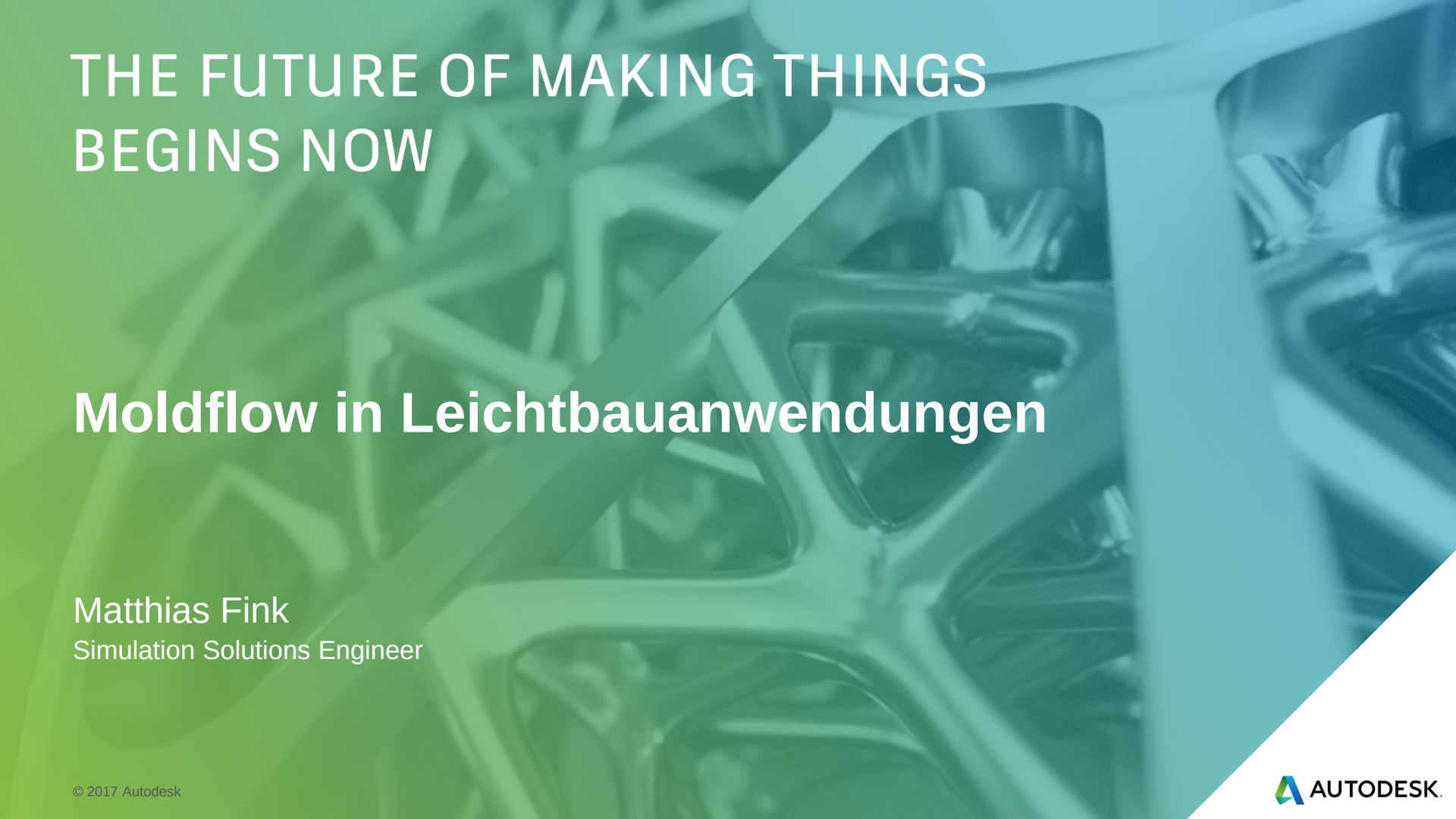


Moldflow in Leichtbauanwendungen

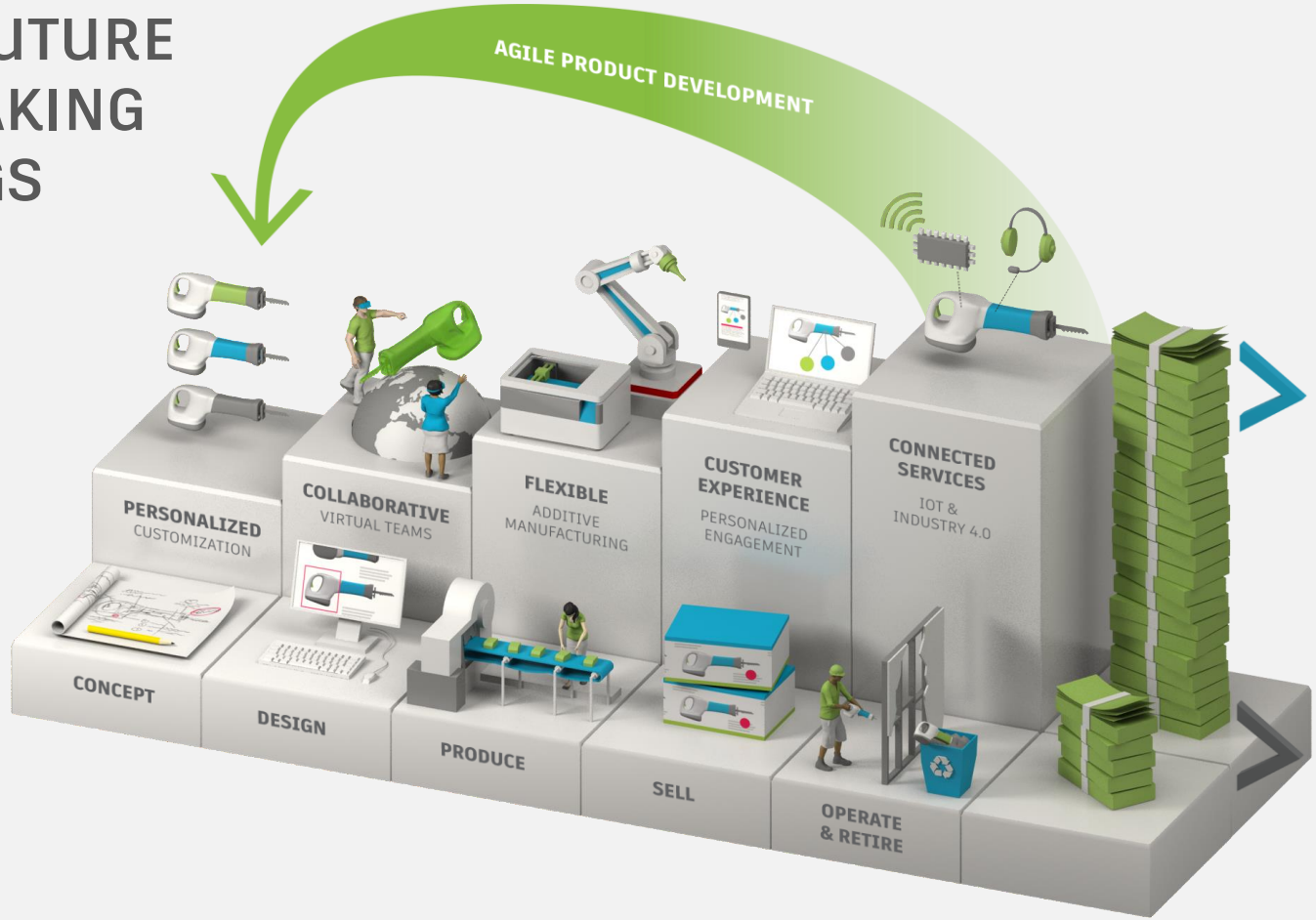
Matthias Fink
Simulation Solutions Engineer

AUTODESK.

Agenda

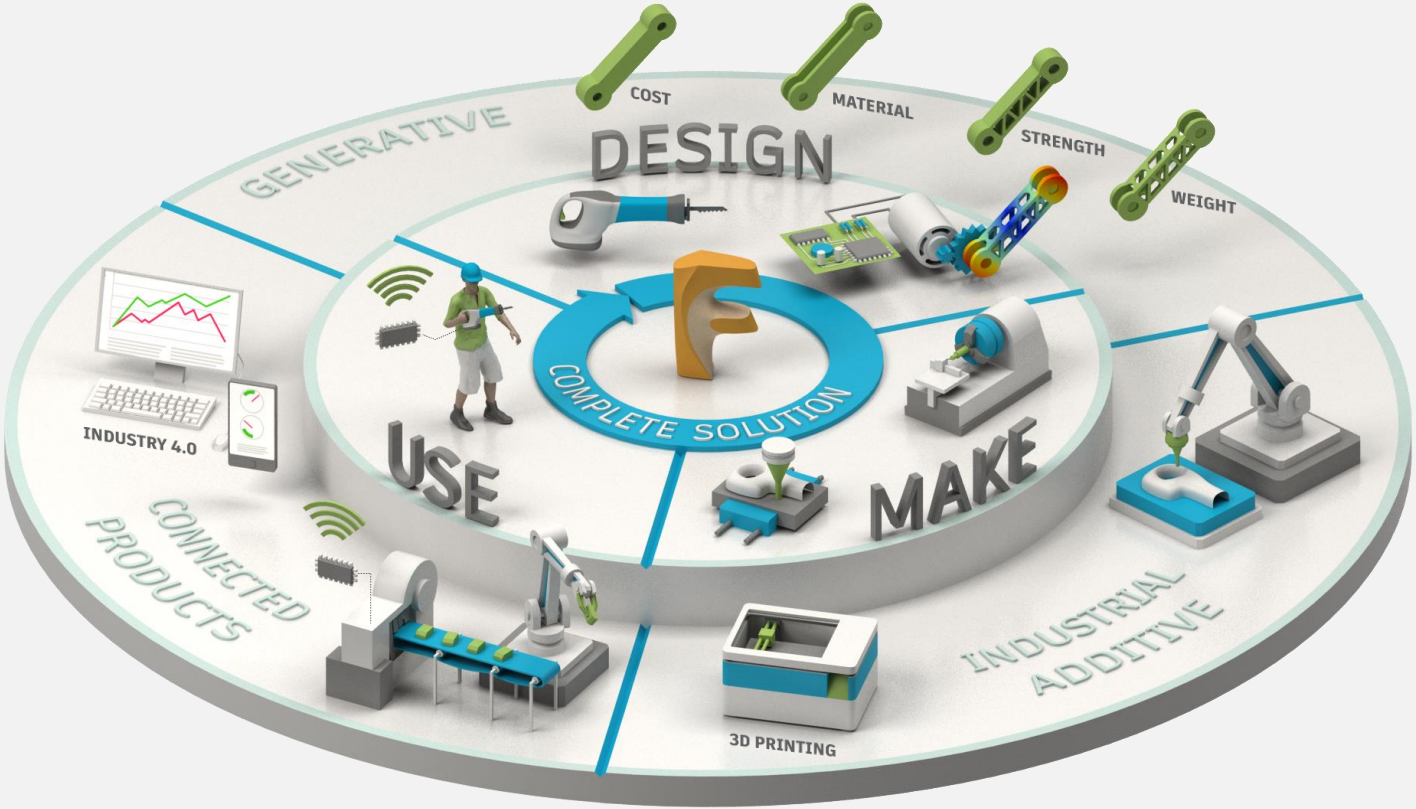
- The Future of making Things
- Advances in Manufacturing for Continuous Fiber
- Resin Transfer Molding in Moldflow
- BMC in Moldflow

THE FUTURE OF MAKING THINGS



AUTODESK.

PRODUKTINNOVATIONSPLATTFORM



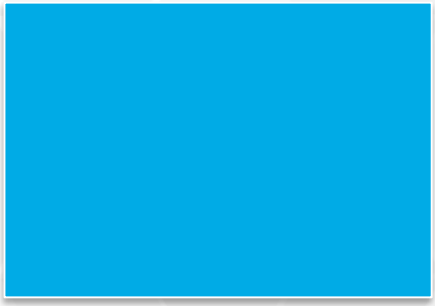
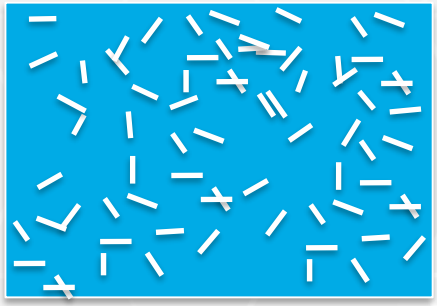
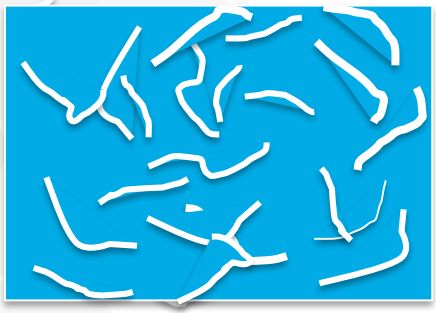
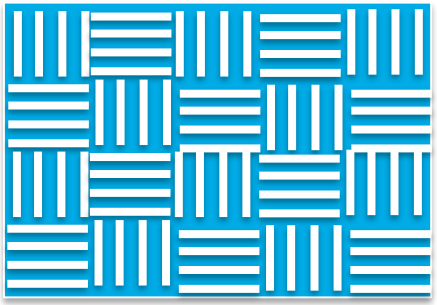
AUTODESK.

‘Composites’ for Strength

Lightweighting Initiatives

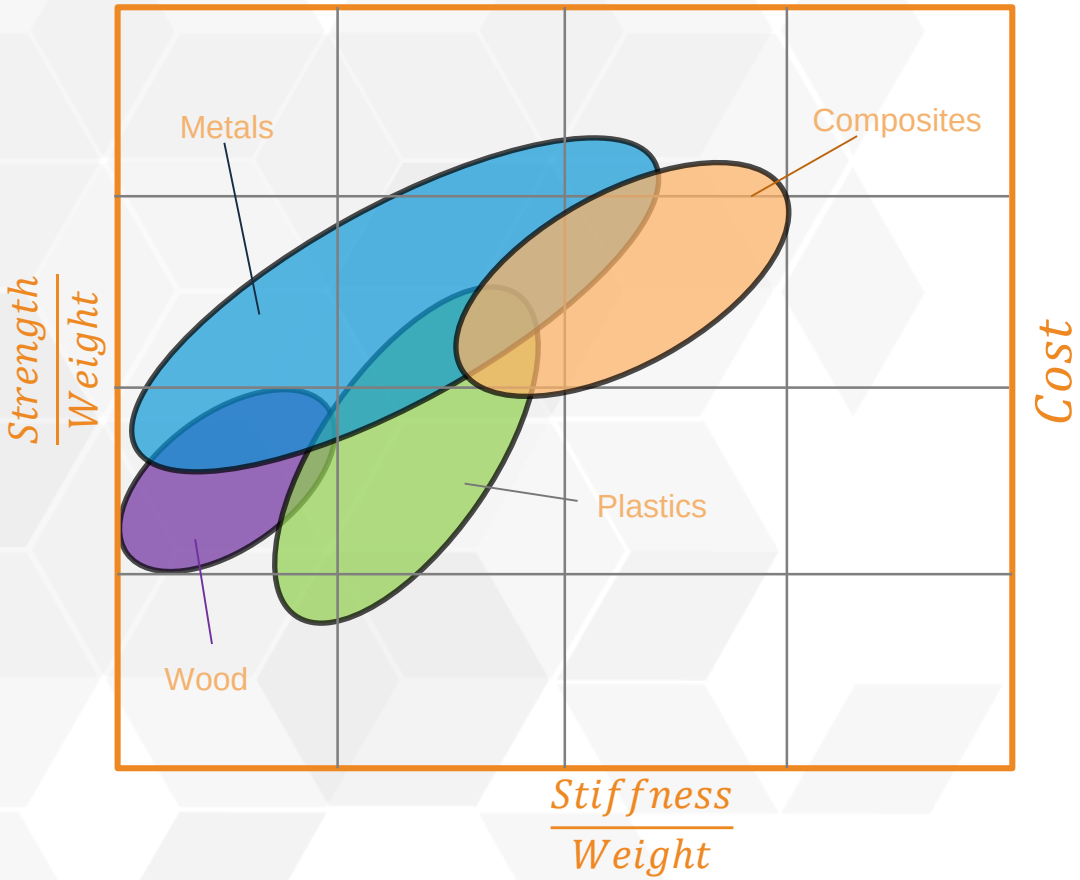
Why ‘Composites’?

‘Composites’

Unreinforced plastics	Short-fiber filled plastics	Long-fiber filled plastics	Continuous fiber
			
Weak			Very strong
Light	Light	Light	Light
$	$$	$$$	$$$$
Very common	Common	Special applications	Exotic/specialty applications

AUTODESK.

Why ‘Composites’?



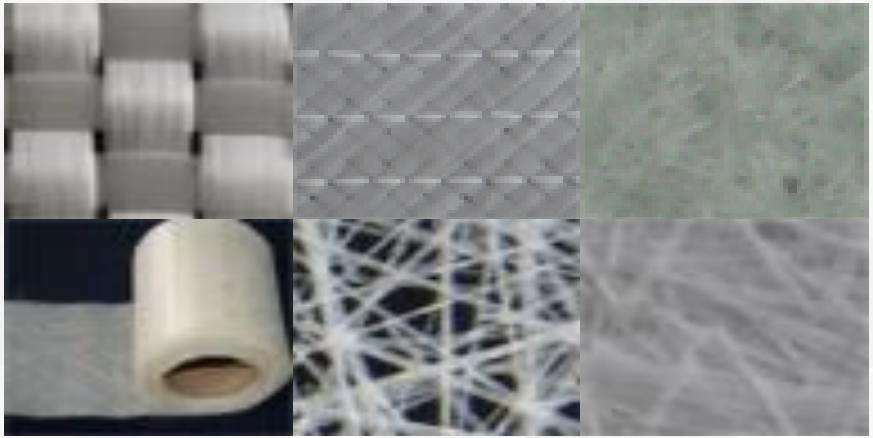
AUTODESK.

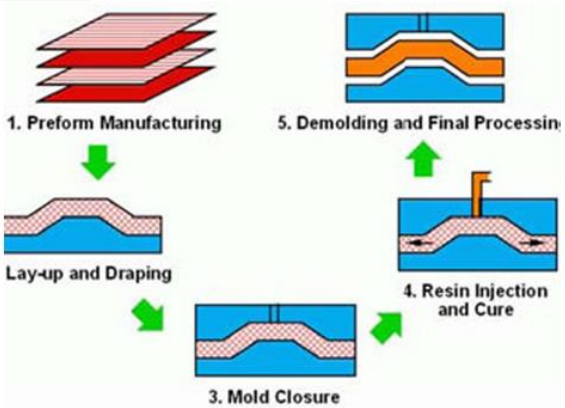
Market & Material Challenge

Resin Transfer Molding (RTM)

Resin Transfer Molding (RTM) Flow Analysis

- Analyze the flow through porous media (preform)
- Preforms (reinforcements) are present in the mold as dry form



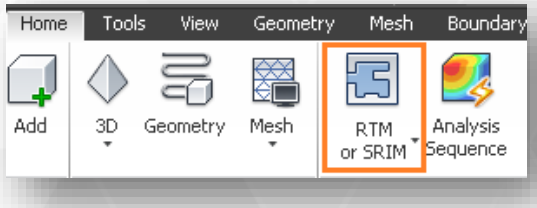


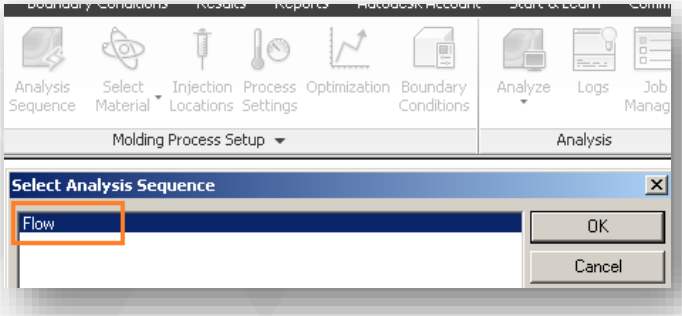
AUTODESK.

Resin Transfer Molding Analysis

- RTM 3D flow analysis:
  - Regular RTM Flow analysis (only macroscopic flow)
  - Simulate anisotropic permeability in the thickness direction
  - Better handling of parts with complicated geometry than mid-plane RTM simulation
  - Handle vacuum pressure using venting analysis
  - Handle gravity effect

Work Flow

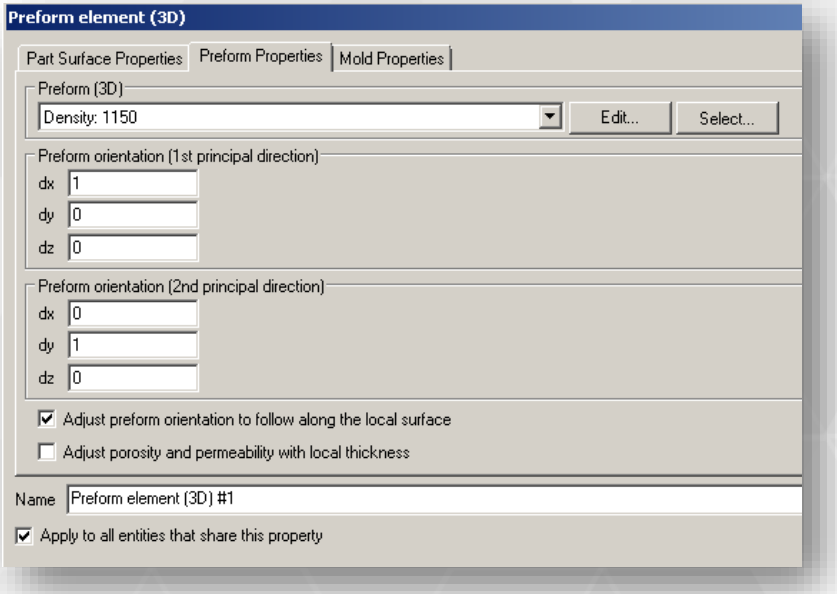




- Molding process: RTM or SRIM
- Only “Flow” analysis sequence
- Assign “Preform element (3D)” for the elements in the area for RTM analysis

AUTODESK.

Preform Properties for Preform Element (3D)

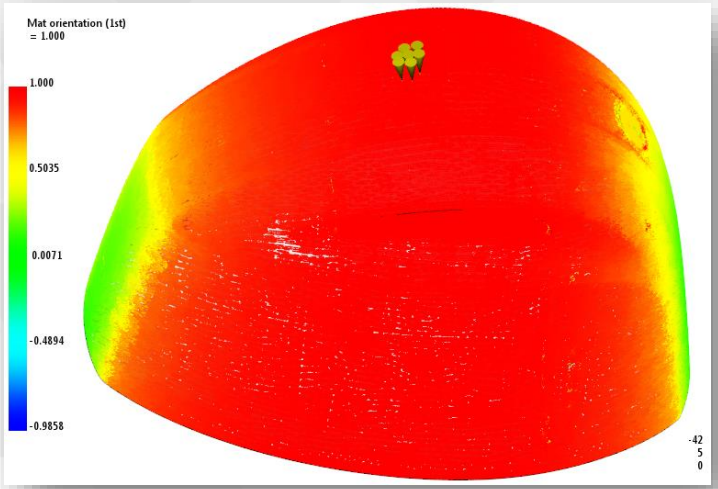


- Preform orientation: 1st and 2nd principal directions
- Adjust preform orientation to follow along the local surface (default: On)
- Adjust porosity & permeability with local thickness (default: Off)

AUTODESK.

Input Data Option: Preform Element (3D)

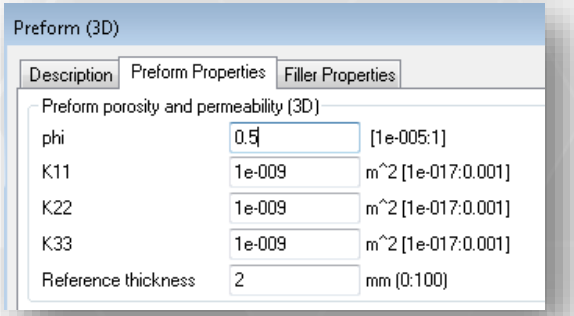
- Adjust preform orientation to follow along the local surface
  - Adjust preform orientation automatically to follow along the surface
- Adjust porosity & permeability with local thickness
  - Use the difference in local thickness and the reference thickness to adjust porosity and the permeability from the input values
  - Use the thickness information from “dual-domain” to improve local thickness accuracy

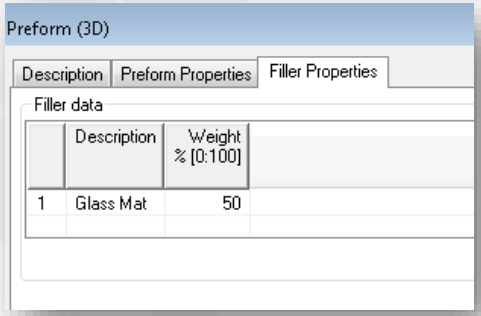


Mat Orientation (1st)

AUTODESK.

Preform / Filler Properties for Preform (3D)



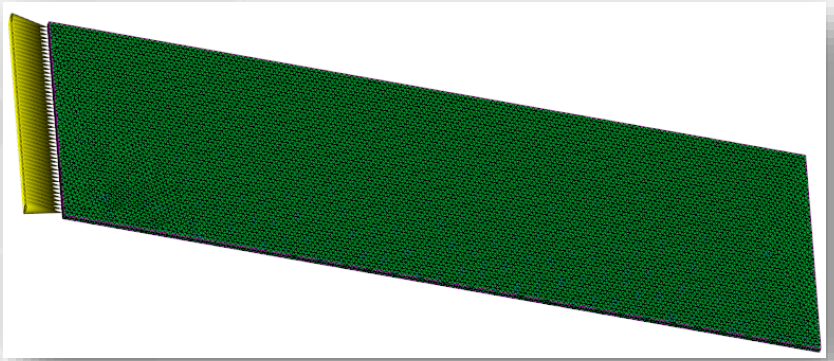


- Porosity: The ratio of the void volume to the cavity volume
- Permeability in 3 principal directions: K11, K22, K33
- Reference thickness: The part thickness at which the porosity/permeability are measured
- Select the fiber mat materials

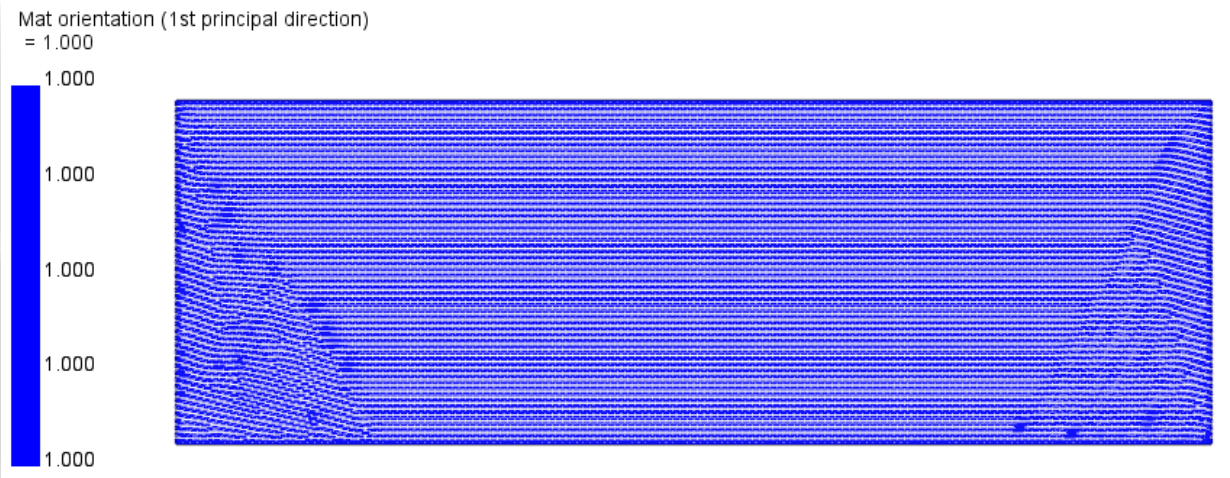
AUTODESK.

Test Case: A Rectangular Plate

- Dimension: 300 x 100 x 2 mm
- Injected from one side
- 1st Principal direction: Length direction
- Flow rate: 0.5 cm^3/sec
- Viscosity: 0.4 Pa-sec
- Permeability (isotropic): 1.0×10^{-9} [m^2/sec]
- Porosity: 0.5



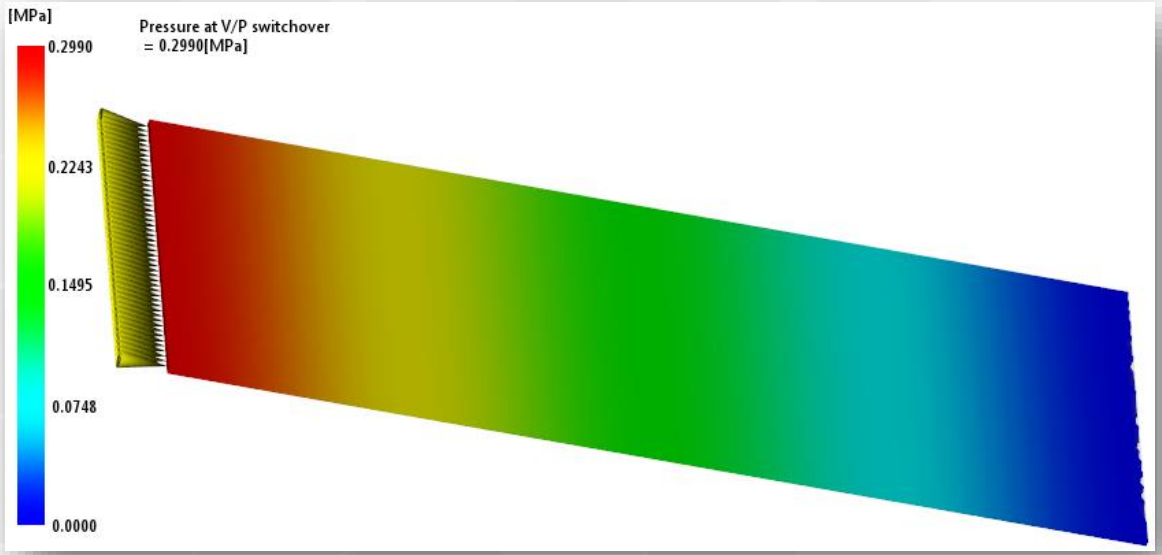
Results



- All the results available for Reactive Molding
- Additional results for RTM
  - Mat orientation (1st, 2nd, 3rd principal direction)

AUTODESK.

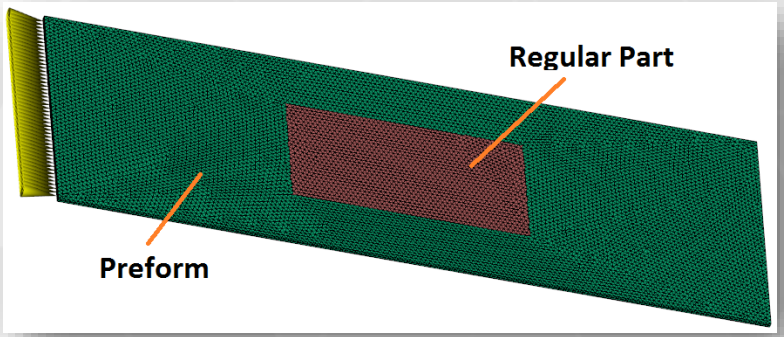
Injection Pressure



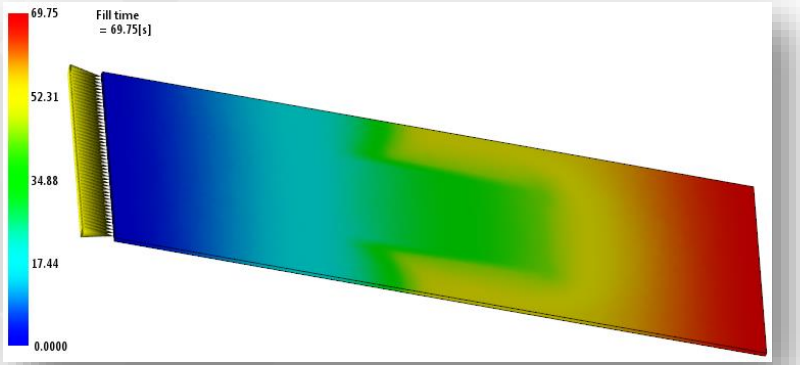
- Injection pressure from simulation: 0.299 MPa
- Analytical solution: 0.3 MPa

AUTODESK.

Mixture of Preform and Regular Part



- Flow in the regular part region (no fiber mat) is faster



AUTODESK.

BMC Validation TUM

BMC Validierung

Screening of methods for process modeling
and simulation of Bulk Molding Compounds (BMC)

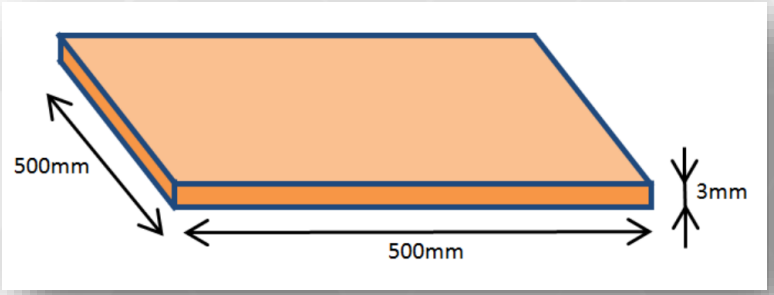
Semesterarbeit von Thomas Roth

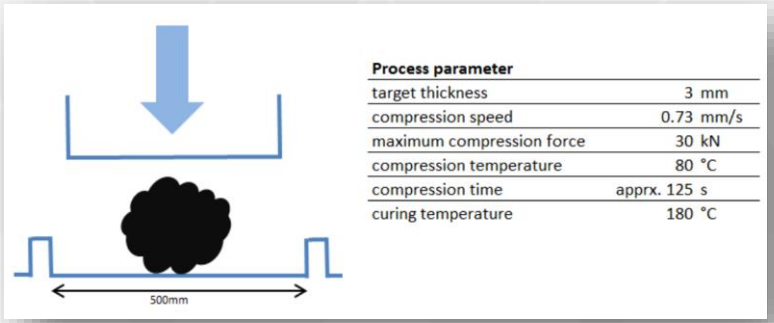
an der Fakultät für Maschinenwesen der Technischen Universität München

Betreut von:

Univ.-Prof. Dr.-Ing. Klaus Drechsler
Lehrstuhl für Carbon Composites
Wiss. Mitarbeiter Dipl.-Ing. Mathias Hartmann
Lehrstuhl für Carbon Composites

BMC Validation Setup

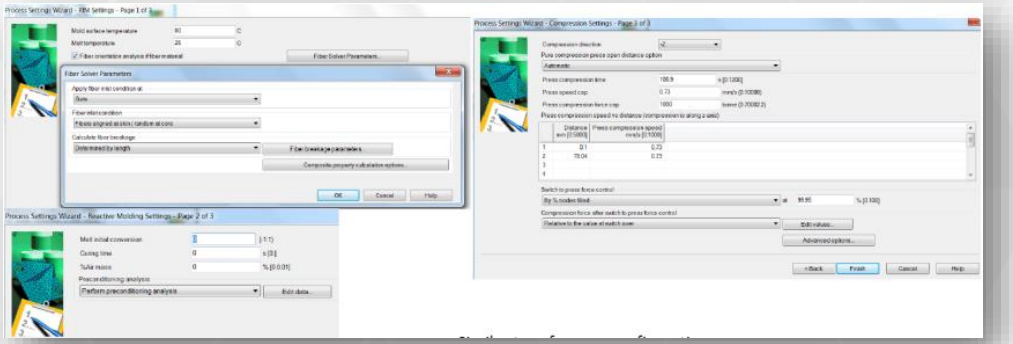


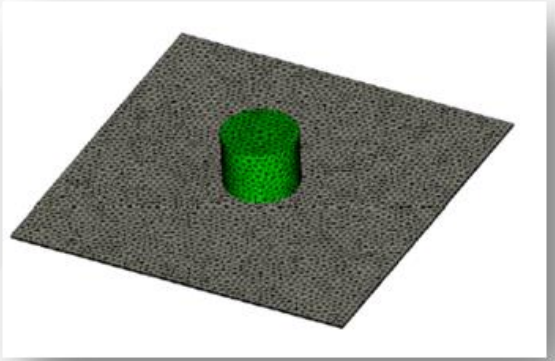


Process parameter		
target thickness	3	mm
compression speed	0.73	mm/s
maximum compression force	30	kN
compression temperature	80	°C
compression time	apprx. 125	s
curing temperature	180	°C

AUTODESK.

BMC Validation Setup

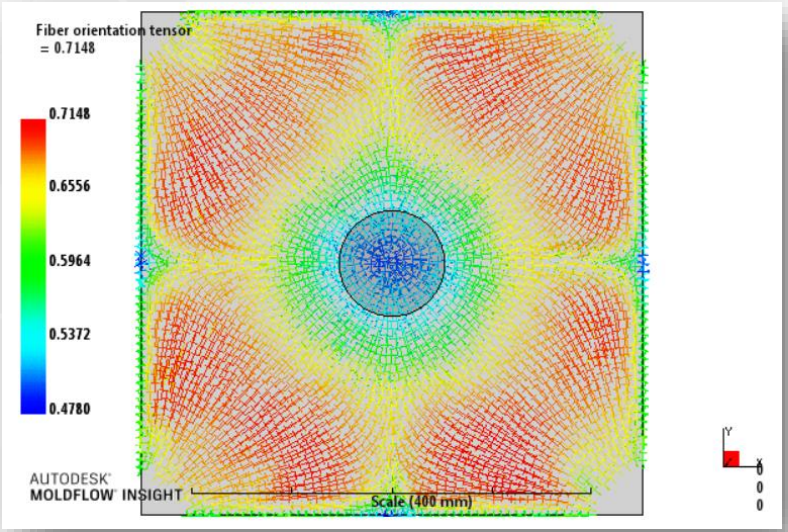




AUTODESK.

BMC Validation Results

“Moldflow simulation results are by a small margin the most accurate to the experimental fiber orientation. Furthermore there is no non-smooth behavior and the parallel fiber alignment near wall areas are in consent to literature observation.”



AUTODESK.

Kernaussagen

- Autodesk stellt sich den Herausforderungen einer sich ändernden Industrie und entwickelt Werkzeuge, welche die sich verändernden und auch neu hinzukommenden Prozesse unterstützt
- Hierbei liegt ein Schwerpunkt auf Leichtbau und additiven Verfahren
- Systeme wie Moldflow sind heute in der Lage die Herstellbarkeit vieler Leichtbauanwendungen zu überprüfen und zu optimieren

Thank you!

Questions?