

Solving Part / Mold Design and Manufacturing Issues with **SOLIDWORKS** Plastics

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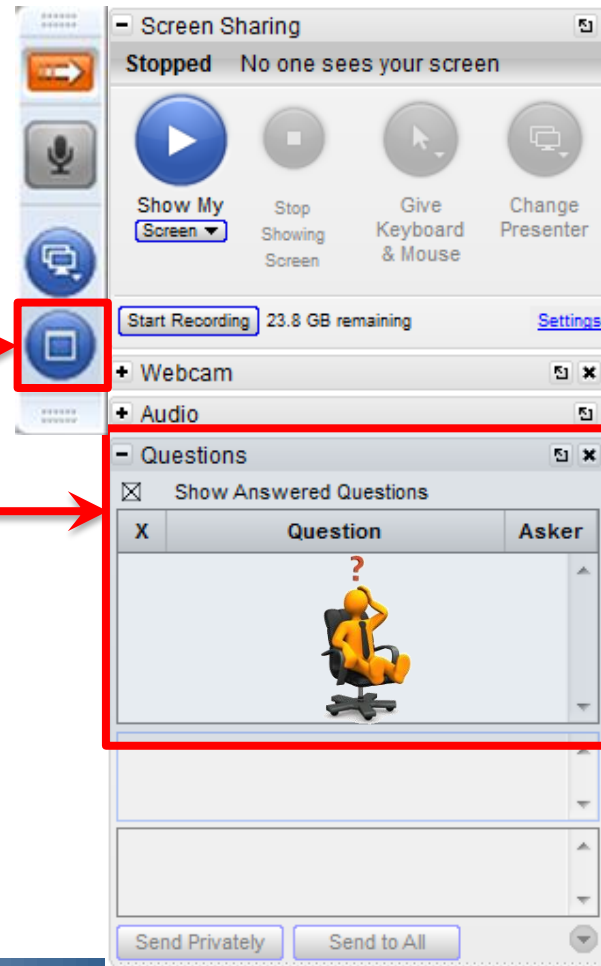


3DEXPERIENCE[®]

Welcome

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1. Viewing Full Screen
2. Exiting Full Screen
3. Asking Questions
4. Answering Poll Questions



Welcome

Gotowebinar - Downloading Handouts

SOLIDWORKS PLASTICS
OPTIMIZE THE DESIGN OF PLASTIC PARTS AND INJECTION MOLDS

VERIFY MANUFACTURABILITY
SolidWorks® Plastics makes it easy for companies that design plastic parts or injection molds to predict and avoid manufacturing defects during the earliest stages of design, eliminating costly rework, improving quality, and accelerating time-to-market. Fully integrate with SOLIDWORKS CAD, the simulation software helps part designers, mold designers, and CRE analysts optimize designs for manufacturability without leaving their familiar 3D design environment.

SOLIDWORKS Plastics Feature Matrix

| Feature | SOLIDWORKS Plastics Standard | SOLIDWORKS Plastics Professional | SOLIDWORKS Plastics Premium |
|-------------------------------------|------------------------------|----------------------------------|-----------------------------|
| CAD Integration | | | |
| SOLIDWORKS Native File Support | ✓ | ✓ | ✓ |
| Associative with SOLIDWORKS | ✓ | ✓ | ✓ |
| SOLIDWORKS embedded | ✓ | ✓ | ✓ |
| Plastics Material Database | | | |
| 1400+ Commercial Plastics | ✓ | ✓ | ✓ |
| Customizable | ✓ | ✓ | ✓ |
| Molding | | | |
| Automatic | ✓ | ✓ | ✓ |
| Boundary Mesh (shell) | ✓ | ✓ | ✓ |
| Solid 3D Mesh | ✓ | ✓ | ✓ |
| Global Mesh Refinement | ✓ | ✓ | ✓ |
| Local Mesh Refinement | ✓ | ✓ | ✓ |
| Simulation Capabilities | | | |
| Filling Phase (1st stage injection) | ✓ | ✓ | ✓ |
| Packing Phase (2nd stage injection) | X | ✓ | ✓ |
| Automatic Gate Location(s) | ✓ | ✓ | ✓ |
| Unbalanced Fill Time Plot | ✓ | ✓ | ✓ |
| Thermal Strainage | X | ✓ | ✓ |
| Sink Mark Analysis | ✓ | ✓ | ✓ |
| Dimension Analysis (Shell) | X | ✓ | ✓ |
| Mold Geometry Support | | | |
| Runner Design Wizard | X | ✓ | ✓ |
| Spray and Runners | X | ✓ | ✓ |
| Hot & Cold Runners | X | ✓ | ✓ |
| Multi-Cavity Molds | X | ✓ | ✓ |
| Family Molds | X | ✓ | ✓ |

ECCO
OPTIMIZING EMERGENCY LIGHT LENSES AND COMPONENTS WITH SOLIDWORKS PLASTICS

By using the SOLIDWORKS Plastics Professional software with the SOLIDWORKS Simulation software, ECCO has accelerated and enhanced the design of emergency light lenses and components, improving the quality of their manufacturing.

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- Handouts: 1 of 5
 - SWlasticsFeatureMatrix.pdf
 - SWPlastics_ECCO_CaseStudy.pdf
 - SWPlasticsBrochure.pdf
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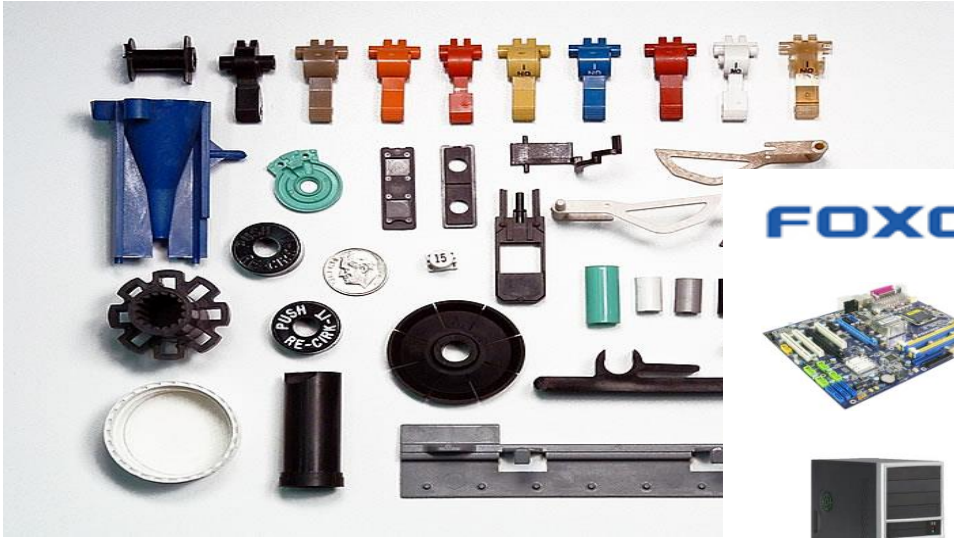
POLL QUESTION #1

POLL QUESTION #2

Agenda

- ▶ Why SOLIDWORKS Plastics?
- ▶ SOLIDWORKS Plastics Demo
- ▶ Validation Example Discussion
- ▶ Q&A

Plastics are everywhere...



FOXCONN



Unanswered Questions...

Is it Manufacturable?

Can I Innovate?

What is the Best Gate location?

How about Quality?

Where are the weld lines/
Air traps?

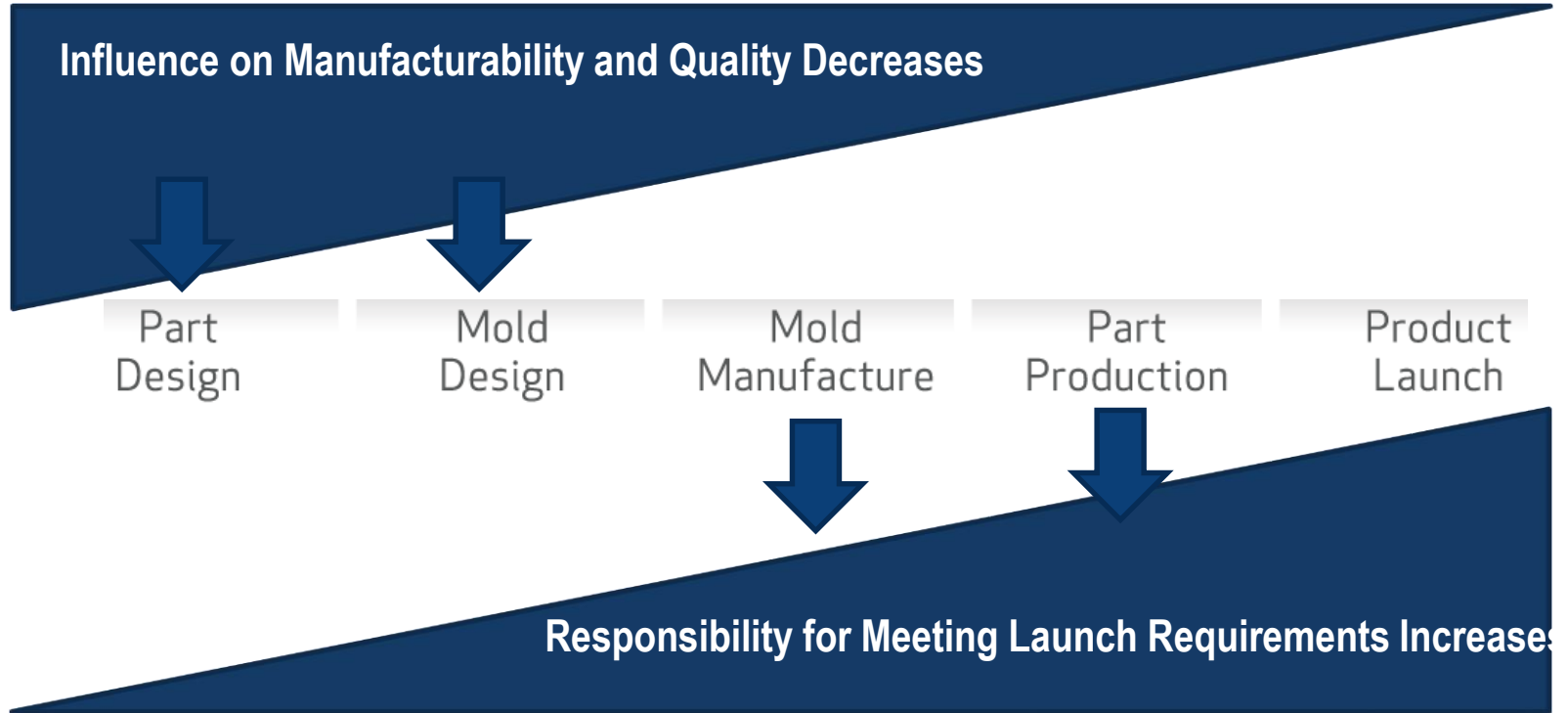
How about Customer rejection
due to visual / structural
defects?

How many mold
revisions?

What about Cost of change?

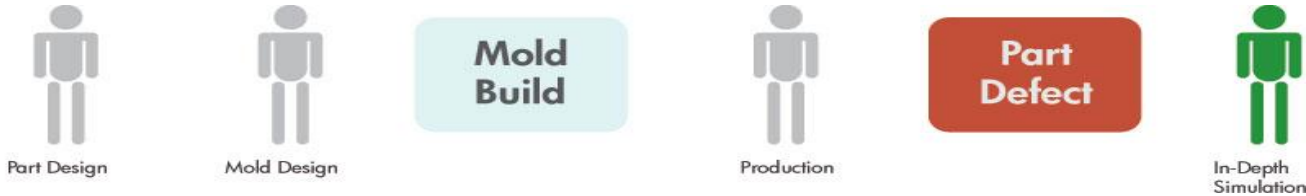


Historical Plastics Development Process



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Old Way #1 – Fix Existing Problems



Problems are fixed after the fact. This is costly and inefficient.

Old Way #2 – Validate Existing Designs



Limited application provides benefits to a small number of parts and there are hidden costs due to the lack of optimization.

Preferred Way – Optimize Part & Mold Design



Using simulation as an integral part of the part and mold design process provides the ability to optimize designs for manufacturability.

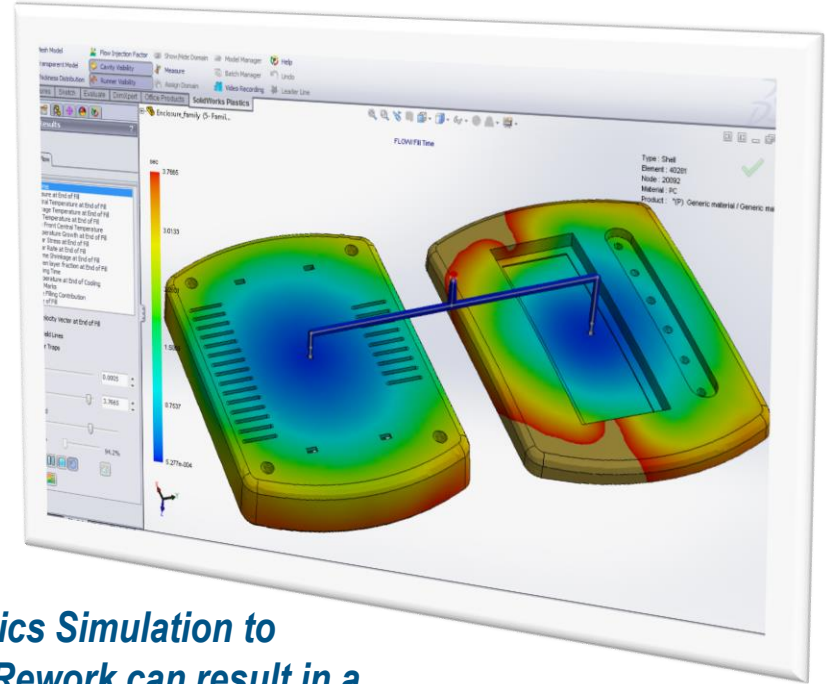
SOLIDWORKS Plastics

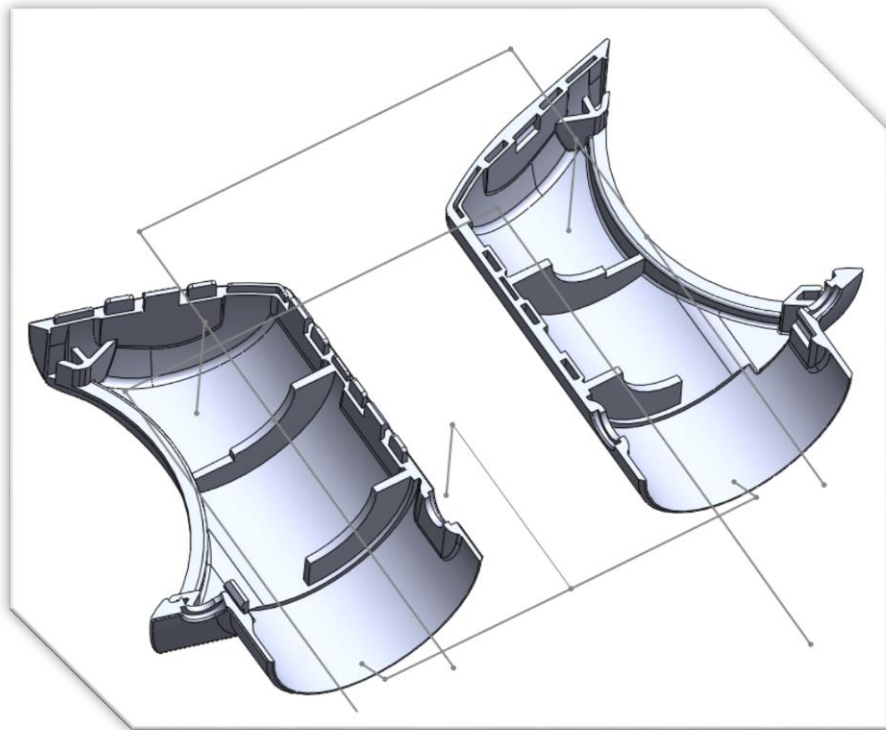
- ▶ Predict and avoid manufacturing defects
- ▶ Eliminate costly mold rework
- ▶ Improve part quality
- ▶ Decrease time to market

Value Proposition

- ▶ >80% of plastic parts are injection molded
- ▶ Injection molding is a complex mix of time, temperature, pressure, material & tooling variables
- ▶ Injection molds range in cost from >\$10K to \$1M+ and mold rework is costly and time-consuming

Using SOLIDWORKS Plastics Simulation to Avoid Just One Round of Mold Rework can result in a Positive Return on Investment





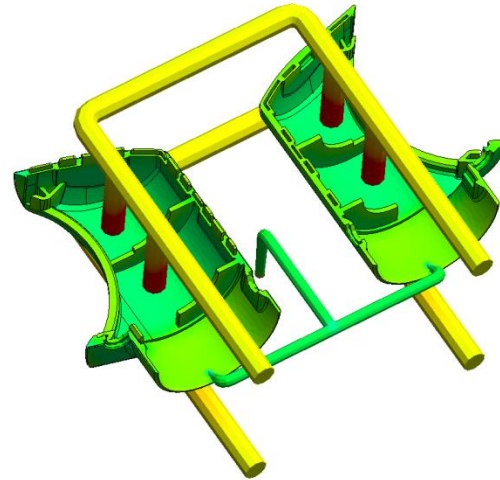
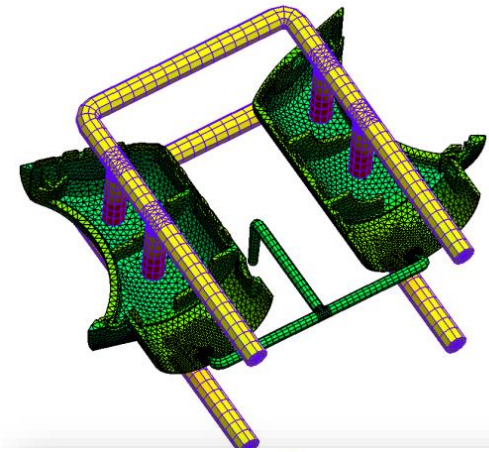
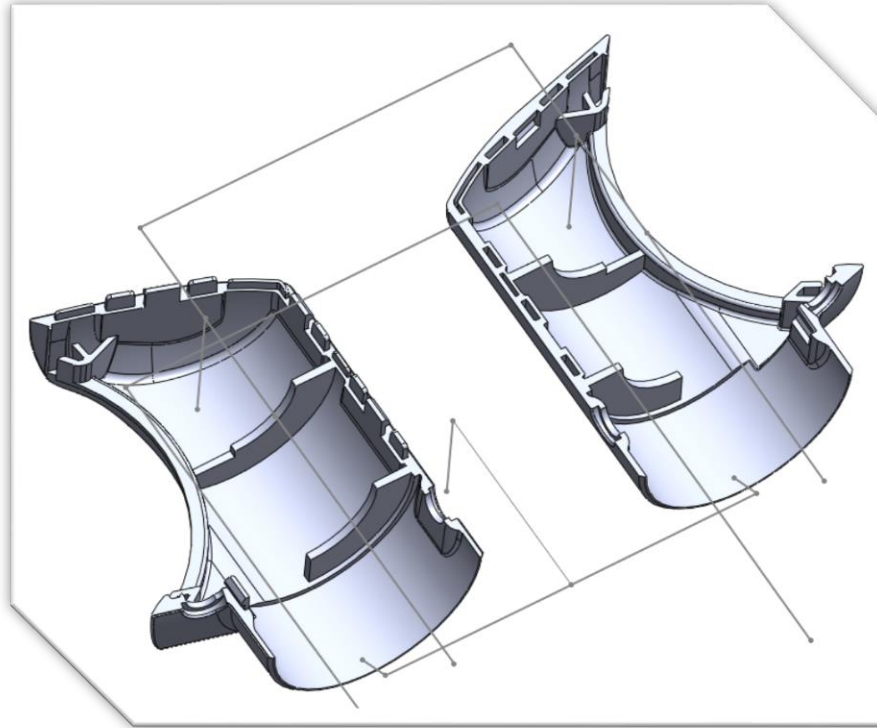
SOLIDWORKS Plastics Demo

Getting a Window into
your Mold

What if scenarios

Multi Cavity / Family
Molds.

Cooling Lines /
Warpage.



SOLIDWORKS Plastics

Getting a Window into
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What if scenarios

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► Identify Key Manufacturability Issues...

- ▷ Will it fill?
- ▷ What's the Optimal Wall Thickness?
- ▷ Where are the Weld Lines? Will it affect function?
- ▷ Where are the Air Traps? Will specialized tooling be required?
- ▷ How about
 - ▶ Cooling time?
 - ▶ Pressure requirements?
 - ▶ Sink Marks?
 - ▶ Volumetric Shrinkage?

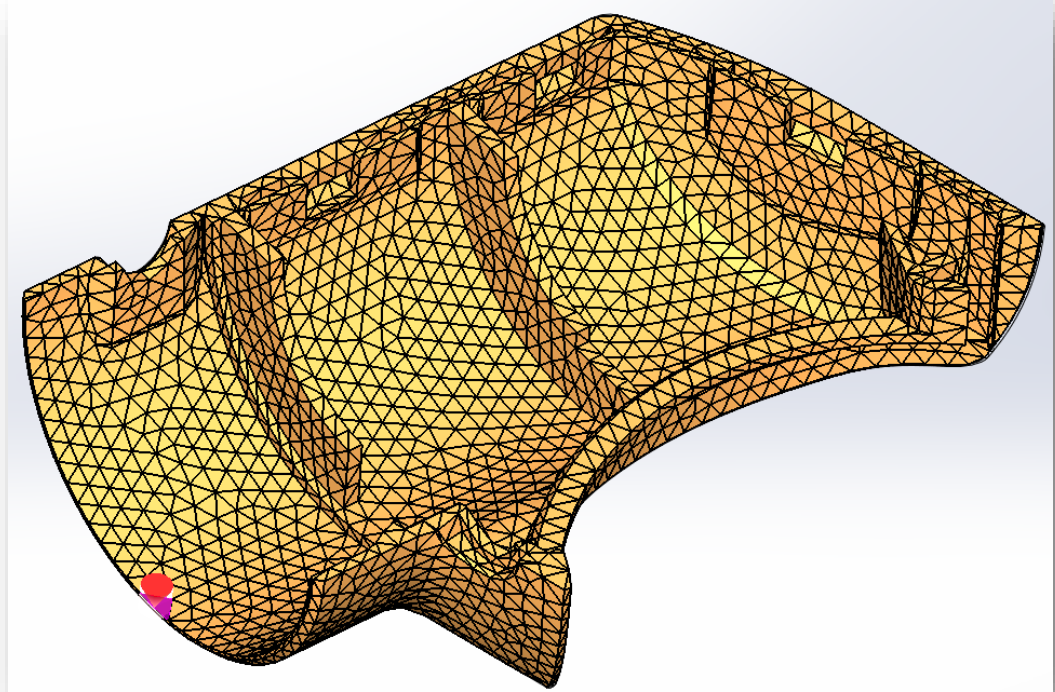
Simulation Workflow

Mesh

Setup

Solve

Review



Mesh with AUTO refinement

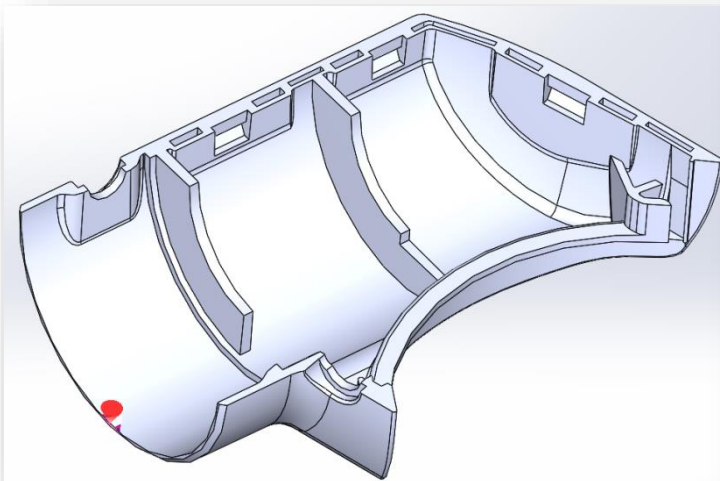
Simulation Workflow

Mesh

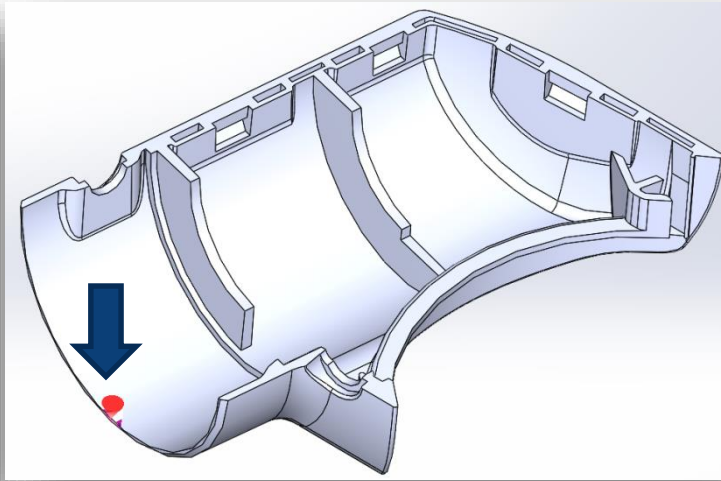
Setup

Solve

Review



Material: Generic ABS

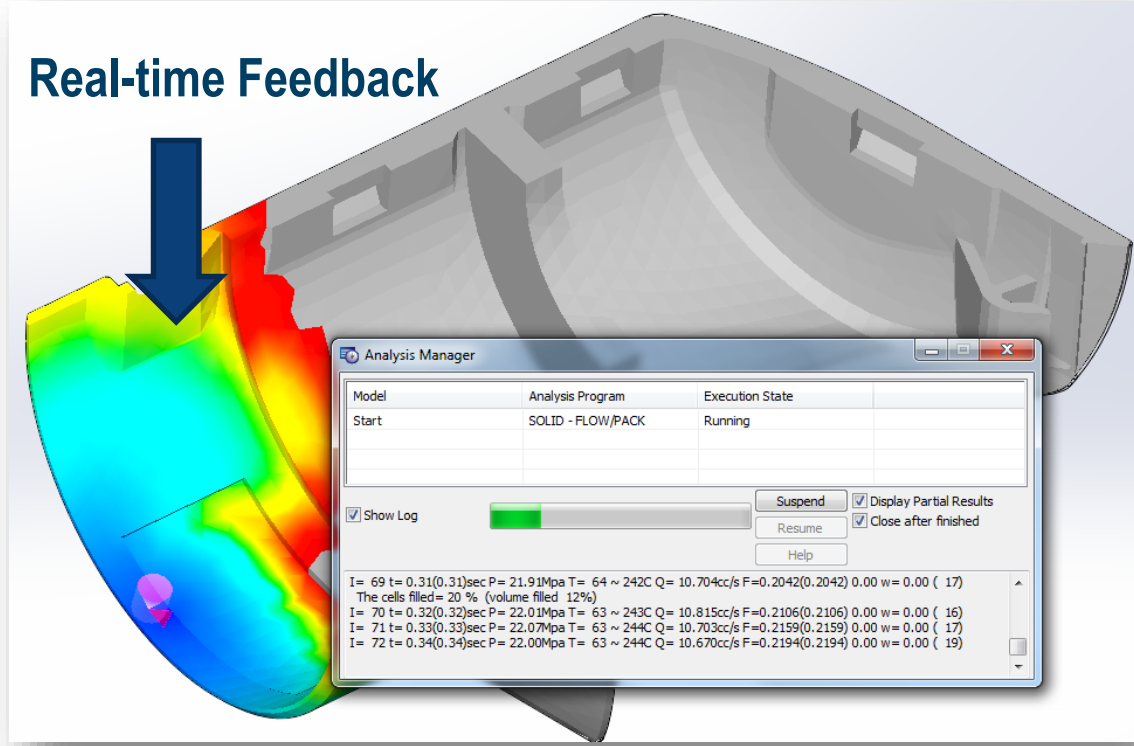


Specify Injection Location

Simulation Workflow

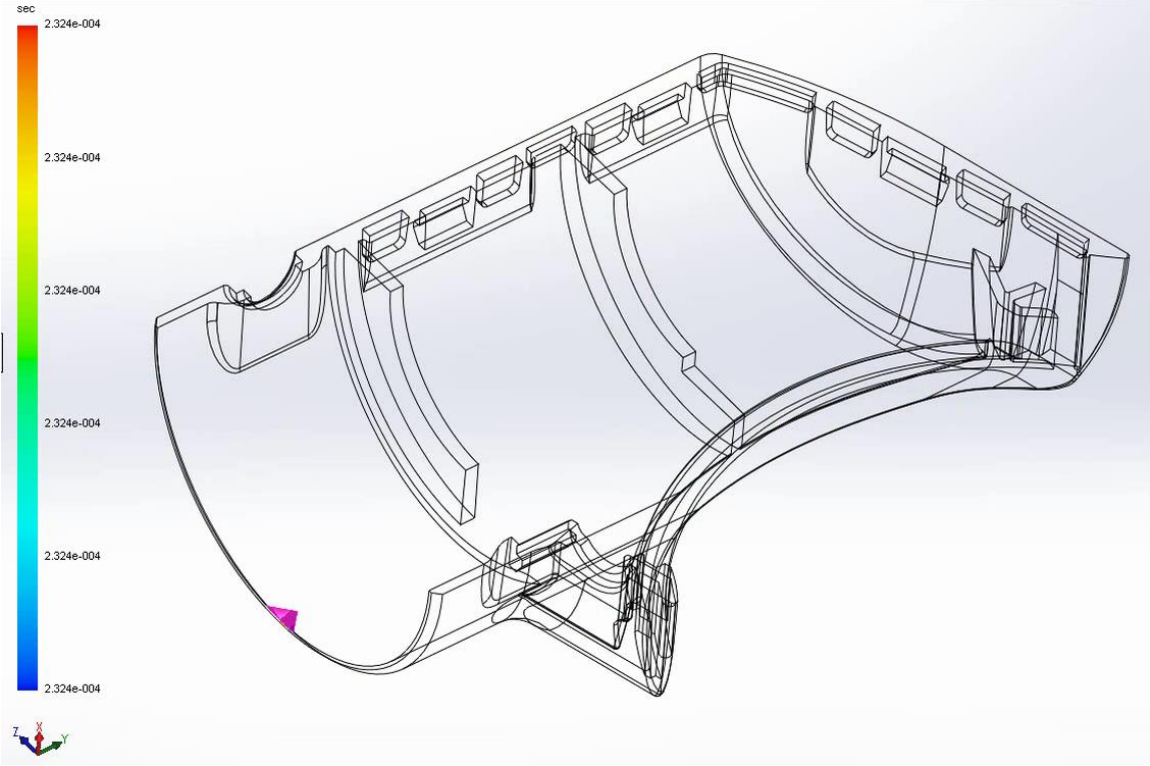
Mesh
Setup
Solve
Review

Real-time Feedback



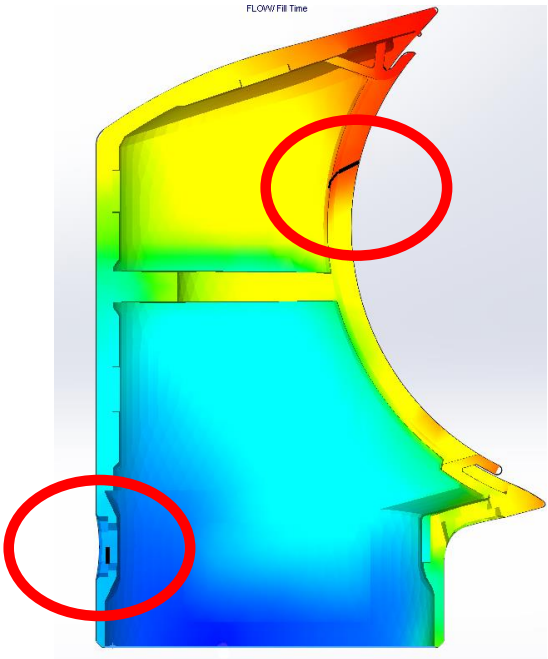
Simulation Workflow

- Mesh
- Setup
- Solve
- Review**

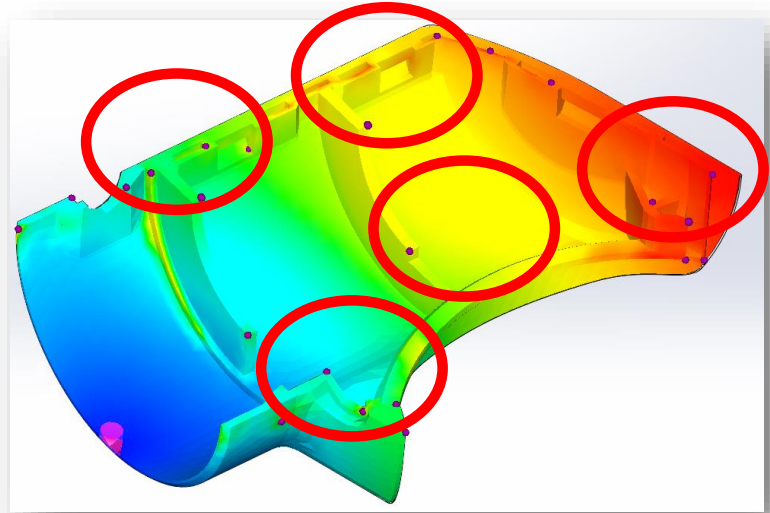


Simulation Workflow

- Mesh
- Setup
- Solve
- Review**

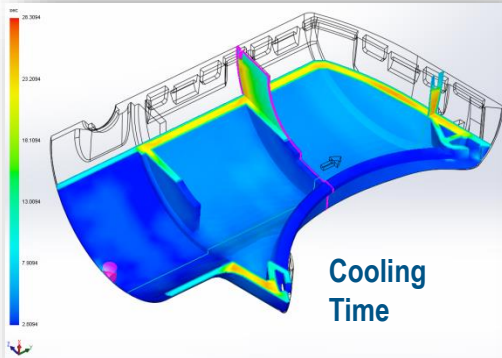
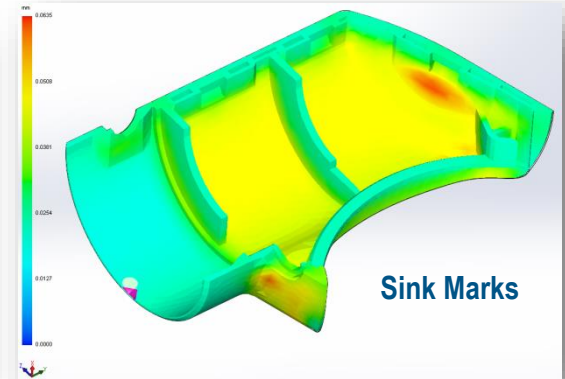
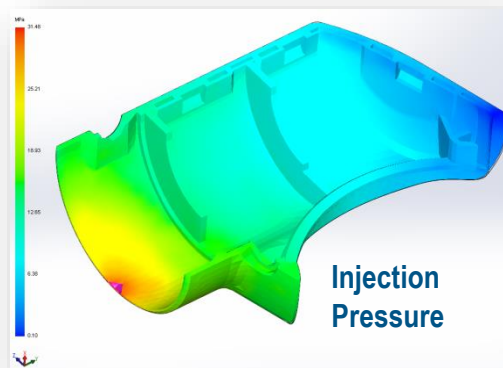


WELD LINES



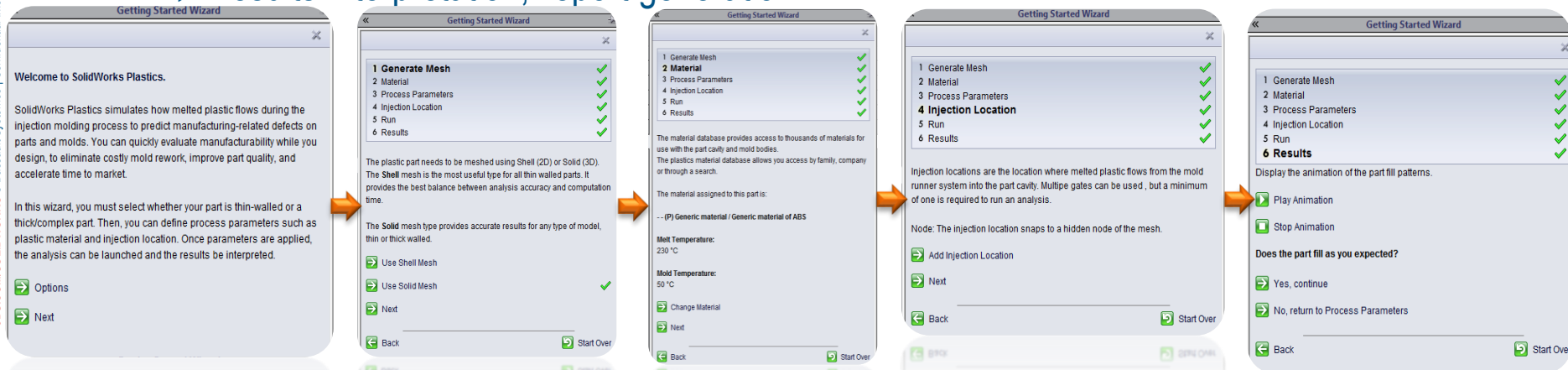
AIR TRAPS

Review Results



Getting Started Wizard

- ▶ Plastics Advisor tool - Answer Simple Questions
- ▶ Step by step guidance through the SOLIDWORKS Plastics workflow
 - ▷ Model setup, Mesh and Run, Process Settings
 - ▷ Results Interpretation, Report generation





SOLIDWORKS

SOLIDWORKS Plastics

Getting a Window into
your Mold

What if scenarios

Multi Cavity / Family
Molds.

Cooling Lines /
Warpage.

Easily identify
Manufacturing issues
upfront

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► NOW WHAT?

- ▷ Fill pattern not acceptable?
- ▷ Sink Marks large?
- ▷ Cooling time too high?
- ▷ Injection Pressure too high
- ▷ Weld Lines in Functional Spots
- ▷ Try a different Gate Location?
- ▷ Try a different material?



SOLIDWORKS

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Reduce / Fix Errors

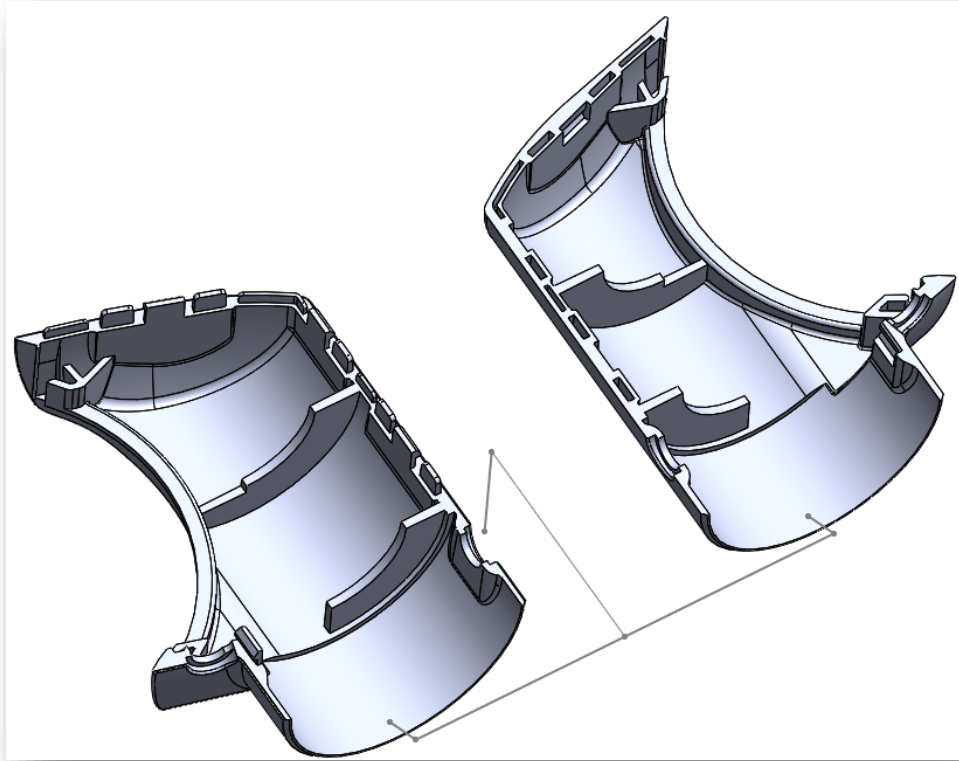
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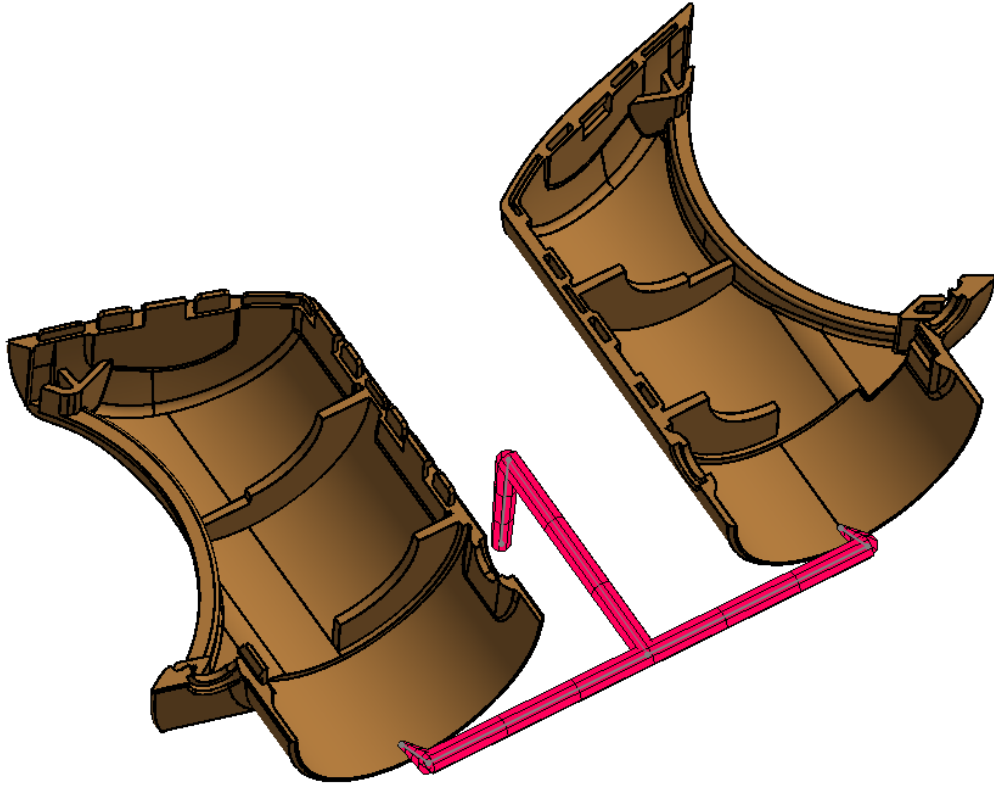
What if scenarios

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Additional Setup



Channel Design Wizard

✓ ✗

Dimensioning Sample

Parameter

Line Mesh: 3

Fine Direction: +X

| | |
|------|----|
| SD 1 | 10 |
| SDL | 10 |
| SD 2 | 10 |
| RW | 10 |
| RT | 10 |
| RL | 10 |
| GT | 5 |
| GW | 5 |
| GL | 5 |

Runner Design

✓ ✗

Type

Runner
 Wizard

Circle

- Circle, D1=5.00, D2=5.00
- Square, D1=5.00, D2=5.00
- Half Circle, D1=5.00, D2=5.00
- Rectangular, D1=5.00, D2=5.00
- Trapezoid, D1=5.00, D2=5.00
- Ellipse, D1=5.00, D2=5.00
- 6, Circle, D1=5.00, D2=5.00
- 7, Circle, D1=5.00, D2=5.00

Parameter

Line Mesh: 3.0000

Fine Coarse

Rotate Angle: 0

1st Point

| | |
|----|---------|
| D1 | 10.0000 |
| D2 | 10.0000 |
| H | 10.0000 |

2nd Point

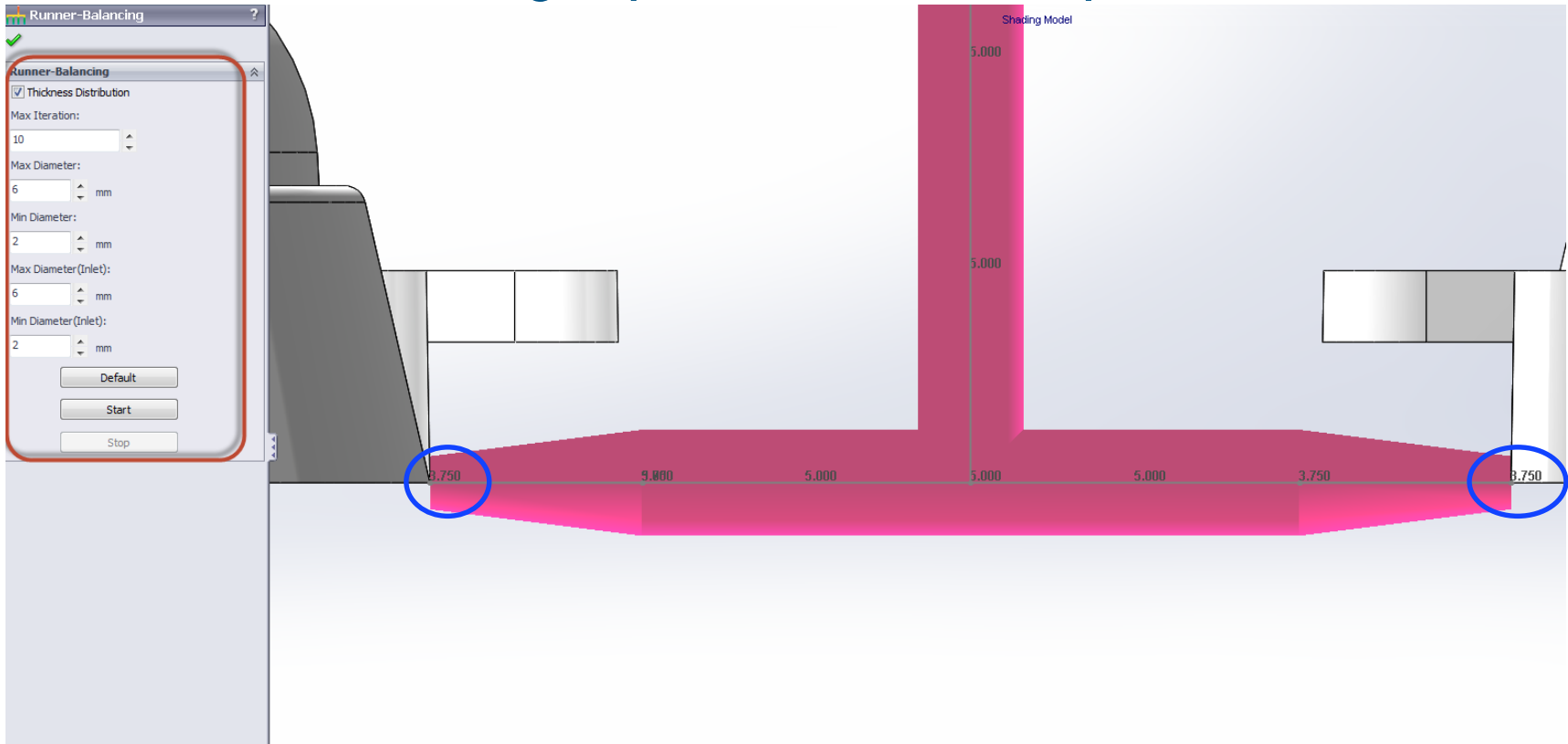
| | |
|----|---------|
| D1 | 10.0000 |
| D2 | 10.0000 |
| H | 10.0000 |

Apply Delete

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Runner Balancing Optimization Setup



Runner Balancing Optimization Results





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Reduce / Fix Errors

**Detailed setup, same
Workflow
Optimization**

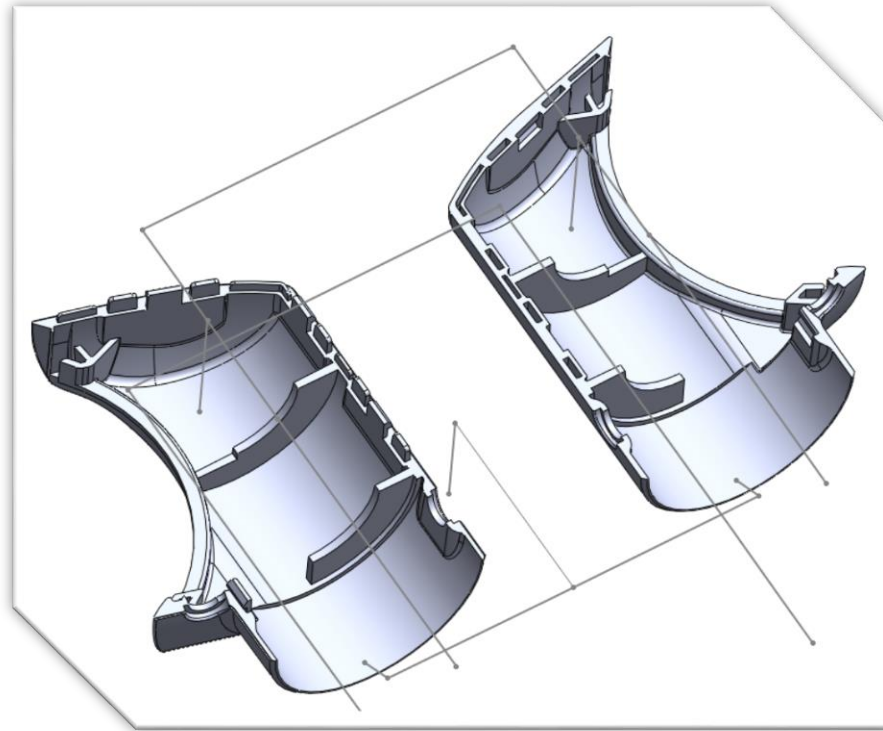
SOLIDWORKS Plastics

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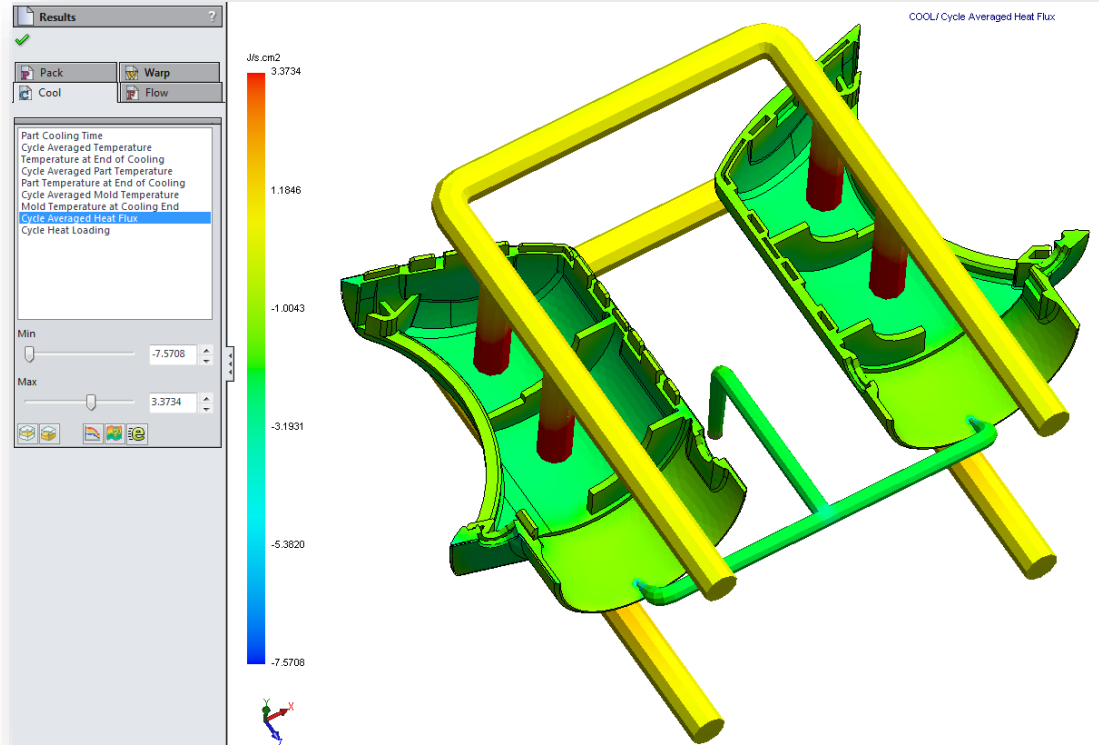
Cooling Lines /
Warpage.



SOLIDWORKS Plastics– Cooling and Warpage

Cooling Analysis Capabilities

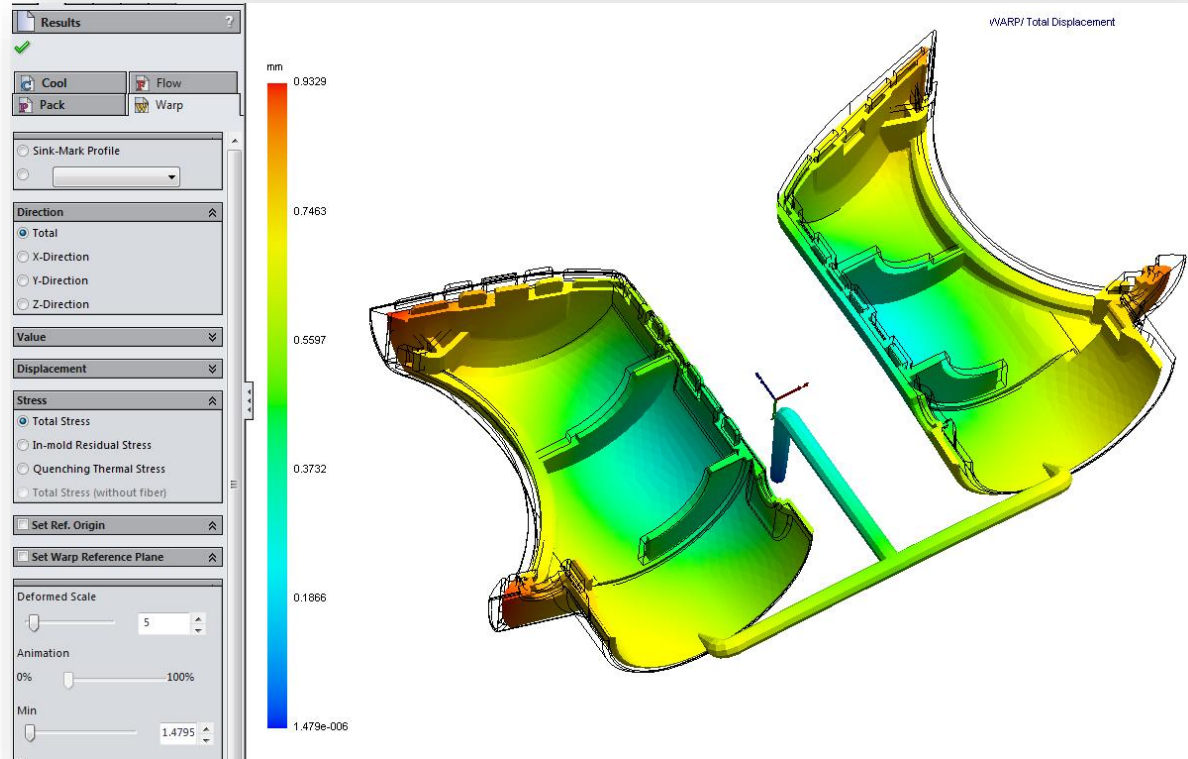
- Design / Analyze simple or complex mold cooling line layouts
- Achieve uniform temperature distributions across mold core and cavity surfaces to minimize part warpage
- Model / Analyze baffles, bubblers and mold inserts
- Optimize cooling system design to minimize cycle times and decrease manufacturing costs



SOLIDWORKS Plastics - Cooling and Warpage

Warpage Analysis Capabilities

- Predict warpage (part deformation) due to molded-in stresses / quenching thermal stresses
- Optimize part and mold design, material selection and processing parameters to reduce or eliminate molded part warpage





SOLIDWORKS Plastics

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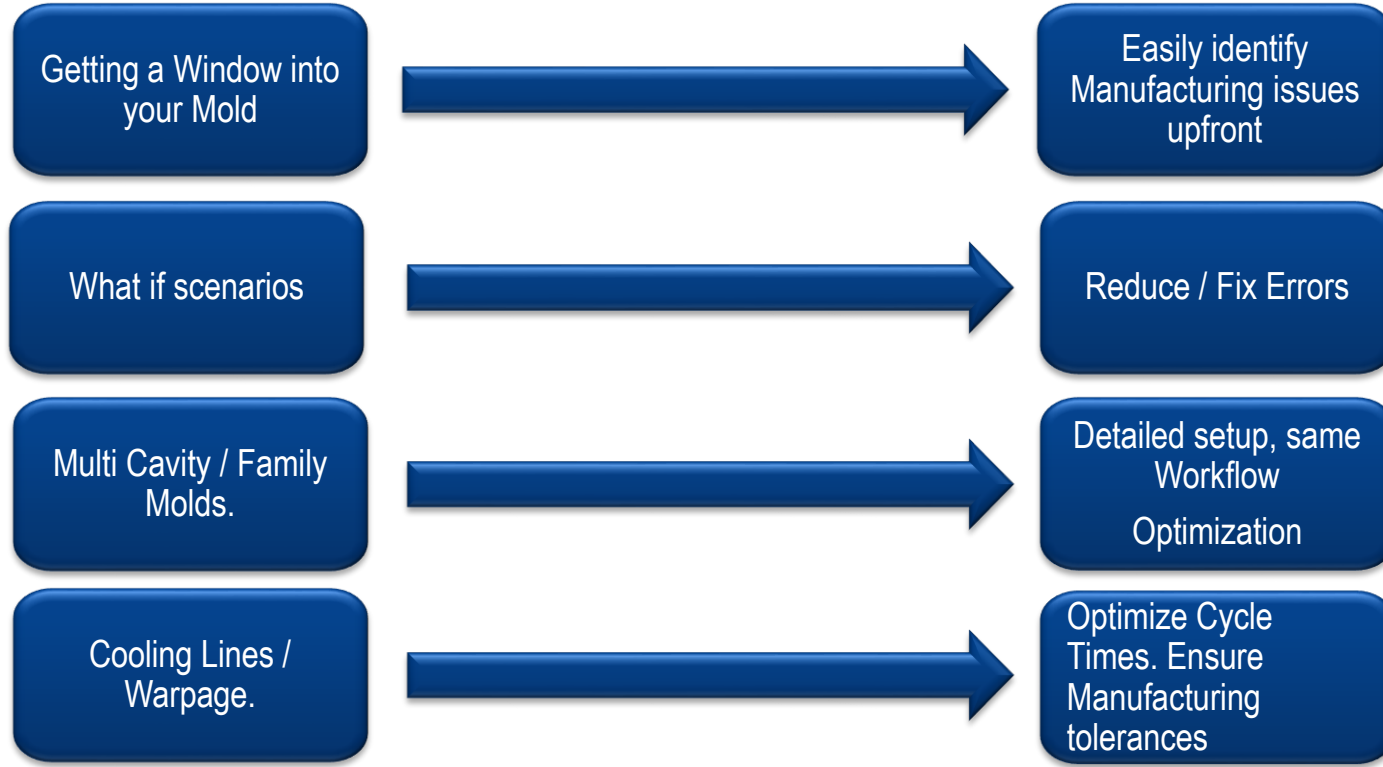
Easily identify
Manufacturing issues
upfront

Reduce / Fix Errors

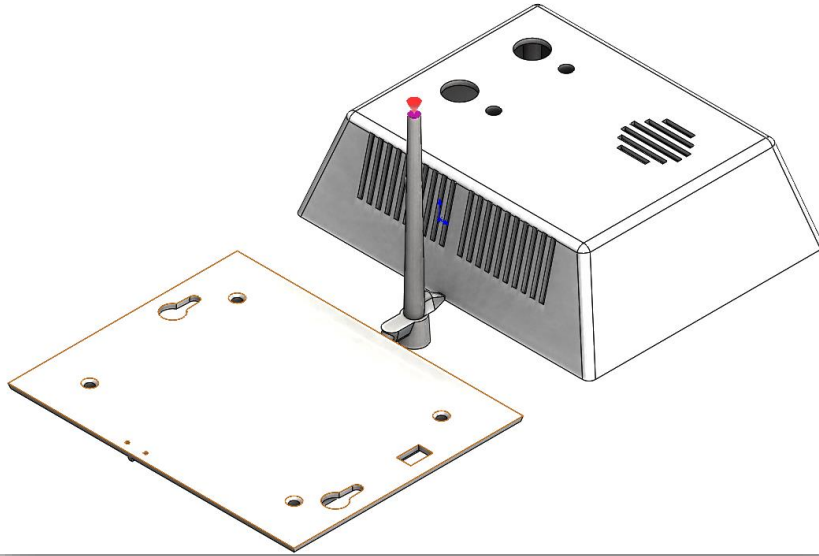
Detailed setup, same
Workflow
Optimization

Optimize Cycle
Times. Ensure
Manufacturing
tolerances

Benefits Summary



Radon Detector Validation Example

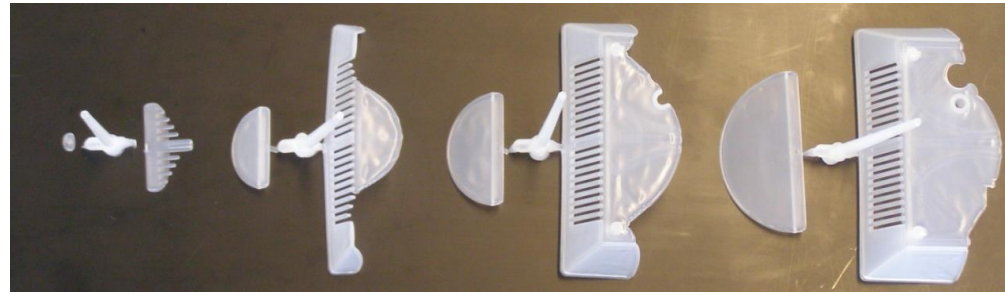


Experimental work by Prof. Stephen Johnston,
UMass Lowell

- ▷ Renowned Plastics Engineering Department
 - ▷ PP material
 - ▷ Arburg, Sumitomo injection molding machines
 - ▷ Family mold (imbalanced)
 - ▷ Pressures taken from machine display, not instrumented tool cavity sensors
 - ▷ Interesting cooling system
- ▷ Clamp forces estimated from machine displays, flashing studies

Filling

Radon Detector Short Shot Series

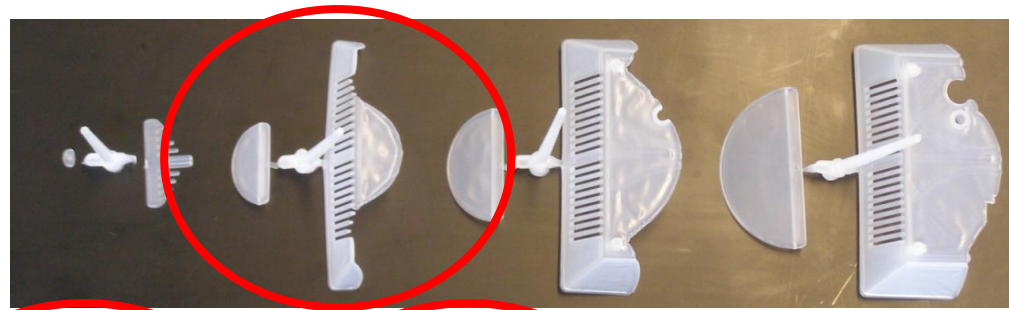


- Short shot simulated experimentally by varying dosage volumes
- Validation of filling pattern evolution



Filling

Radon Detector Short Shot Series

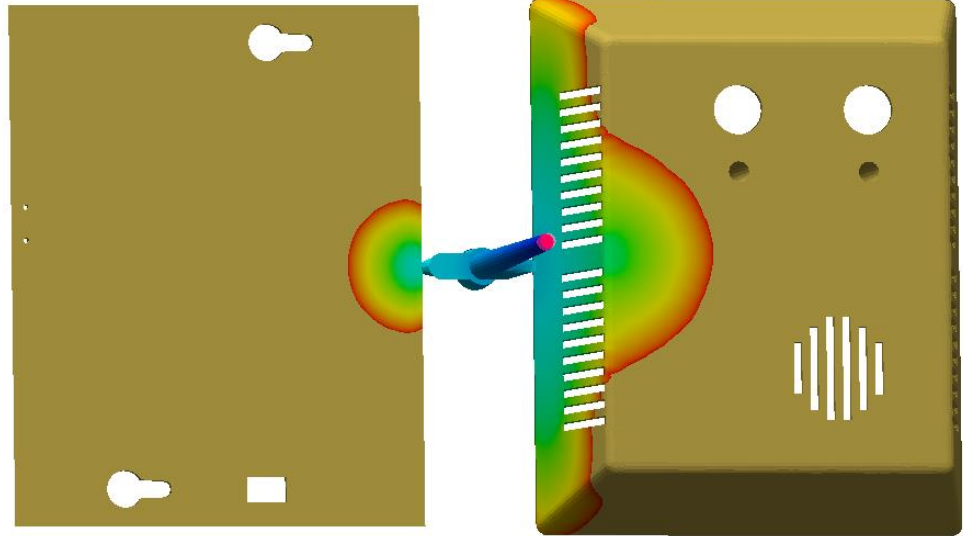


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Filling

Radon Detector Short Shot Series

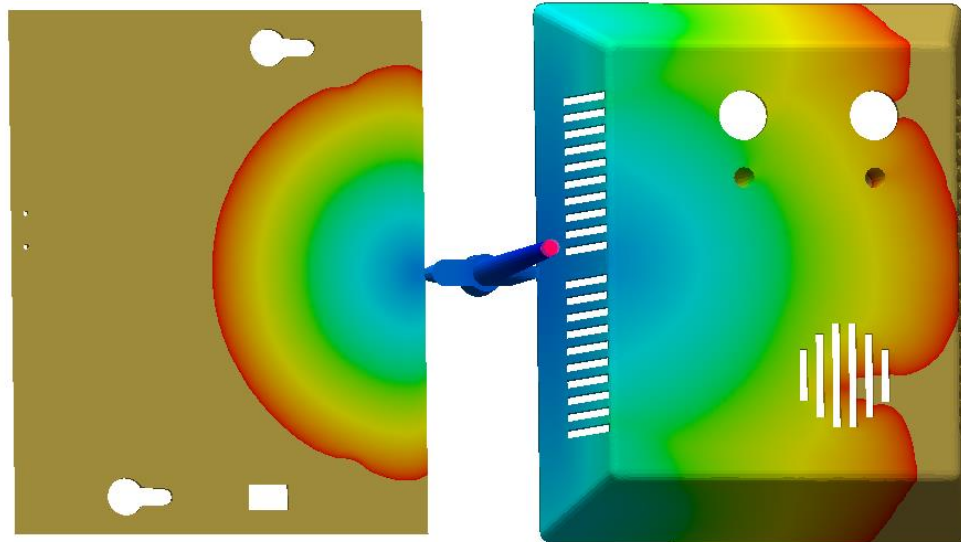
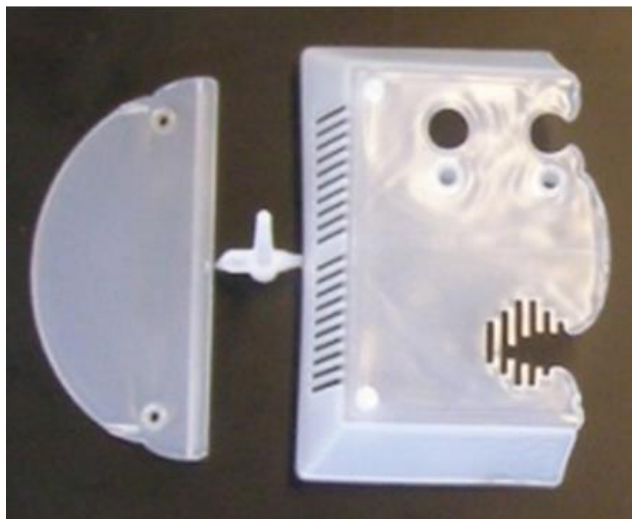
- Dosage volume: 20 cc
- Filling time: 0.47 sec (.40 Sim)



Filling

Radon Detector Short Shot Series

- Dosage volume: 60 cc
- Filling time: 1.48 sec (1.40 Sim)

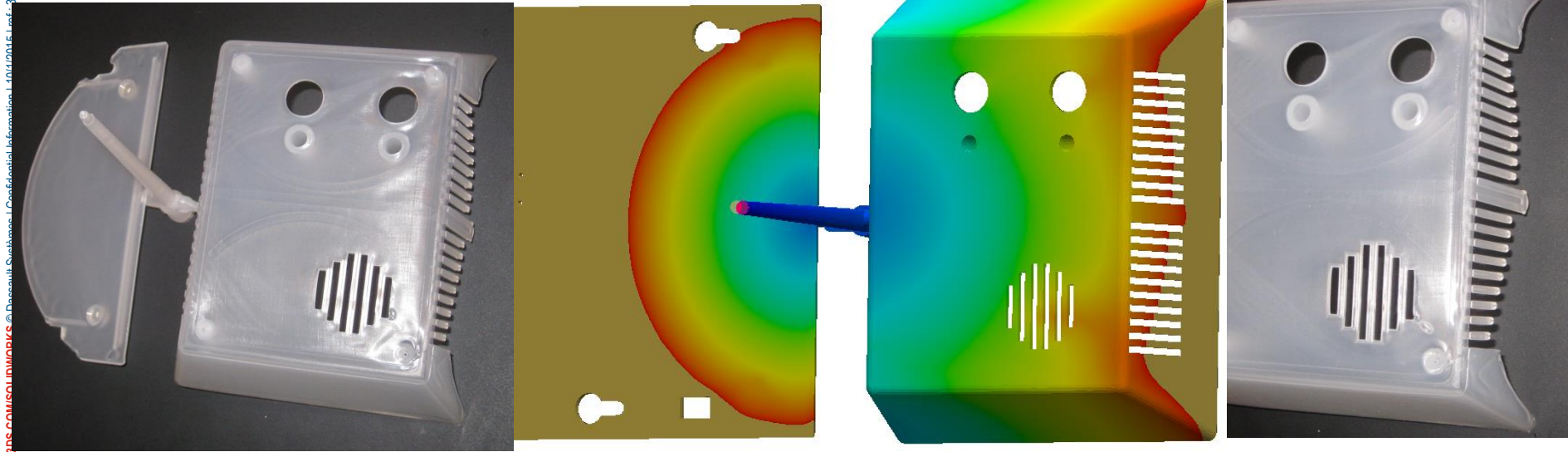


Filling

Radon Detector Short Shot Series

- Dosage volume: 70 cc
- Filling time: 1.72 sec (1.68 Sim)

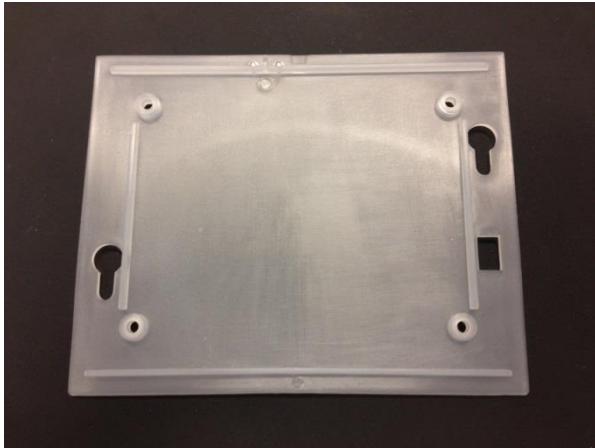
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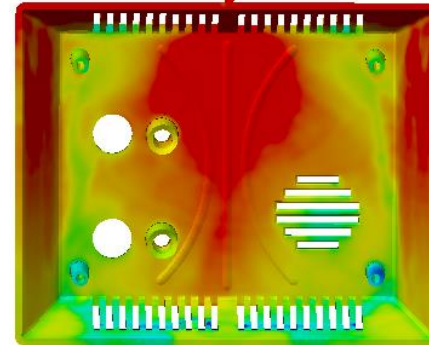
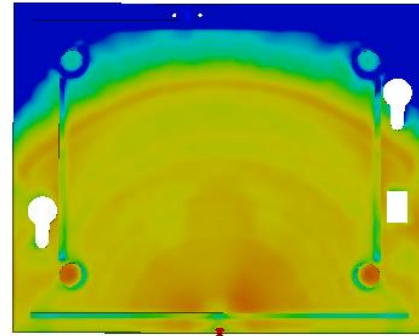
Filling

Gate Imbalance

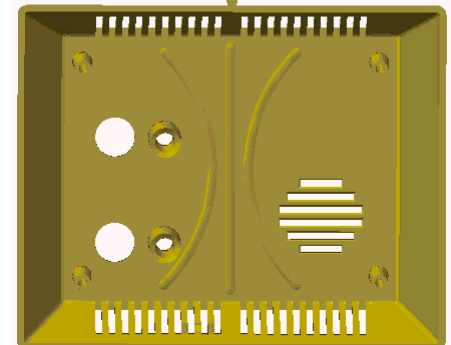
- Larger cavity fills first
- “hesitation mark” defect



visible defect in actual finished part

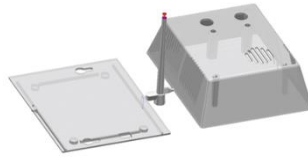


flow front central temperature



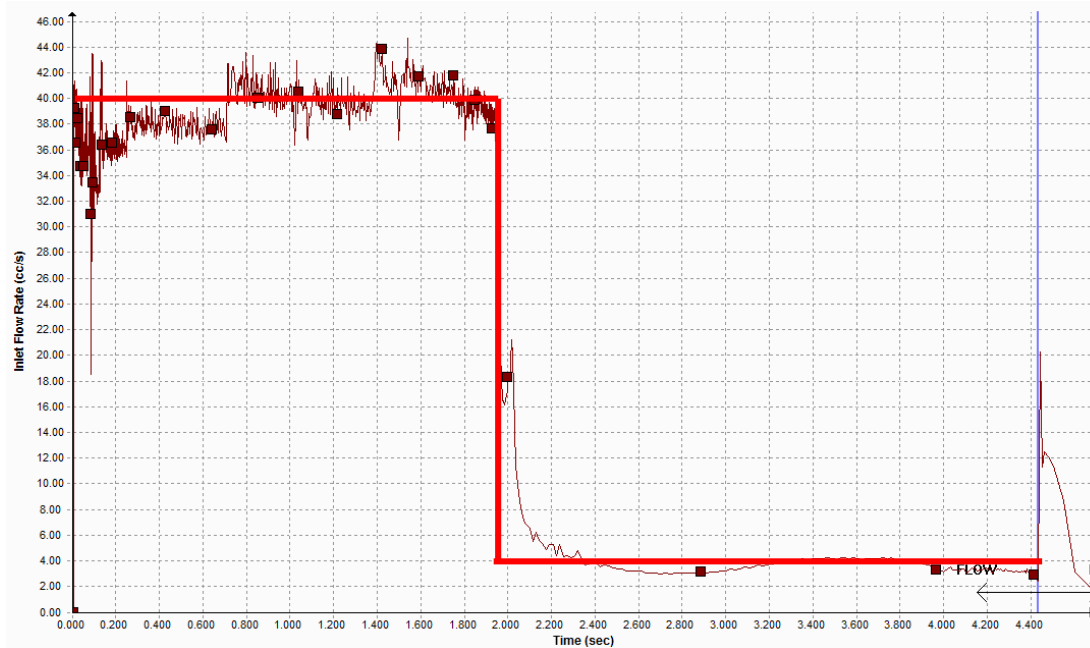
filling time animation

Filling

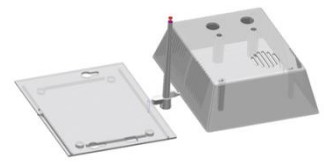


- Flow rate control selected
- Profile defined to reproduce test

Inlet Flow Rate (Machine Set Point: **40cc/s**)

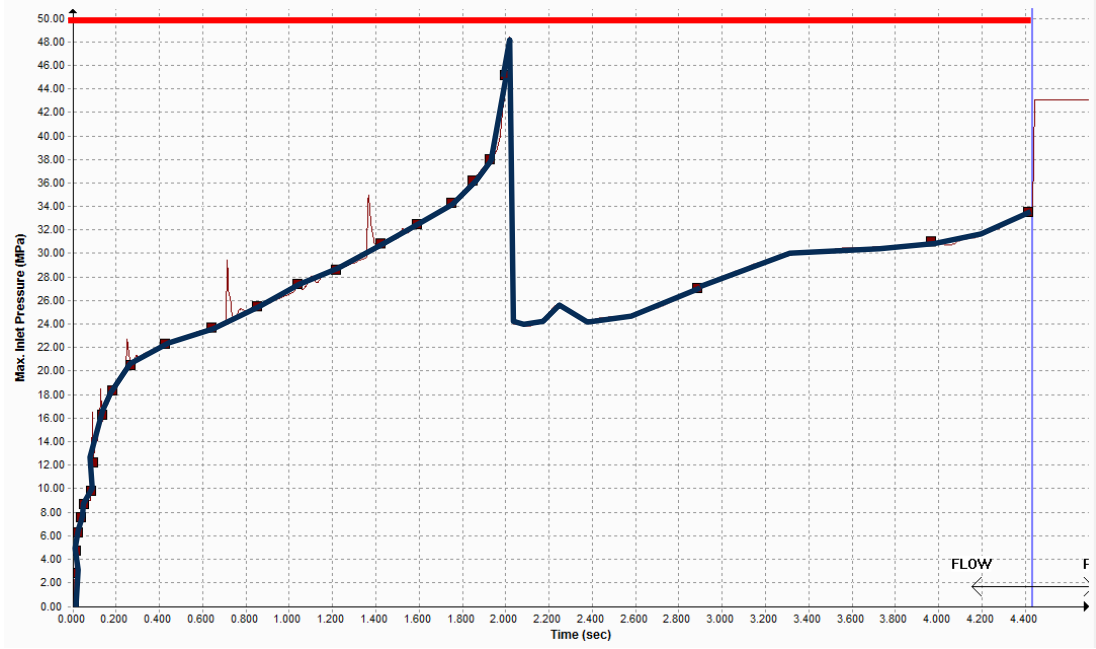


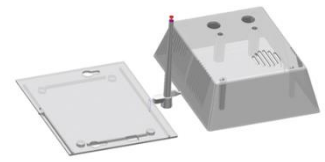
Filling



Inlet Pressure (Maximum Test Fill Pressure: **50.9 MPa**)

- Computed pressure to produce required flow rate
- Spike at end of 40 cc/sec interval
- Max Pressure
 - ▷ Simulation = 48 MPa
 - ▷ Test = 50.9 MPa

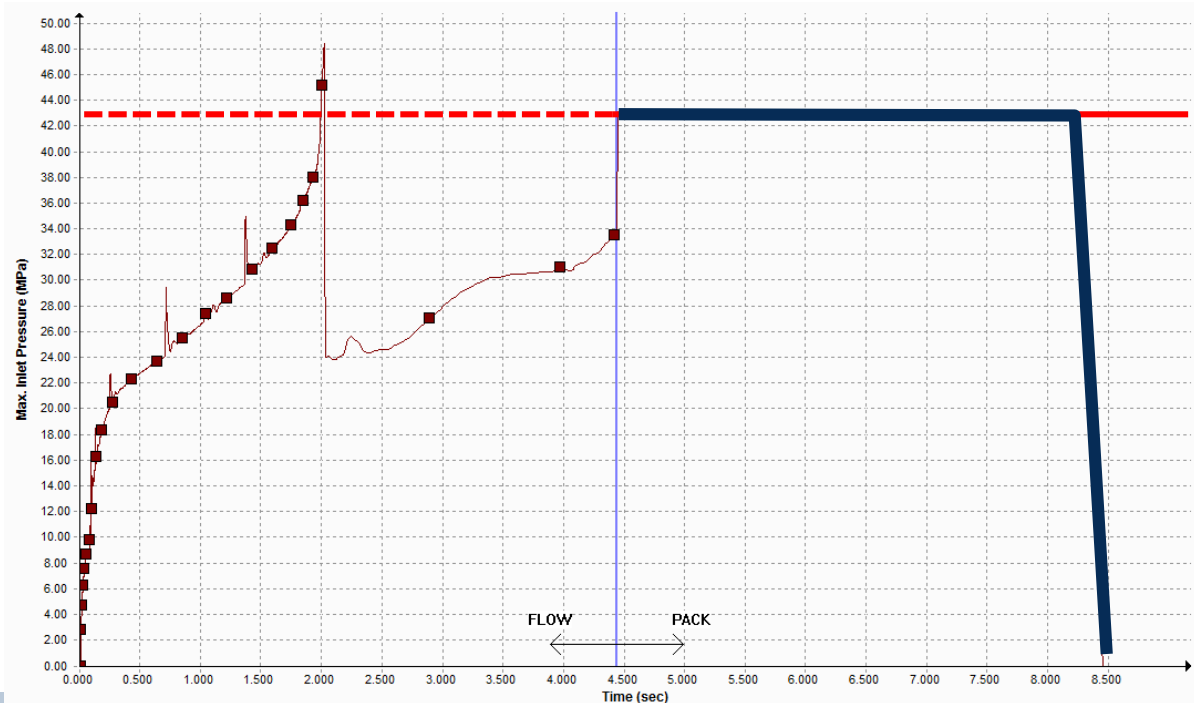


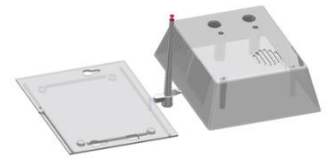


Packing

Holding Pressure (Maximum Test Packing Pressure: **43 MPa**)

- Absolute pressure control selected
- Test pressure input

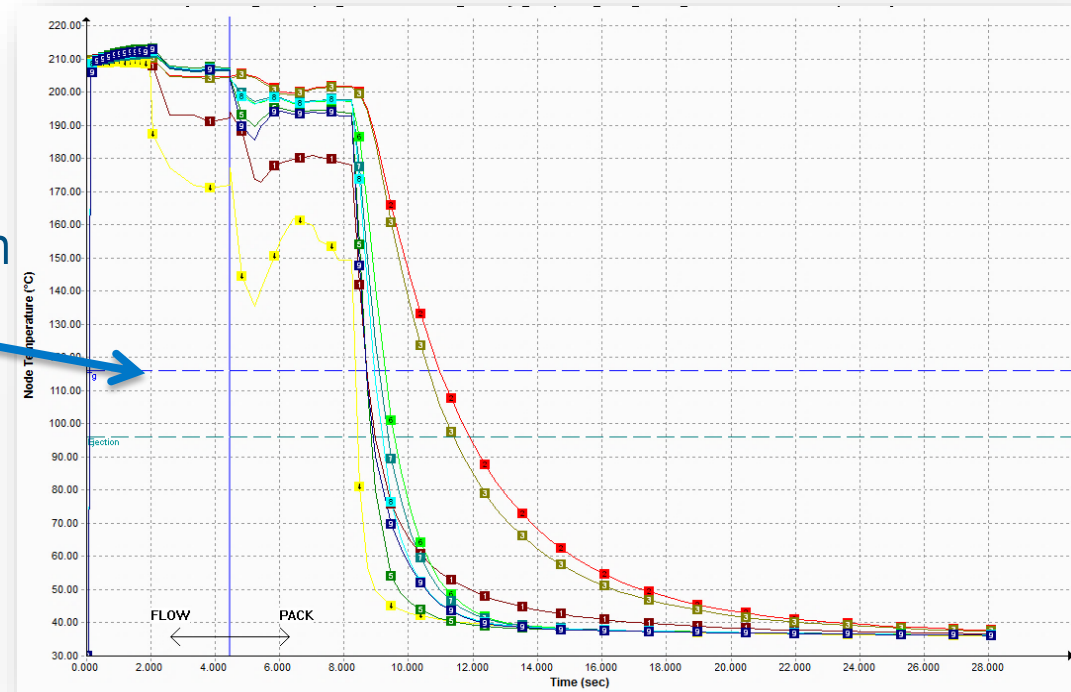
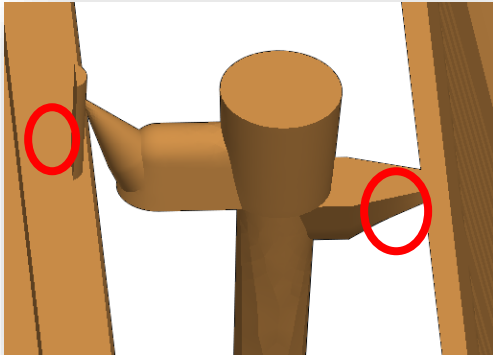




Packing

Gate Freeze Prediction

- Plot temperature at several node in gate cross-section
- Compare to Glass Transition Temperature (T_g)

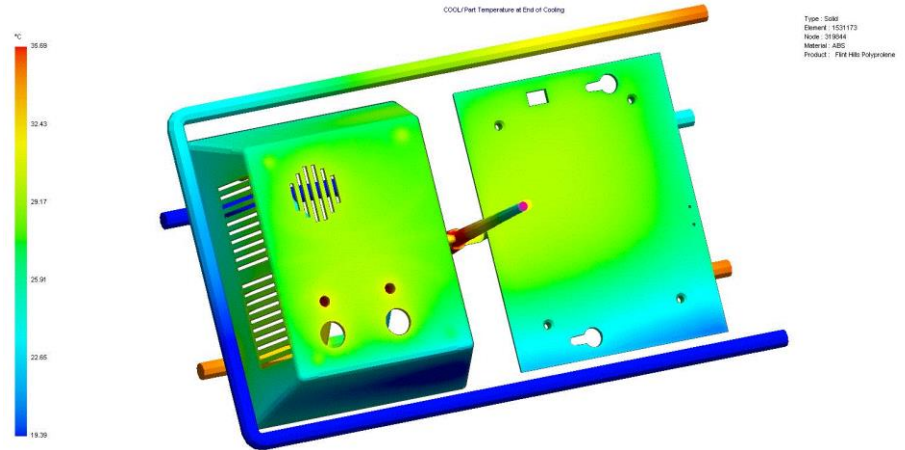
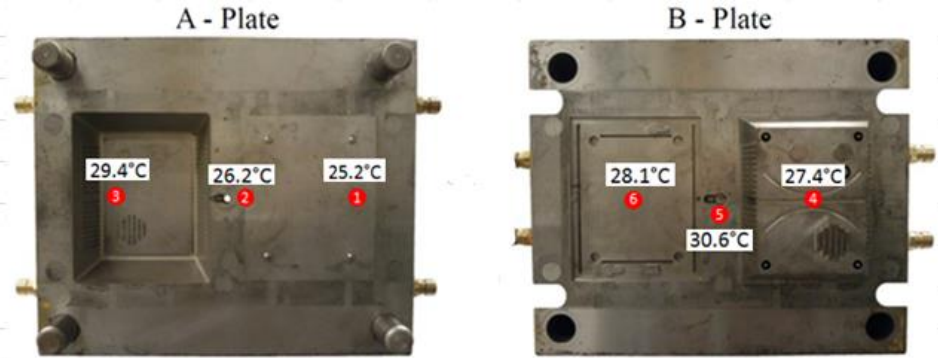


Cooling

Non-Uniform Cavity Temperature

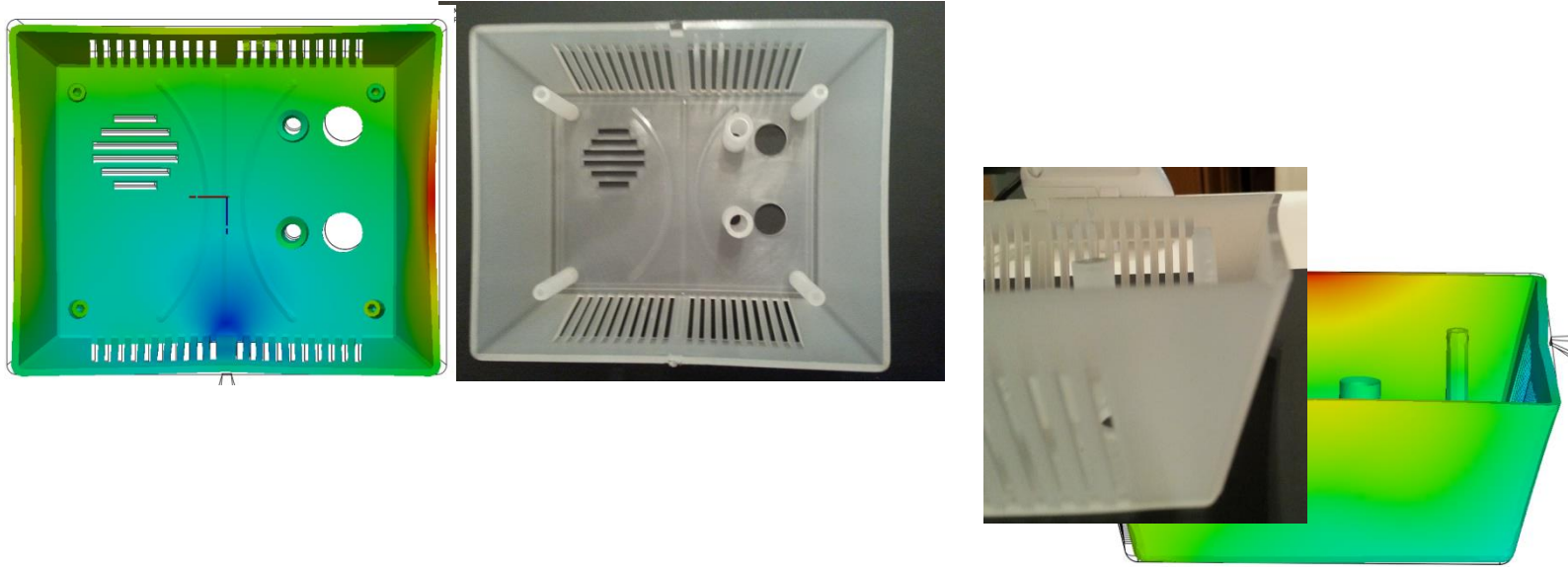
- Sprue inlet temperature = 207°C
 - ▷ Measured in “purge shot”

| | Test(°C) | Sim(°C) |
|------------|-------------|---------|
| Location 1 | 25.2 | 26.4 |
| Location 2 | 26.2 | 29.0 |
| Location 3 | 29.4 | 27.4 |
| Location 4 | 27.4 | 30.4 |
| Location 5 | 30.6 | 27.8 |
| Location 6 | 28.1 | 29.9 |



Warping

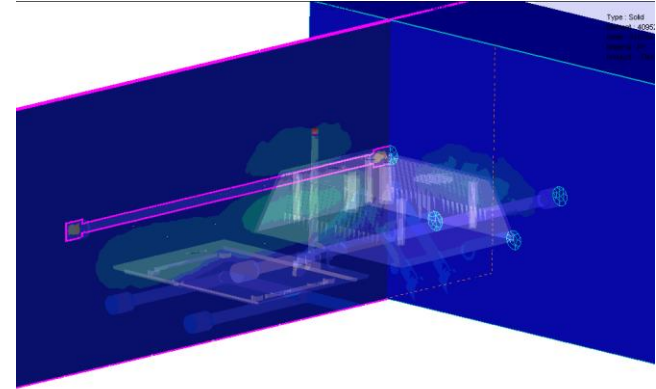
Part Shrinkage (1 mm warpage on actual part, 0.9345 mm - Simulation)



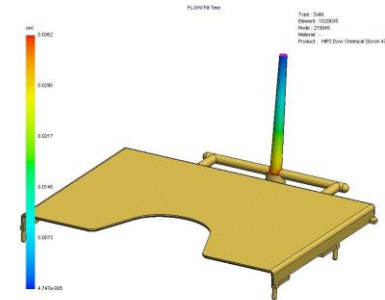
warping(magnified deformation)

Manufacturing Objectives & Problems

- ▶ Reduce cycle time
 - ▷ Open tools as soon as possible
- ▶ Cooling system design
 - ▷ Avoid hotspots that delay solidification
- ▶ Uniformity in multi-cavity tools
 - ▷ 3x3 array of parts in one tool
- ▶ Part appearance
 - ▷ Incomplete filling, weld lines, overheated regions
- ▶ Part net shape (shrinkage & warpage)



temperature cross-section in mold tooling



SOLIDWORKS Plastics Delivers Value...

Streamlined Communication with Mold Manufacturers

Eliminate costly mold rework

Decrease time to market – Cut down cycle times, machine downtime

Improve product quality

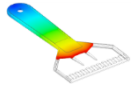
SOLIDWORKS Plastics - Packages

SOLIDWORKS Plastics Standard(Fill)

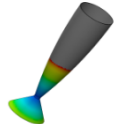
Surface &
Solid Meshing



Filling



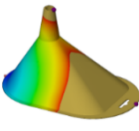
Short Shots



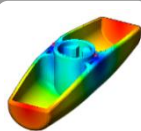
Weld Lines



Air Traps



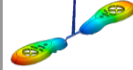
Multiple
Gates



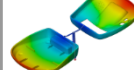
SOLIDWORKS Plastics Professional

(Fill + Pack)

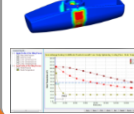
Multi-Cavity



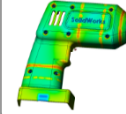
Runner
Balancing



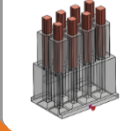
Cooling Time



Shrinkage &
Sink Marks



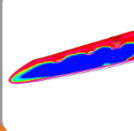
Insert
Overmolding



Gas-Assist &
Valve Gates



Co-Injection

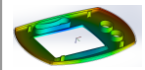


Fiber Analysis &
Birefringence



SOLIDWORKS Plastics Premium (Warp + Cool)

Warp



Cool



Thank You!

- ▶ Visit the SOLIDWORKS website at <http://www.solidworks.com> to learn more about SOLIDWORKS and its product offerings.
- ▶ Contact your local SOLIDWORKS reseller for information on pricing and training. To find a reseller in your area call:
 - ▷ 1-800-693-9000 (US and Canada)
 - ▷ +1-781-810-5011 (Outside the US and Canada)

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POLL QUESTION #3

