3D-Prozessimulation im Leichtbau

Steffen Paul, SimpaTec GmbH

Inhalt

Vorstellung SimpaTec GmbH

Leichtbau – Anwendungen, Verfahren und Simulation

- Metal Replacement
- Process and structural analyse Isotprop – anisotrop
- Fiber length prediction
- Injection processes and simulation
  - Multi-component molding
  - MuCell
  - Foam injection molding
  - Compression molding
  - RTM – resin transfer molding
  - Gas- and Water injection molding

Meilensteine

- gegründet 1/2004
- Vertriebspartner von Moldex3D
- seit 2004 in Deutschland
- seit 2005 in BeNeLux
- seit 2006 in Frankreich, Schweiz und Österreich
- deutsche Niederlassung in Reutlingen und Suhl
- ausländische Niederlassungen in Guebwiller, Frankreich und in Bangkok, Thailand
- seit 10/2007 Vertriebspartner von Beaumont Technologies Inc.

Beaumont BEAUMONT TECHNOLOGIES, INC. MELTFLIPPER®

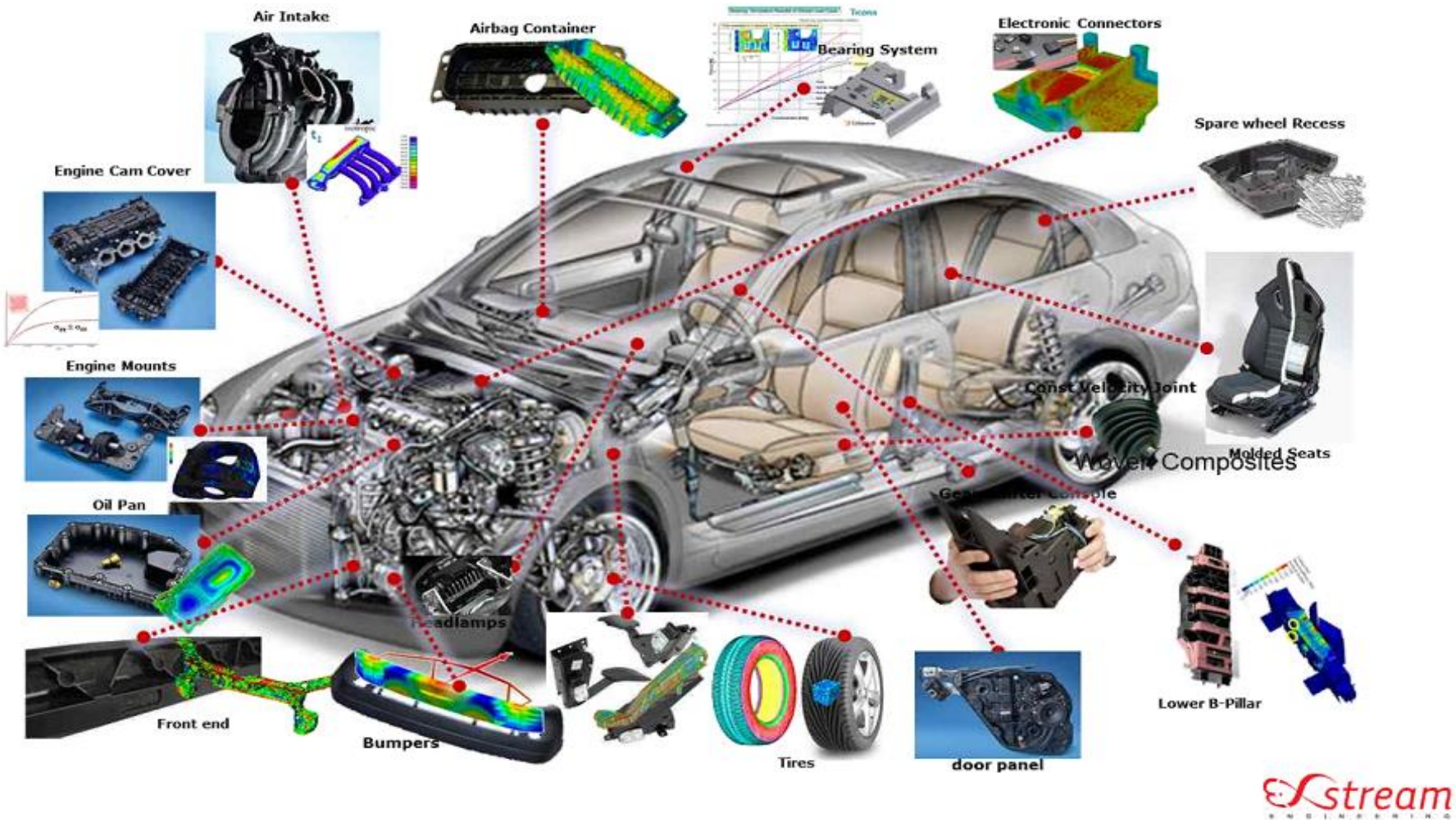
- seit 01/2013 Vertriebspartner von Elysium

ELYSIUM

Softwarekompetenz

- die Softwarelösung für die Auslegung und Optimierung des Kunststoffspritzgießprozesses
- die Softwarelösung für das Tiefziehen
- die Softwarelösung für das Blasformen
- die Lösung für die Vermeidung einer ungleichmäßigen Füllung
- die Lösung zur Konvertierung und Aufbereitung von 3D-CAD Daten

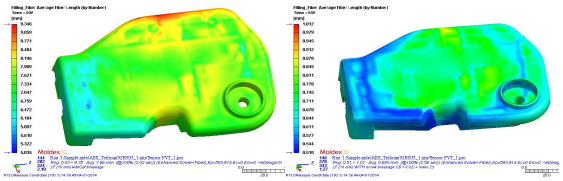
Automotive plastics application



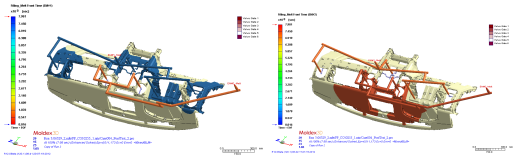
Übersicht Simulationsmöglichkeiten Leichtbau

SIMPATEC

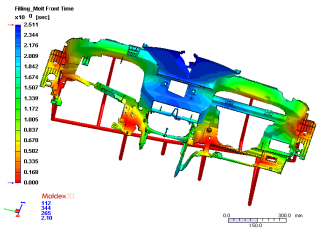
Fasern und Faserbruch



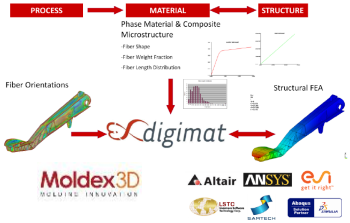
Co- und Bi-Injektion



MuCell

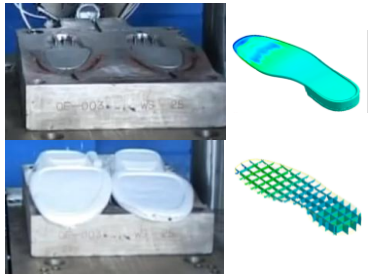


Mikromechanische Kopplung FEA



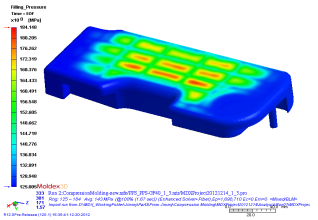
Moldex3D
MOLDING INNOVATION

chem. Schäumen

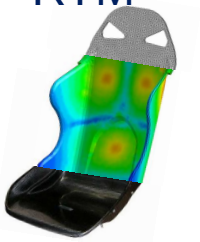


GID und WID

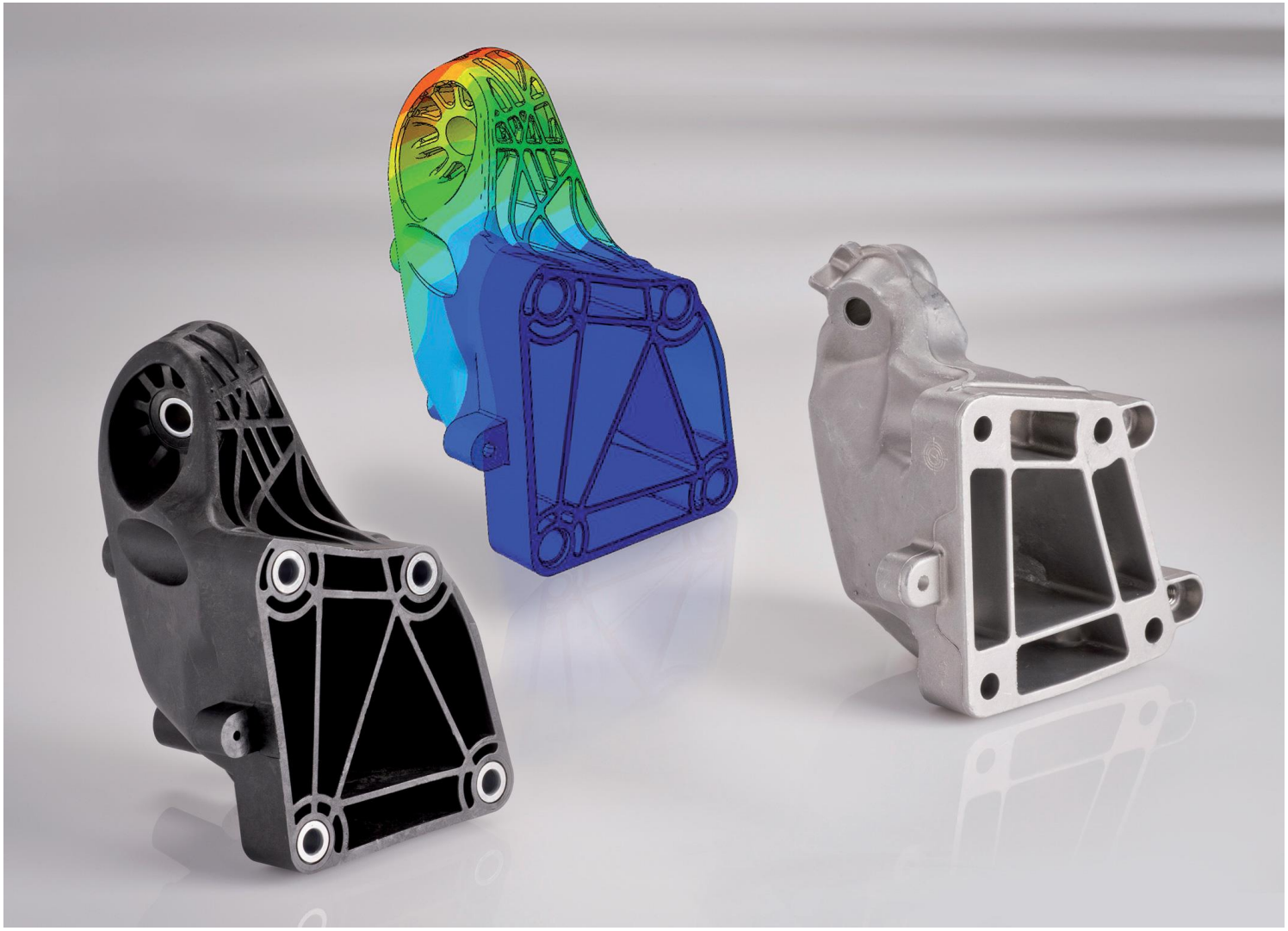
Spritzprägen und Fließpressen



RTM

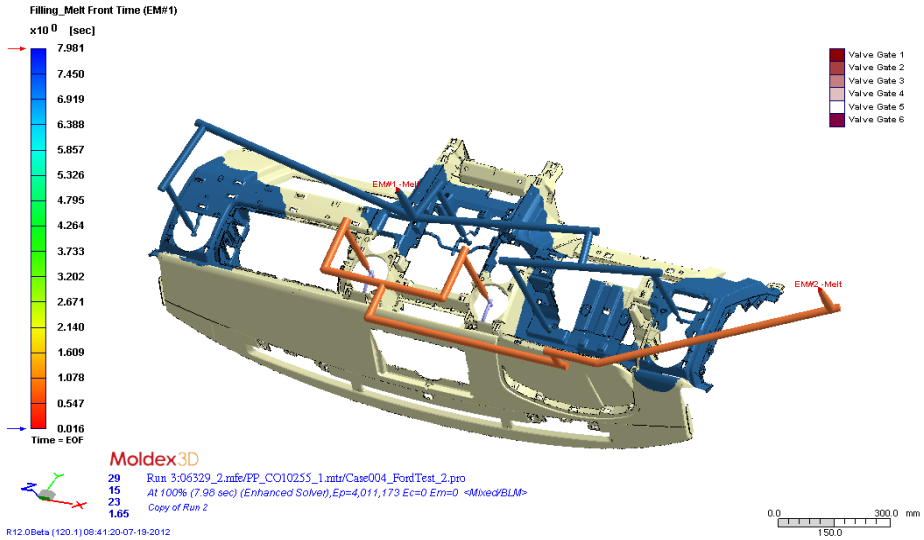


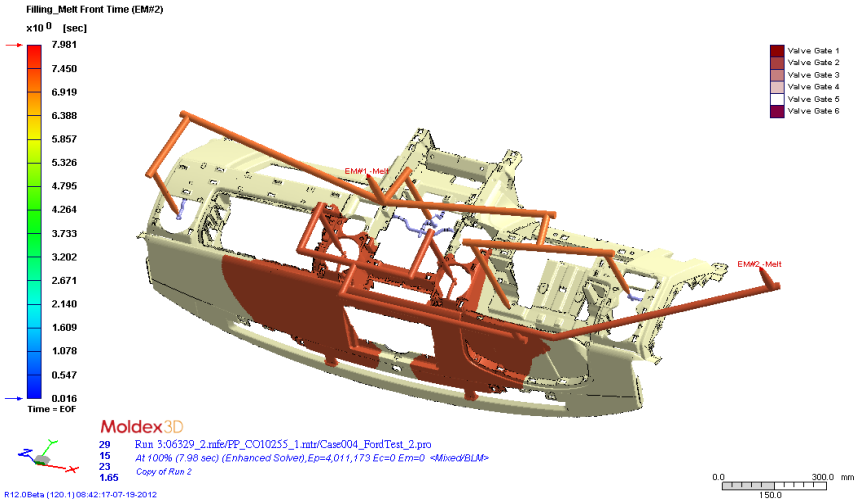
Metal replacement



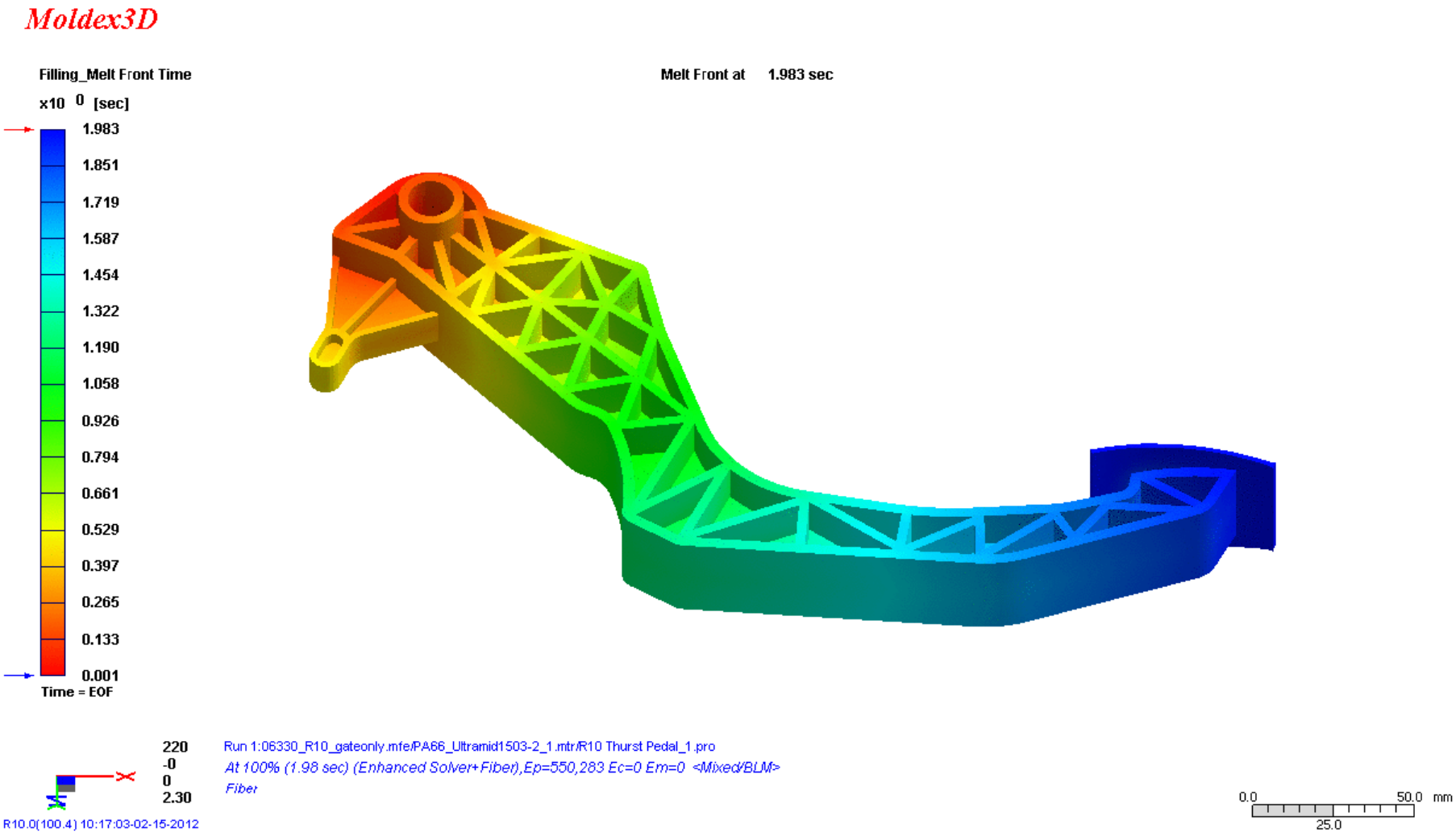
Multi-component molding design

Bi-injection two-color IP

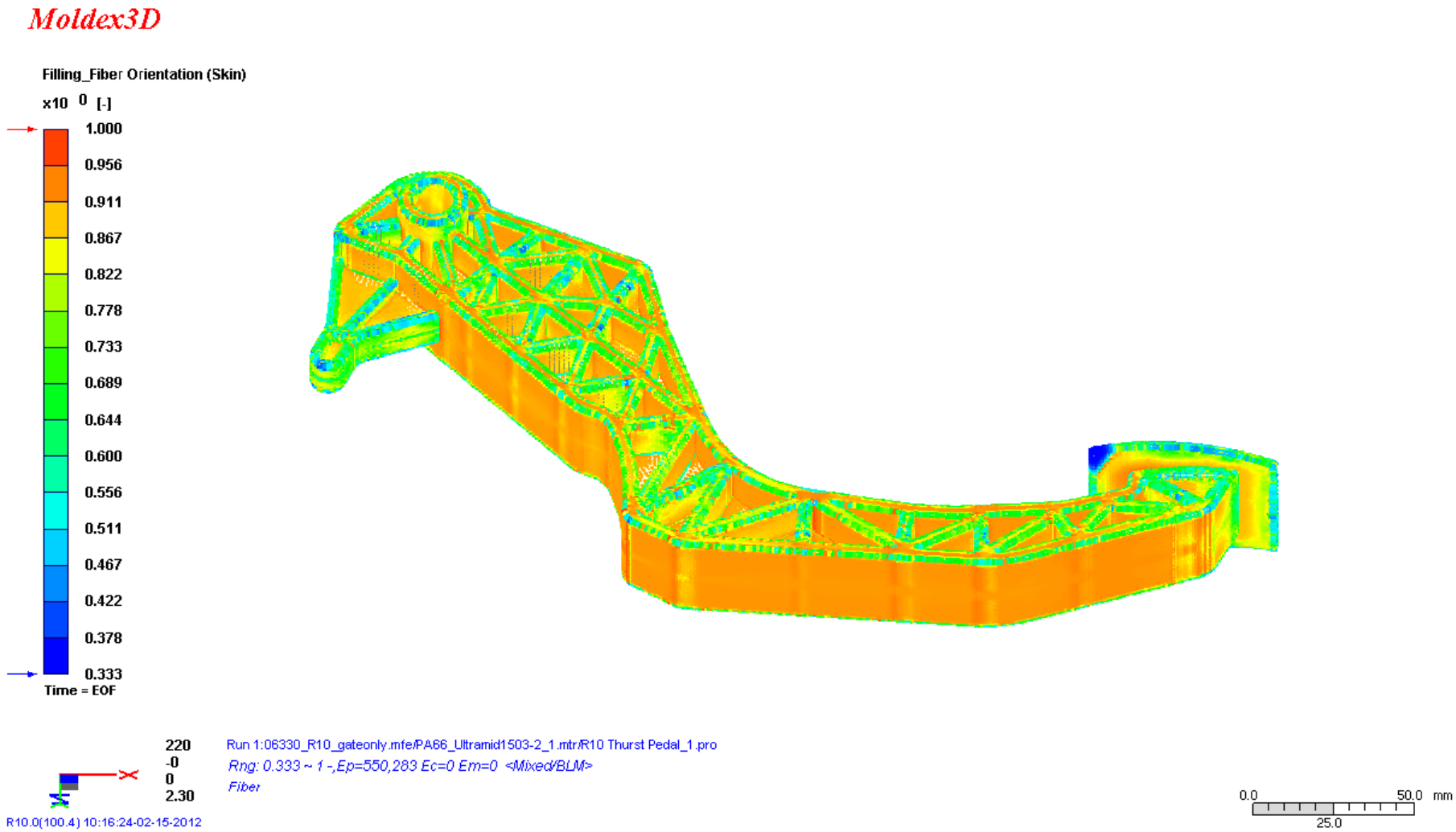




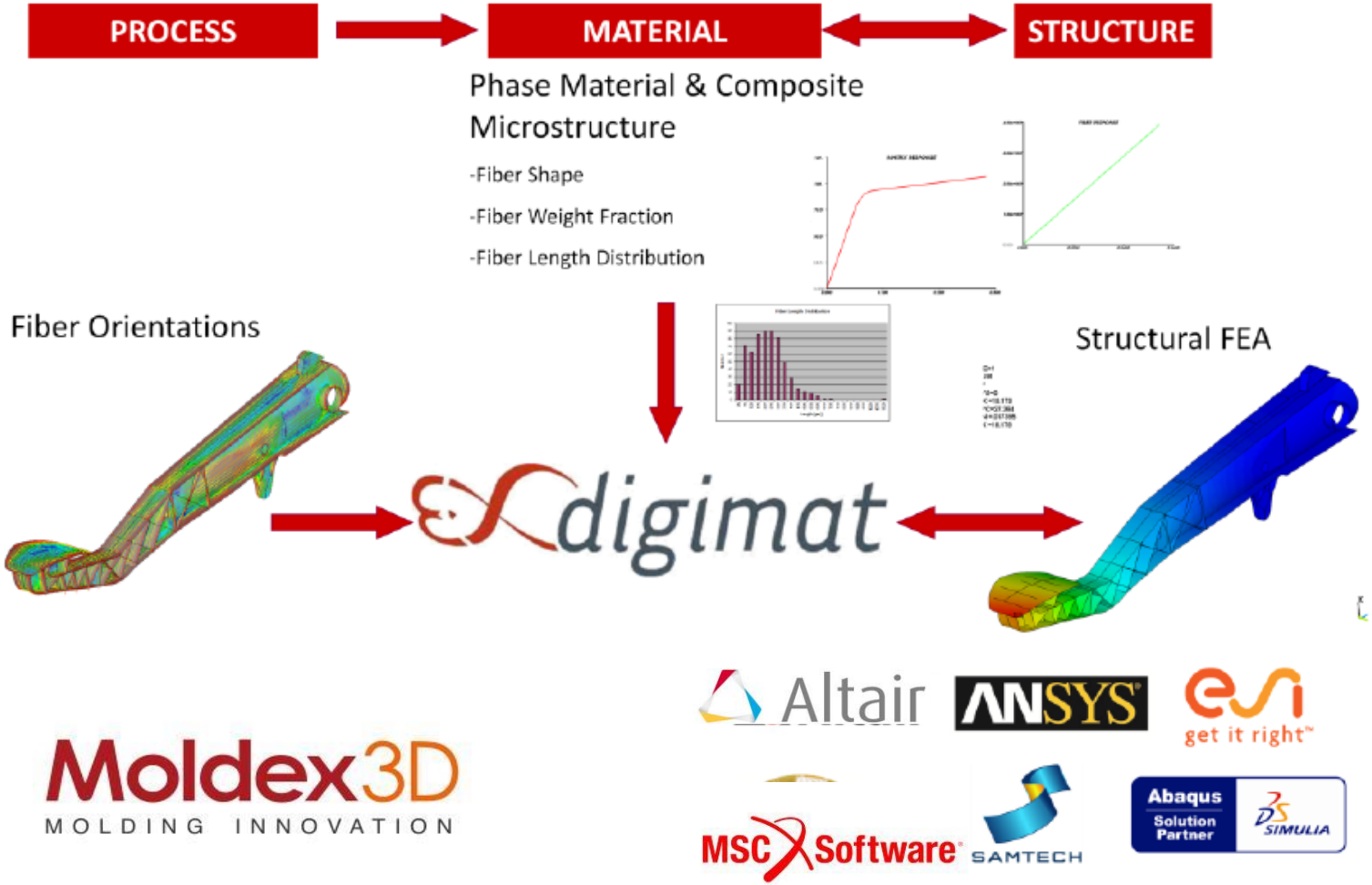
Thrust Pedal – Filling Animation



Thrust Pedal – Fiber Orientation



Structural Performance Evaluation of Fiber Part

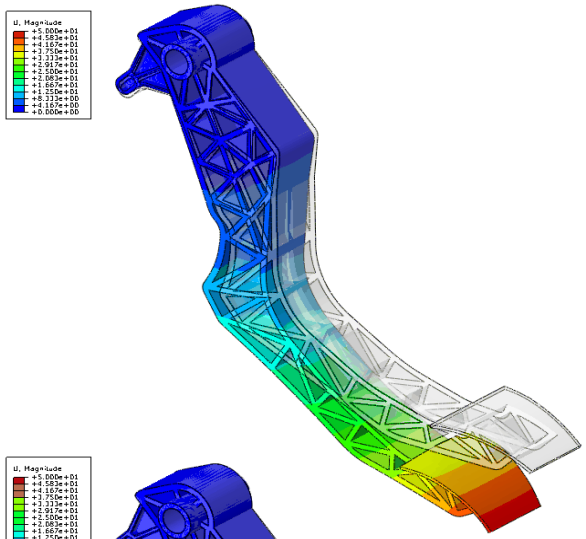


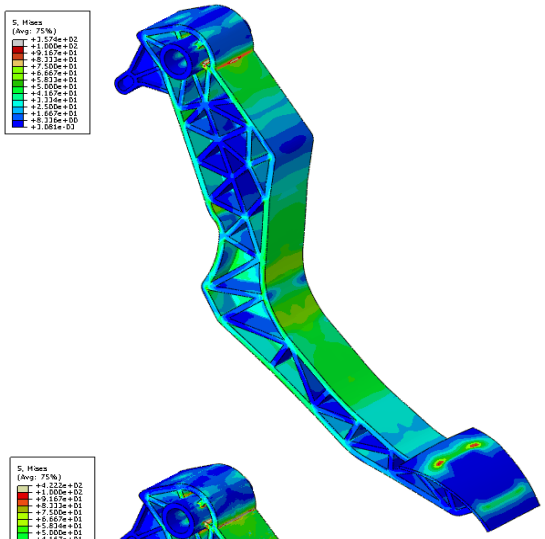
Thrust Pedal – Displacement & Stress

200lbf (900 N) Force Applied

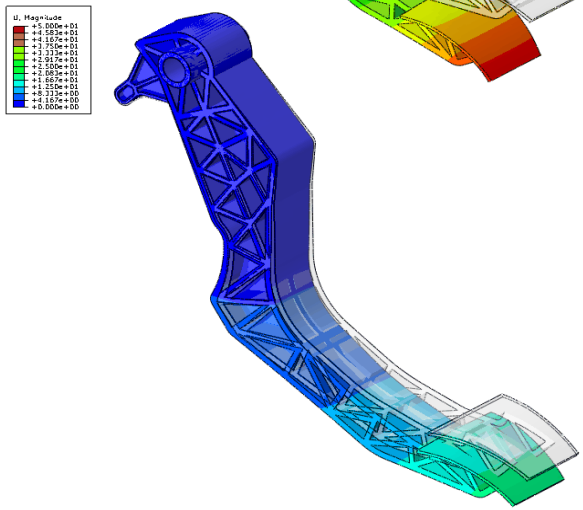
Displacemnet

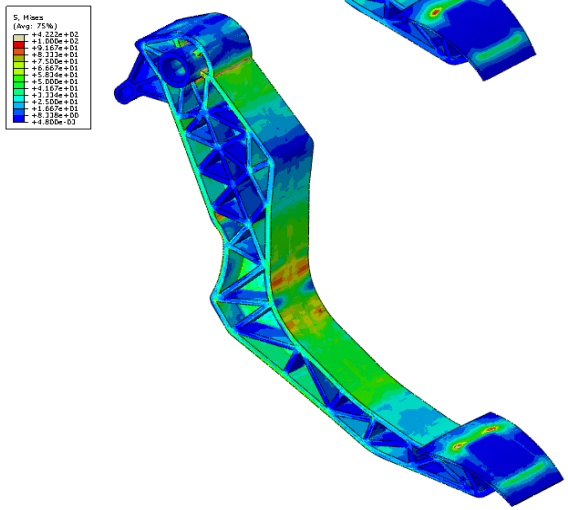
Stress





isotropic



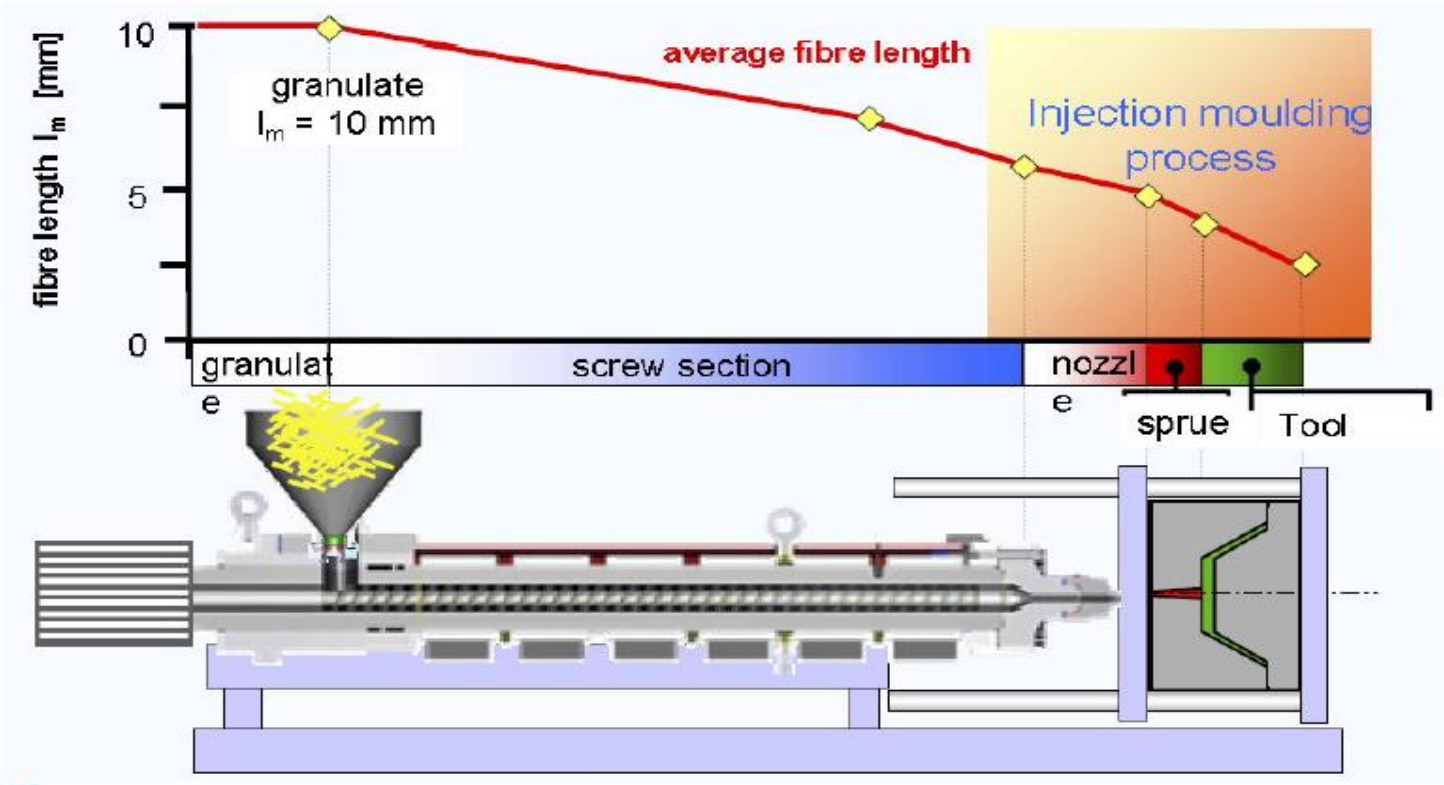


anisotropic

0-50 mm range

0-100 MPa range

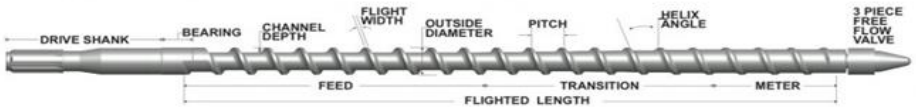
Fiber breakage during plastication

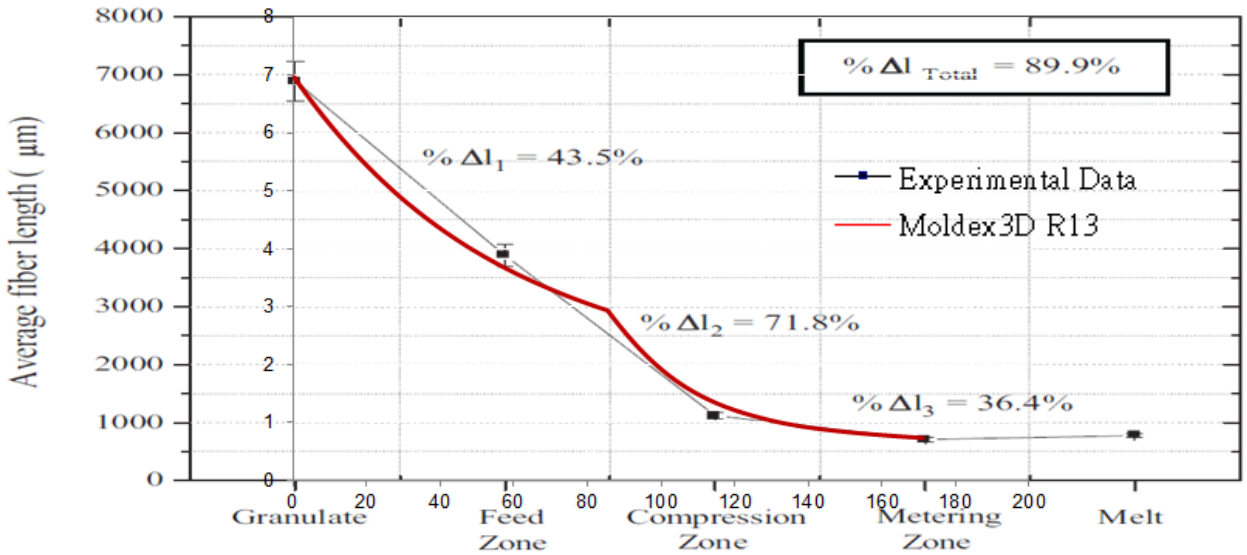


EATC EUROPEAN ALLIANCE FOR THERMOPLASTIC COMPOSITES

Fiber: Fiber Length Prediction

- Provides the option to consider fiber breakage behavior induced by screw
- **Moldex3D** R13 can also predict the fiber length within the melt in the screw stroke area, and the length result agrees with the experimental data





Initially, average fiber length of granules is 7 mm, but the average fiber length is around 0.7 mm at melting zone in screw

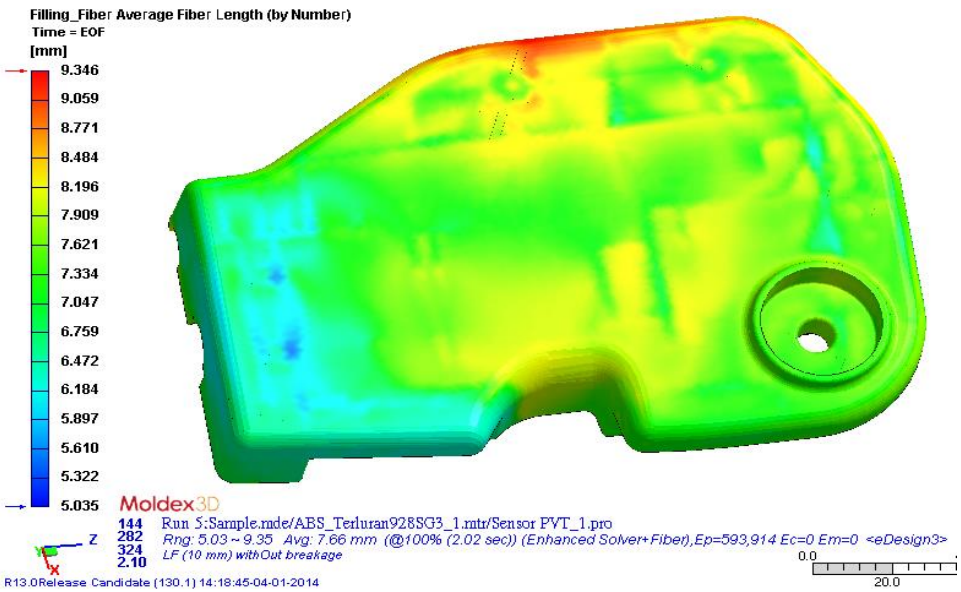
PP with 40 wt% of long-glass-fibers

Characterization of Fiber Length Distribution in Short and Long-Glass-Fiber Reinforced Polypropylene during Injection Molding Process, KASETSART JOURNAL: NATURAL SCIENCE, Vol. 42, pp. 392 - 397 (2008)

Enhanced Fiber Length Simulation

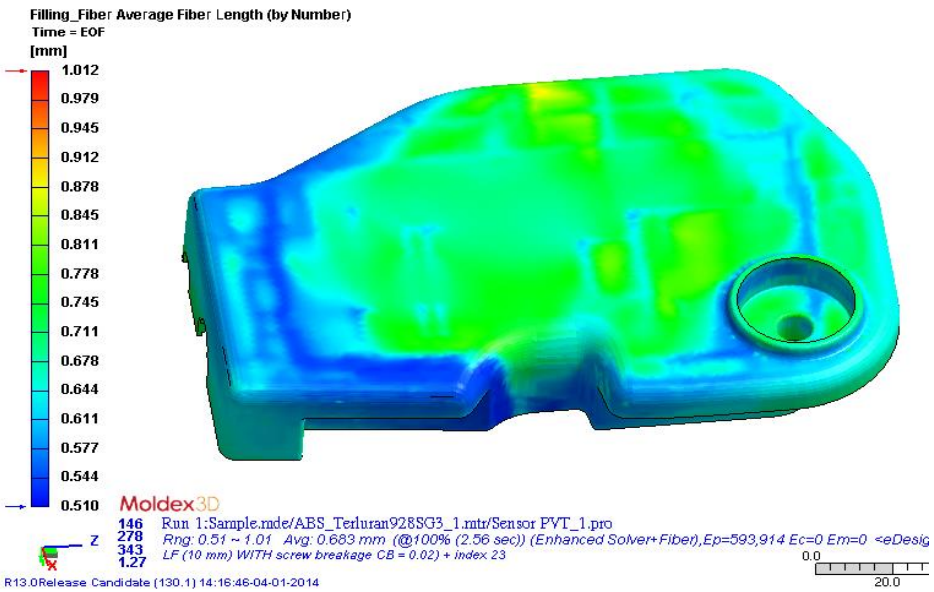
Don’t consider fiber breakage in screw

Range from 5.0 – 9.3 mm

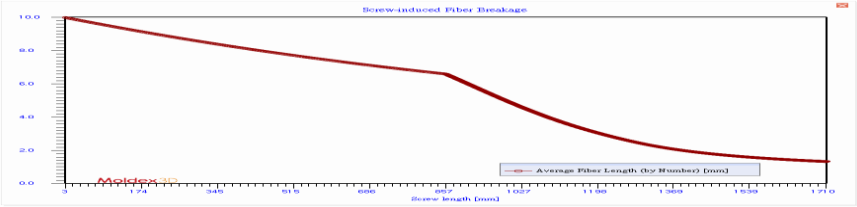


Consider fiber breakage in screw

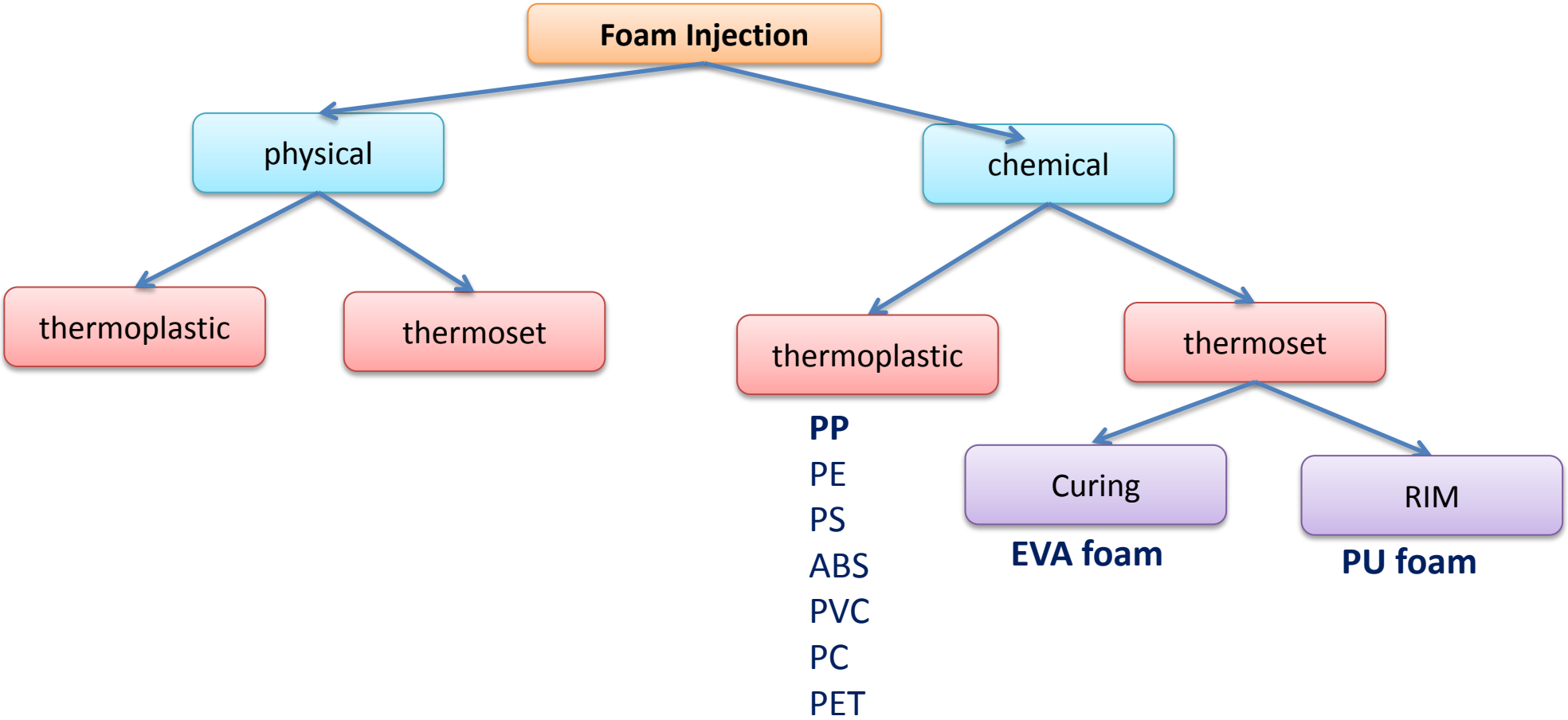
Range from 0.5 - 1.0 mm



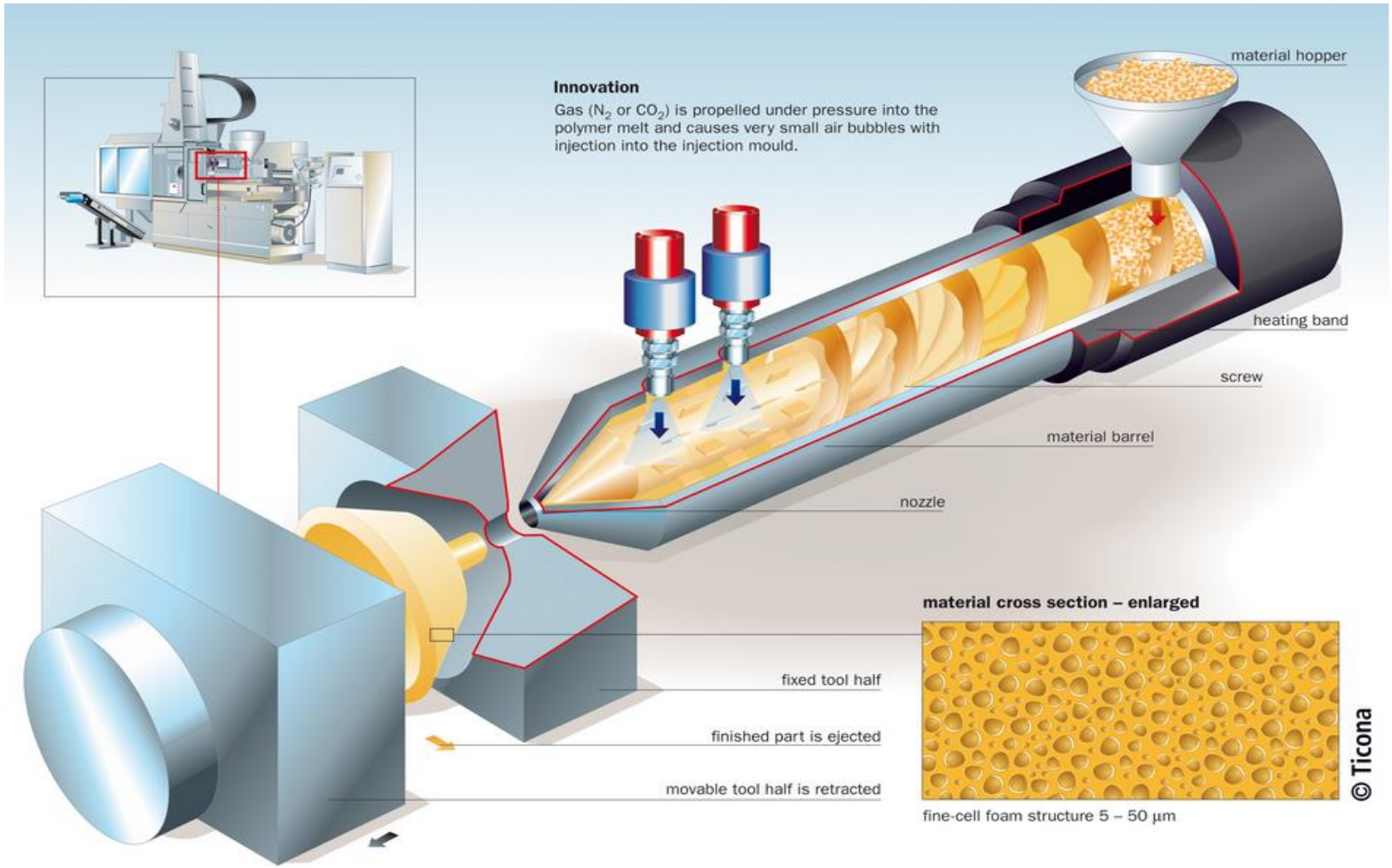
Initial fiber length: 10 mm



Scope of foam injection molding



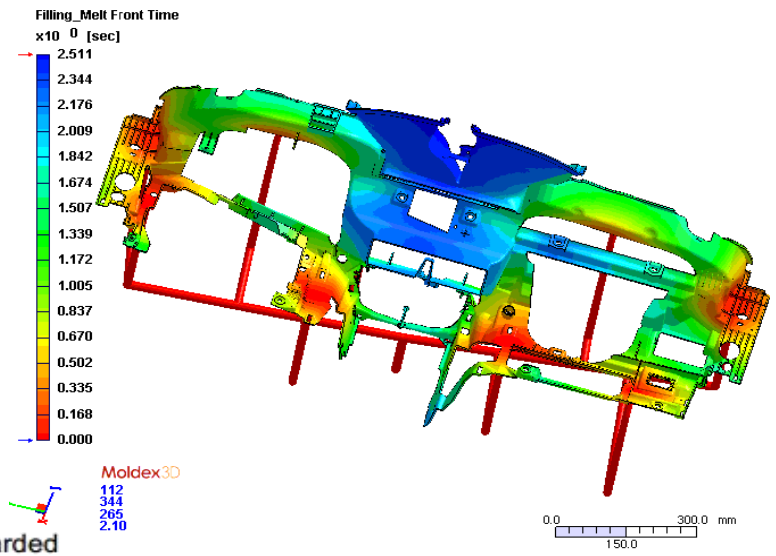
Microcellular Foam Injection Molding



http://03429d3.netsolhost.com/injection-molding-solutions/implementing-mucell.php

MuCell® + LGFPP Instrumental Panel

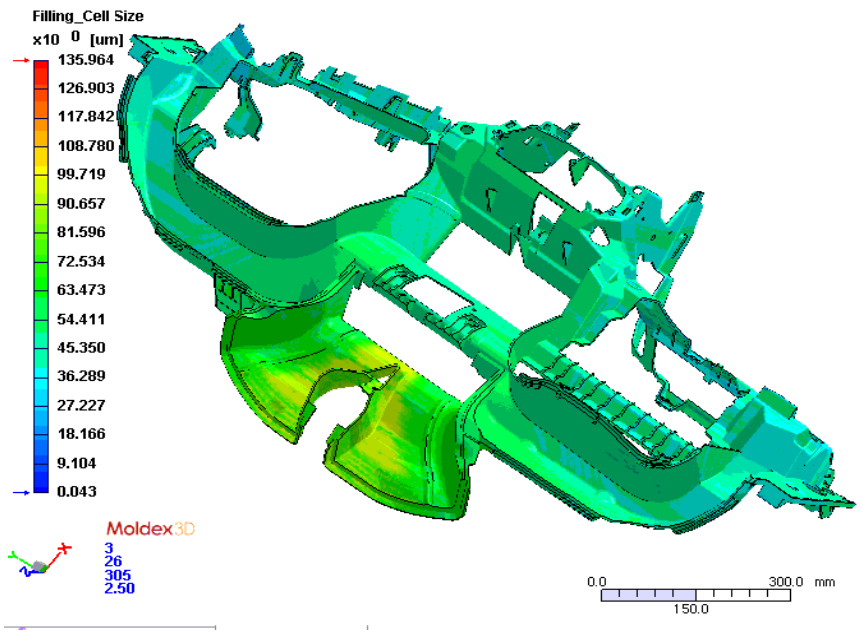
MuCell Technology Helps Ford Win the Grand Award at the 41st SPE Automotive Innovation Awards

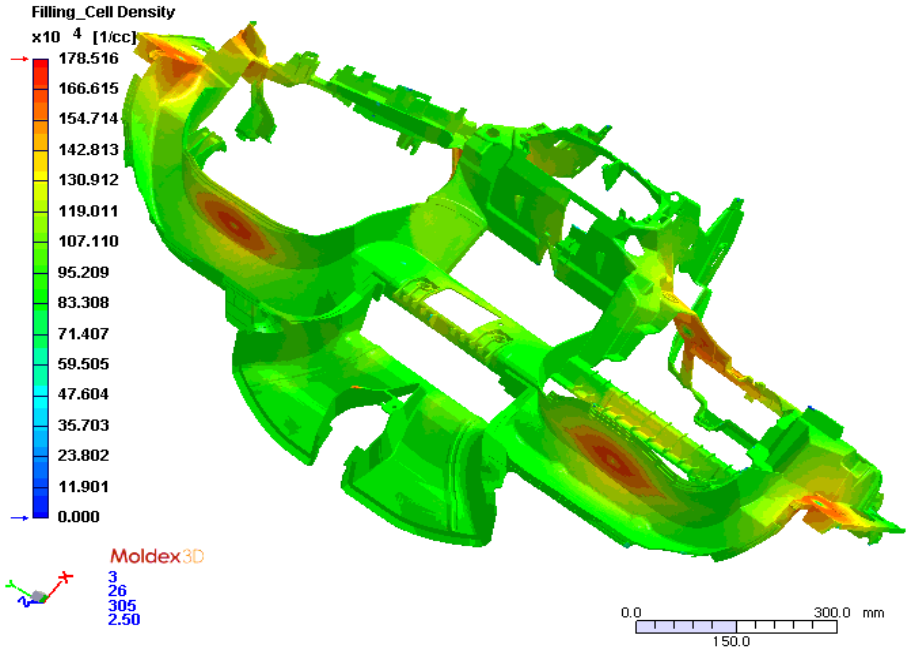


Livonia, MI & Wilmington, MA, Nov. 9, 2011 – The Society of Plastics Engineers awarded Ford's use of the MuCell process the Grand Award at the association's 41st Auto Innovation Awards Competition, held November 9th at the Burton Manner, in Livonia, MI. The instrument panel was originally entered in the Process/Assembly/Enabling Technologies category. By creating the instrument panel structure for the new Ford Escape in microcellular foam, weight is reduced more than 1 lb, mechanical properties are improved, molding cycle time is reduced 15%, and molding clamp tonnage is reduced 45%, saving an estimated $3 US / vehicle vs. solid injection molding.

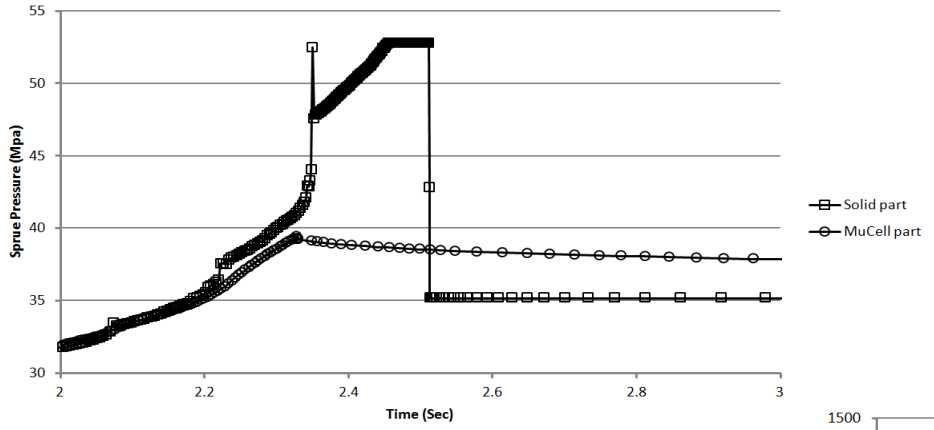
MuCell® + LGFPP Instrument Panel

Cell Structure

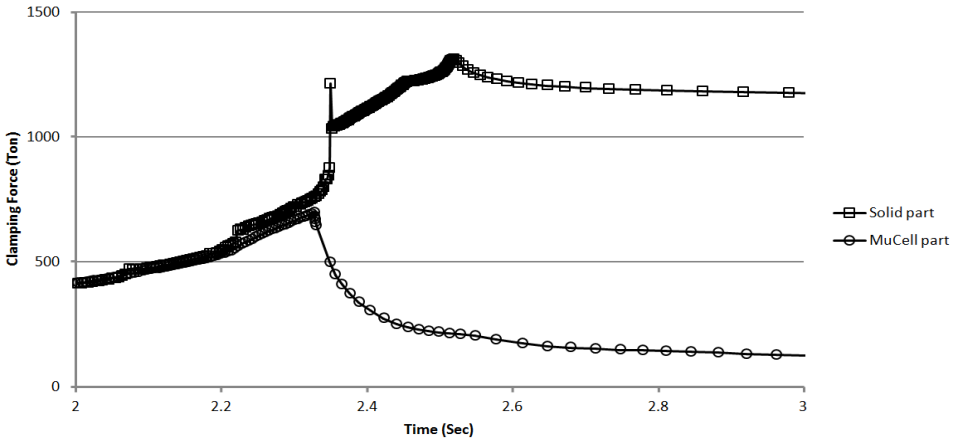




MuCell® + LGFPP Instrument Panel



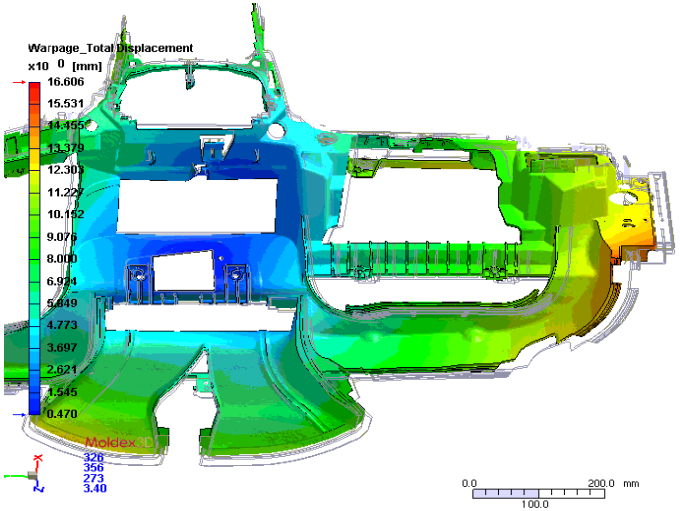
Sprue Pressure



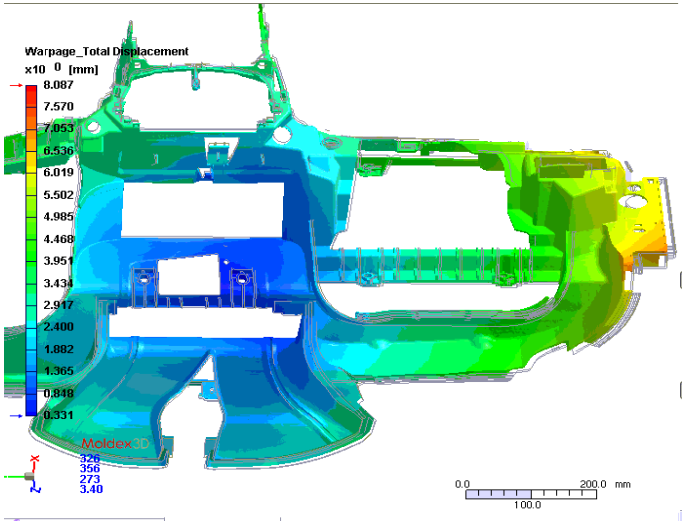
Clamping Force

MuCell® + LGFPP Instrument Panel

Warpage comparison



Solid part



MuCell® part

MuCell® + LGFPP Instrument Panel

Summary

	Solid Part	MuCell Part
Part Weight [g]	2724.2	2446.9
Max. Clamping Force [Ton (m)]	1579	699.5
x-Displacement [mm]	11.37	3.81
y-Displacement [mm]	15.69	6.87
z-Displacement [mm]	8.27	3.32

Part dimension: 644.5*1415.8*562.4 (mm)

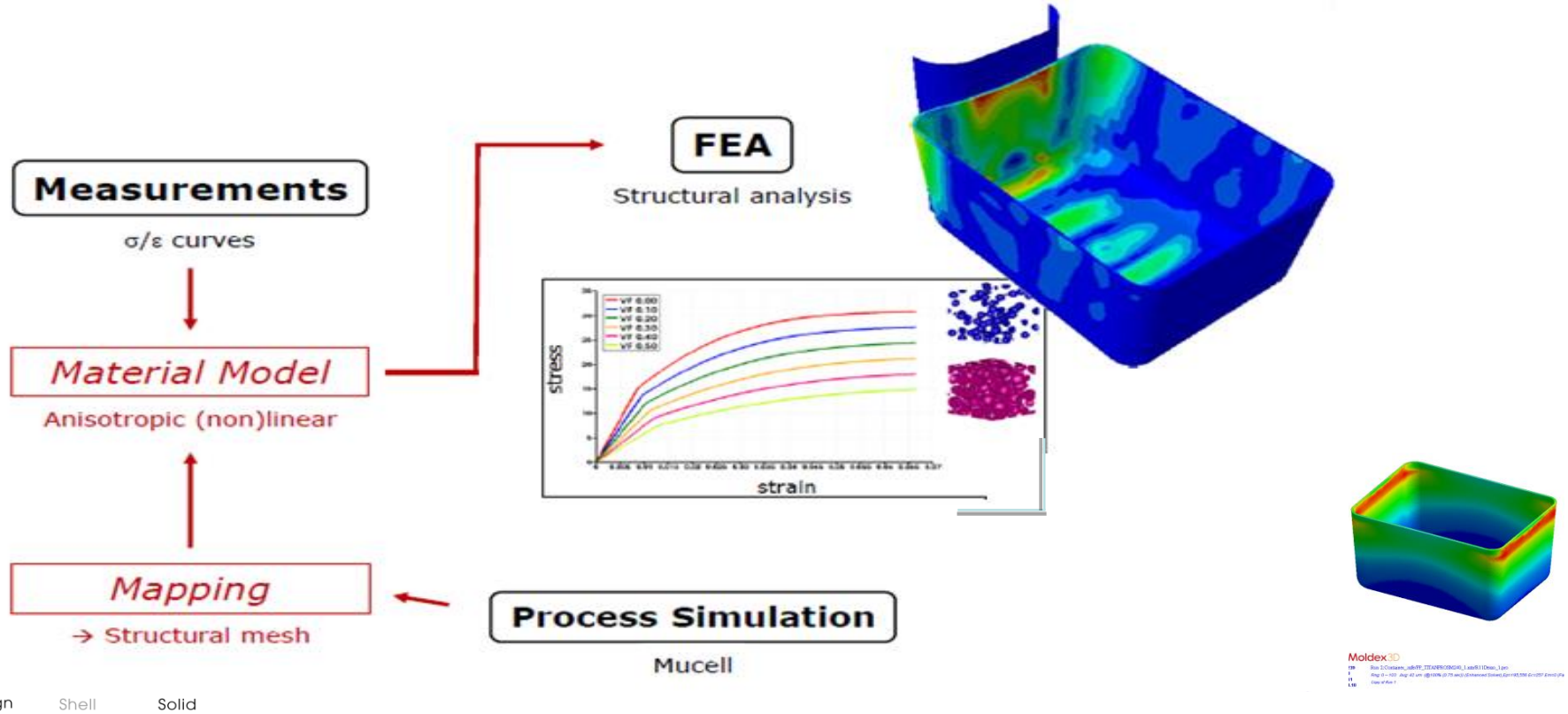
Table 1 Comparisons of simulation results from conventional injection molding and microcellular injection molding. Weight reduction: 10.18%

10% W.R.

55% Reduction

More Digimat options output in MuCell® Analysis

- A new workflow for MuCell® part structural performance evaluation
- Moldex3D outputs cell size and cell density data for Digimat
- Benefit
  - Completely considers the cell size and cell density effects in MuCell ® parts



BATZ 50 urte

Meeting your challenges

Case study 1:
Critical WIT parts design optimization with Moldex3D
Meeting your challenges
Application to water injected pedals

BATZ Automotive Systems: Technical evolution

ORIGIN

Design supplied by OEM

EVOLUTION

Co design Batz - OEM

CURRENT SITUATION

Black Box designs

INNOVATION

- New *Markets*
- New *Products*
- New *Processes*

Pedals: structurally critical parts

Safety part
Ergonomical requirements

Traditonally made out of metal

Very restrictive mechanical requirements:
- **Strength**
- **Stiffness**

Relatively **complex geometry**

Moldex 3D & BATZ: WIT simulation research

- Working jointly since 2012 to improve WIT simulation capabilities of Moldex3D, in order to speed up the development process of a pedal

BATZ50

Actual part manufacturing / engineering

Moldex3D
MOLDING INNOVATION

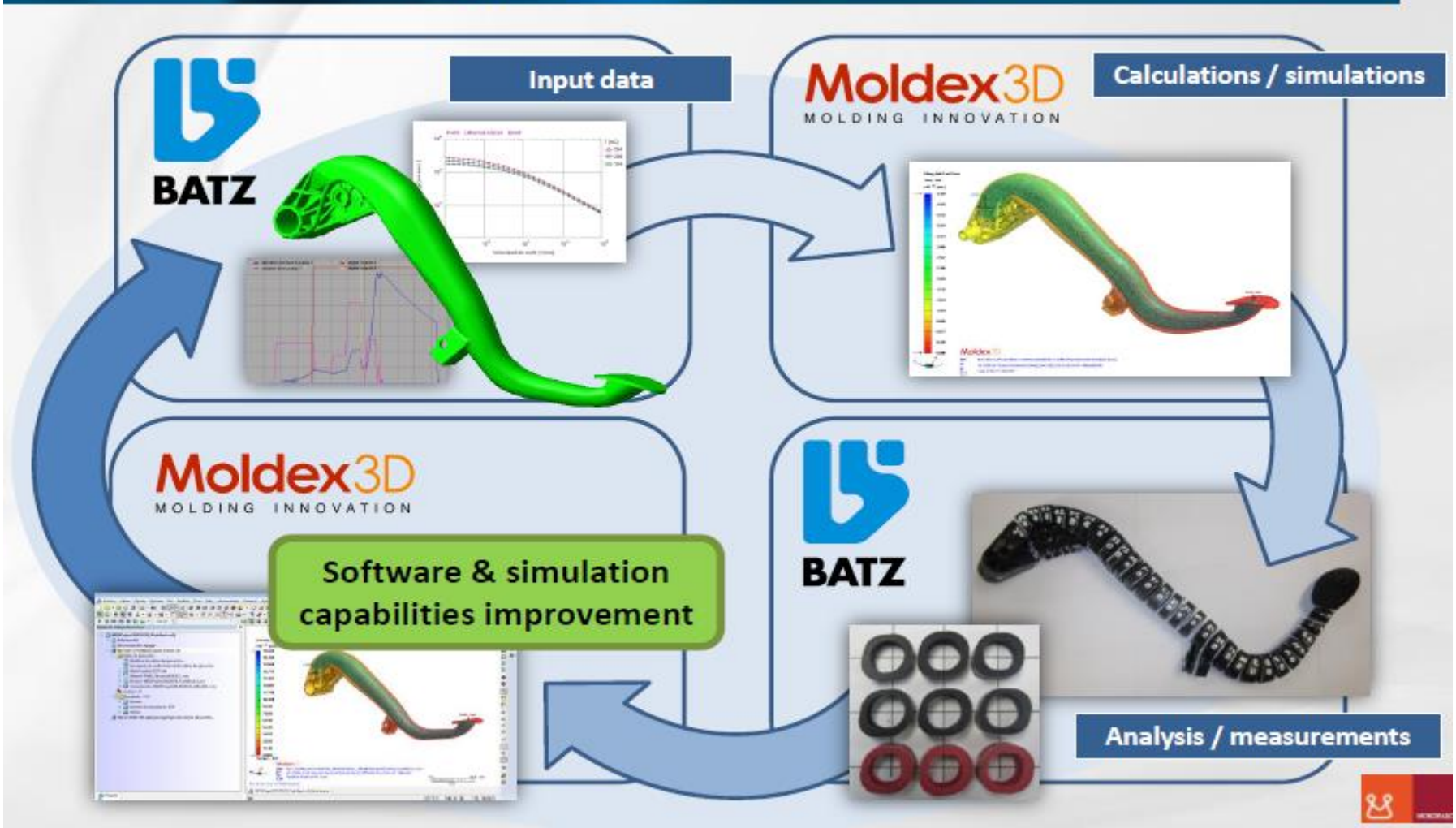
WIT Process simulation capabilities

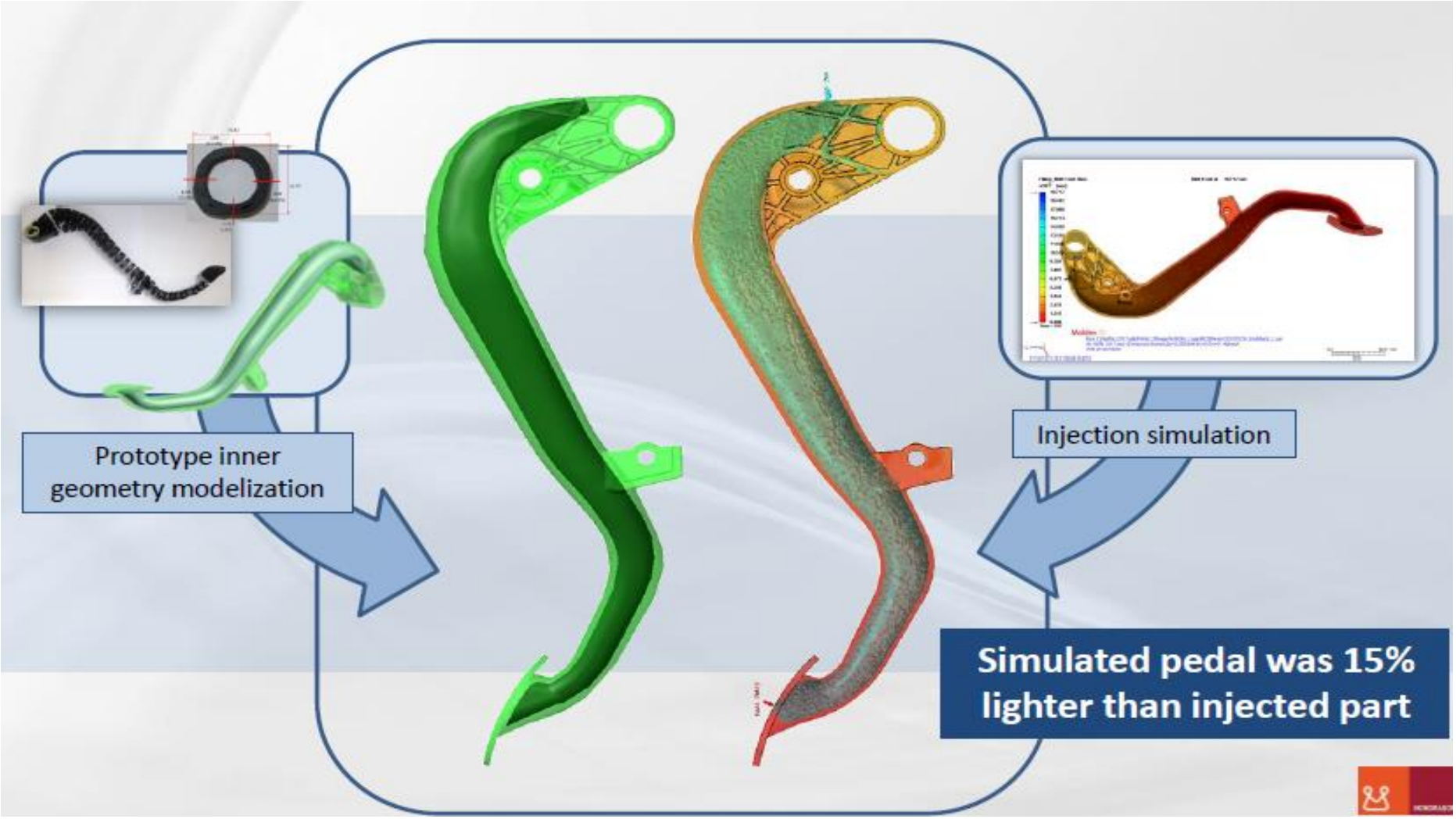
Goals

- **Mass** prediction
- **Process** prediction
- **Mold shape vs. final** part prediction

- **Costs savings**
- **Reduced cycle time**
- **Reduced tooling development time**

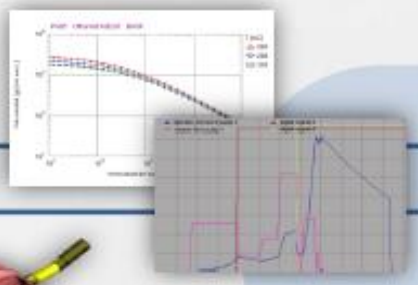
Research metodology

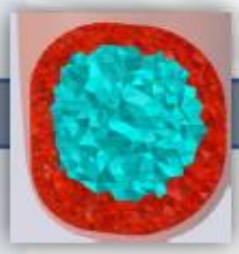



Prototype inner geometry modelization
Injection simulation
Simulated pedal was 15% lighter than injected part

Project development

Challenges	Solutions
Outdated process/material data	Further information gathered
Evolving design	Updated pedal / water inlet geometry
Output mesh handling difficulties	Improved mess exportation posibilities
Prior software version	New kernel released





First trials

Current situation

60% improvement

Mass prediction:

Simulation is **15%** lighter

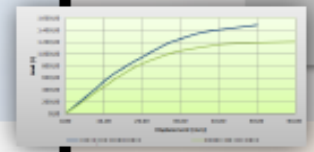
Mass prediction:

Simulation is **5%** lighter

30% improvement

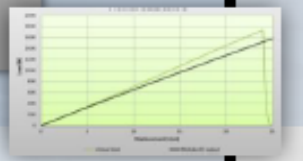
Mechanical behavior:

Simulation is **15%** lighter



Mechanical behavior:

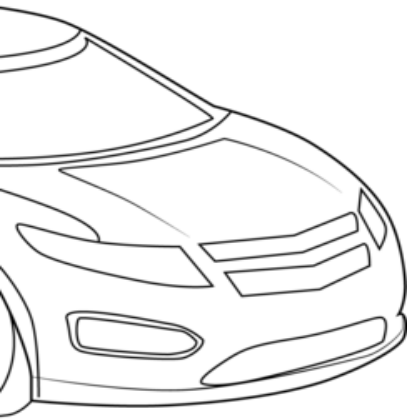
Simulation is **10%** less stiff



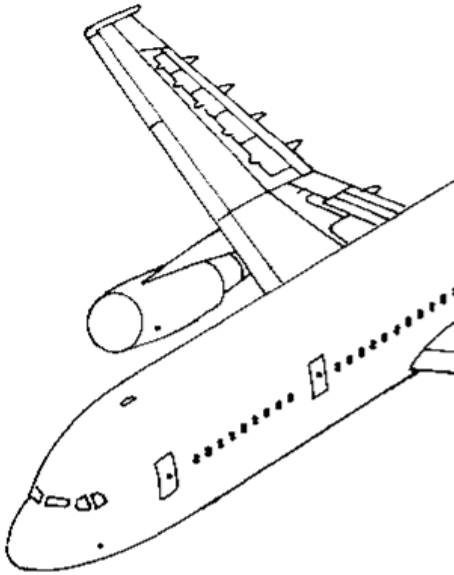
CLOSING THE GAP TOWARDS A PERFECT CORRELATION

Automotive composite development trend

Lesson learned from the aerospace industry



	Laminate
	Filament winding
RTM	RTM
GMT Compression	GMT Compression
Long fiber	Long fiber
Short fiber	Short fiber



Lightweight future


Autoevolution.com

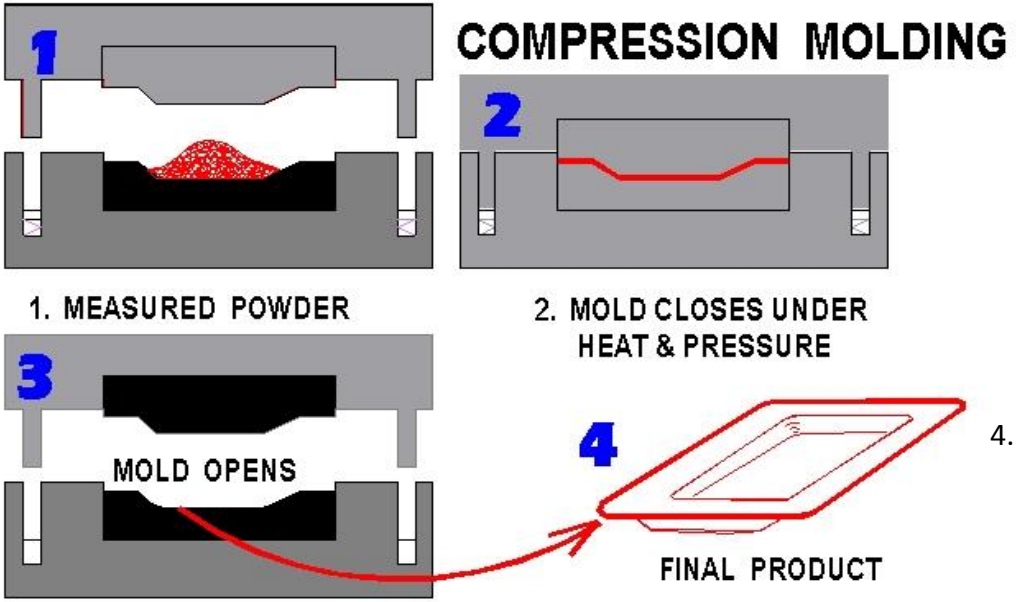

perspectives.3ds.com


Compositesworld.com

Compression Molding Process

>A simplest way to make rubber products

>It's a process which involves:



4. Open the mold and remove the part (The excess rubber, called flash, needs to be trimmed off the part)

>In some applications, compression molding is still the best way

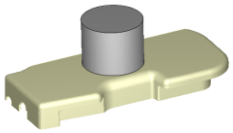
Image Ref: http://paws.wcu.edu/ballaaron/www/met366/modules/module5/imageJPS.JPG

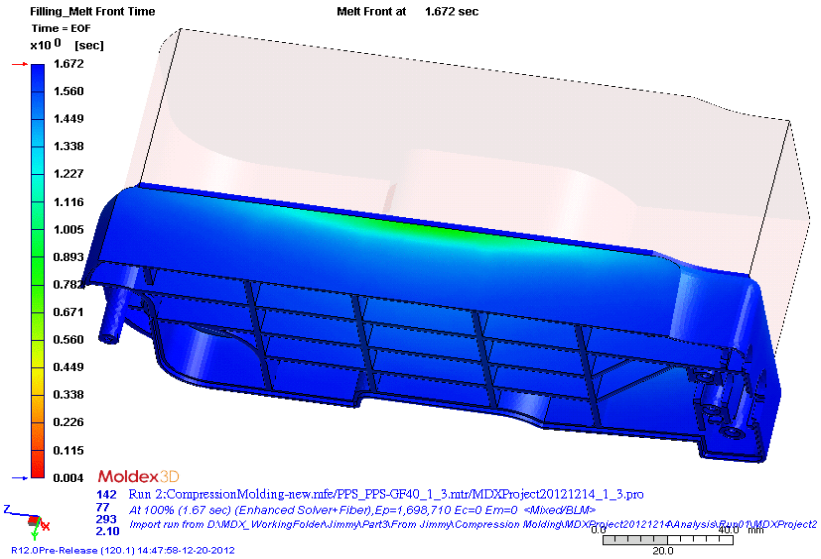
Multiple Charge Design Simulation

>Support arbitrary charge volume & shape setting

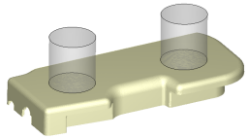
>Support single or multiple charges

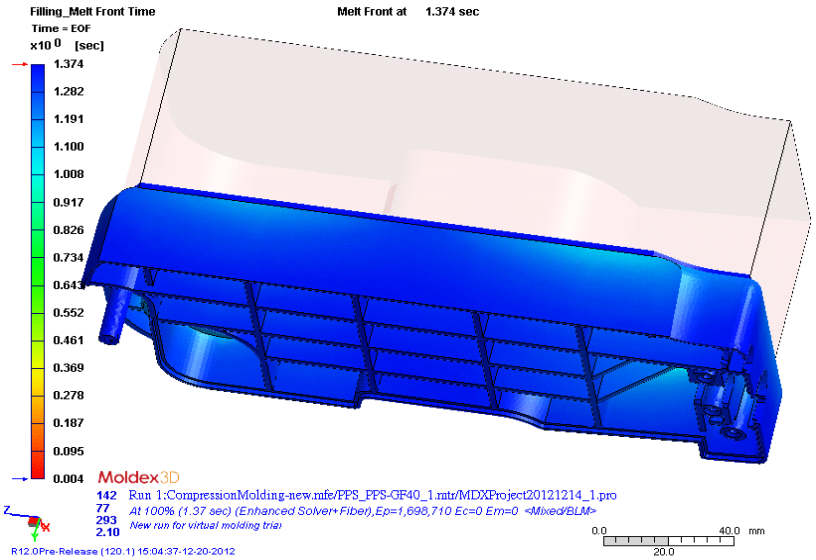
Molding with one charge





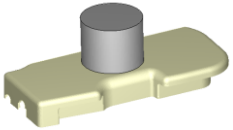
Molding with two charges

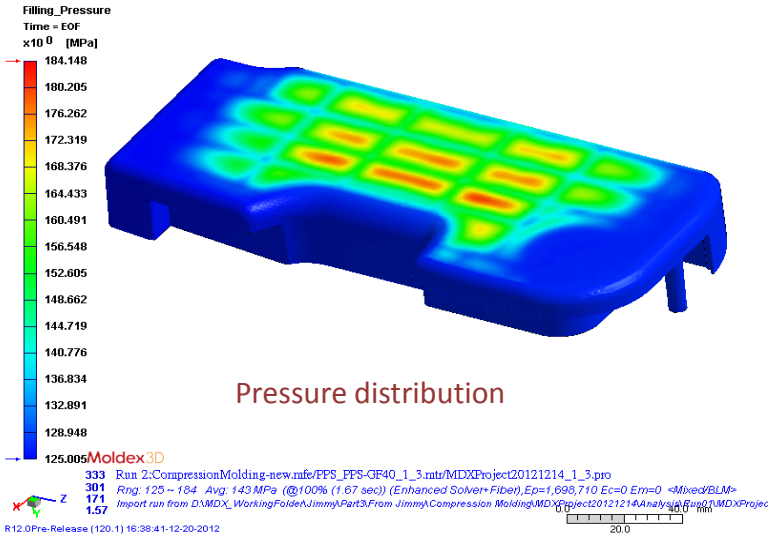




Result Comparison of Charge Designs (1)

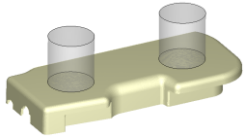
V Molding with one charge

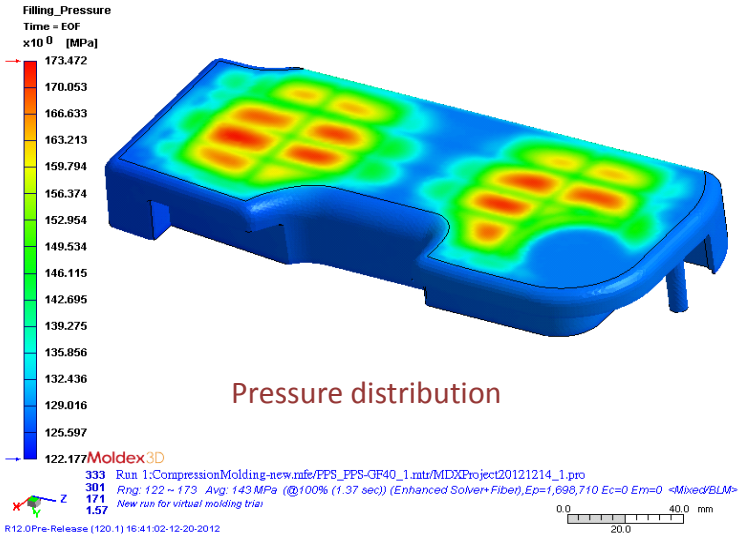




Pressure distribution

Molding with two charges





Pressure distribution

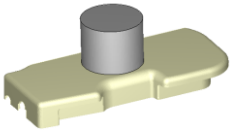
One-charge design has more uniform pressure distribution than two-charge design

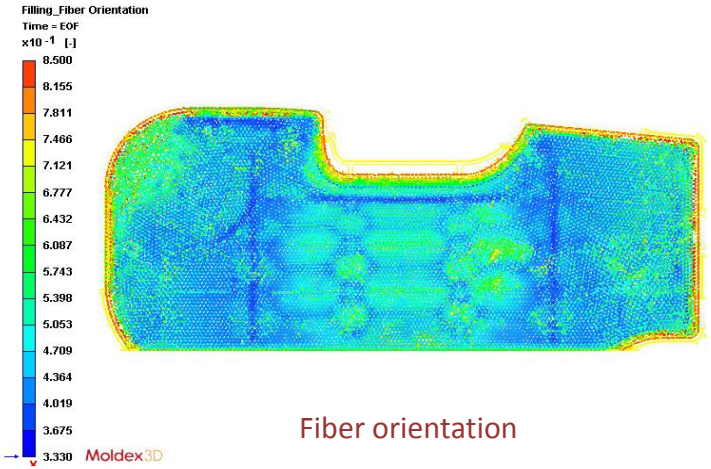
Uneven pressure distribution leads higher deformation

Result Comparison of Charge Designs (2)

V

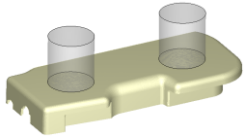
Molding with one charge

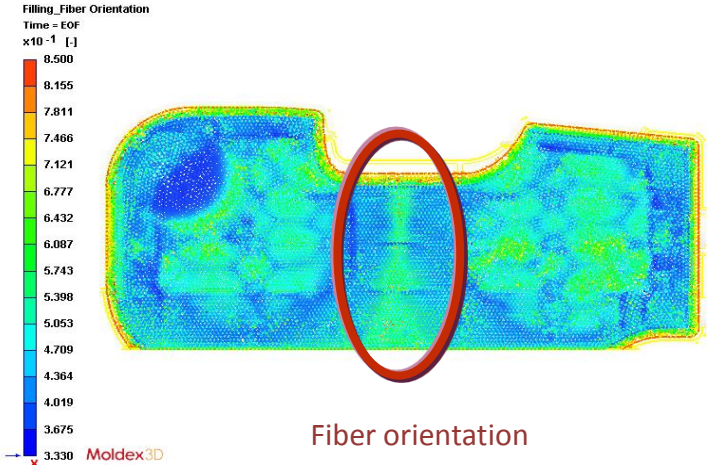




Fiber orientation

Molding with two charges





Fiber orientation

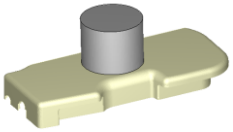
One-charge design has more uniform fiber orientation distribution

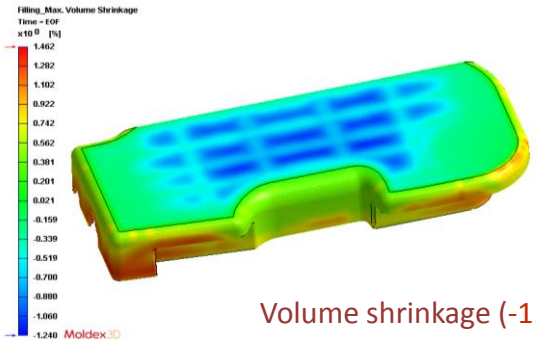
The area of perpendicular fiber distribution leads part weakness to external force loading

Result Comparison of Charge Designs (3)

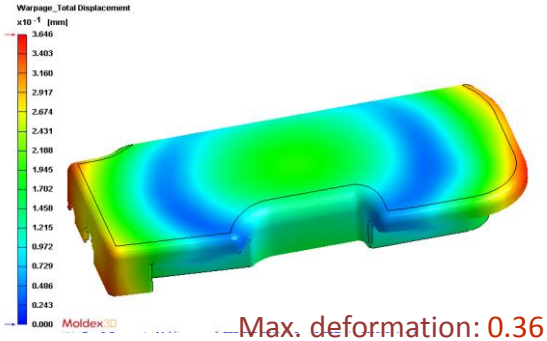
V

Molding with one charge



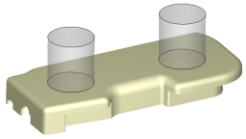


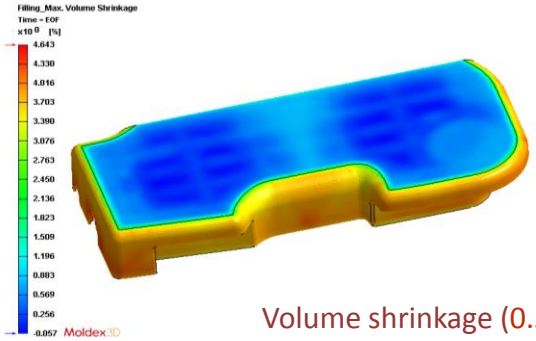
Volume shrinkage (-1.24%~1.46%)



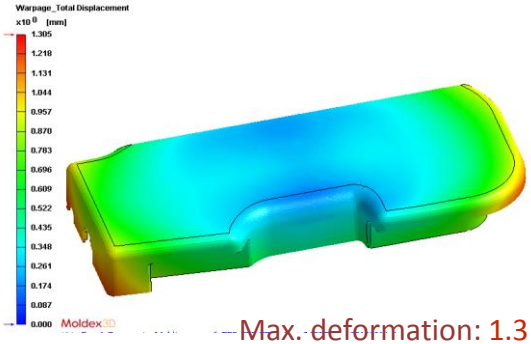
Max. deformation: 0.36 mm

Molding with two charges





Volume shrinkage (0.57%~4.64%)

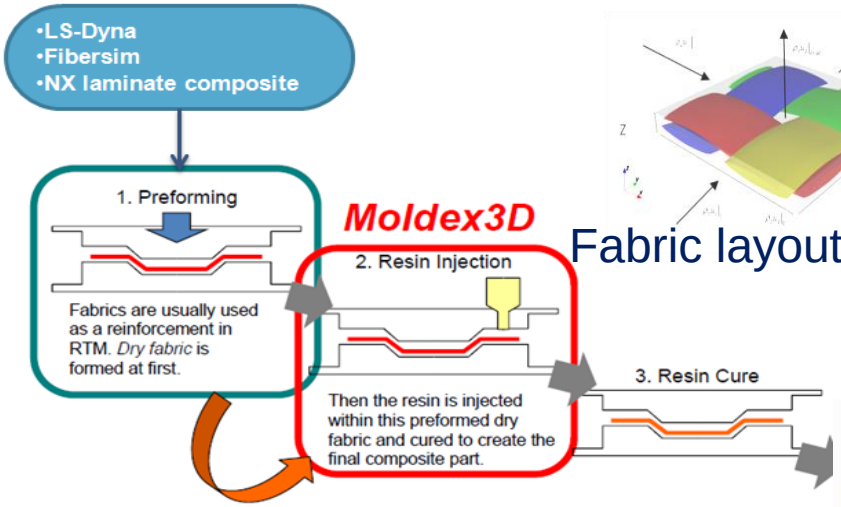


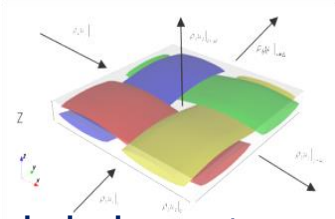
Max. deformation: 1.3 mm

One-charge design minimizes the deformation losses

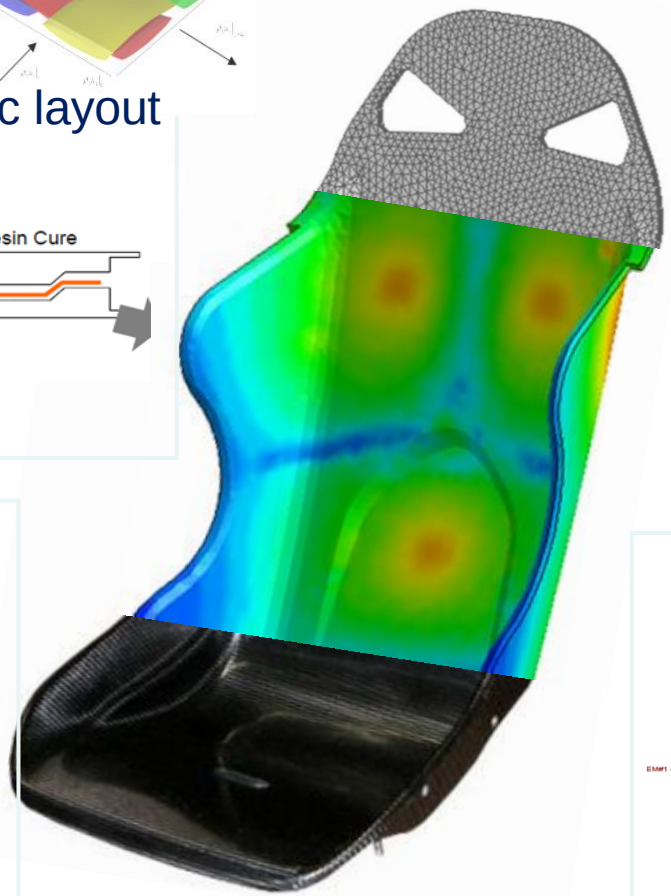
◎ **With Moldex3D, users can find a shortcut to design solution**

Resin Transfer Molding features

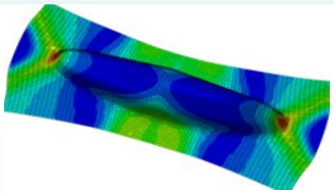


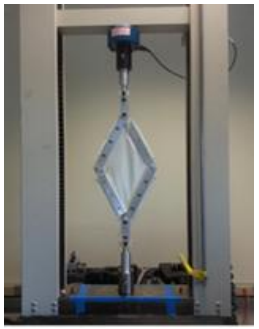


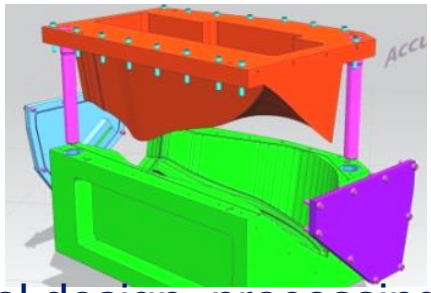
Fabric layout



Draping

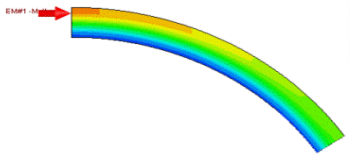


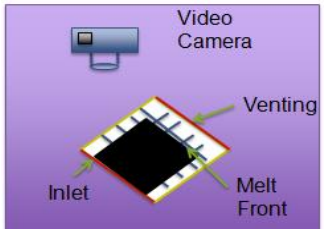




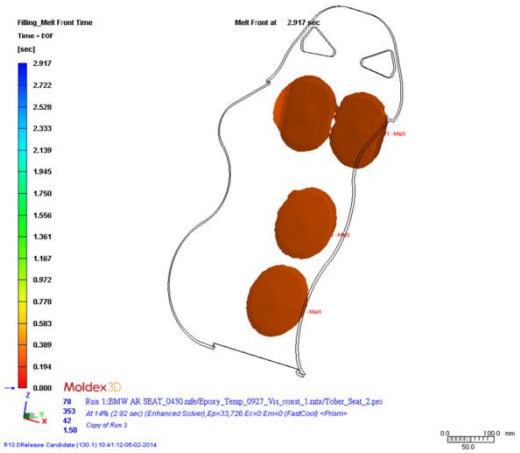
Tool design, processing

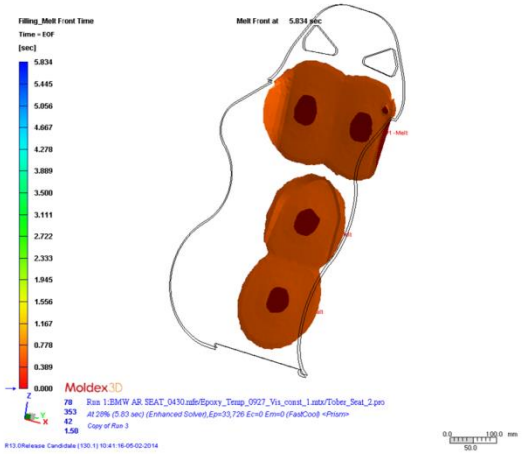
Permeability measurement

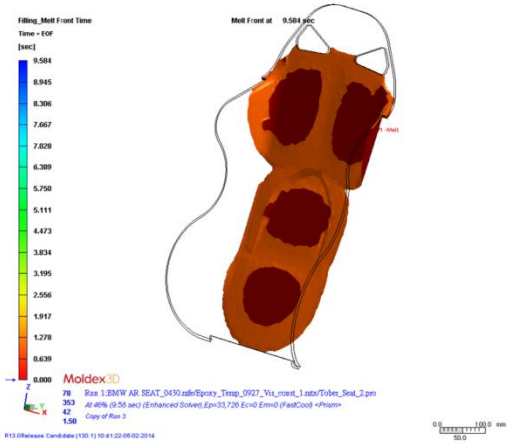


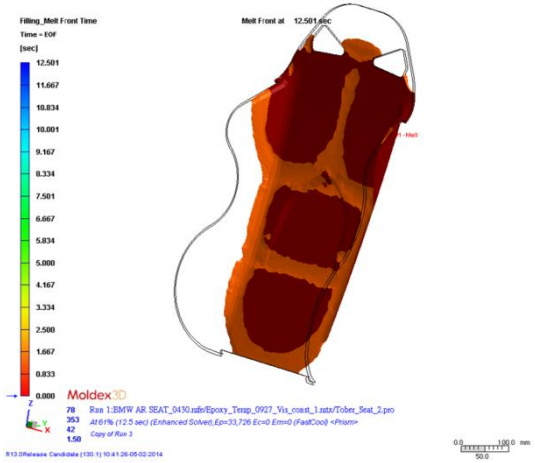


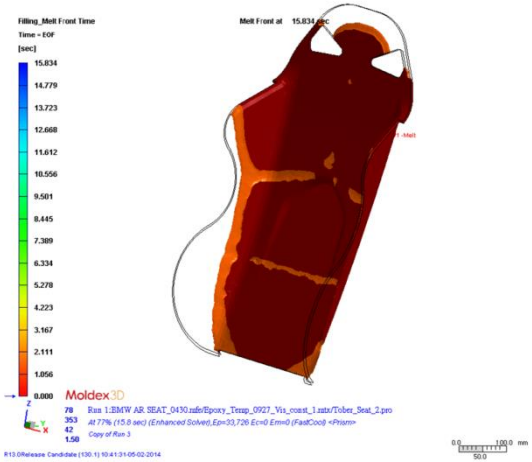
Resin Transfer Molding

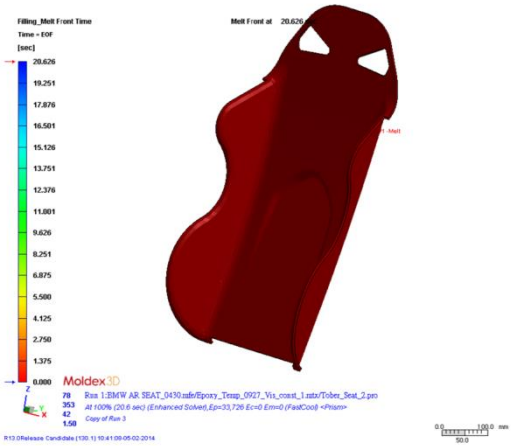




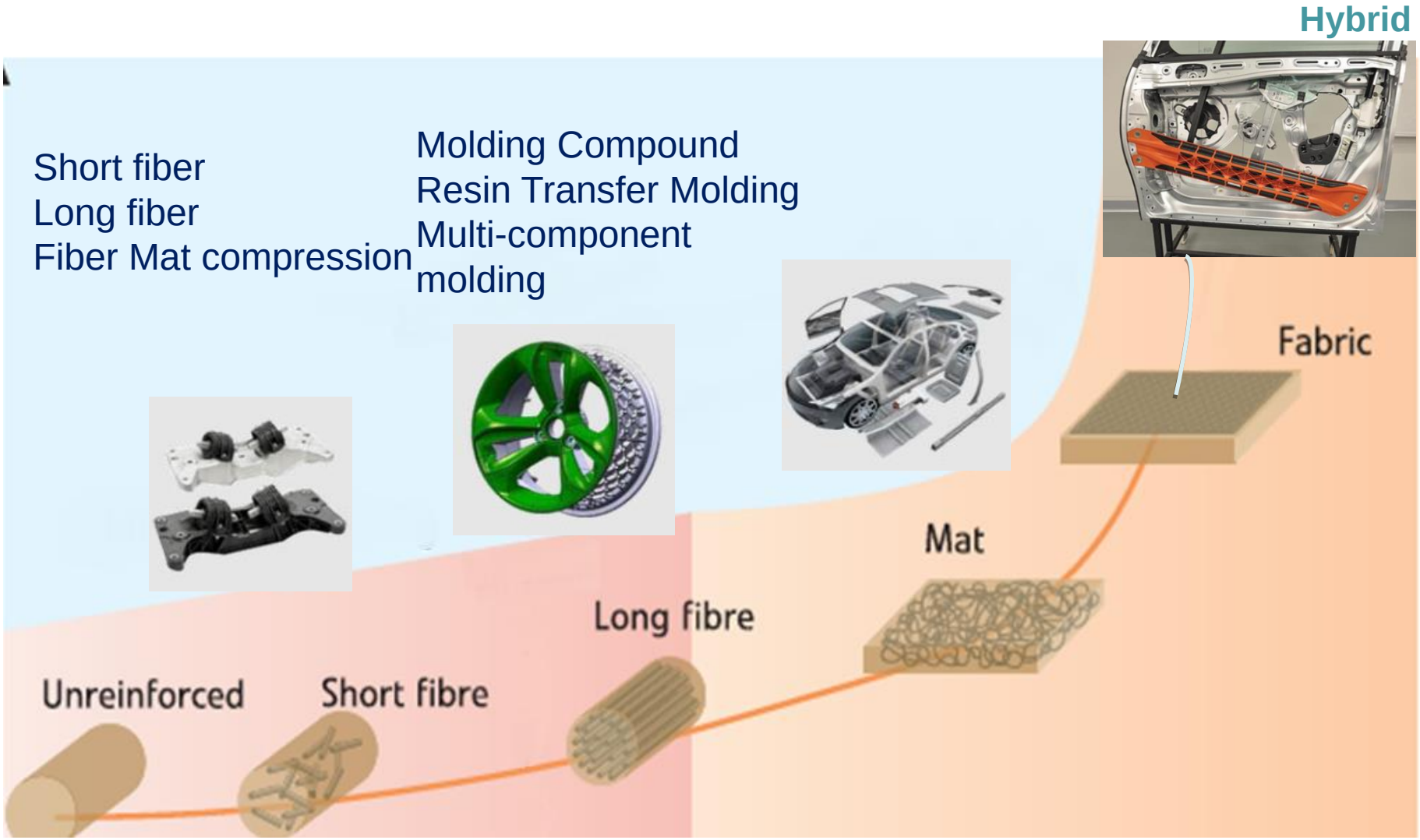








Complete fiber reinforced process portfolio



Interessiert? Sprechen Sie uns an:

SimpaTec GmbH
Steffen Paul

Am Hoheloh 3
98527 Suhl
Telefon: +49 3681 707207
Email: s.paul@simpatec.com
www.simpatec.com

SimpaTec GmbH
Steffen Paul

Wurmbenden 15
52072 Aachen
Telefon: +49 241 565282-80
Email: s.paul@simpatec.com
www.simpatec.com