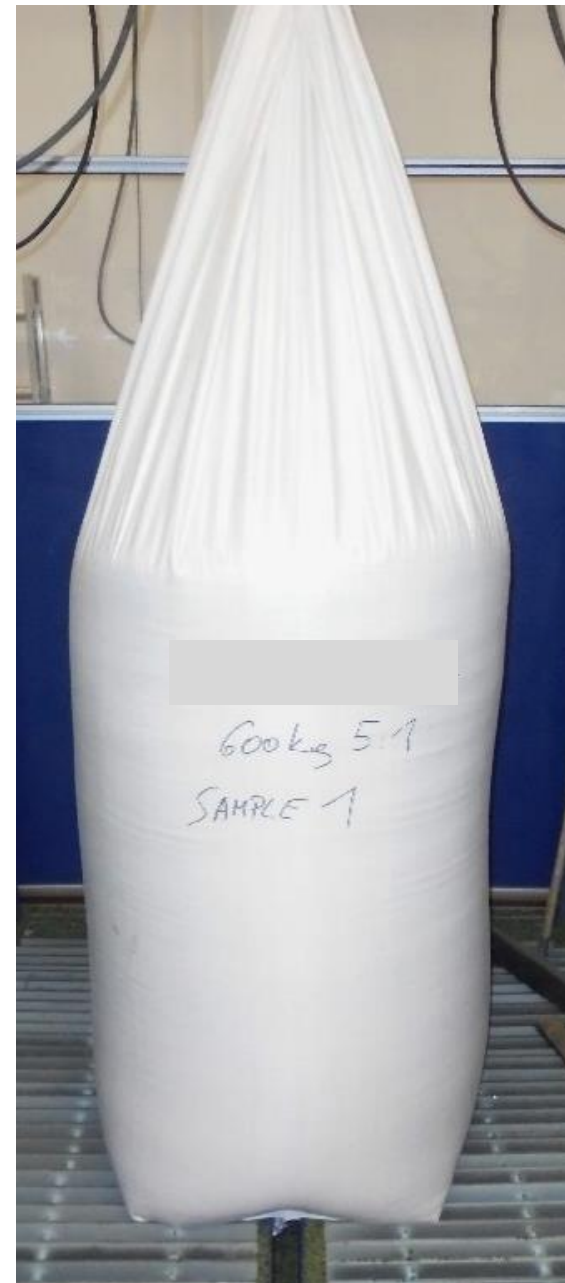
See more: C. Weinberger, B. Hirschmann (4a engineering); J. Eichelter (Franz S. Huemer) - *Biotex BigBag Simulation - LS-DYNA Airbag Tool Unusual Application*, 11. Europäische LS-DYNA Konferenz 2017



Projekthinhalt

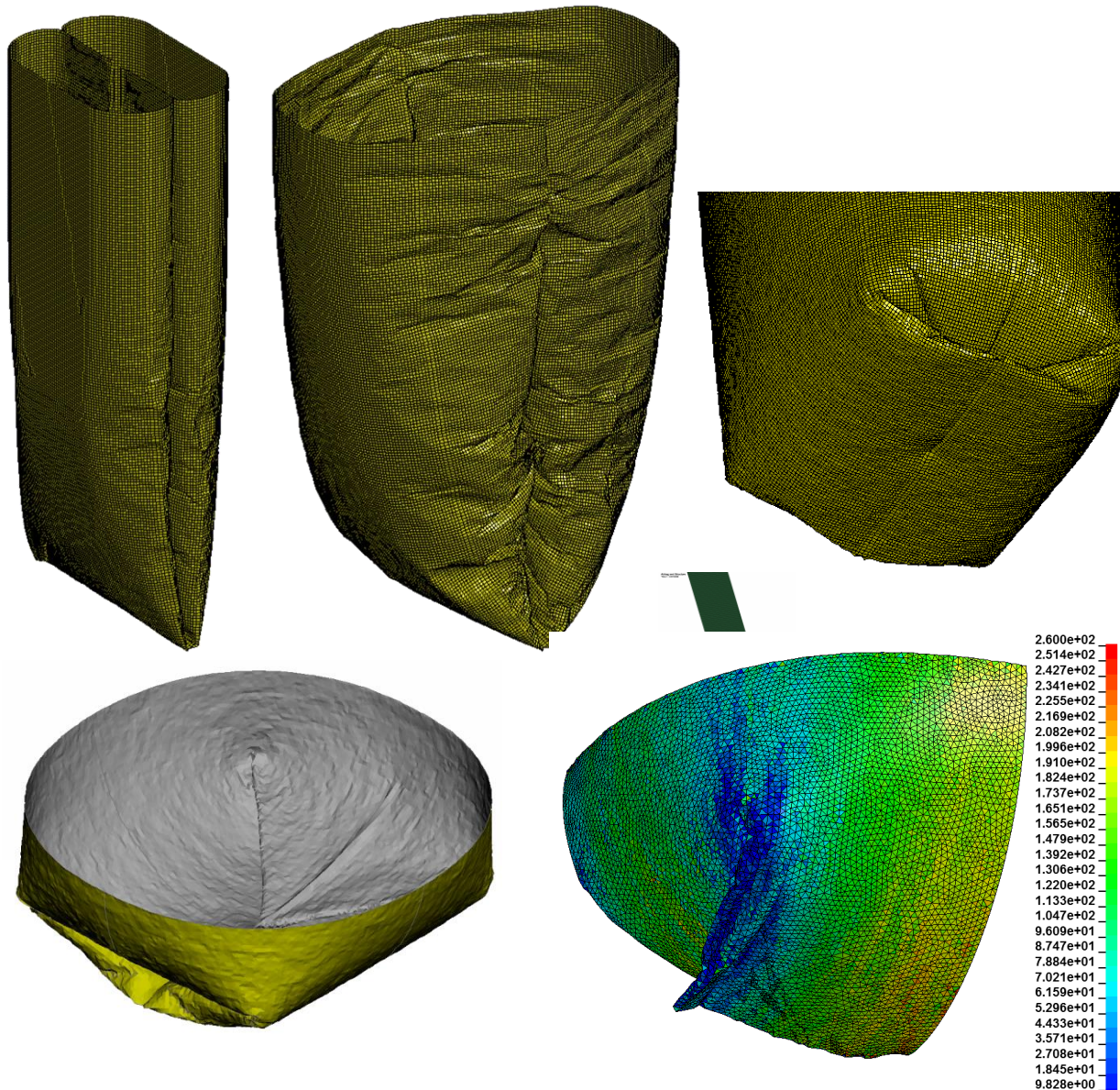
- BigBags hergestellt aus **PP/PE Tapes**
- Prüfung der Säcke mit dem 5-6-fachen des zulässigen Füllgewichts
- Zukünftig: Verwendung von **Bio-Polymeren**
- Vorhersage der Auslastung durch Simulation

- **ZIEL: Machbarkeit - Abbildung der Geometrie und Simulation der Belastung**



See more: C. Weinberger, B. Hirschmann (4a engineering); J. Eichelter (Franz S. Huemer) - *Biotex BigBag Simulation - LS-DYNA Airbag Tool Unusual Application*, 11. Europäische LS-DYNA Konferenz 2017

Lösungsweg - Ergebnis

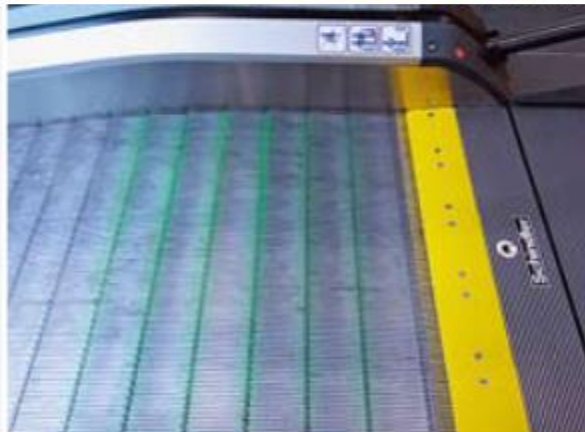
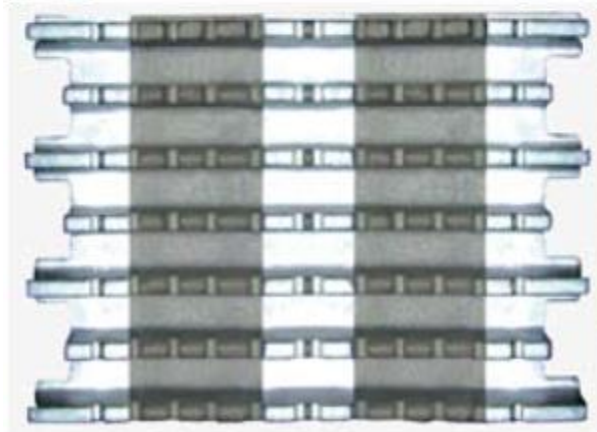


- Herausforderung:
 - Geometrie gefüllter Sack
 - Abbildung der **Falten / Knickung**
- *AIRBAG_SIMPLE_AIRBAG_MODEL
- Innendruck als 2. Schritt
- Ermittlung der **Spannung** in TAPE-Richtungen



See more: C. Weinberger, B. Hirschmann (4a engineering); J. Eichelter (Franz S. Huemer) - *Biotex BigBag Simulation - LS-DYNA Airbag Tool Unusual Application*, 11. Europäische LS-DYNA Konferenz 2017

Optimierung Kettenradgeometrie Fahrsteig

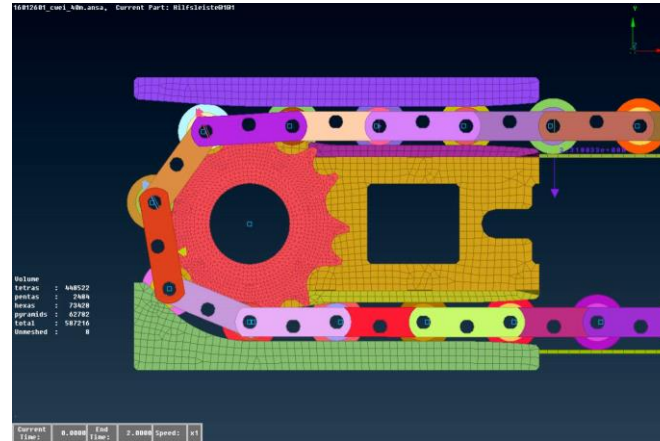
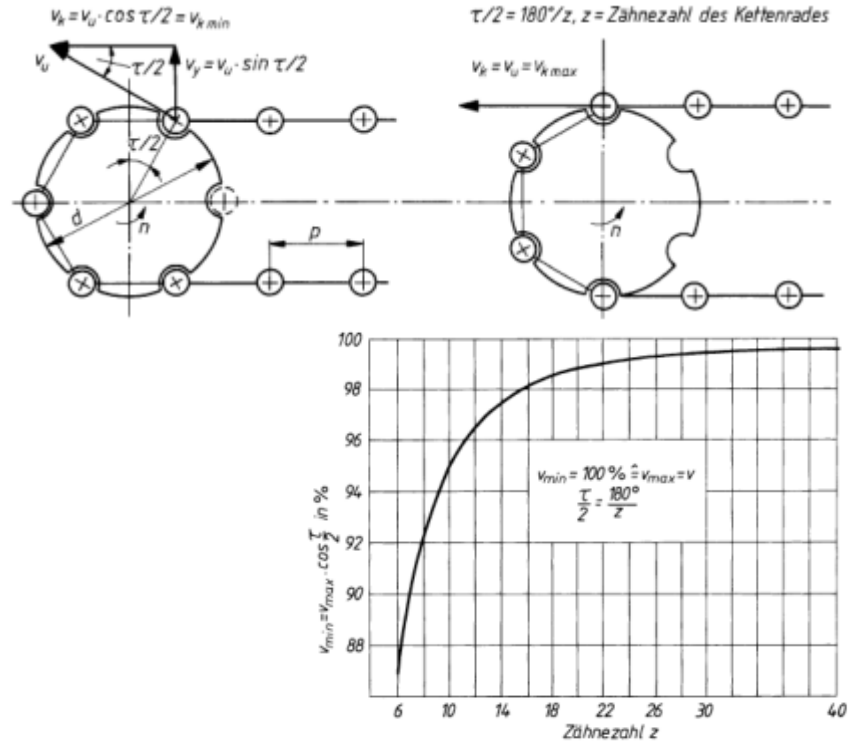


Schindler



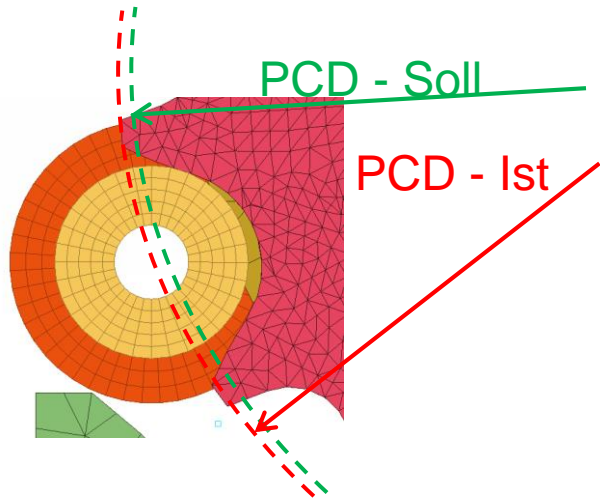
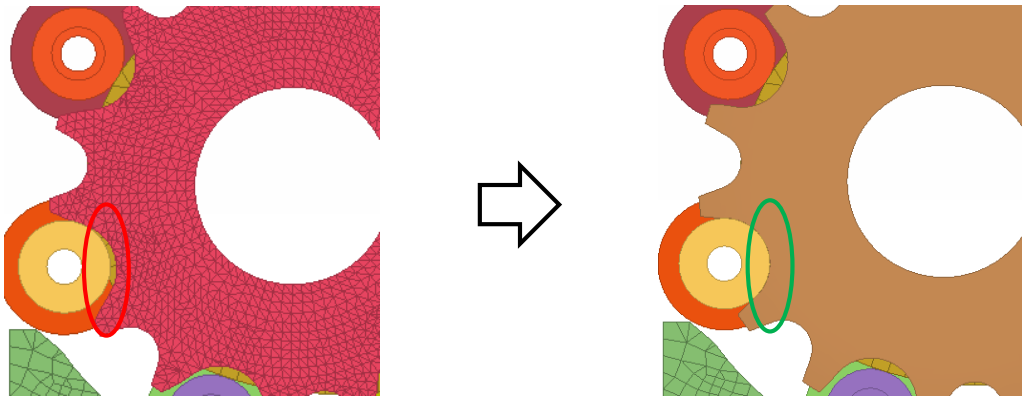
Projekthalt

- Zusammenarbeit seit **2005**
- Vorangegangene Projekthalte:
 - **Entwicklung eines polygonfreien Kettenantriebs**
- Aktuellster Projektschritt:
Optimierung Zahnkontakt
- Herausforderungen:
 - Zähnezah 7 (mindest-Zähnezah)
 - Jede zweite Rolle im Eingriff - Kräfte
- **ZIEL: Reduktion der Geräuschentwicklung - Zahnkontakt**



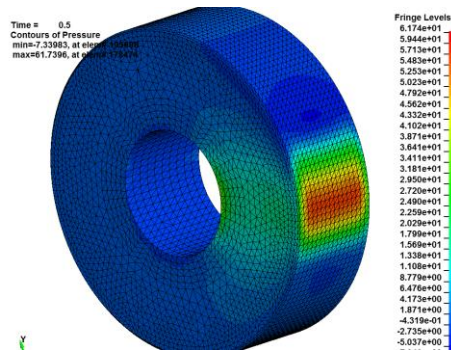
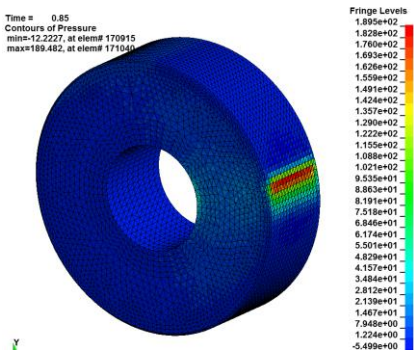
Schindler





Lösungsweg - Ergebnis

- Mehrkörpersimulation (**MKS**) - ANSA
- Darstellung der Lastsituation – Kinematik der Rollen
- Verbesserte Zahngeometrie:
 - Kinematische **Verbesserungen** (bessere Führung der Rollen)
 - Zahn-Rolle Kontakt



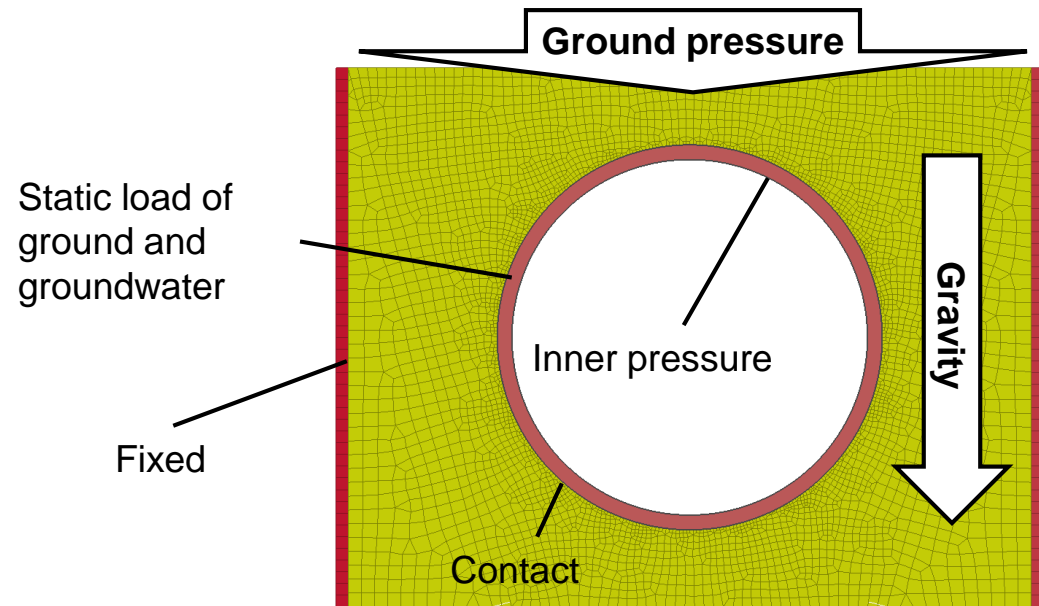
Schindler

Beulen unter Langzeitbelastung Rohr

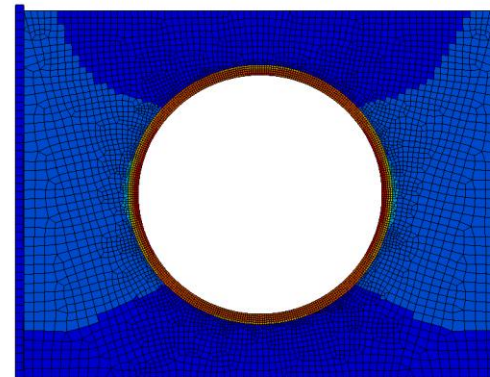


Projekthinhalt

- Zusammenarbeit seit **2006**
- Erdverlegtes PE Rohr $\varnothing > 3\text{m}$
- **Außendruckbelastung** durch:
 - Erdreich 13 m
 - Grundwasserdruck
 - Berücksichtigung Auftrieb
- **Innendruckbelastung** d. Wasser
- Verwendung von Kriechdaten
- ATV-DVWK-A 127 (kein Innendruck)
- **ZIEL: FEM Berechnung des Beuldrucks**



LS-DYNA keyword deck by LS-PrePost
Time = 1
Contours of Effective Stress (v-m)
max IP. value
min=0, at elem# 5542
max=2.92921, at elem# 482



Fringe Levels
2.929e+00
2.685e+00
2.441e+00
2.197e+00
1.953e+00
1.709e+00
1.465e+00
1.221e+00
9.764e-01
7.323e-01
4.882e-01
2.441e-01
0.000e+00



Lösungsweg - Ergebnis

- Analytische Berechnung des Innen- und Außendrucks (**360 Segmente**).
- Automatisiertes Zuweisen der **Drücke** + Erstellung des LS-DYNA-Files
- Schnelle Umsetzung verschiedener Lastfälle
- **Nachweis** für alle Lastfälle
- Vergleich zur analytischen Rechnung plausibilisiert



```
*SET_SEGMENT
2000001 0.000 0.000 0.000 0.000MECH
2000000 2000001 2000001 2000001 0.000 0.000 0.000 0.000
*SET_SEGMENT
2000002 0.000 0.000 0.000 0.000MECH
2000001 2000002 2000002 2000002 0.000 0.000 0.000 0.000
*SET_SEGMENT
2000003 0.000 0.000 0.000 0.000MECH
2000002 2000003 2000003 2000003 0.000 0.000 0.000 0.000
```

LS-DYNA keyword deck by LS-PrePost

Time = 0.68352

Contours of Effective Stress (v-m)

max IP. value

min=0, at elem# 5542

max=4.91492, at elem# 415

Fringe Levels

4.915e+00

4.505e+00

4.096e+00

3.686e+00

3.277e+00

2.867e+00

2.457e+00

2.048e+00

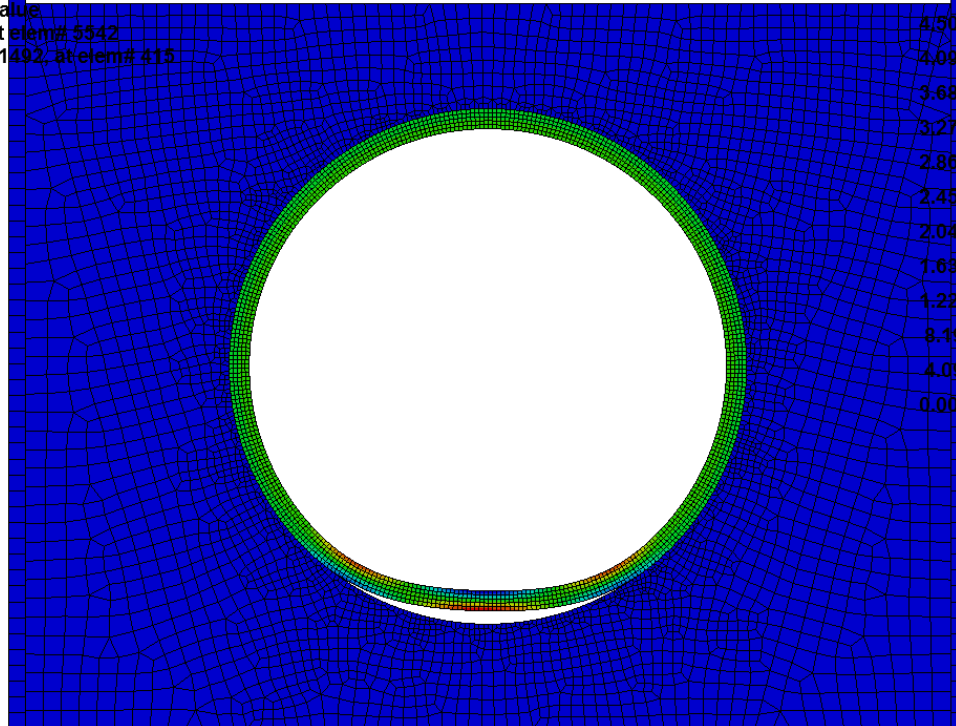
1.638e+00

1.229e+00

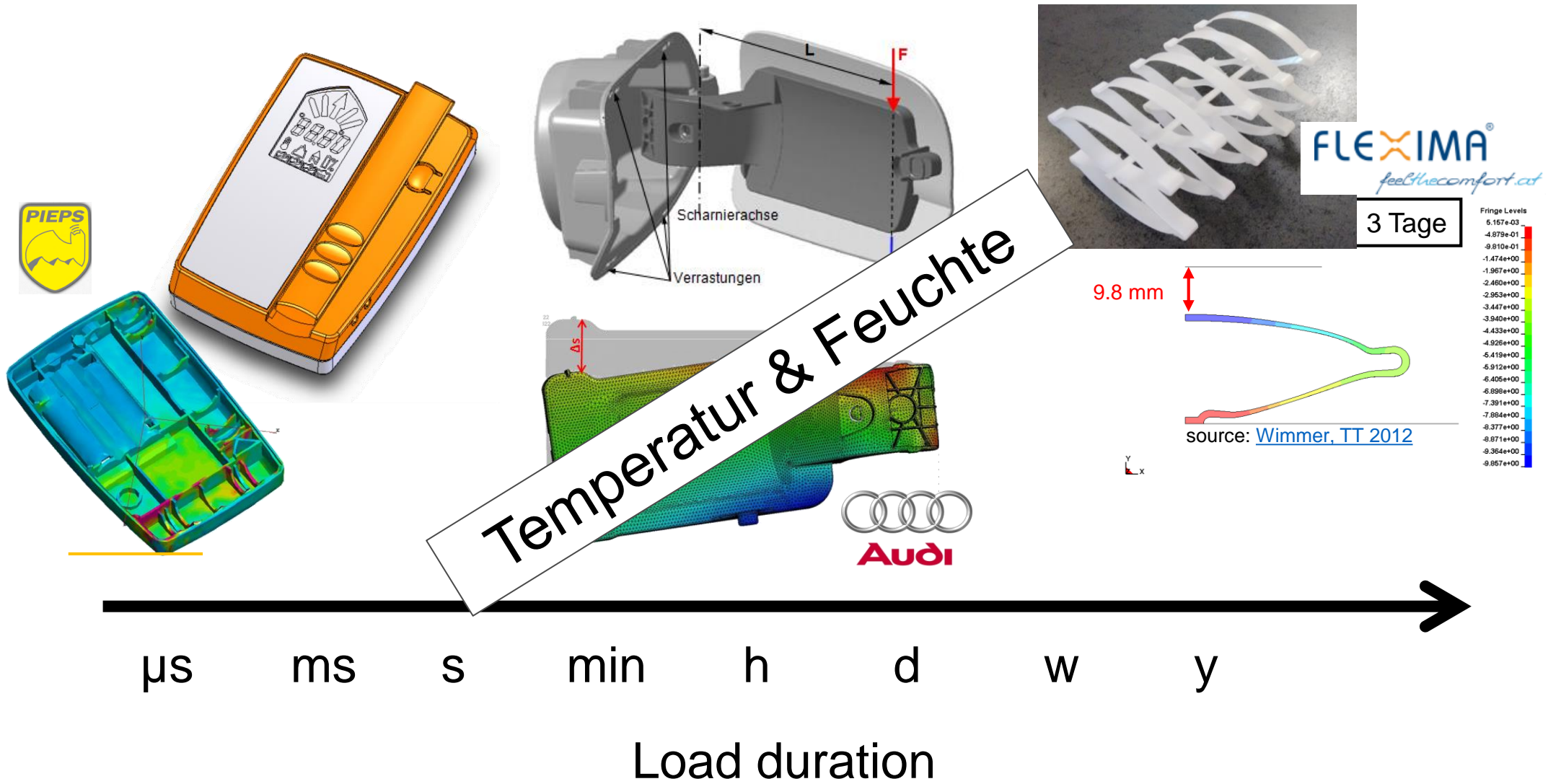
8.192e-01

4.096e-01

0.000e+00



Zeitabhängiges Materialverhalten von Kunststoffen

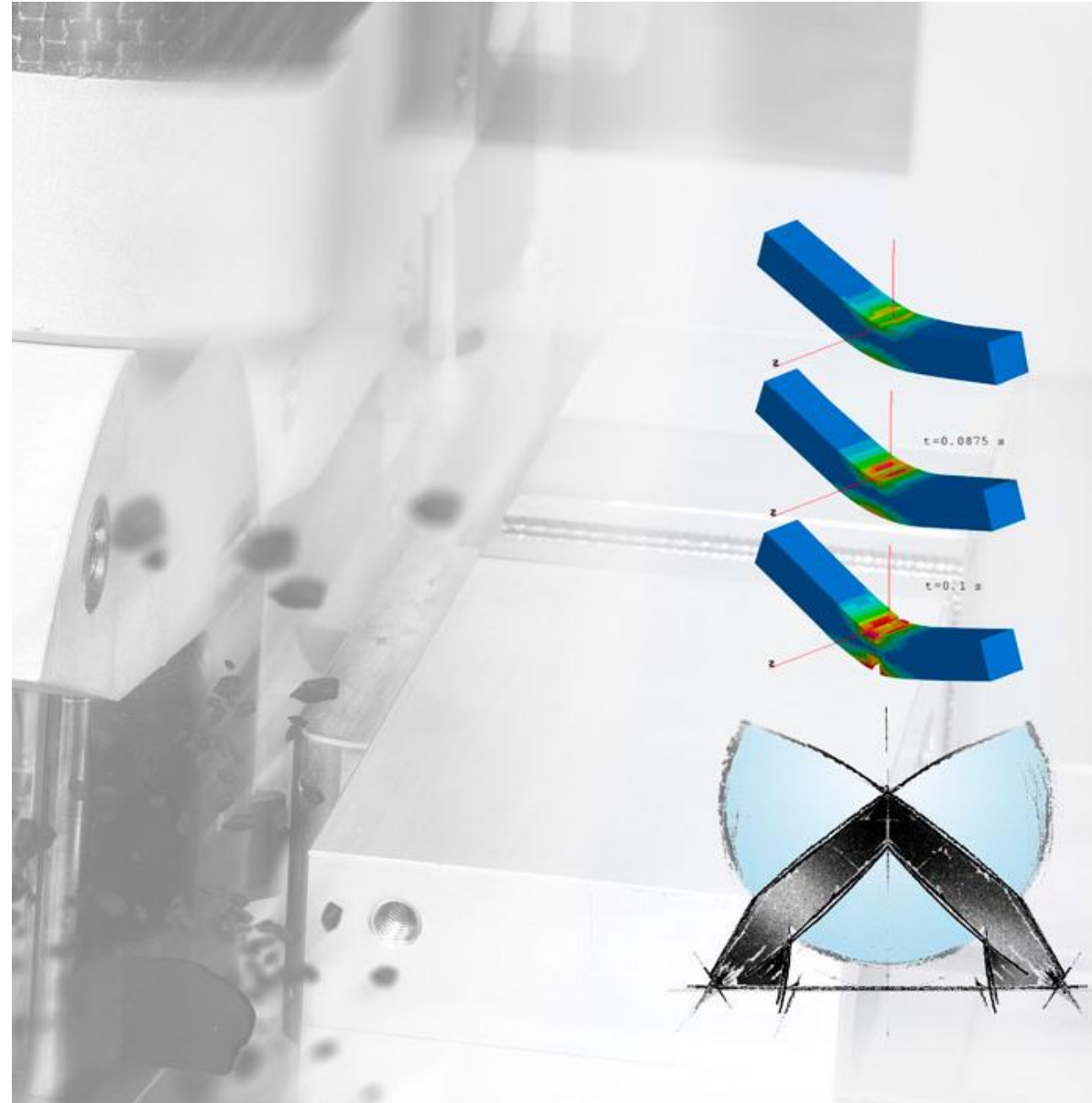


intelligent testing systems



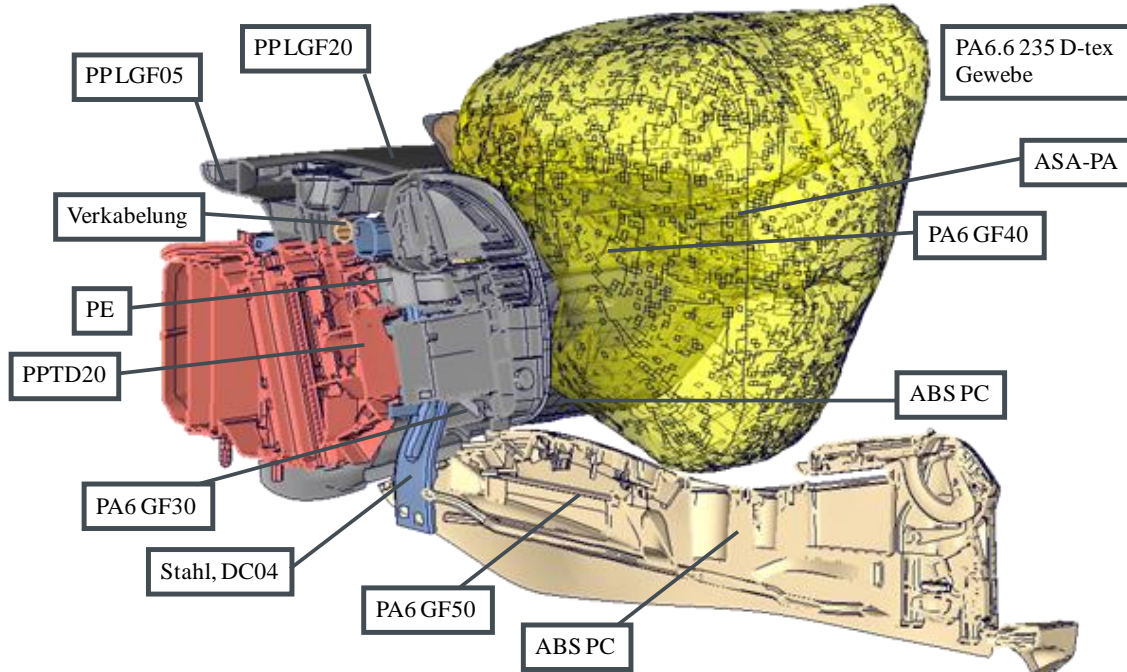
IMPETUS

engineering plastics production
excellence in testing
concepts simulation
lightweight prototypes



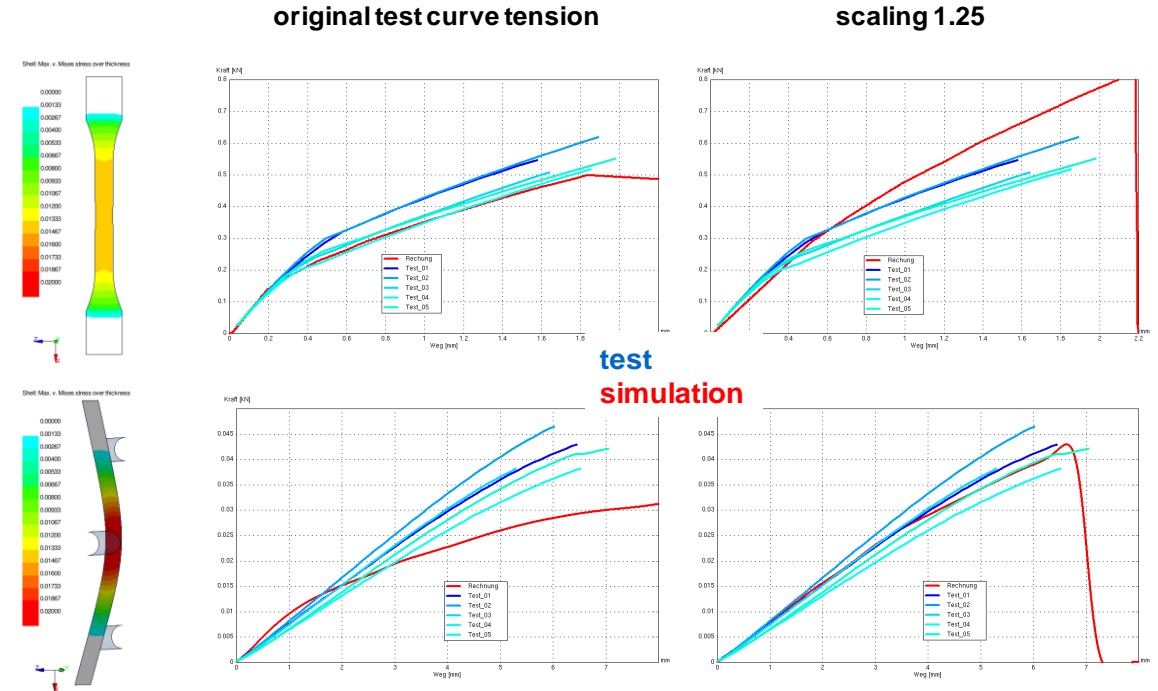
2004 - motivation

material variety



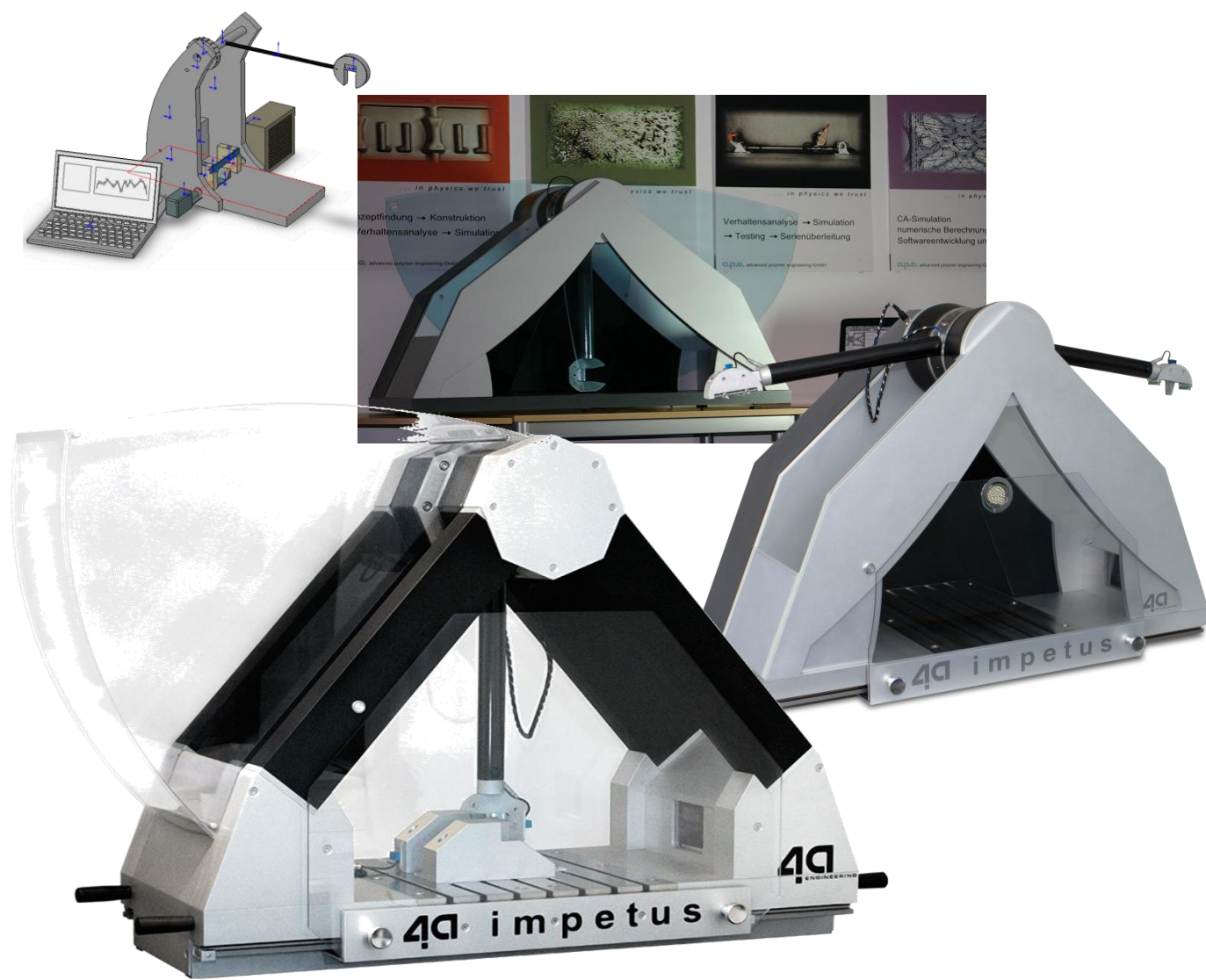
See more: R. Luijckx - *Kunststoffmaterialien in der Interieur Funktionsauslegung bei Audi AG*, 4a Technologietag 2010

bending load case



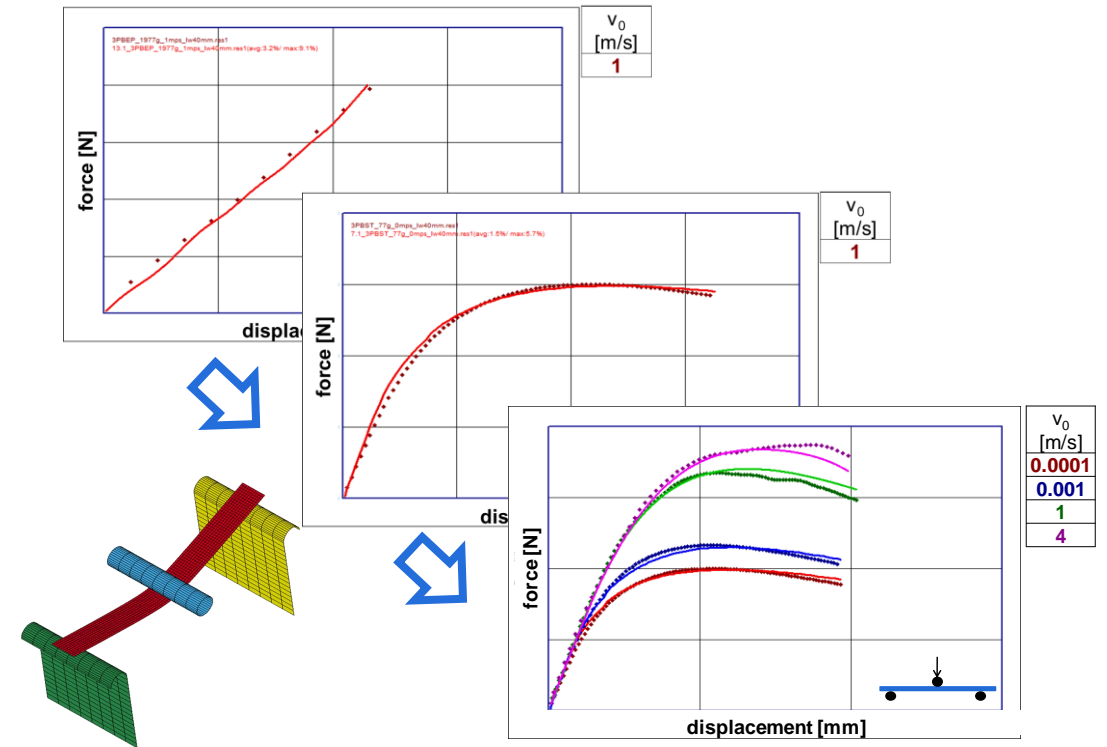
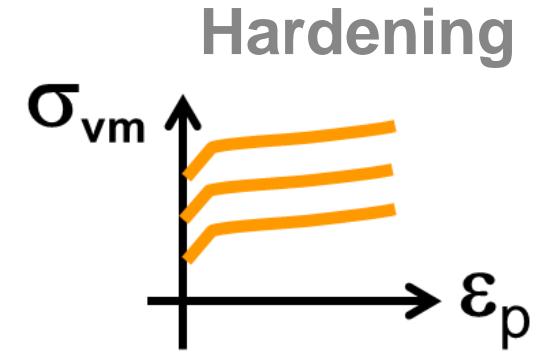
intelligent testing systems

- desktop testing device
- instrumented high speed testing
 - acceleration → force / displacement
- impact speed 0.5 – 4.5 m/s
- maximum energy up to 25 J



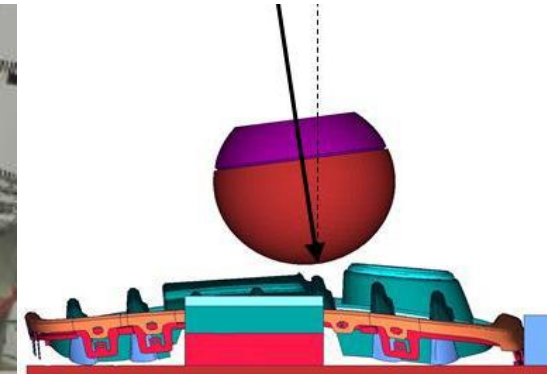
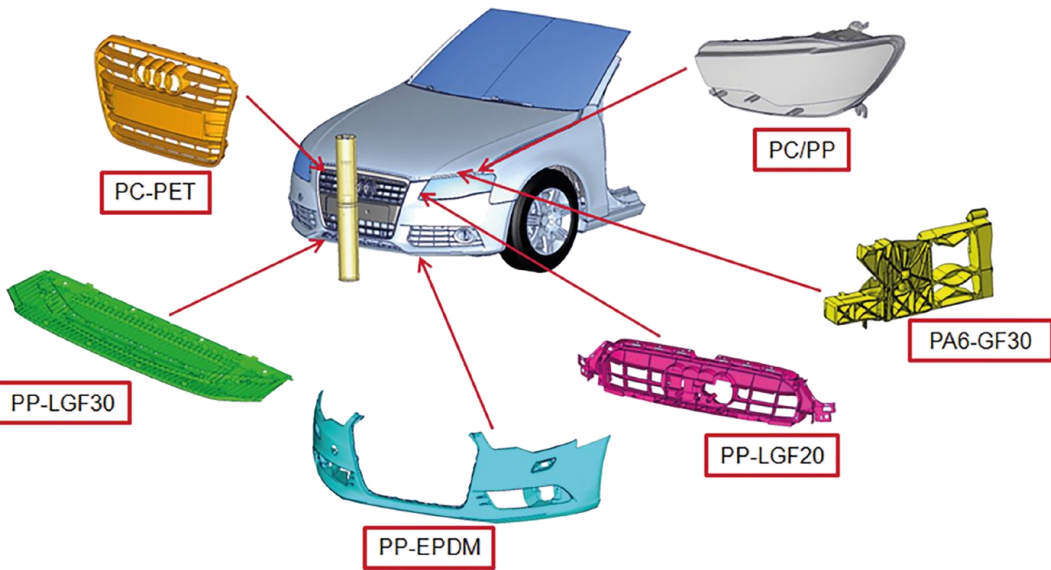
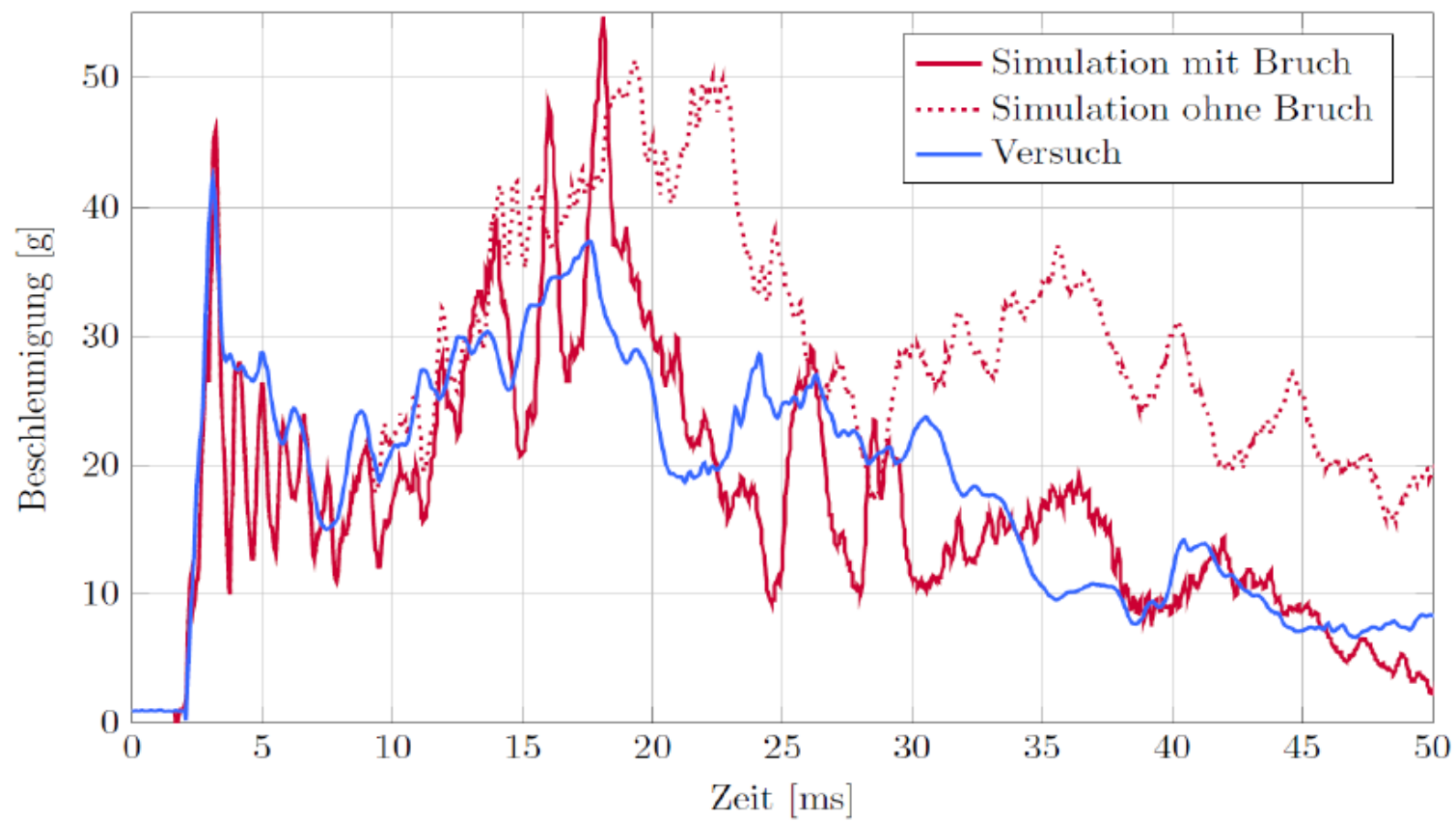
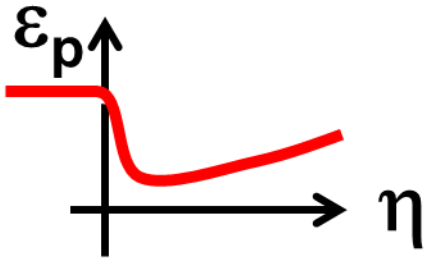
intelligent testing systems

- desktop testing device
- instrumented high speed testing
 - acceleration → force / displacement
- impact speed 0.5 – 4.5 m/s
- maximum energy up to 25 J
- easy approach - deformation
 - plastics → bending → materialcard
 - foams → compression → materialcard



2014 - motivation

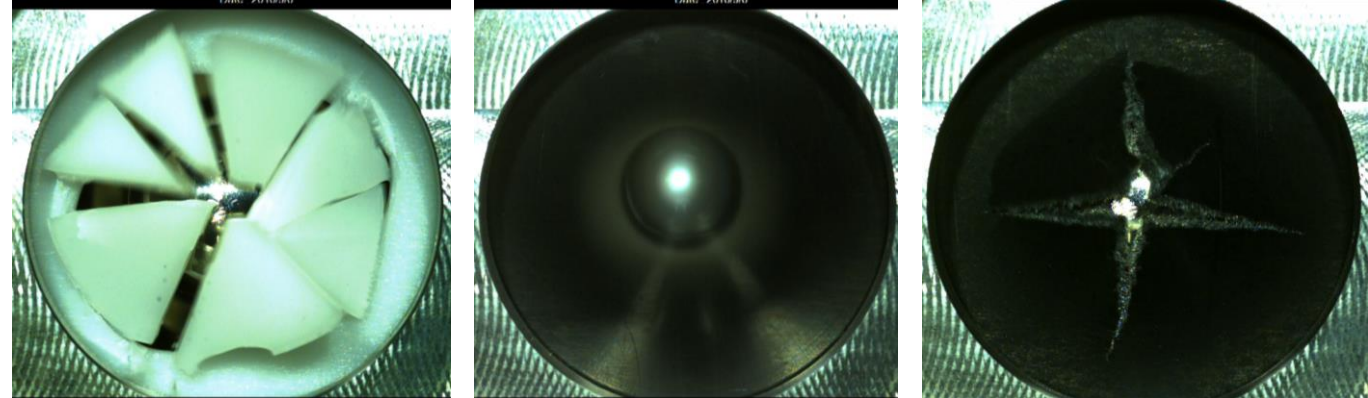
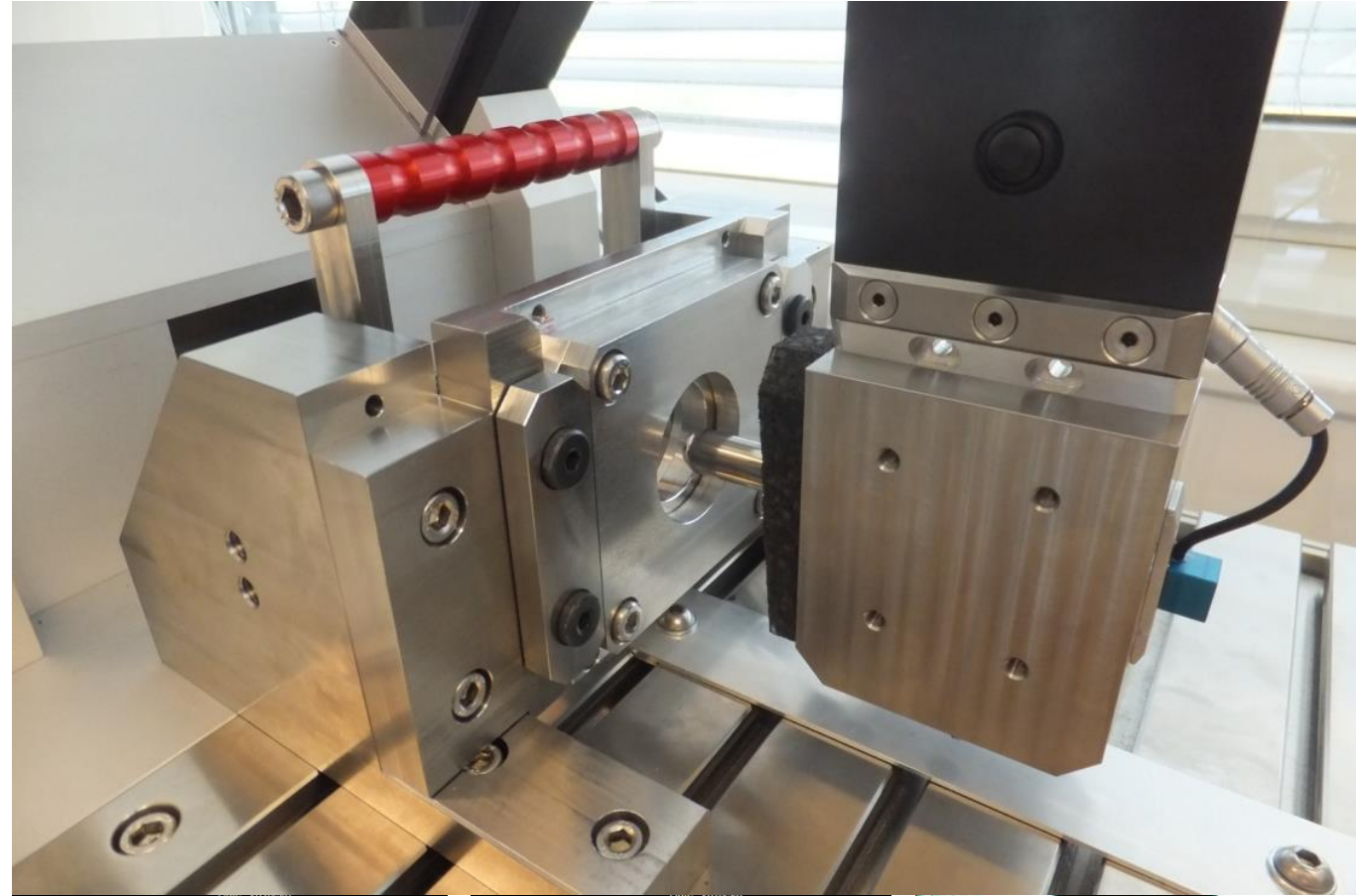
Damage/Failure



See more: H. Staack, Audi AG: Anforderungsgerechte Material- und Bruchmodellierung für die Fahrzeugsicherheit, TT16 Schladming

intelligent testing systems

- Different load cases
 - Bending
 - Tension Bending
 - Compression
 - Puncture
 - Component
 - ...
- High speed camera
 - Sync. recording
- Maximum energy up to 50 J
- Material Card
Deformation → Failure



injection mold for material characterization (25-50 kg granular is needed)

DOM & wall thickness



Melt- & Weldlines

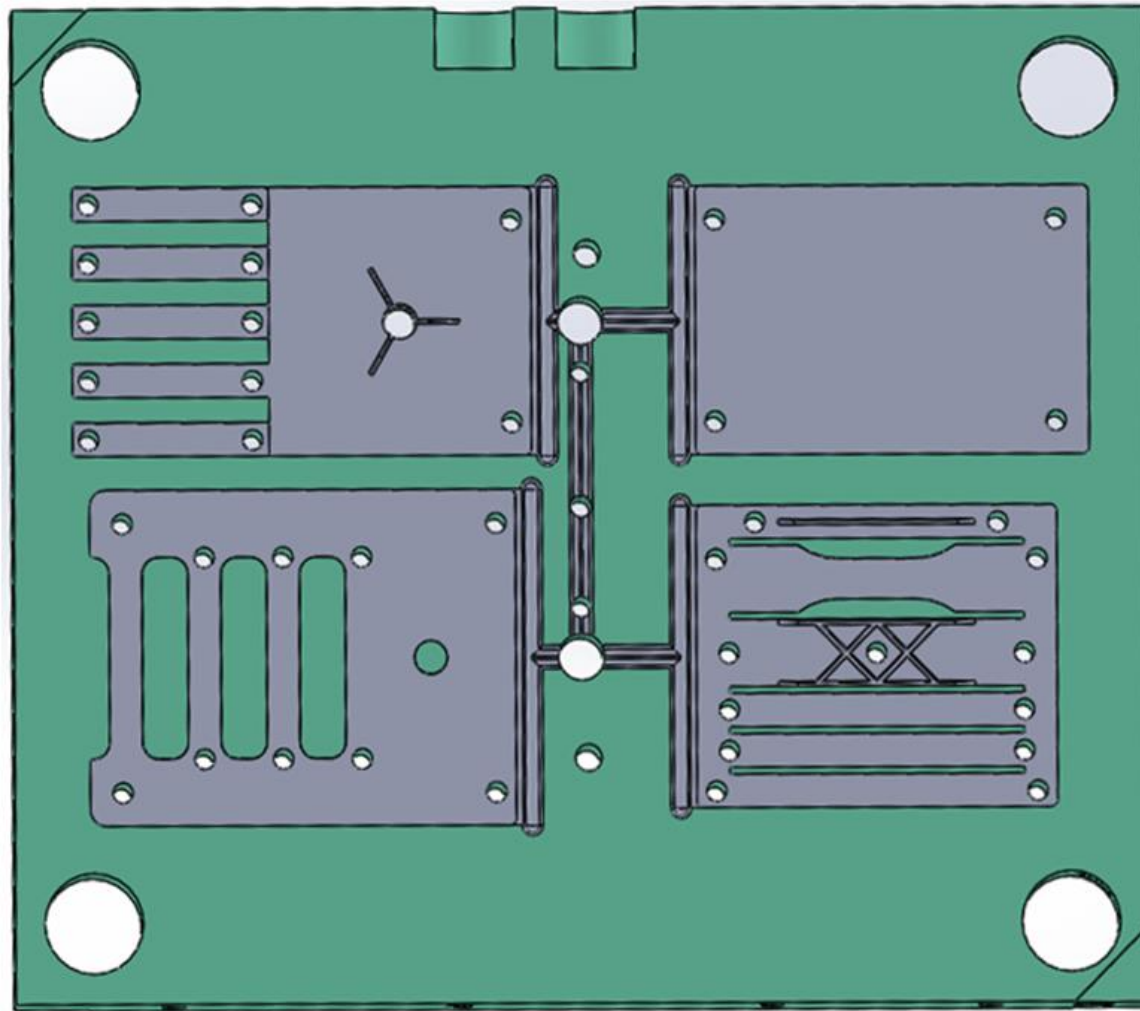
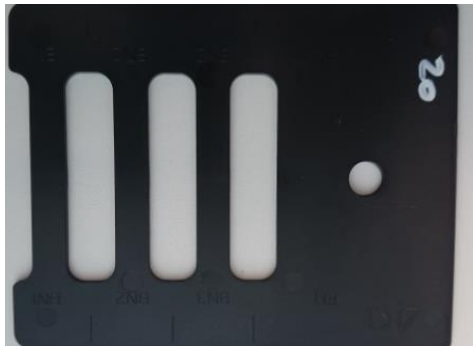


plate 120 x 80 x 2 mm



Specimen & rib & component



material characterization pyramid

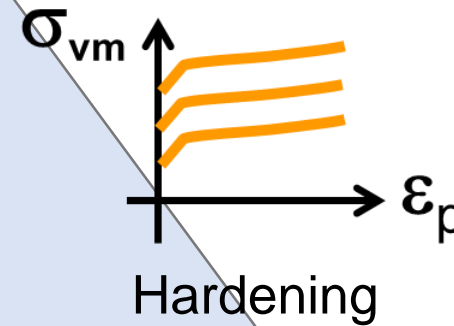
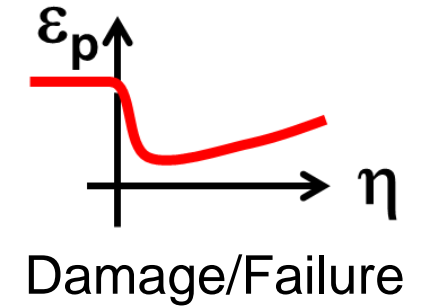
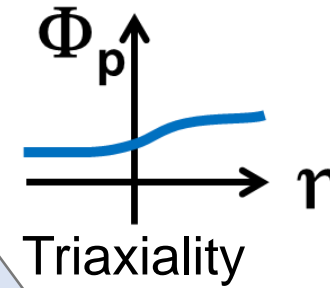
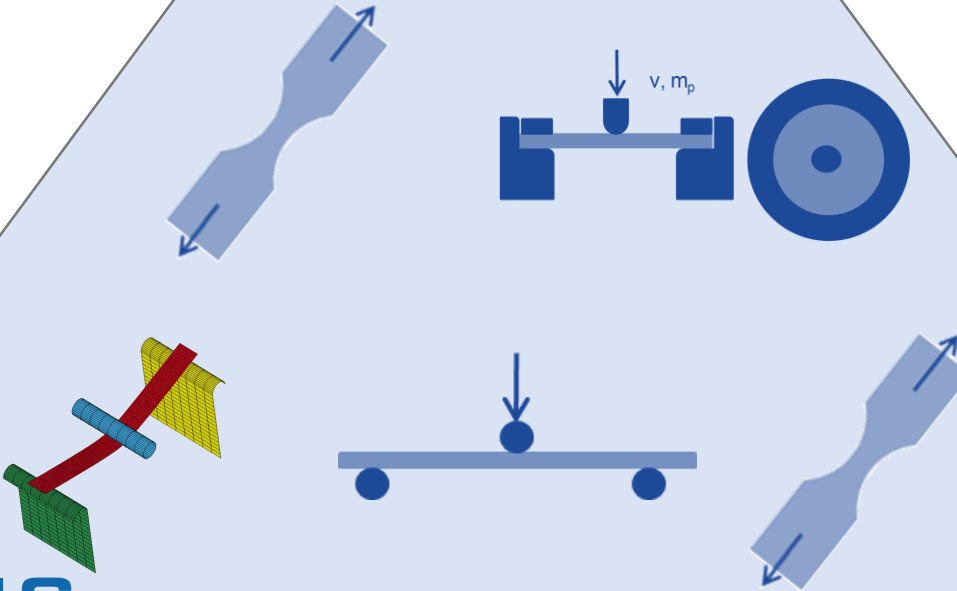
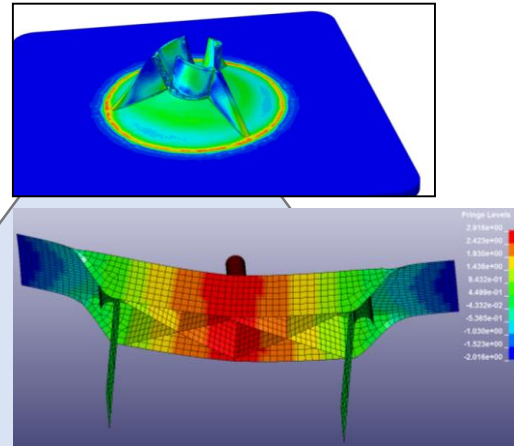


VALIMAT

Deformation → Failure

Creep → Static → Crash

ISOTROPIC → ANISOTROPIC

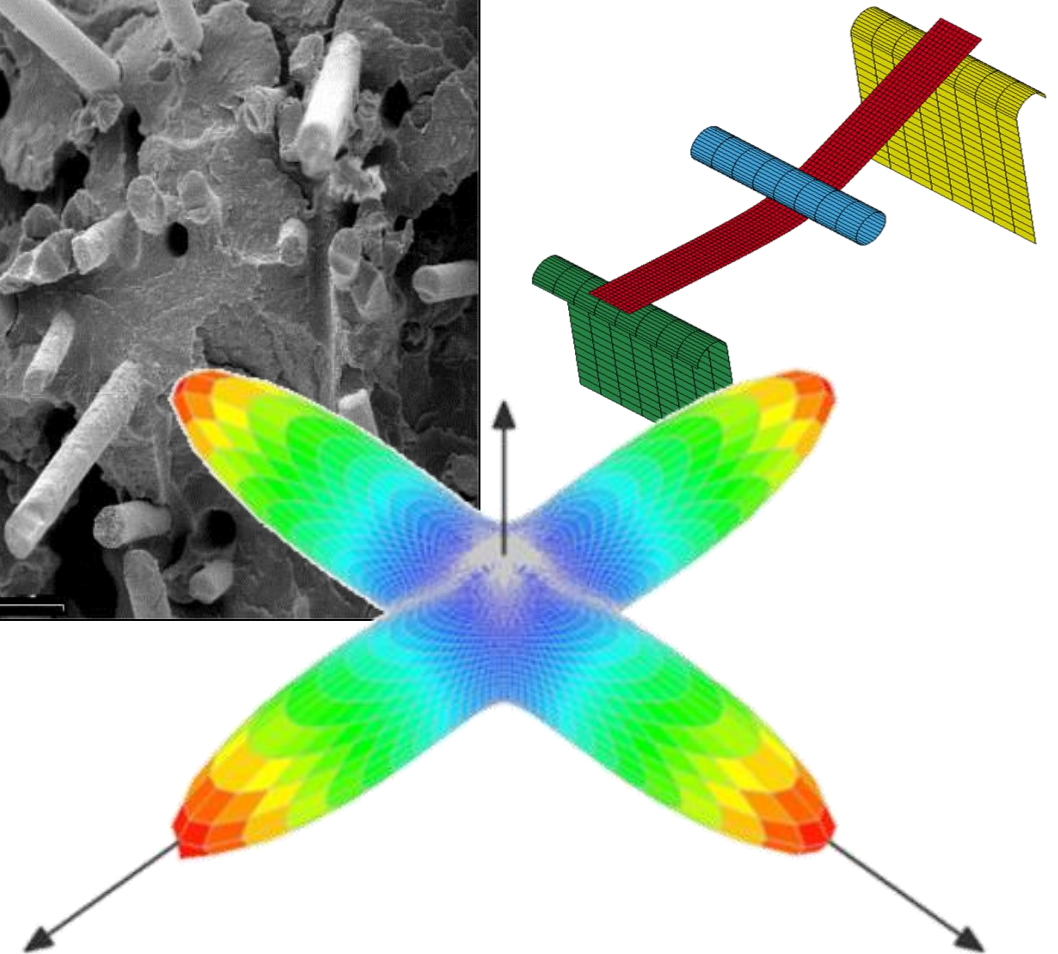
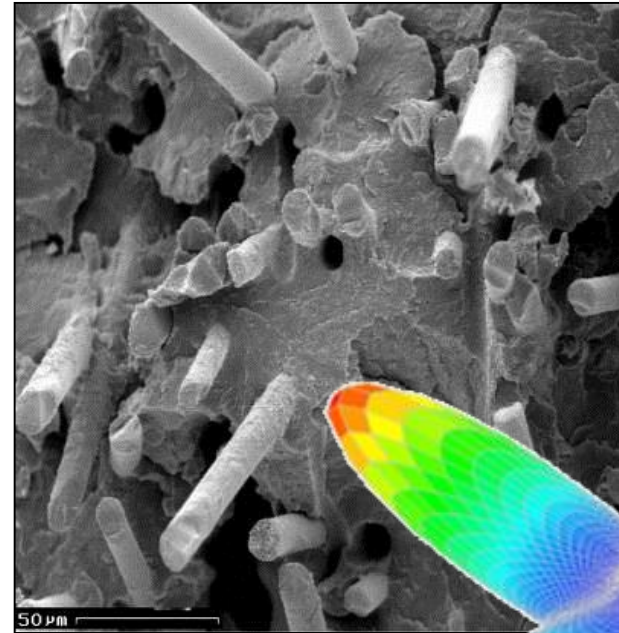


IMPETUS



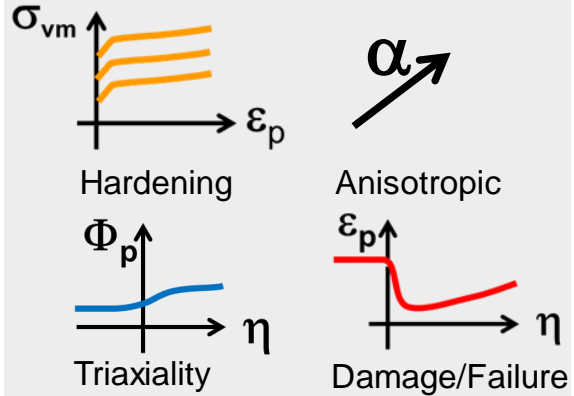
Software- & Methodenentwicklung

engineering plastics production
concepts **excellence in simulation** testing
lightweight prototypes



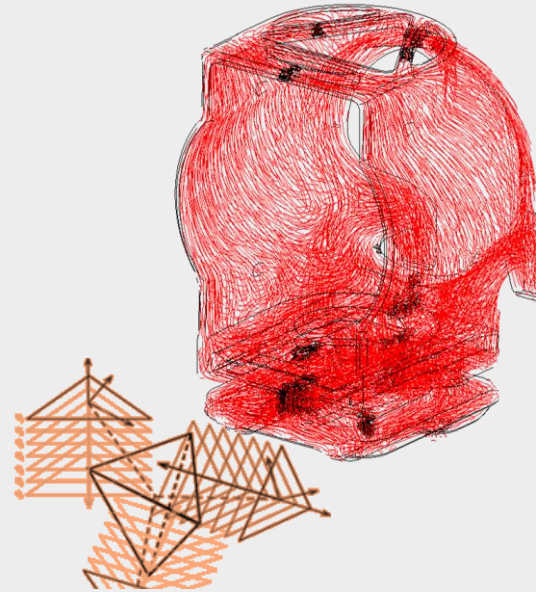
intelligent reliable solutions for plastics, composites, metals, foams, ...

 **VALIMAT**



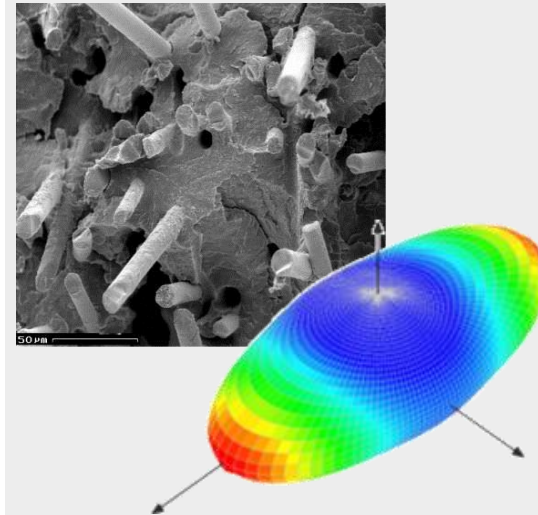
from test to validated material cards

 **FIBERMAP**



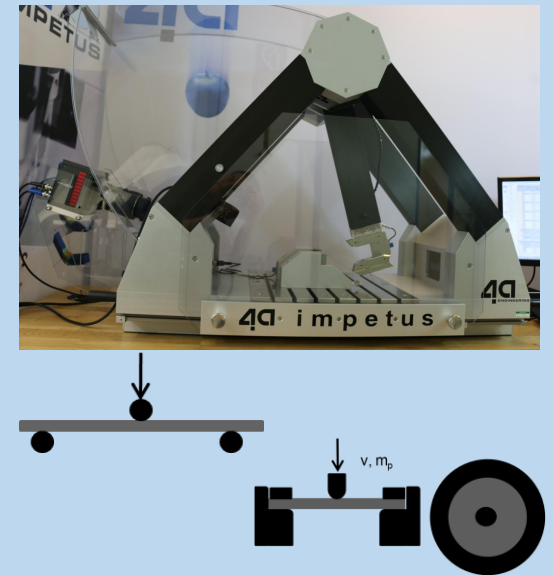
individual mapping process information

 **MICROMECC**



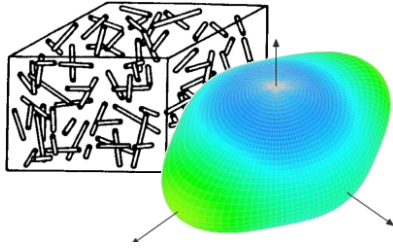
3D anisotropic material cards

 **IMPETUS**

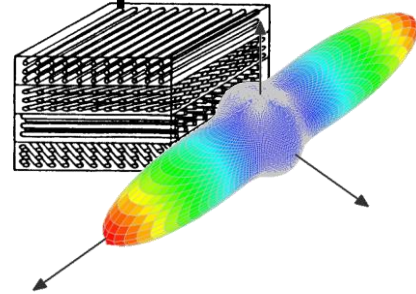


efficient dynamic testing

SFRT / LFRT



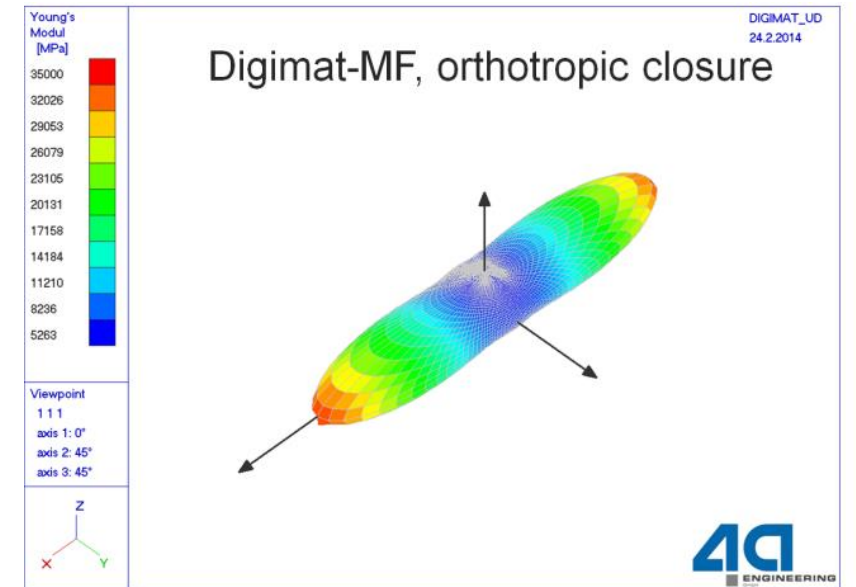
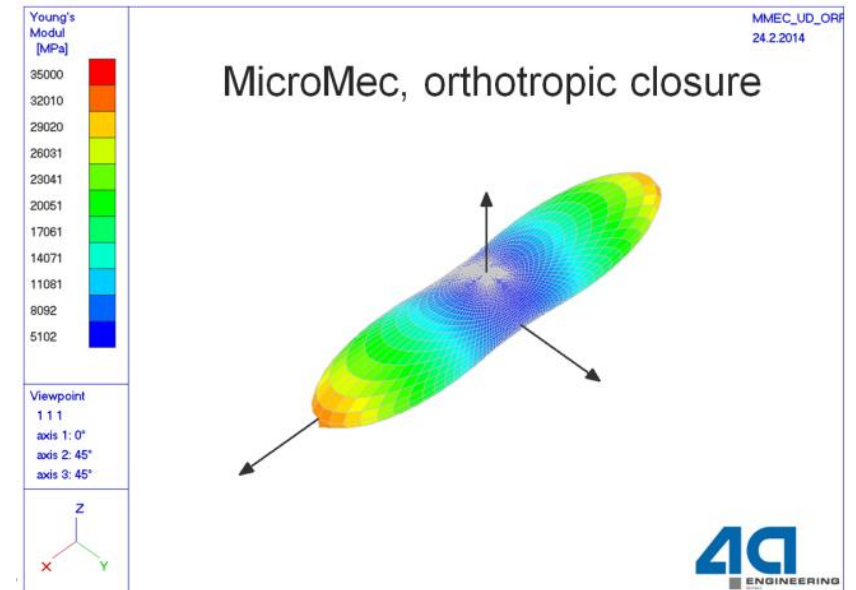
Composite



$$\bar{C} = \varphi \bar{F} + (1 - \varphi) \bar{M}$$

C...composite, F...fiber, M...matrix

- Standalone product (2001)
- Library → 4a impetus (2015)
- Usermaterial (2007)
- in LSDYNA R10.1 (2018)
*MAT_4A_MICROMECC



Comparison by University of Leoben [Bodor2014]

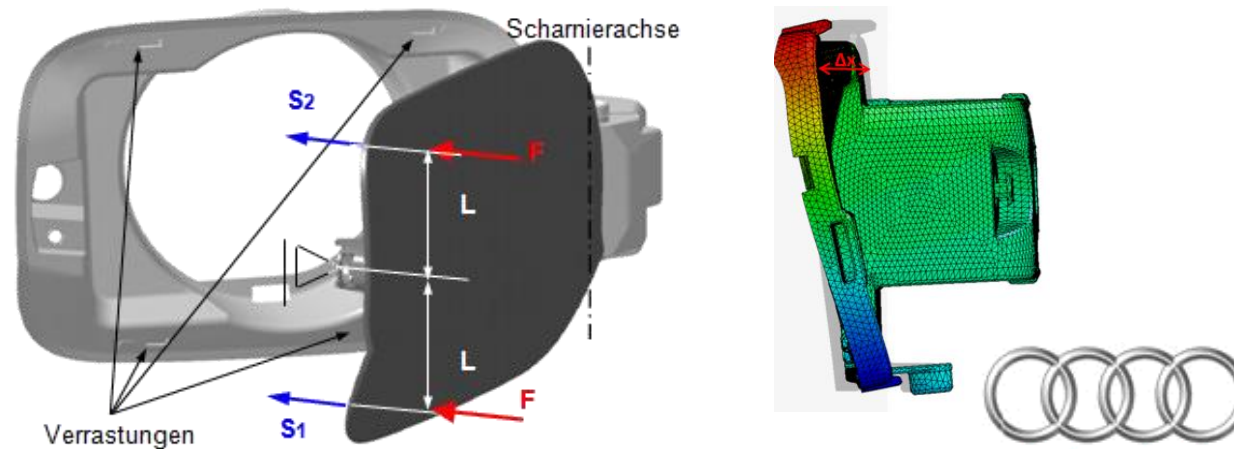
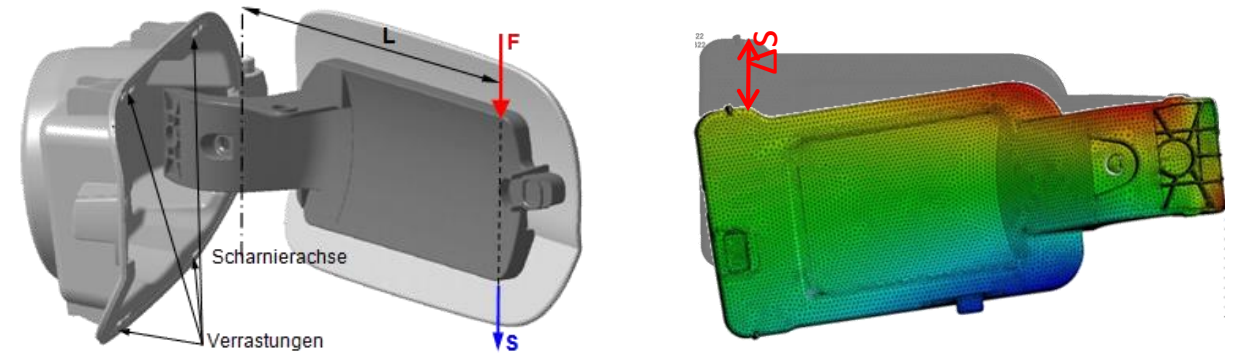
INTEGRATIVE SIMULATION Tankklappe



Projekthinhalt

- **ZIEL:**
Höhere virtuelle Prognosegüte
- **Problematik:**
Anforderung Premiumsegment
Öffnen des Tankdeckels an unterschiedlichsten Druckpunkten
 - Steifigkeitsvorhersage
 - isotrope Vorhersage
- Material: SFRT (PA6 GFXX) - Feuchtigkeit
- **Lösung:**
 - Berücksichtigung der prozessbedingten Faserorientierung
 - Validierung mit Material & Bauteilversuchen

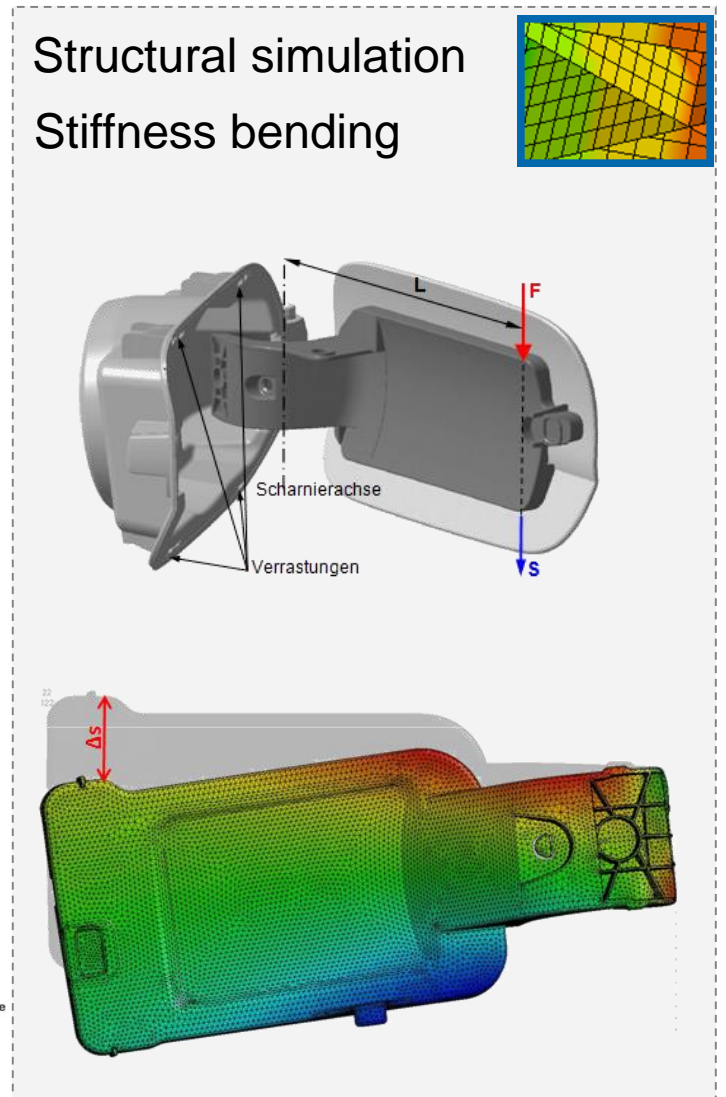
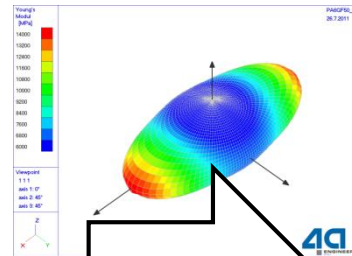
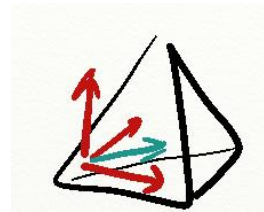
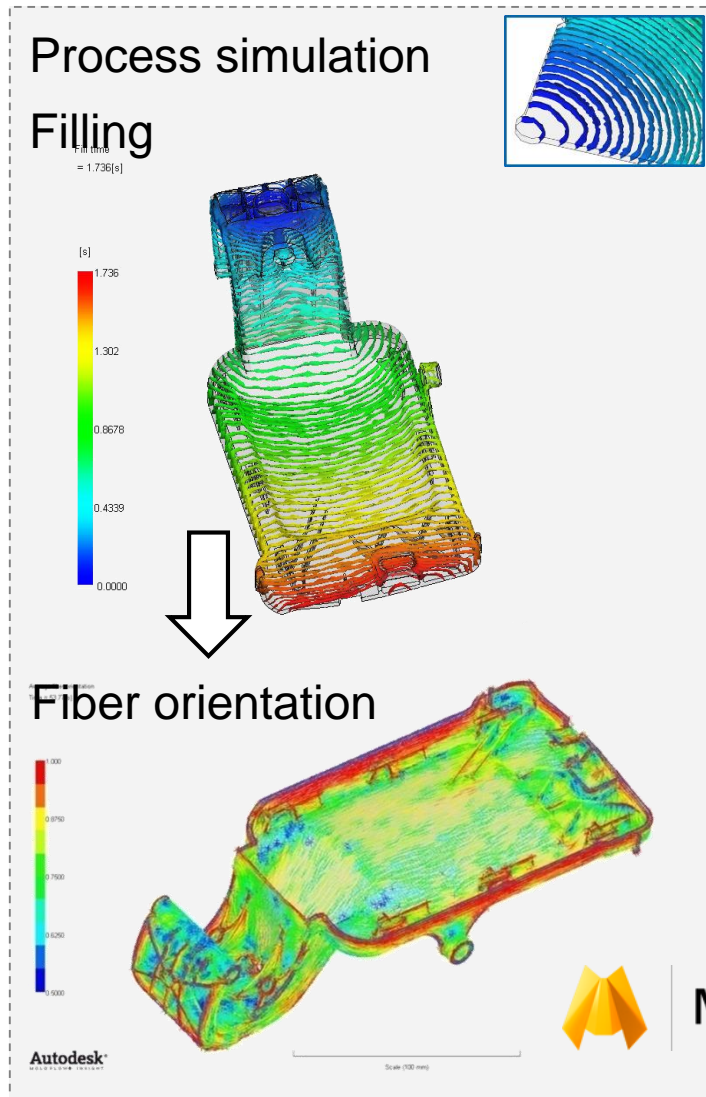
Lastfälle



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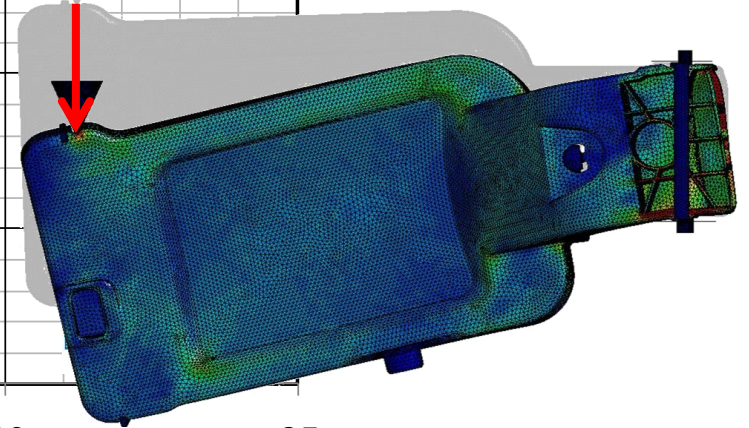
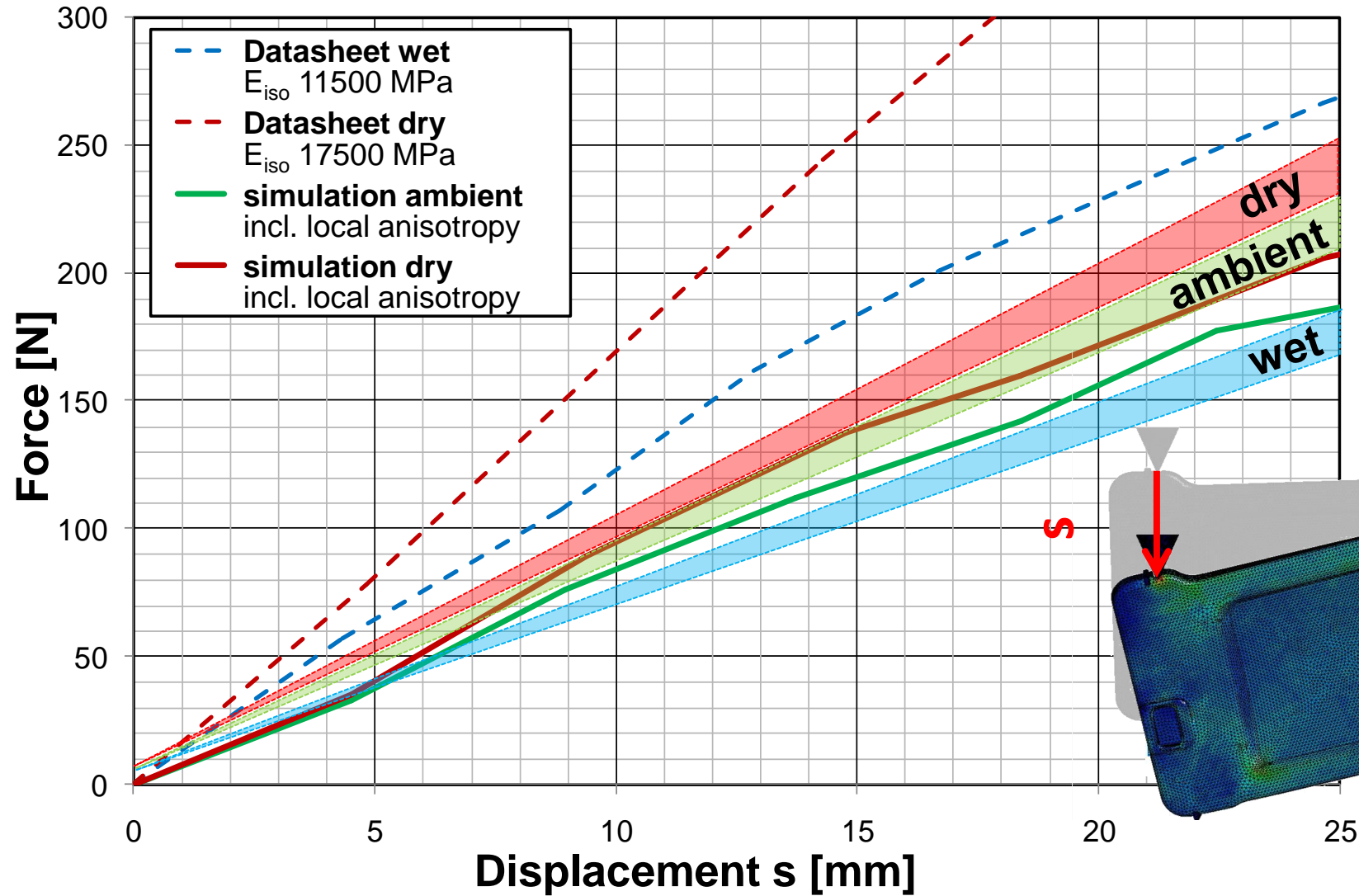


INTEGRATIVE SIMULATION Tankklappe



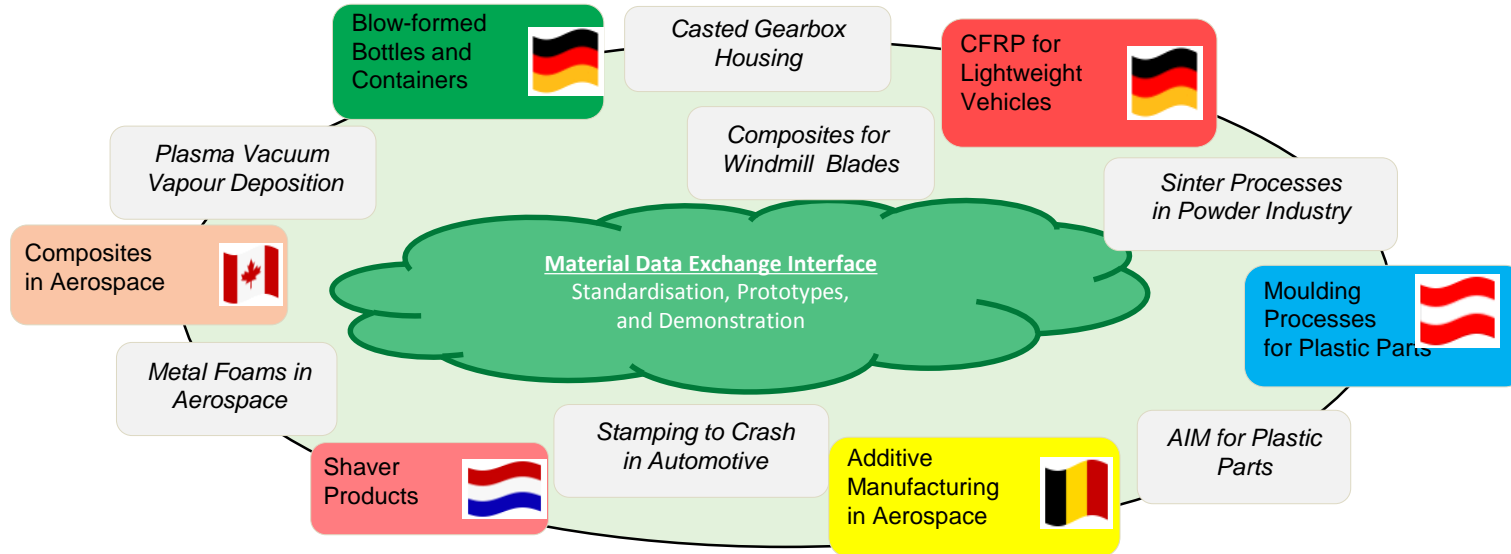
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INTEGRATIVE SIMULATION Tankklappe



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A new Interface Standard for Integrated Virtual Material Modelling in Manufacturing Industry





Ideen
die Chance geben, sich zu
verwirklichen.
Thomas A. Edison