Moldex3D-Radioss Integration for Designing Plastic Parts to Meet Reliability Requirements

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2010/10/28 @ Altair 2010 European HTC

CoreTech System Co., Ltd.
www.moldex3d.com

Content Outline

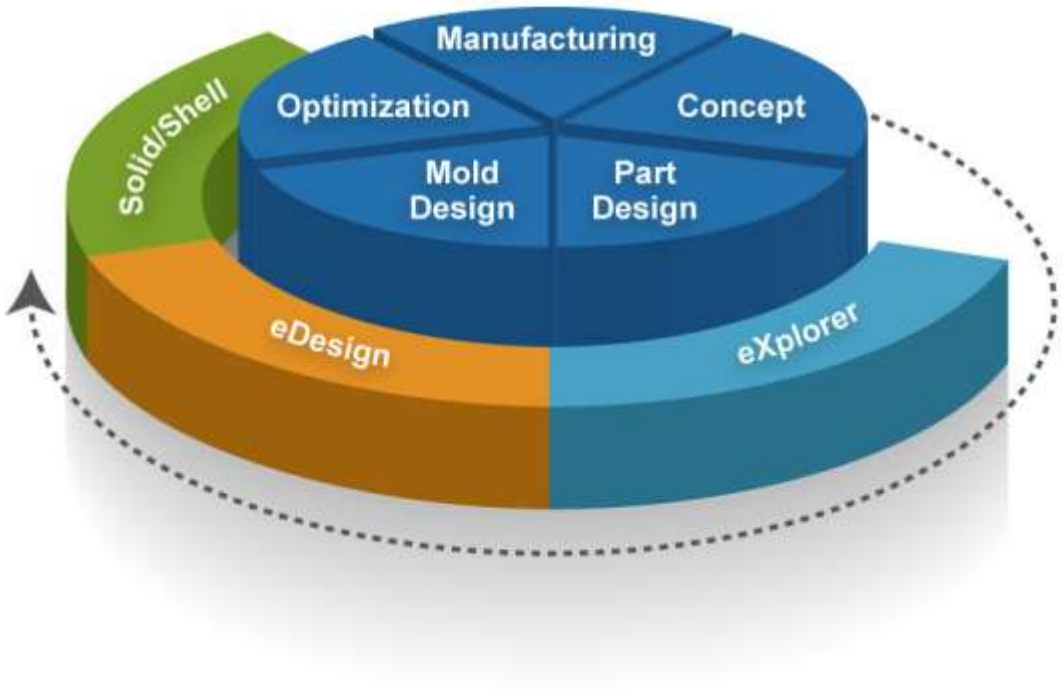
- Introduction to CoreTech System Co., Ltd and Moldex3D
- PLM and Injection Molding Process
  - The roles of injection molding analysis and structural analysis in PLM
- Case study
  - How to use Moldex3D-I2 to integrate injection molding analysis with structural analysis
  - Integrate Moldex3D with Radioss
  - Explore process-induced material variation effects
- Conclusion

CoreTech System

Moldex3D

- The world's largest plastic injection molding CAE ISV
- 80% experienced engineering professionals
- 9 global offices
- 100+ international resellers
- Strategic alliance with PTC, Dassault Systemes, Siemens PLM, Cimatron, Altair, ANSYS, LSTC, and MSC

Moldex3D Product Line



> **Moldex3D eXplorer**

Design investigation tool for part designer to validate design concept

> **Moldex3D/eDesign**

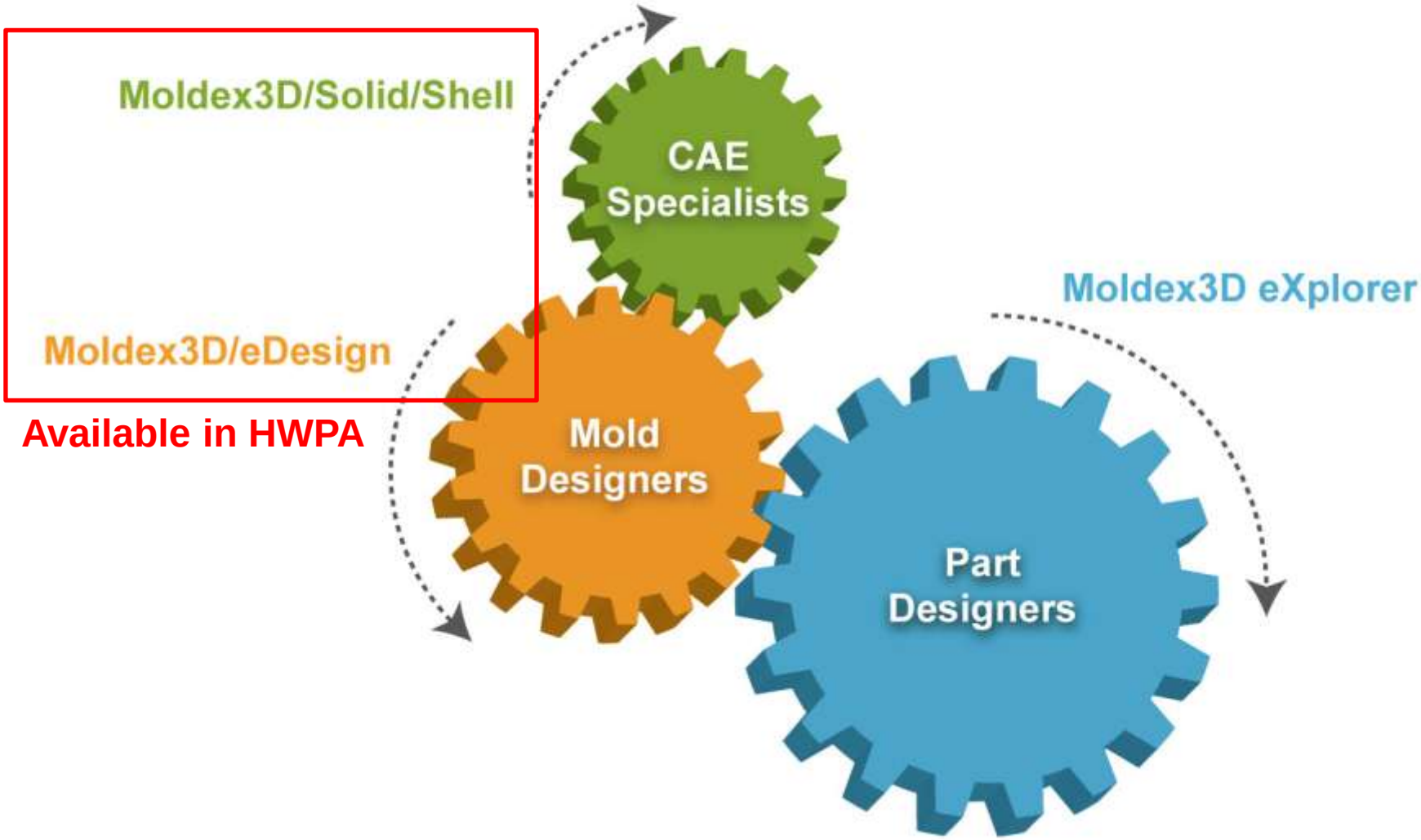
Design verification tool for all product and mold designers

> **Moldex3D/Solid/Shell**

Design optimization tool for all parts, especially engineering products

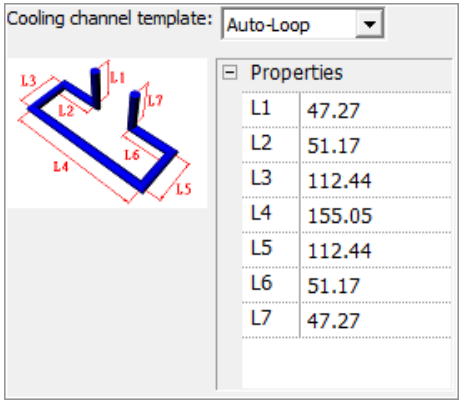
Professional CAE for Every Plastics Engineer

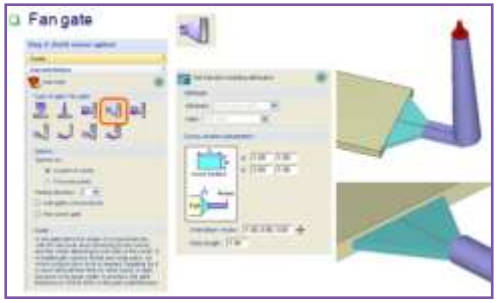
Moldex3D

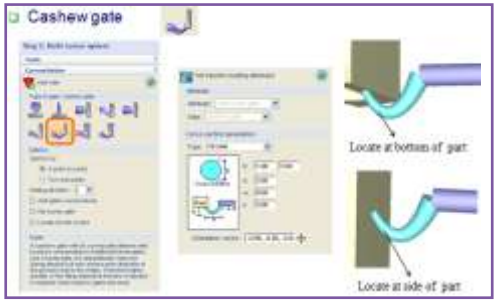


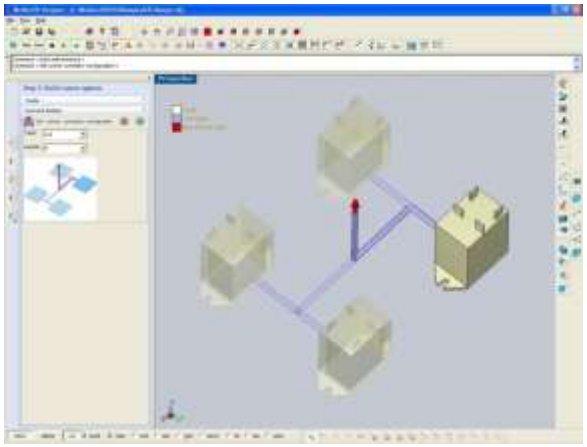
Unique Features of eDesign

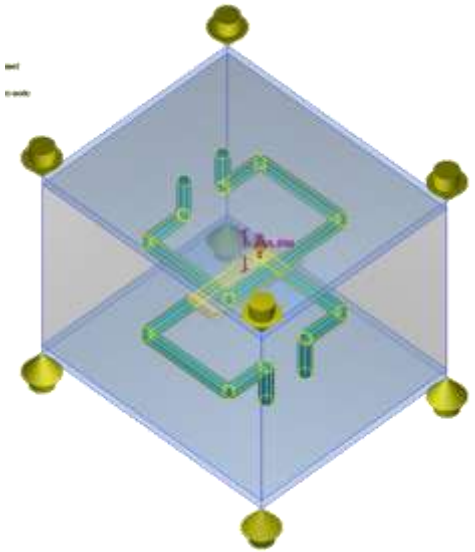
- Designer-oriented
- Gate Wizard, Runner Wizard, and Cooling Wizard
- Fully automatic solid mesh generation











Complete Features for Plastics Professionals

Moldex3D

True 3D, Parallel Computing

FLOW → PACK → COOL → WARP

Fiber

MCM

Viscoelastic

Optics

Interface to Structural CAE

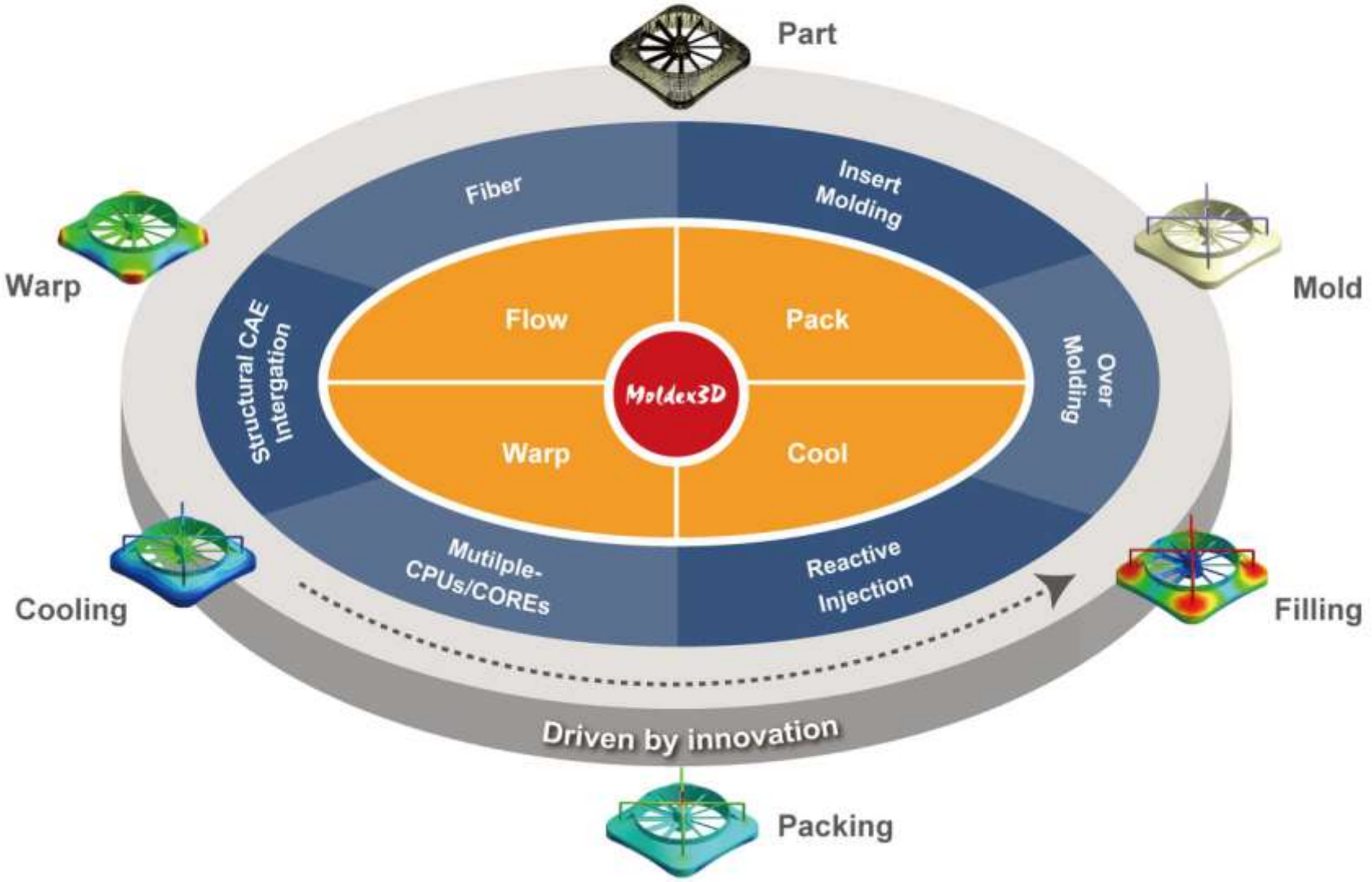
Plastics Injection Molding	Fiber-Filled Multi-Shots	Precision Parts Optical Parts	Reactive Injection Molding

1,000+ Global Customers

Moldex3D

Automobile	High Tech/Electronics	Material/Equipment
YAMAHA	FOXCONN	BASF
DELPHI	FLEXTRONICS	DSM
BOSCH	Logitech	SUMITOMO CHEMICAL
INTEVA	Unilever	CHIMEI
MABUCHI MOTOR	PEGATRON	PRIME POLYMER
molex	OLYMPUS	SPT Sodick Plustech
TYC	LEGO	NISSEI
Visteon	KONICA MINOLTA	The Chen Hsong Group
ANTOLIN	TOMTOM	YUDO
Koito	Salcomp	
	SAMSUNG	
	NXP	
	Danfoss	
	wistron	
	YAZAKI	
	SHIMANO	
	nunc	
	LITEON	
	HellermannTyton	
	LG	

True 3D Simulation Technology



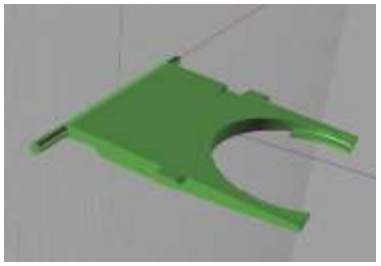
PLM and Injection Molding

PLM and Injection Molding Process

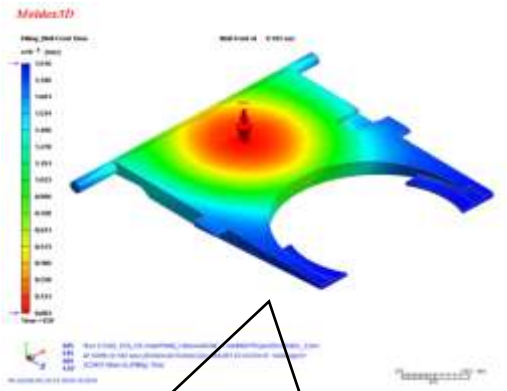
Moldex3D

Concept

Design



CAE
Injection molding



Since it is fabricated with injection molding, process induced material properties must be addressed!

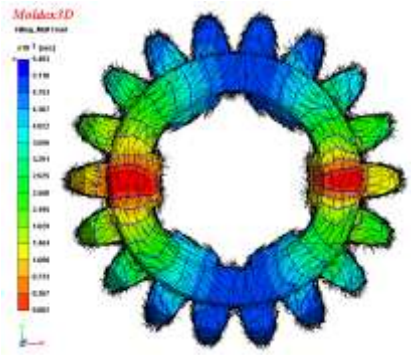
Ideal case by assuming uniform material properties

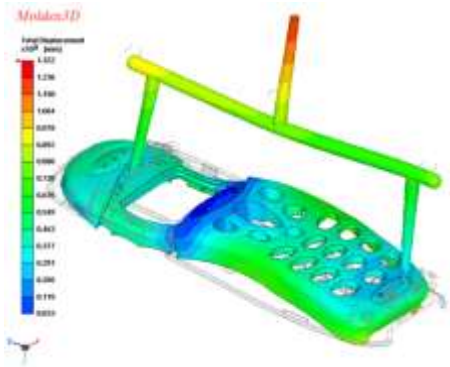
CAE
Structure Analysis

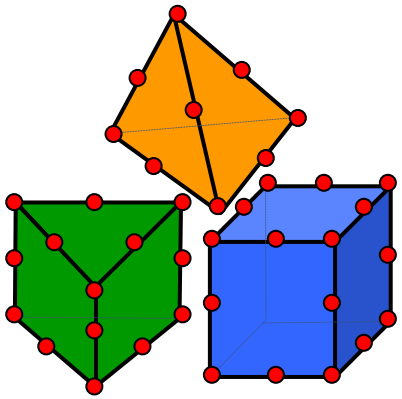
Production

What can Moldex3D-I2 do?

> To consider the process-induced variation during the processes
  - Map material properties between different meshes
  - Fiber orientation output
  - Material reduction
  - Thermal / Flow Residual stress output
  - EOP Temperature output
  - Initial strain output
  - Multiple time step melt flow pressure output
  - Moldbase related data output (pressure, temperature)



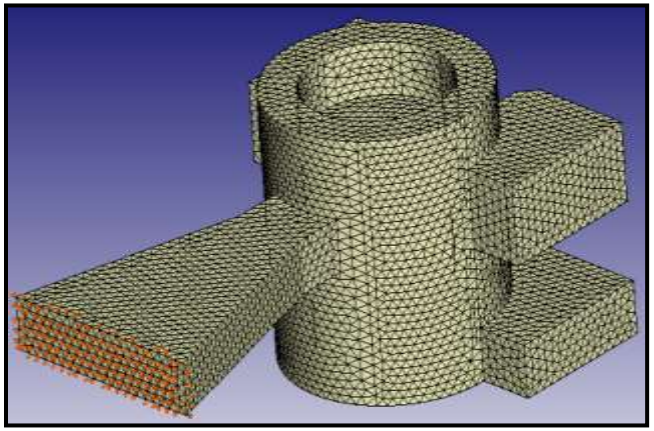




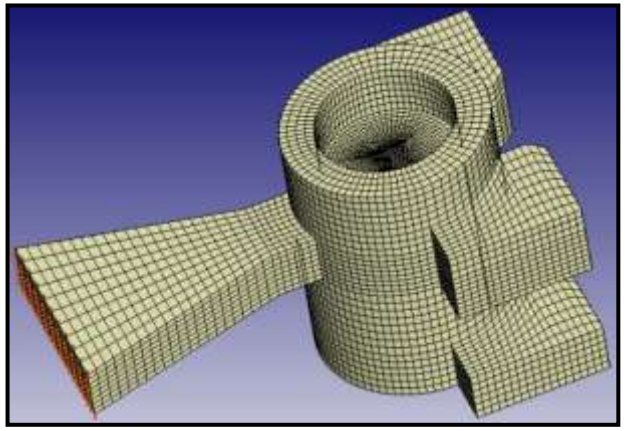
Moldex3D-I2 - Mesh Mapping

> Due to different analysis needs, the mesh type and mesh densities are often different in injection molding and structural analyses

> Moldex3D-I2 can map material properties and analysis result between different meshes.



Moldex3D tetra mesh



Structure analysis 2nd order hexa mesh

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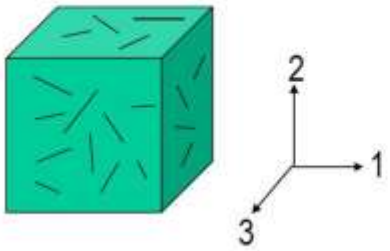
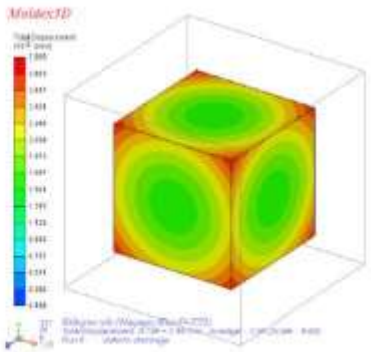
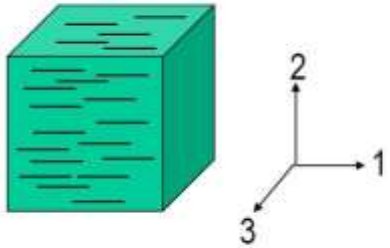
Moldex3D-I2 - Fiber Orientation

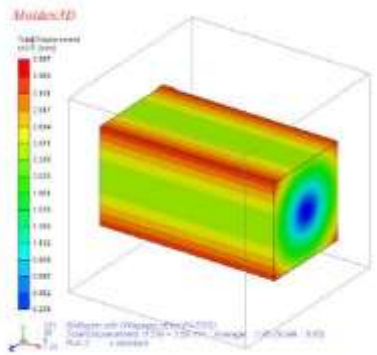
> Fiber orientation effects
  - Fiber can increase strength and decrease shrinkage
  - Random fiber orientation leads to uniform shrinkage
  - Fiber orientation causes less shrinkage in fiber direction

> Moldex3D-I2 can transfer fiber orientation effects to Radioss









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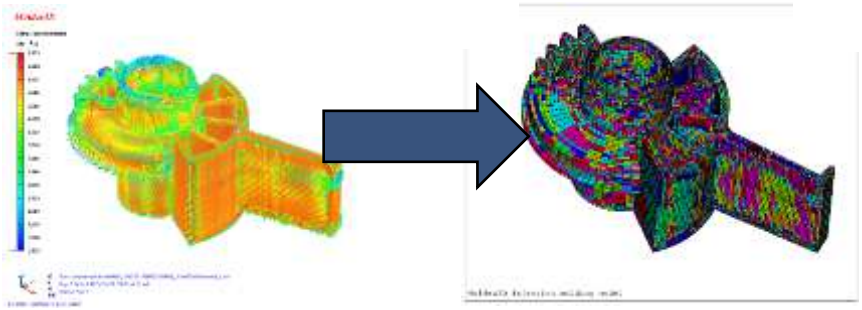
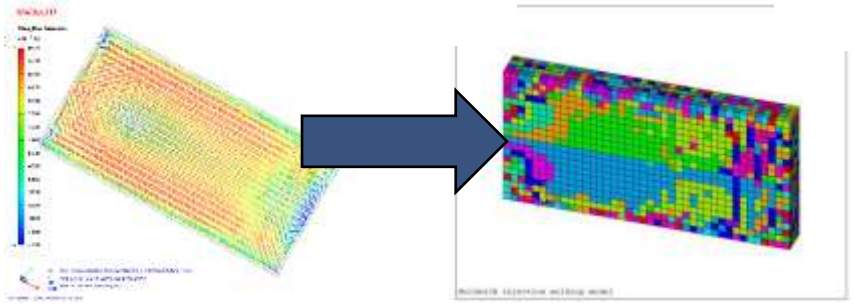
Moldex3D-I2 - Material Reduction

> Material Reduction

- Material properties (strength & stiffness) are function of fiber orientation
- Moldex3-I2 can reduce total material number to increase computation efficiency



Total material number from 76,150 to 1,866



Total material number from 3,392 to 668

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Supported Interfaces in Moldex3D R10

Structure FEA Software	ANSYS	ABAQUS	MARC	LS-DYNA	MSC NASTRAN	*NX NASTRAN
Material Reduction	◎	◎	◎	◎	◎	*◎
Residual Stress	◎	◎	◎	◎		
Initial Strain	◎	◎	◎	◎	*◎	*◎
EOP Temperature	◎	◎	◎	◎	*◎	*◎
Melt Flow Pressure	◎	◎	◎	◎	◎	*◎
Digimat Fiber Orientation	◎	◎				
Moldbase Output	◎	◎	◎	◎	◎	*◎

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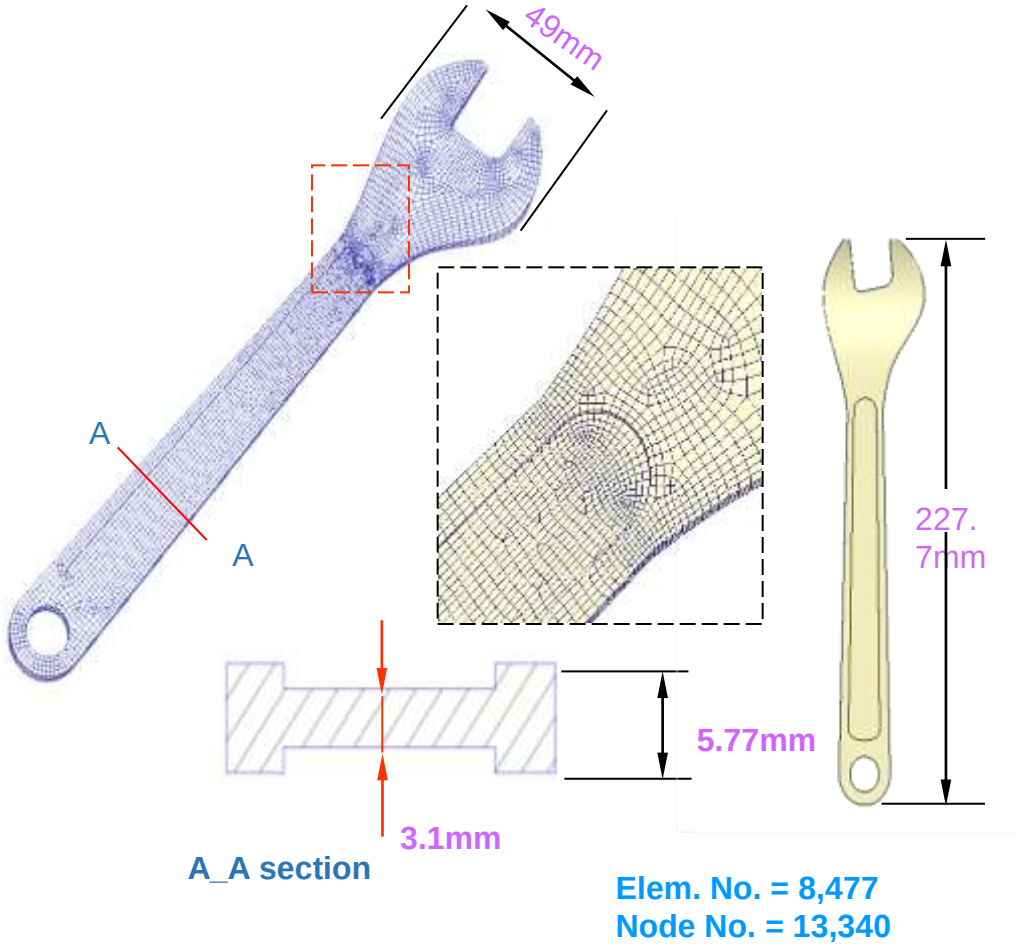
Simple Example - Wrench

> Introduction
  - Thickness：3.1 ~ 12.3 mm
  - Length：227.7 mm

> Width
  - 49 mm

> Material
  - PA66 \ ORGALLOY RS6630 \

> Process condition
  - Filling Time：1.5 Sec
  - Melt Temperature：300 ℃
  - Mold Temperature：70 ℃



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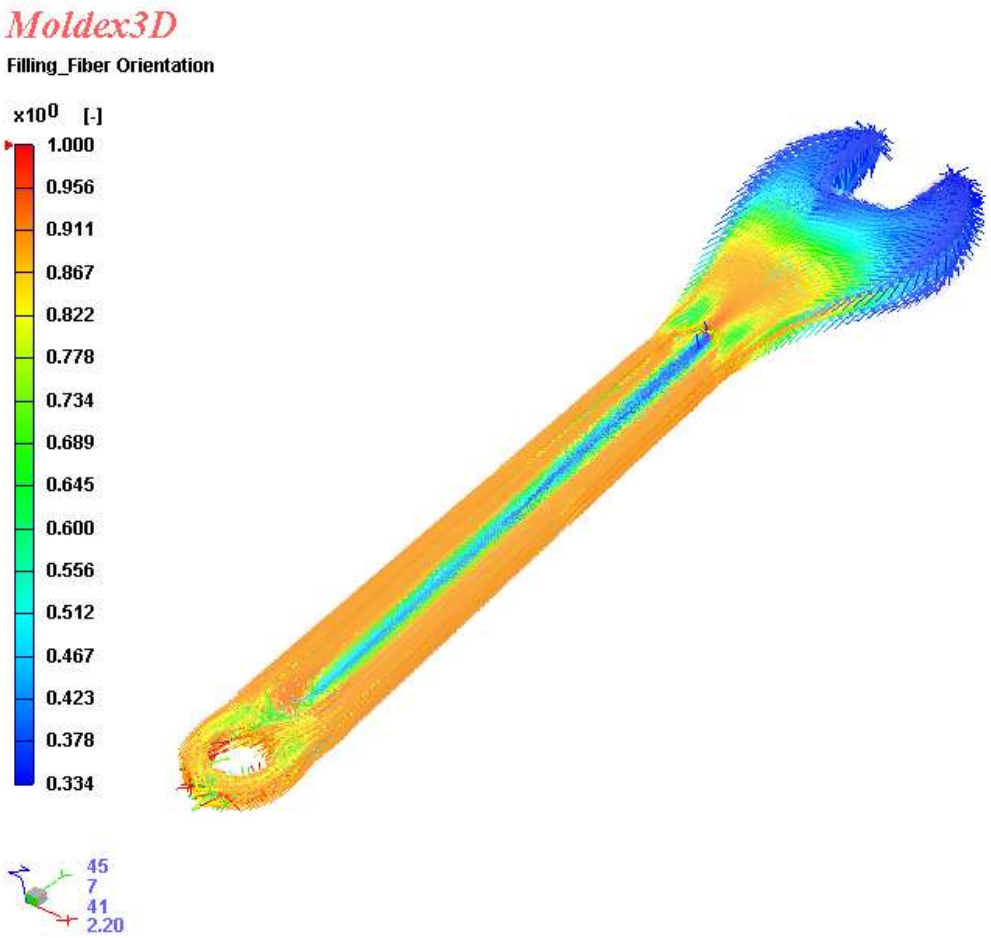
Simple Example – Fiber Orientation

> Fiber orientation distribution:



- Fiber orientation distribution shown the fiber orientation vector distribution of plastic melt at EOF.
- The value 0.33 means the fibers are random orientation; 1 means the fibers are 100% oriented. The higher value means the fiber is highly oriented over the region by the flow field.
- Fiber orientation effects not only the shrinkage but also the strength of the part.

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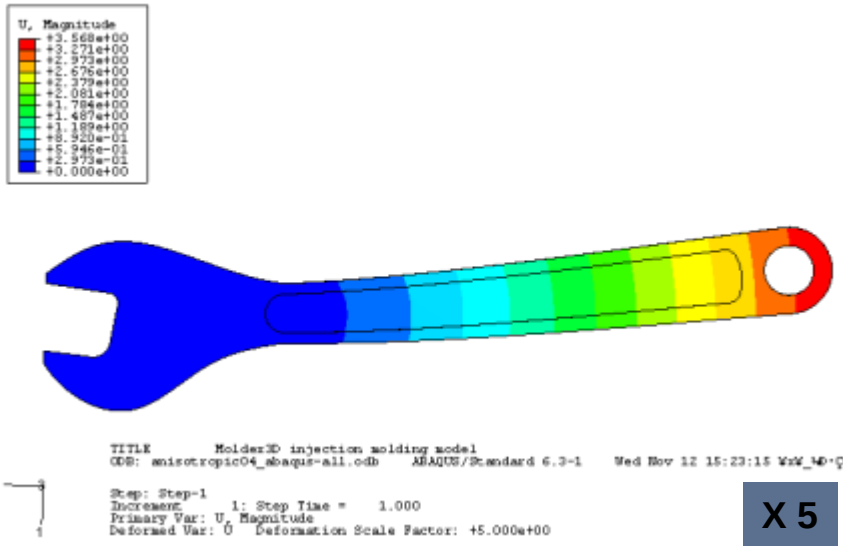
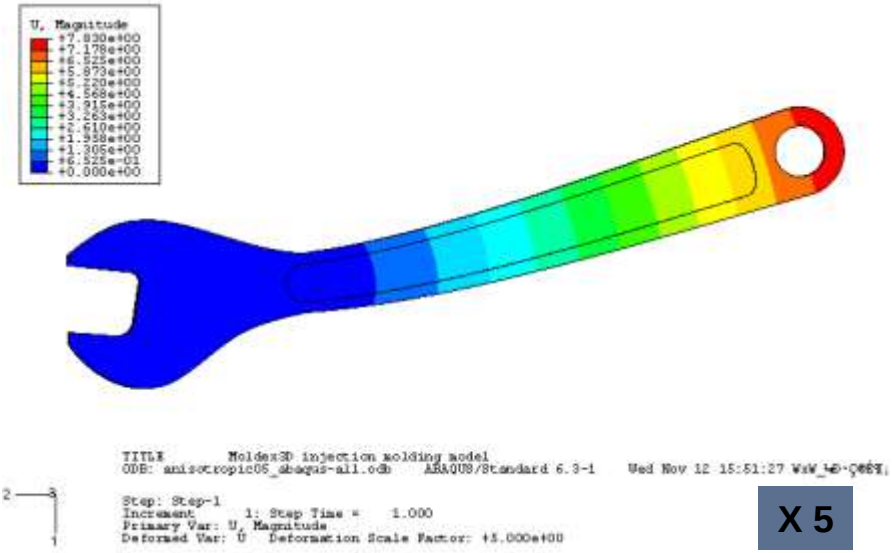
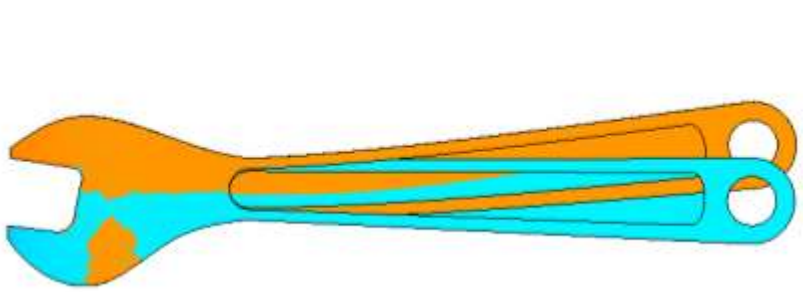
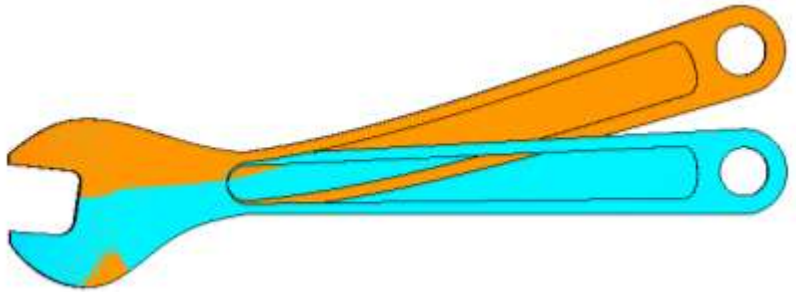
Simple Example – Deflection

> Analysis result: Deformation









Anisotropic (With Fiber Orientation)

Isotropic (Without Fiber Orientation)

Fiber-filled molded part has less deformation

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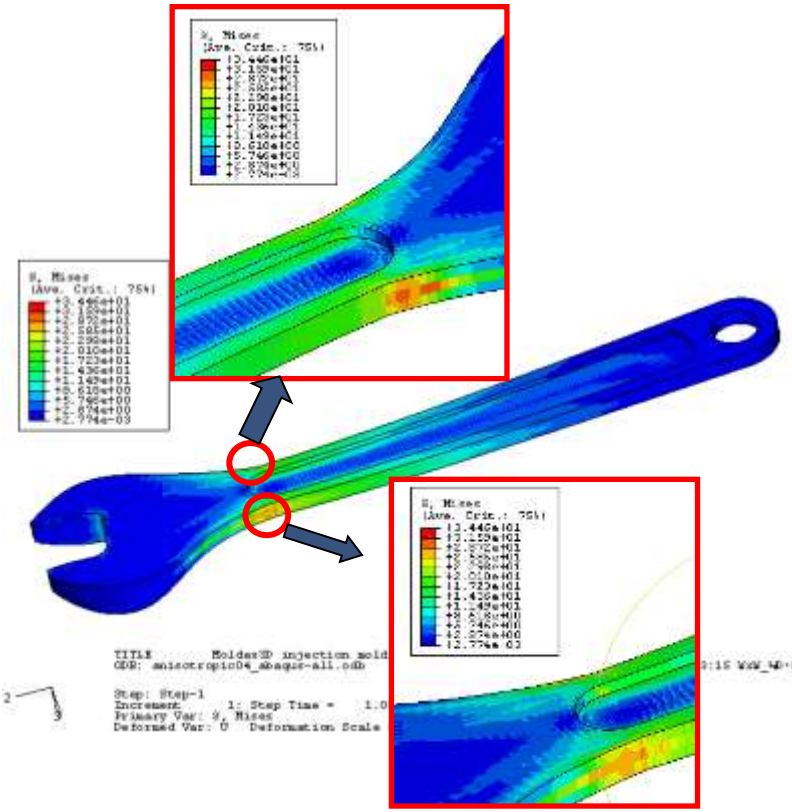
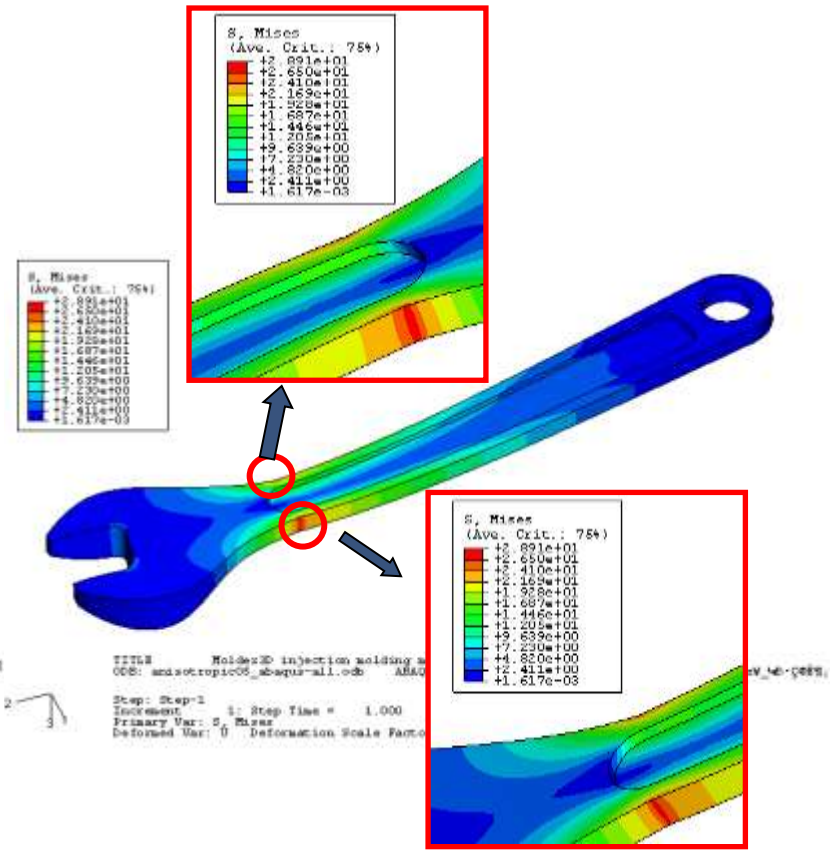
Simple Example – Stress Concentration

> Analysis result: von Mises stress



Anisotropic (With Fiber Orientation)



Isotropic (Without Fiber Orientation)

Anisotropic properties induce higher von-Mises stress

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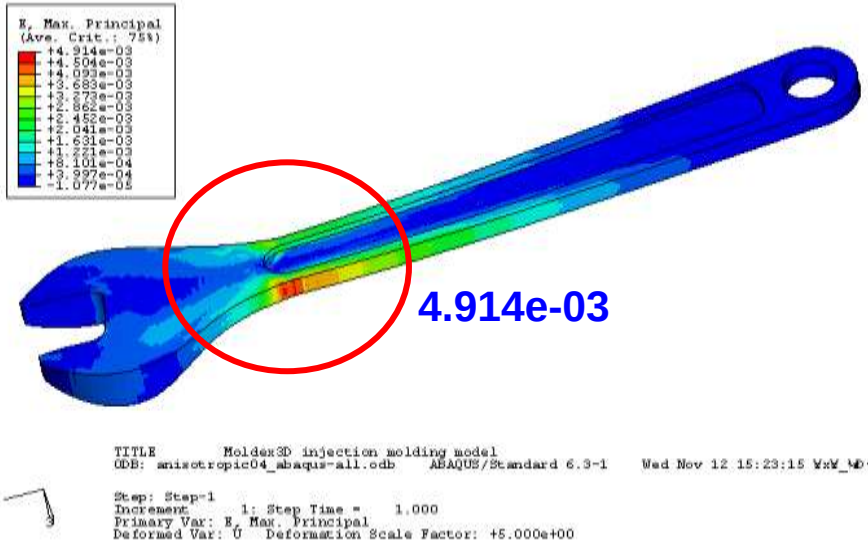
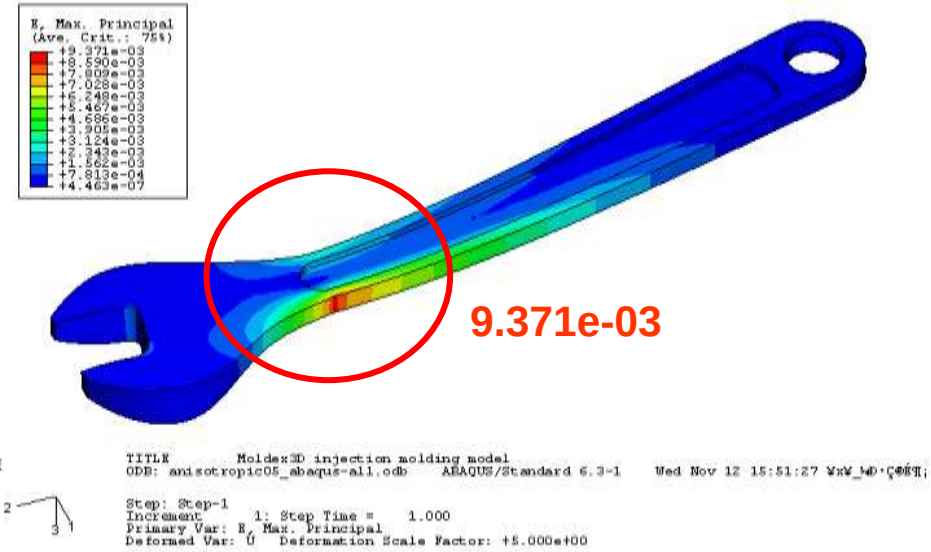
Simple Example – Principal Strain

> Analysis result: Principal Strain





Anisotropic (With Fiber Orientation)

Isotropic (Without Fiber Orientation)

Anisotropic properties can reduce the principal strain

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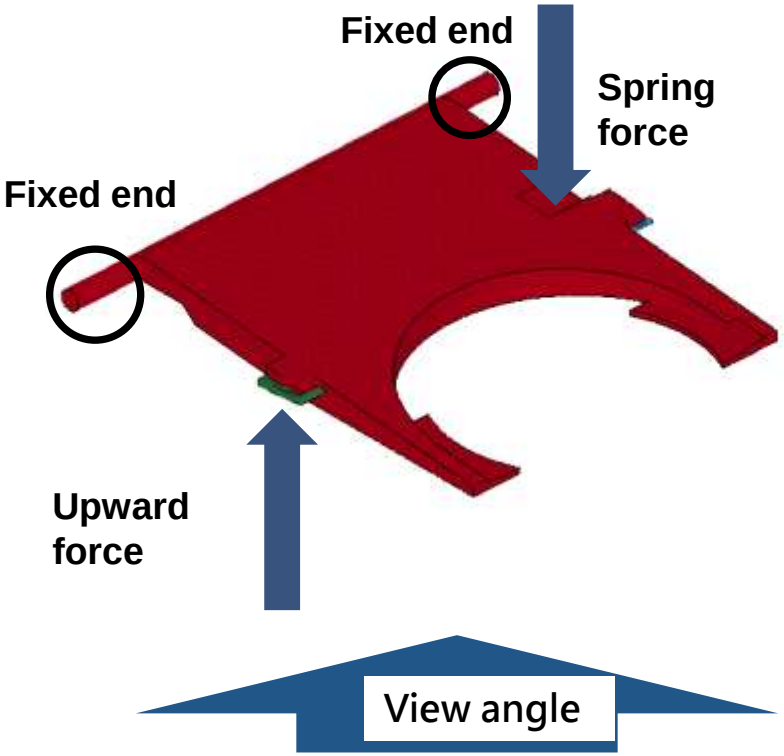
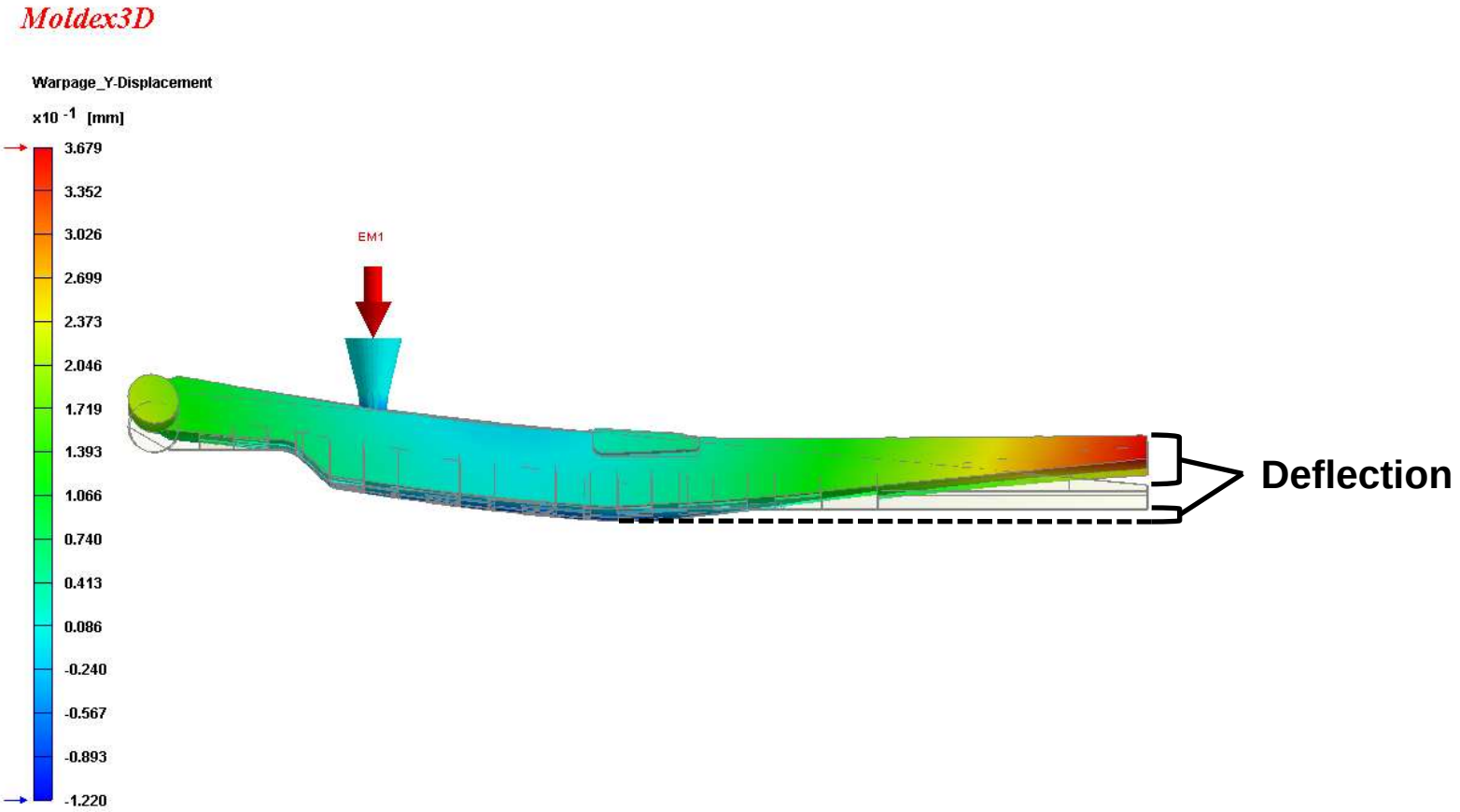
Case Study

- Name: CD drive mechanism
- Size: 50.5 × 5.1 × 44.6 mm
- Function: CD is elevated due to upward force during insertion ; CD comes back to original position due to spring force during ejection



Case Study - Quality Requirement (1)

> Warpage cannot exceed 0.5mm



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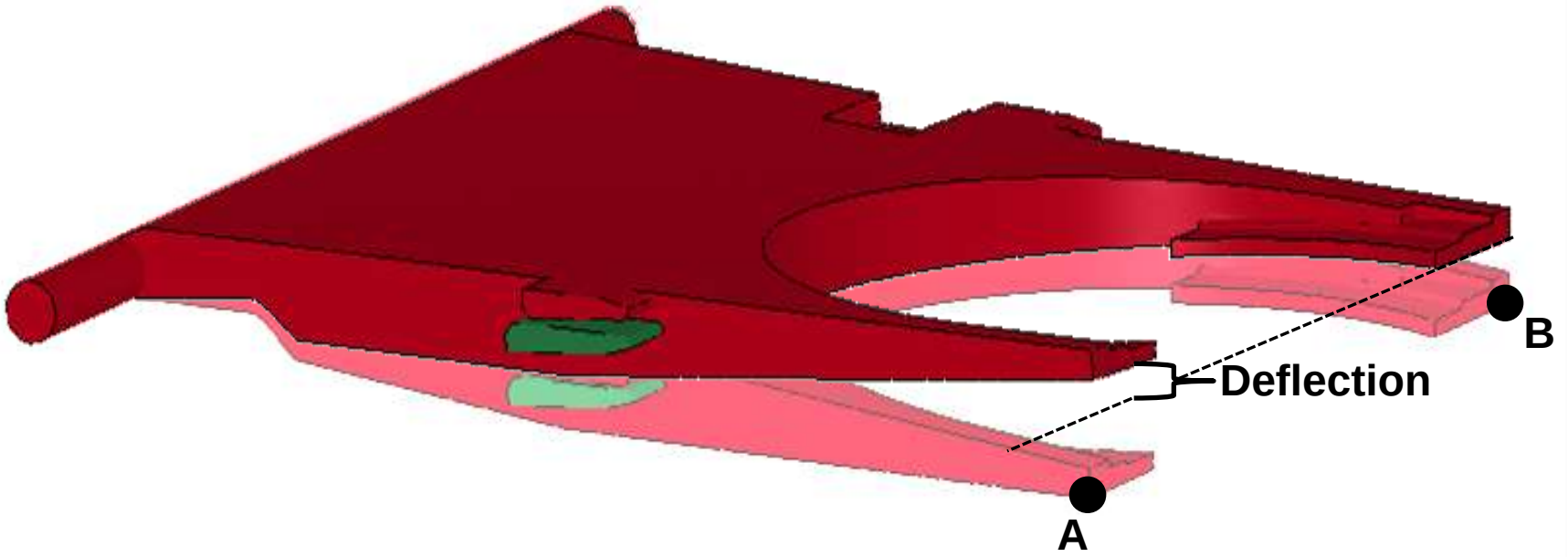
Case Study - Quality Requirement (2)

> Height difference between two ends cannot exceed 1.0mm



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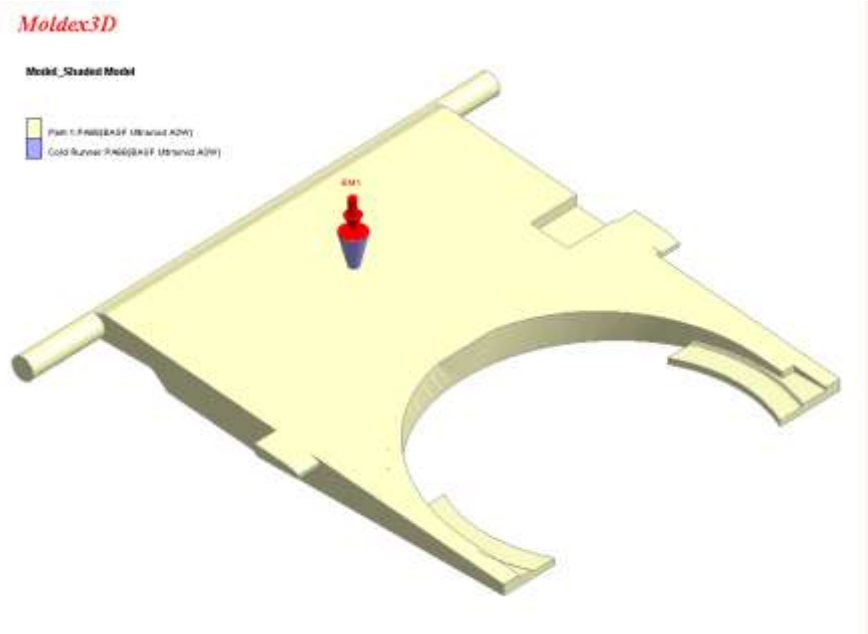
Moldex3D - Analysis Conditions

- Material: PA66 \ Ultramid A3W
- Process Conditions
  - Filling time：0.2 sec.
  - Melt temperature：300 ℃
  - Mold temperature：85 ℃



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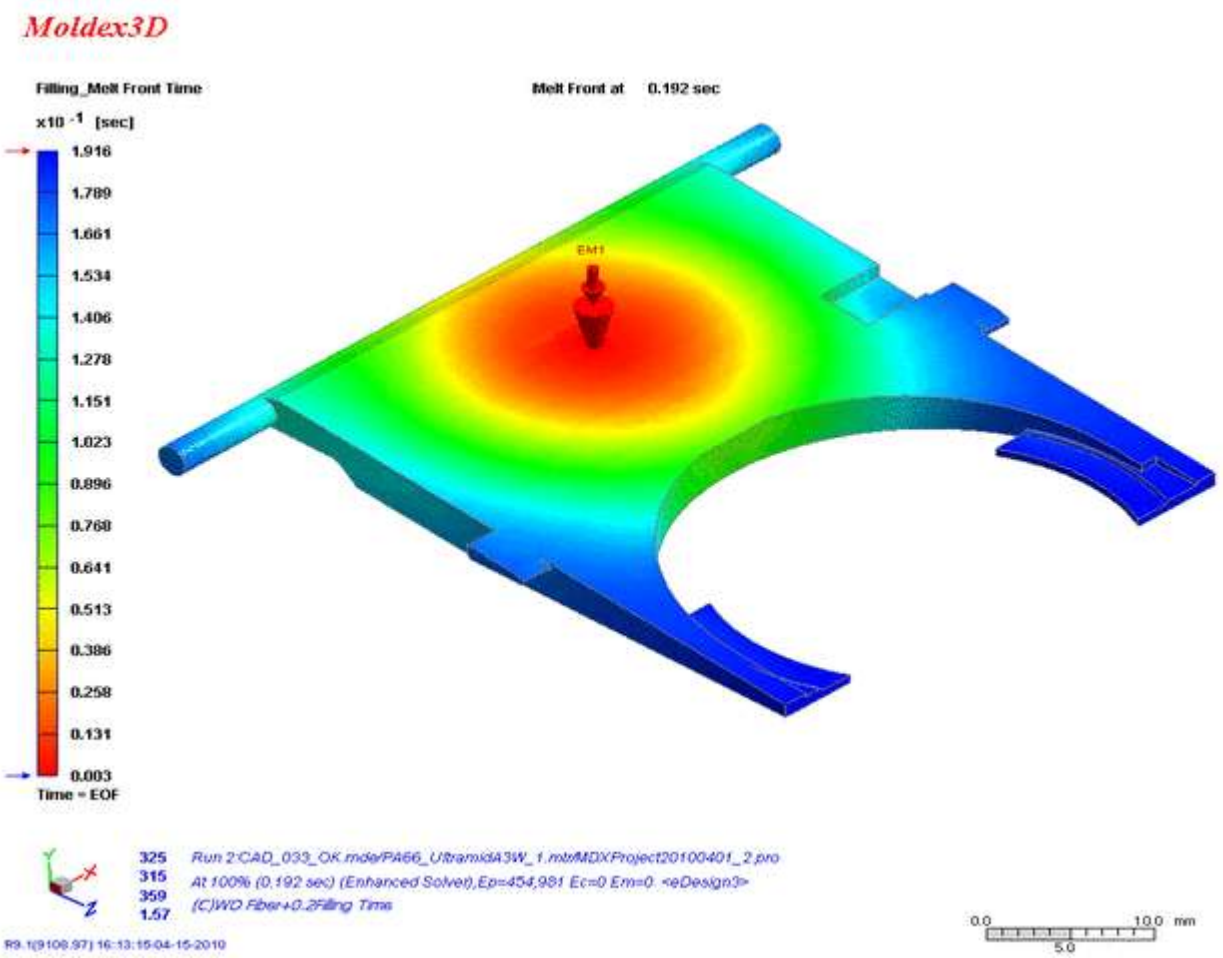
Moldex3D - Analysis Result (1)

> Melt front time



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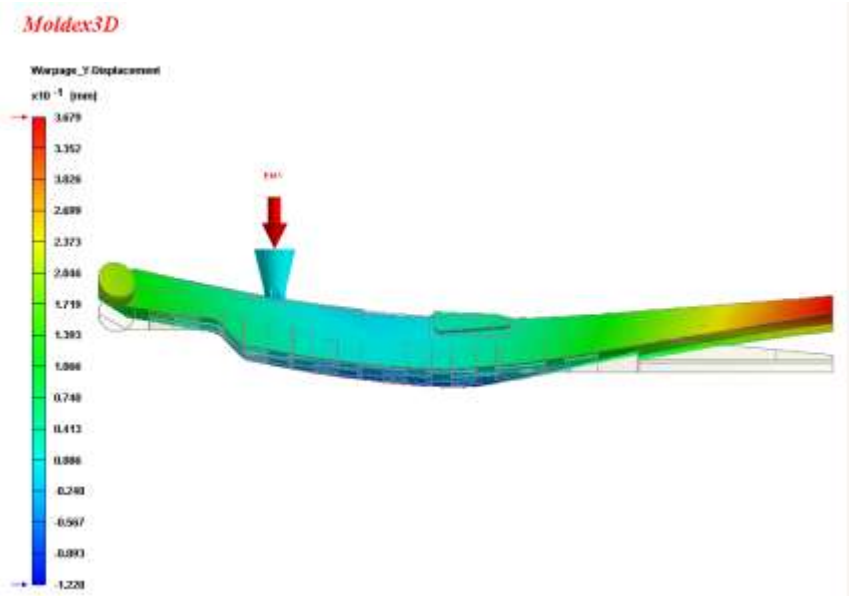
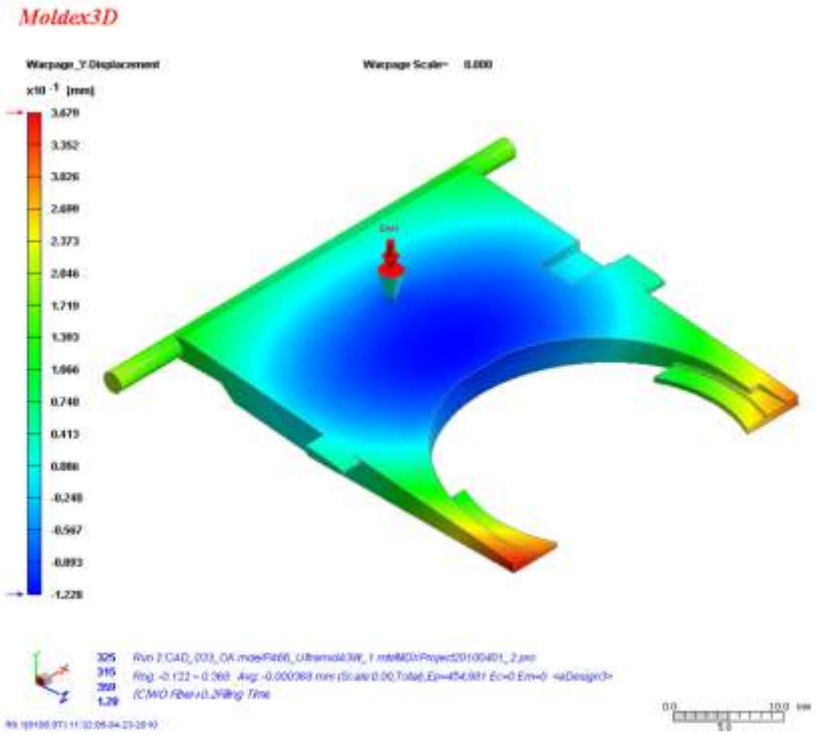
Moldex3D - Analysis Result (2)

> 10x Warpage result(mm)





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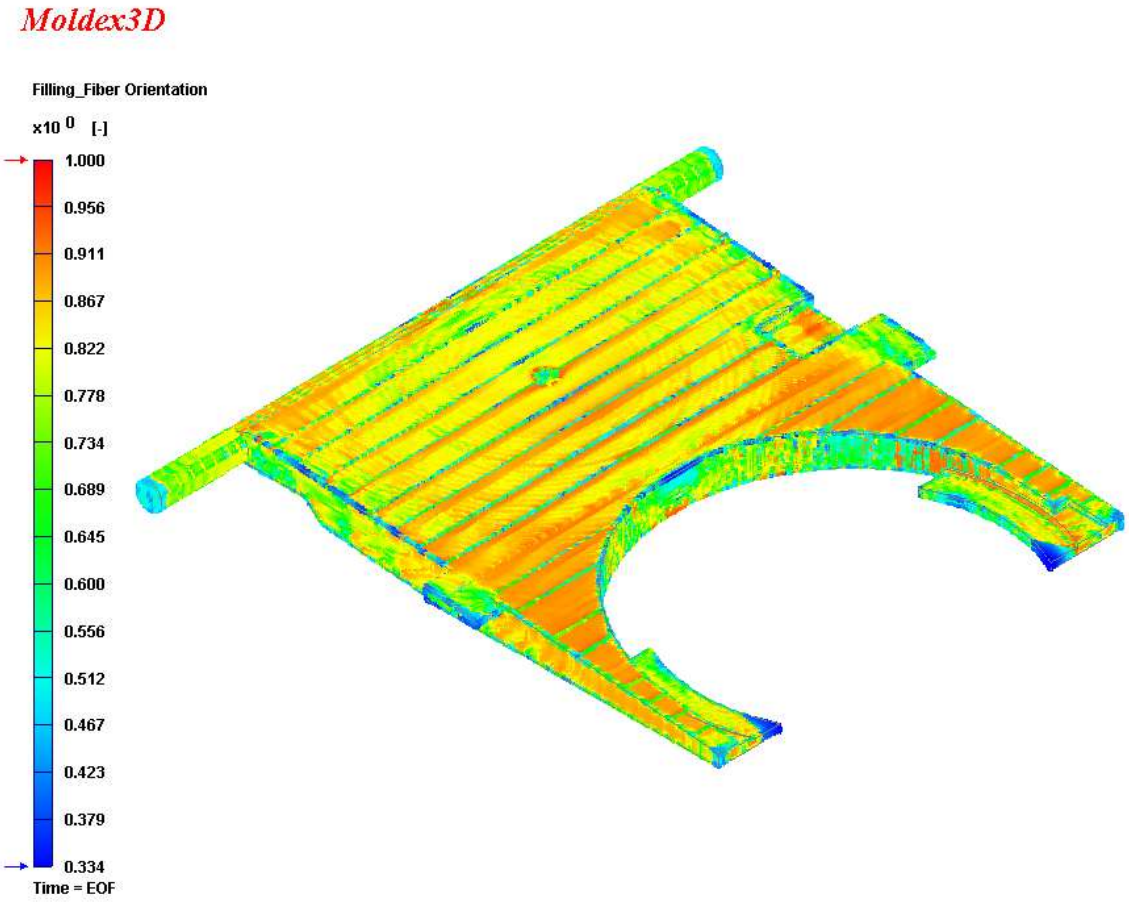
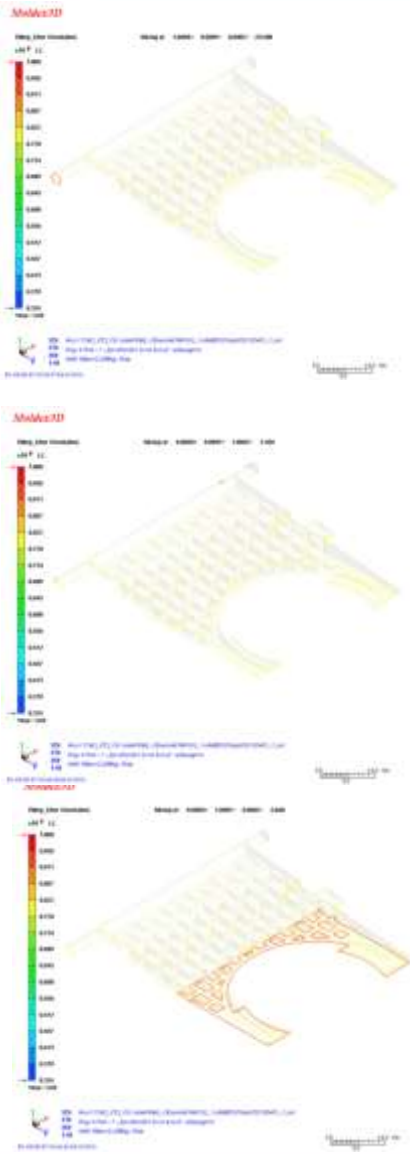
Moldex3D - Analysis Result (3)

> Fiber orientation





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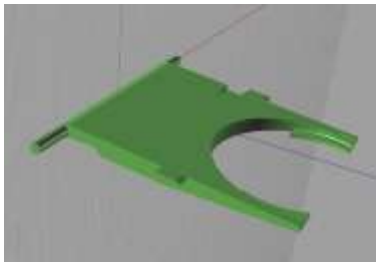
Case Study - Analysis Process

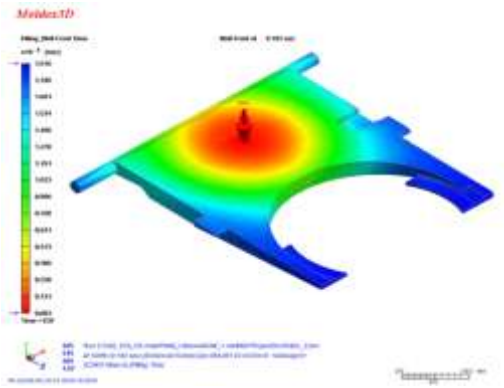
Moldex3D

Concept

Design

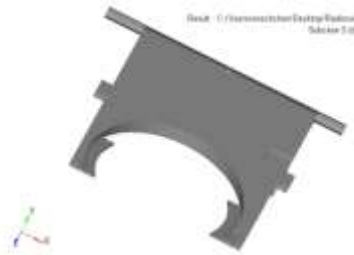


Moldex3D
Injection molding



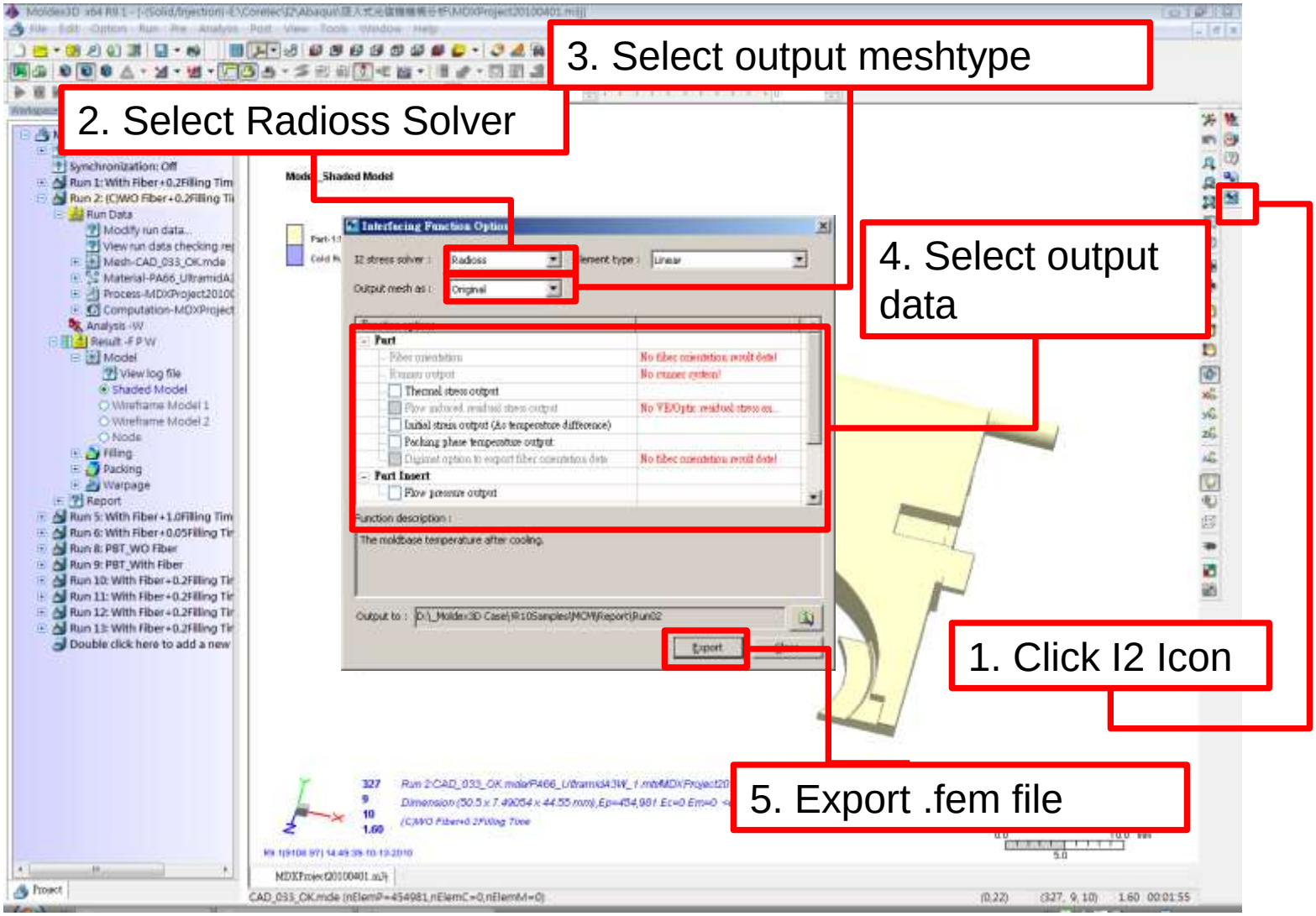
Moldex3D-I2

Radioss
Structure Analysis

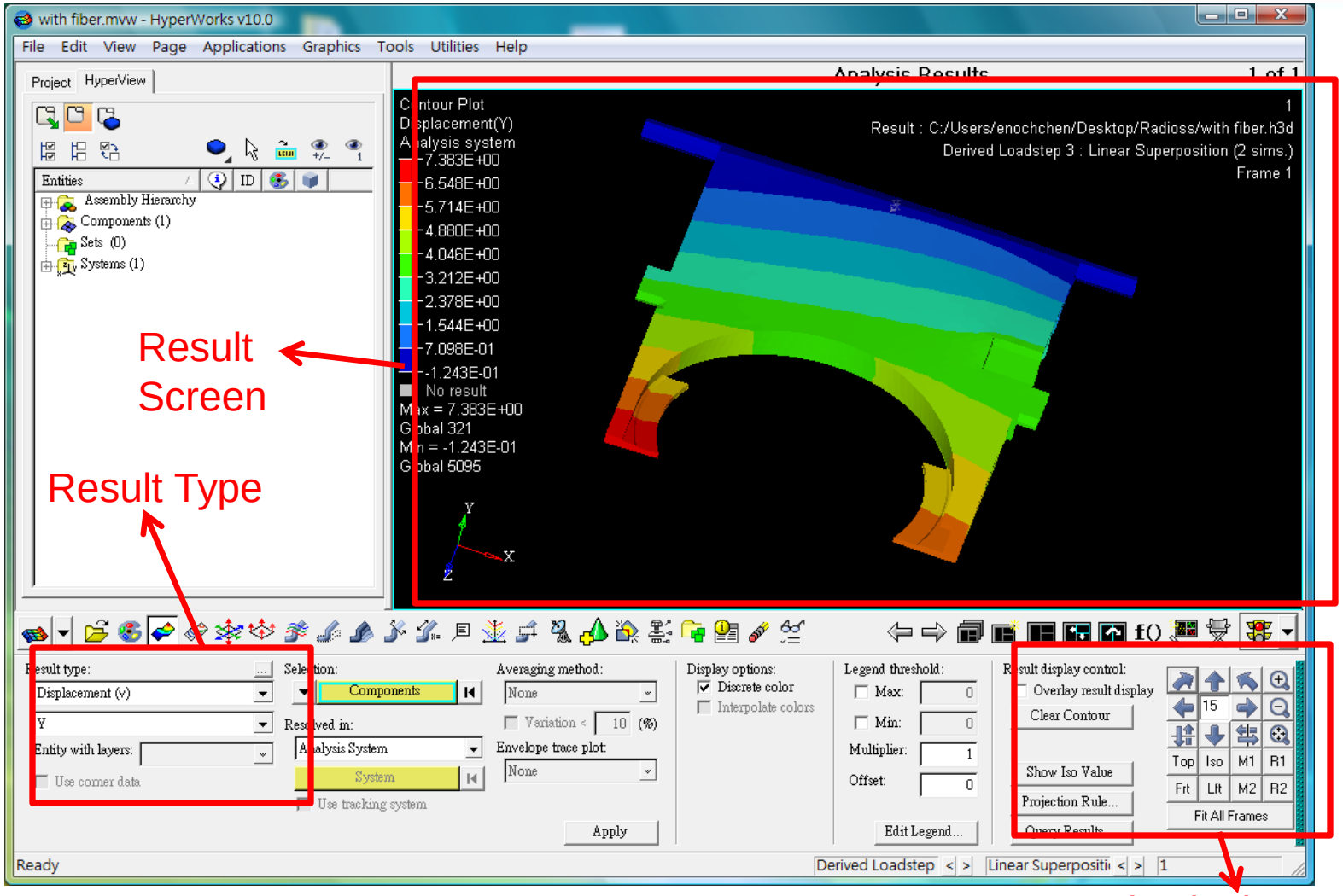


Production

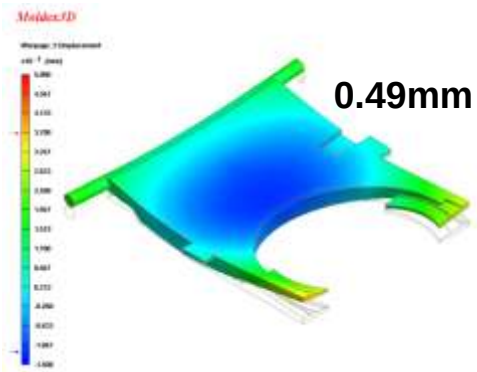
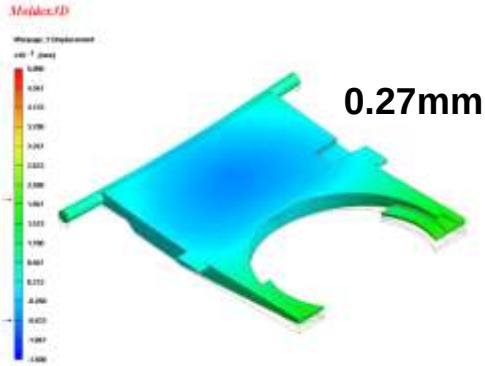
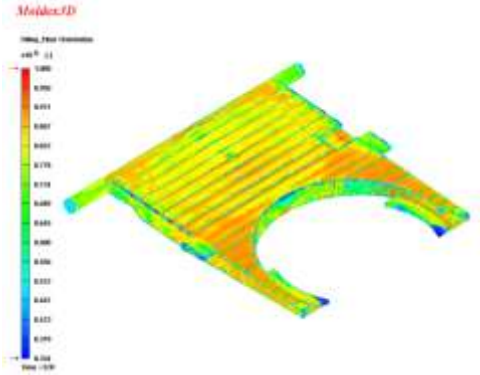
Moldex3D-I2 - Interface



Radioss - Interface



Fiber Orientation Effect

	Not considering fiber	Considering fiber
Warpage	 0.49mm	 0.27mm
Fiber orientation		

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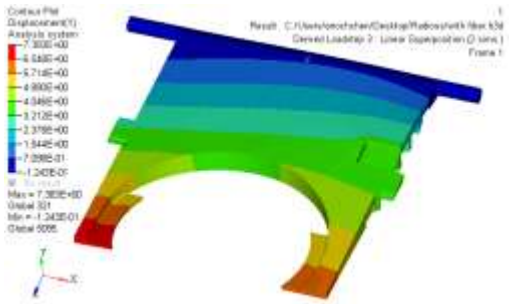
Fiber Orientation Effect

Material Name	PA66 UltramidA3W	PA66 UltramidA3WG10
Fiber content (%)	0	50
Young's Modulus (dyne/cm^2)	3.1e+010	1.96e+011 / 5.76e+010
Poisson ratio	0.4	0.37(v12) / 0.56(v23)
Thermal expansion coefficient (1/K)	8.5e-005	1.2e-005 / 5.5e-005
Warpage (mm)	0.49	0.27
Fiber-orientation induced warpage (mm)	X	0.09
Height difference (mm)	2.23	0.79



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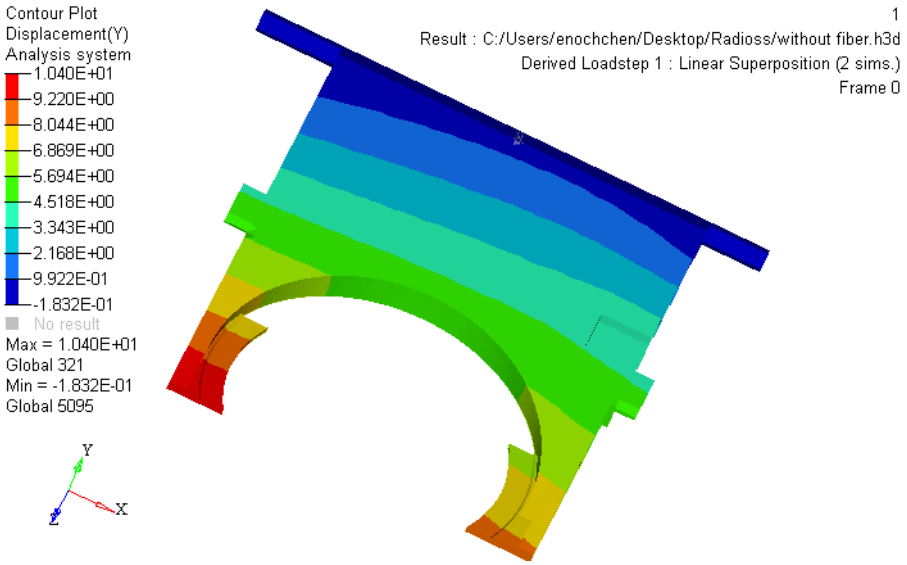
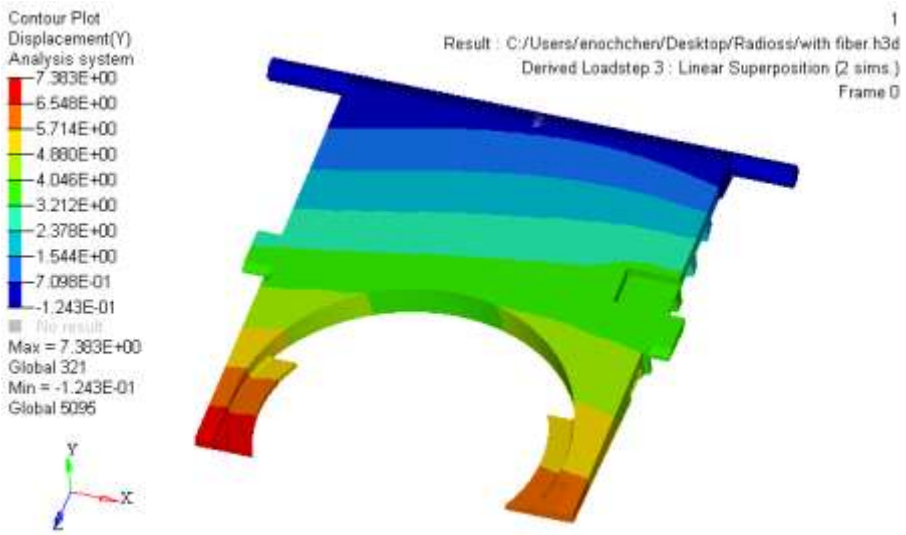
Fiber Orientation Effect

Animation-Without fiber



Animation-With fiber



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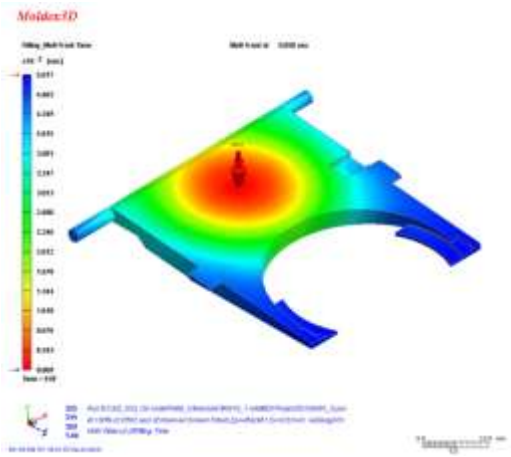
The Process Parameter Effects on Process-induced Material/Product Variations

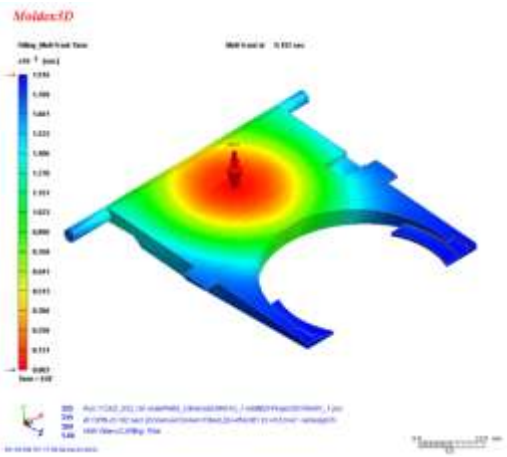
Process Condition Effect - Filling Time

> Melt-front time

0.05sec



0.2sec



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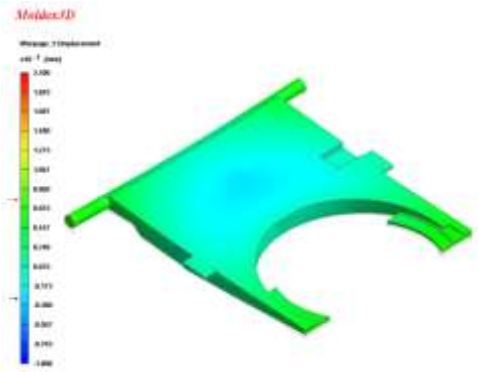
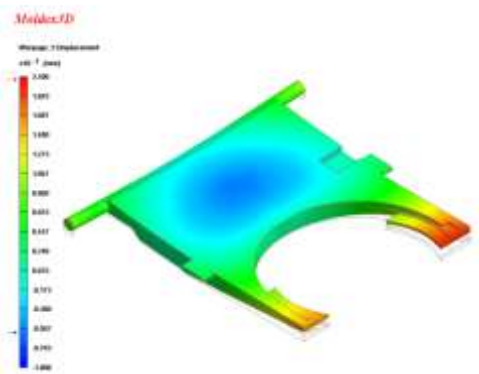
Process Condition Effect - Filling Time

Filling time (Sec)	0.05	0.2
Warpage (mm)	0.11	0.27
Fiber-orientation induced warpage (mm)	0.08	0.09

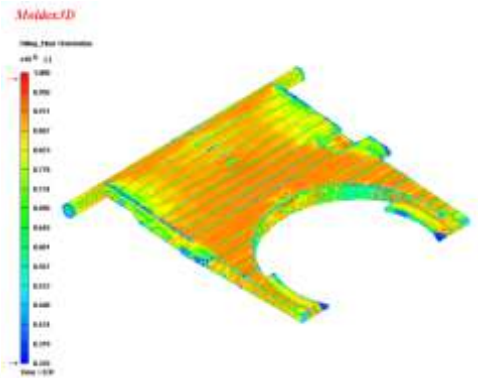
0.05sec **0.2sec**

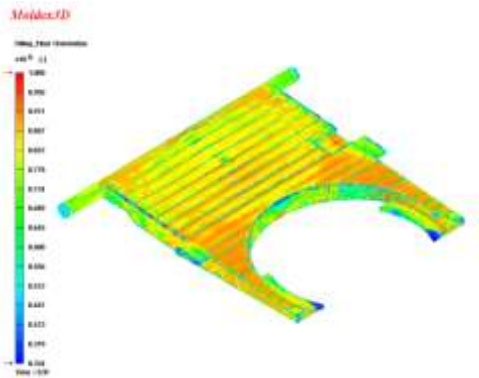
10x warpage (mm)





Fiber orientation





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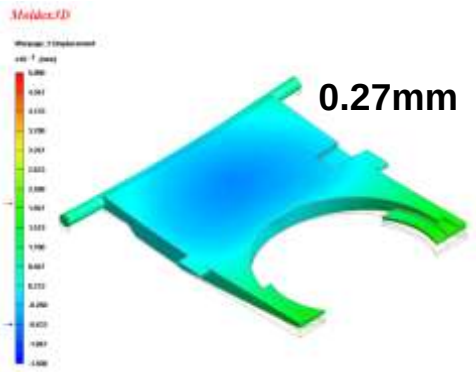
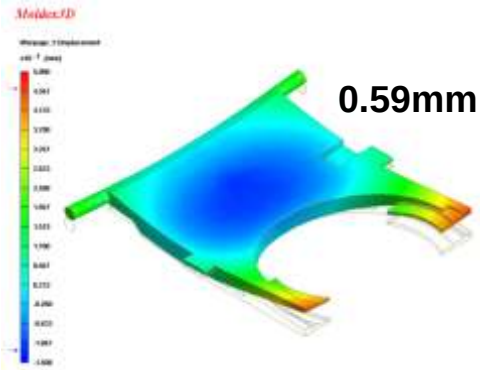
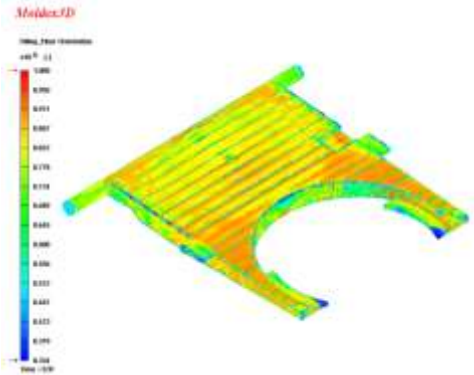
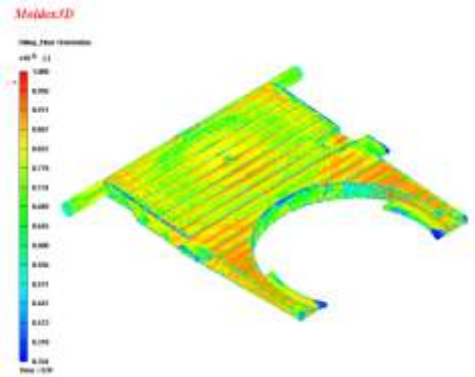
Material Property Effect - Fiber

	PA66 UltramidA3WG10	PBT UltradurB4036G2
10x warpage (mm)	 0.27mm	 0.59mm
Fiber orientation		

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Different Material Property Effect

Material Name	PA66 UltramidA3W	PA66 UltramidA3WG10	PBT UltradurB4036	PBT UltradurB4036G2
Fiber content (%)	0	50	0	10
Young's Modulus (dyne/cm^2)	3.1e+010	1.96e+011 5.76e+010	2.38e+010	6.4e+010 4e+010
Poisson ratio	0.4	0.37(v12) 0.56(v23)	0.4	0.37(v12) 0.46(v23)
Thermal expansion coefficient (1/K)	8.5e-005	1.2e-005 5.5e-005	1.05e-004	3.2e-005 5.6e-005
Warpage (mm)	0.49	0.27	0.48	0.59
Fiber-orientation induced warpage (mm)	X	0.09	X	0.10

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Conclusion

> In Product Lifecycle Management (PLM)
  - Structural analysis on ideal product may lead to incorrect conclusion due to neglect of injection molding process effect
  - The variety of process parameters combinations leads to different material/product variations which lead to different structural analysis results

> In order to effectively consider process-induced material/product variations, Moldex3D-I2 module has been successfully developed to
  - Integrate injection molding analysis (Moldex3D) with structural analysis (Radioss)
  - Transfer process-induced material variation to structural analysis with mesh mapping, material anisotropy and material reduction

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Thank you for your attention!

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True 3D CAE for Injection Molding