MOLDFLOW SIMULATION

## Warpage Best Practices

INTRODUCTION

Seek to gain an understanding of Moldflow warpage reduction workflows

- What warp is and how it is displayed
- How does Moldflow help identify root cause of warp
- Warp workflows
- Result review example

WHAT IS WARP?

How do you define warp?
- What should the part below look like in moldflow if it does not warp?
  - Total Deflection
  - X Component
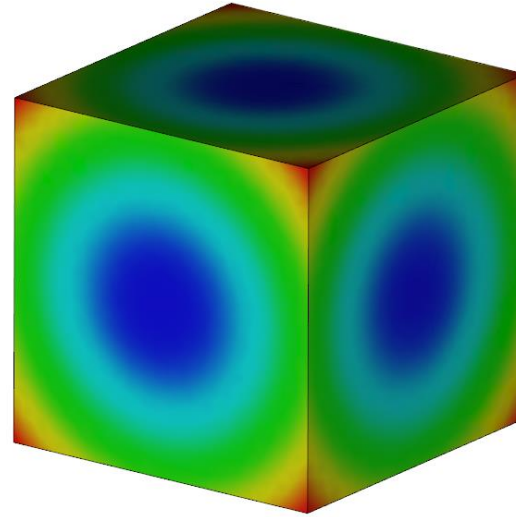 - Y Component
  - Z Component
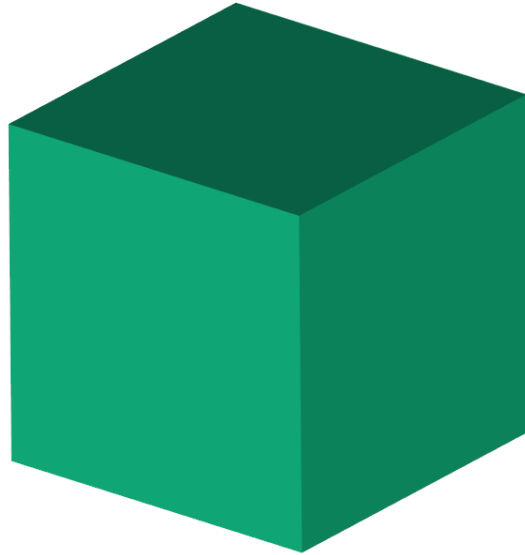
WARPAGE DEFINED

Shrinkage vs Warpage
- Shrink – In plane change in size
- Warp – Out of plane change in shape
  - Due to variations in shrinkage

Has the cube warped?

DEFLECTION RESULTS

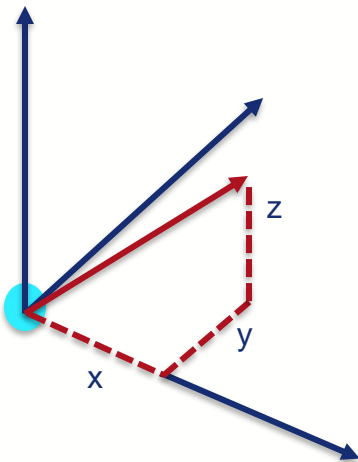By default a best fit display technique is used

- Makes it appear as though the part is shrinking towards the center of the geometry

Deflection, X, Y, Z component

- Change in node position in x, y, or z compared to the input model
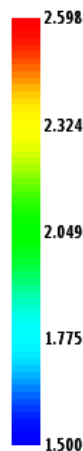
Deflection

- Vector magnitude of the x, y, z component deflections
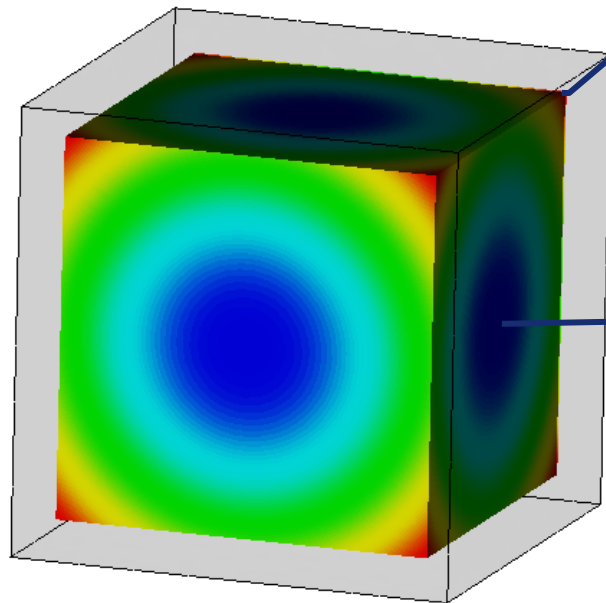 - $(x^2 + y^2 + z^2)^{1/2}$

HAS THE CUBE WARPED?

Deflection, 3% shrinkage: Deflection
Scale Factor = 5.000

[mm]

2.598

2.324

2.049

1.775

1.500

AUTODESK
MOLDFLOW INSIGHT

Scale (100 mm)

X: -1.5 mm
Y: -1.5 mm
Z: -1.5 mm
$(-1.5^2 + -1.5^2 + -1.5^2)^{1/2} = 2.598$ mm

X: -1.5 mm
Y: 0 mm
Z: 0 mm
$(-1.5^2 + 0^2 + 0^2)^{1/2} = 1.50$ mm

-76
-18
-6

MOLDFLOW WARP THEORY

CAUSES OF WARP

Variations in shrinkage are classified by Moldflow in to the following categories

- Region-to-region
    - Differential Shrinkage
- Through the thickness of the cross section
    - Differential Cooling
- Differences parallel and perpendicular to the material orientation
    - Orientation Effects
- Differences through the thickness to the in-plane shrinkage
    - Corner Effects

REGION-TO-REGION
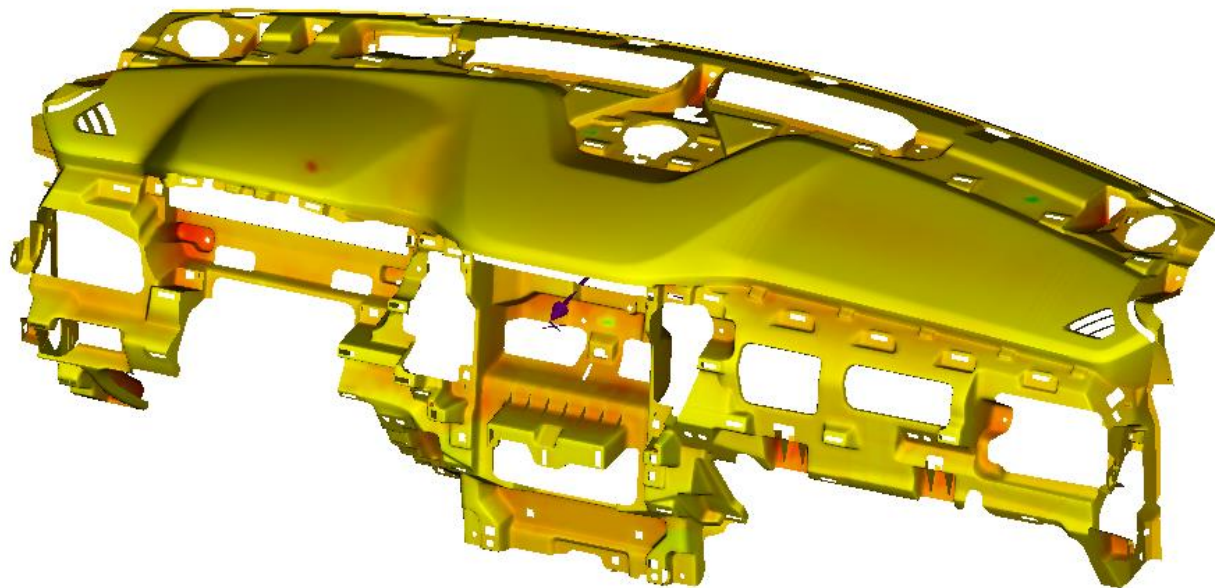

Volumetric shrinkage at ejection = 10.24[%]

[%]

10.24

7.985

5.733

3.482

1.231
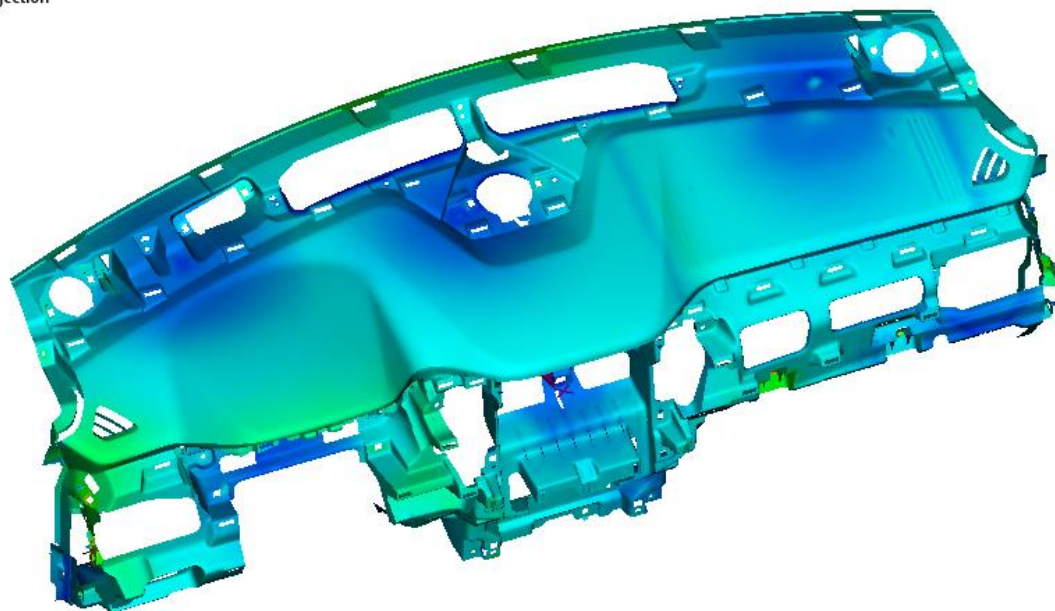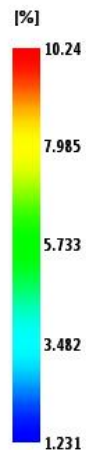
AUTODESK
MOLDFLOW INSIGHT

Scale (1000 mm)

THROUGH THE THICKNESS

Temperature difference, part
= 34.83[C]

[C]
34.83
13.06
60.95
108.8
156.7

AUTODESK
MOLDFLOW INSIGHT

Scale (1000 mm)

PARALLEL AND PERPENDICULAR DIFFERENCES
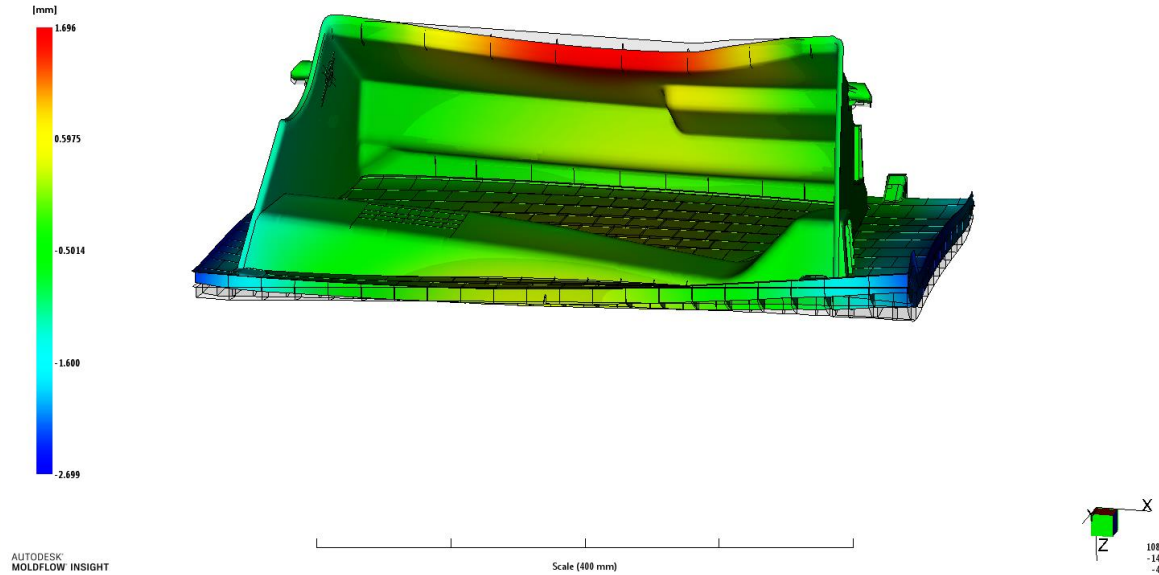

Orientation at top skin = 2.000

Orientation at core = 1.000

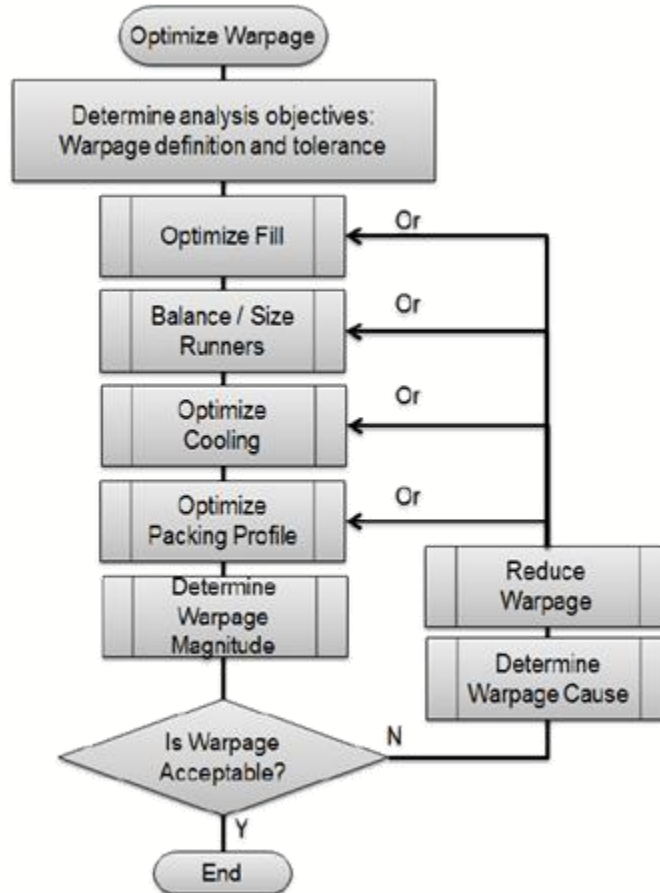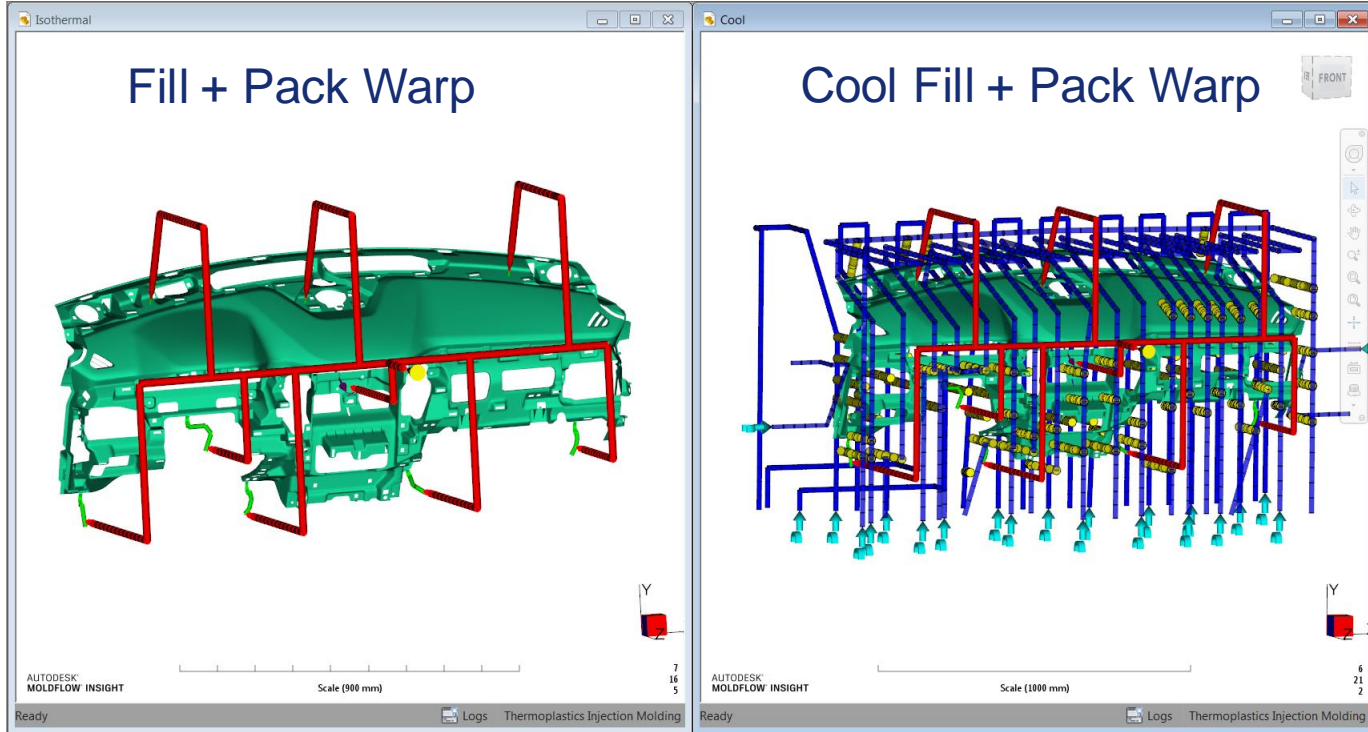# DIFFERENCES THROUGH THE THICKNESS TO THE IN-PLANE SHRINK
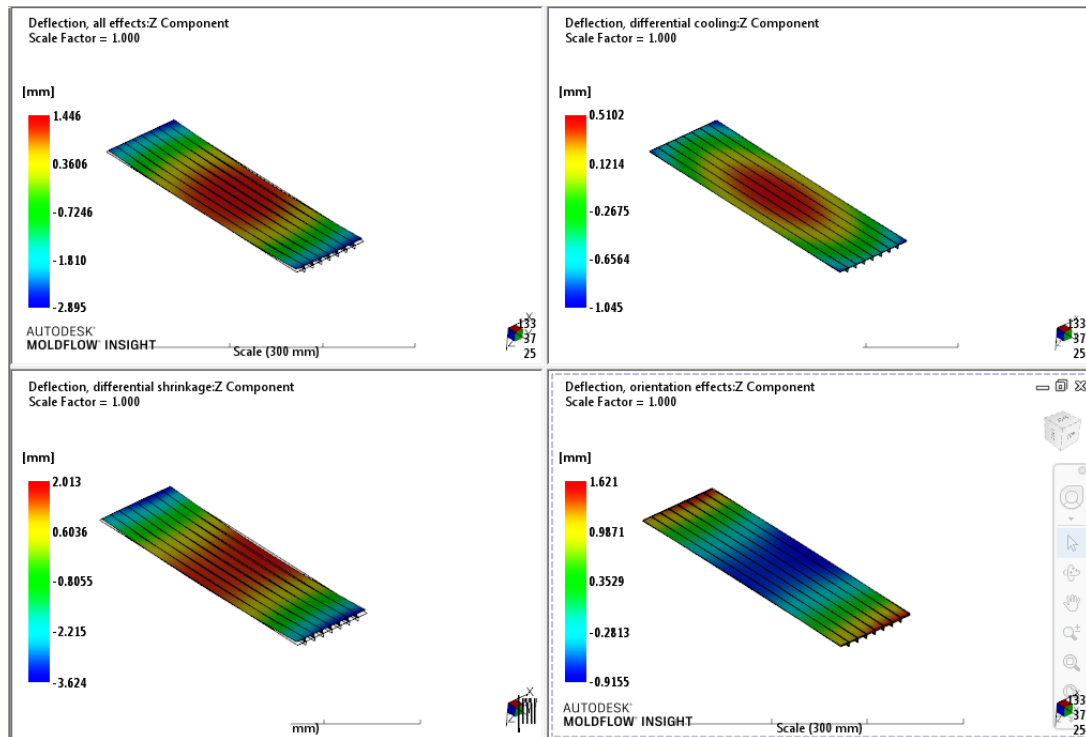
WARP WORKFLOWS

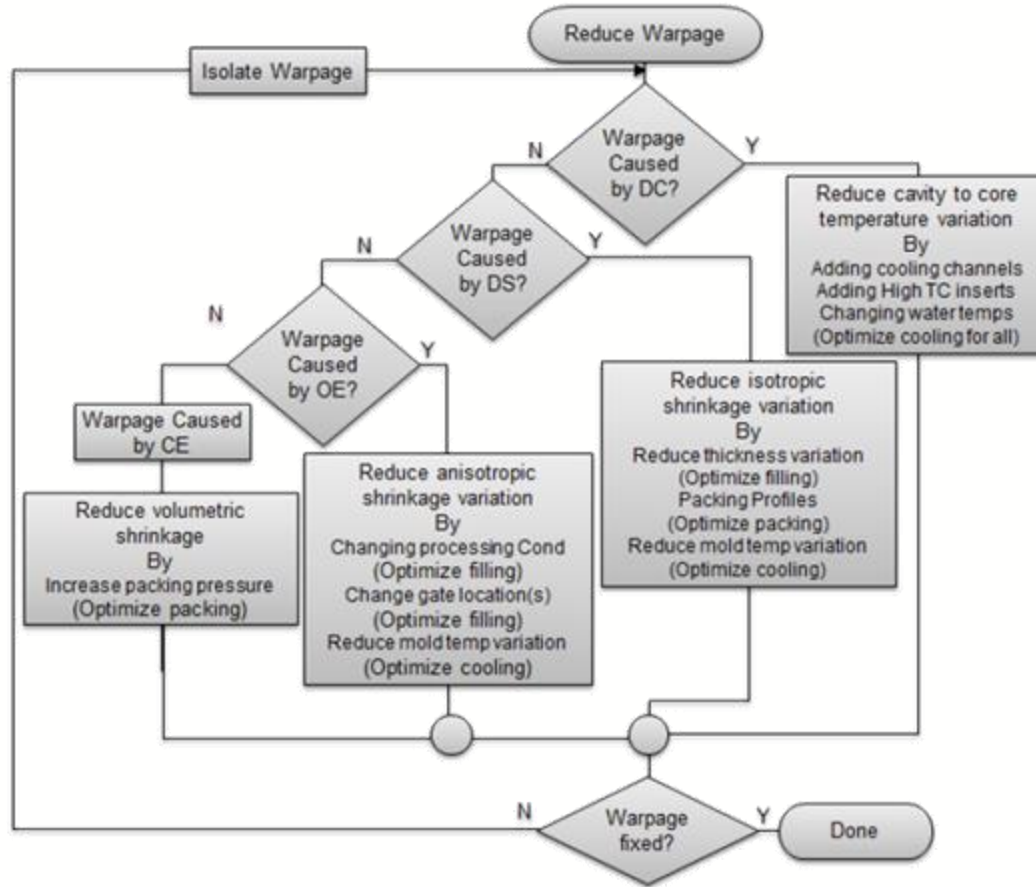# NOMINAL PARTS

OPTIMIZE WARPAGE WORKFLOW
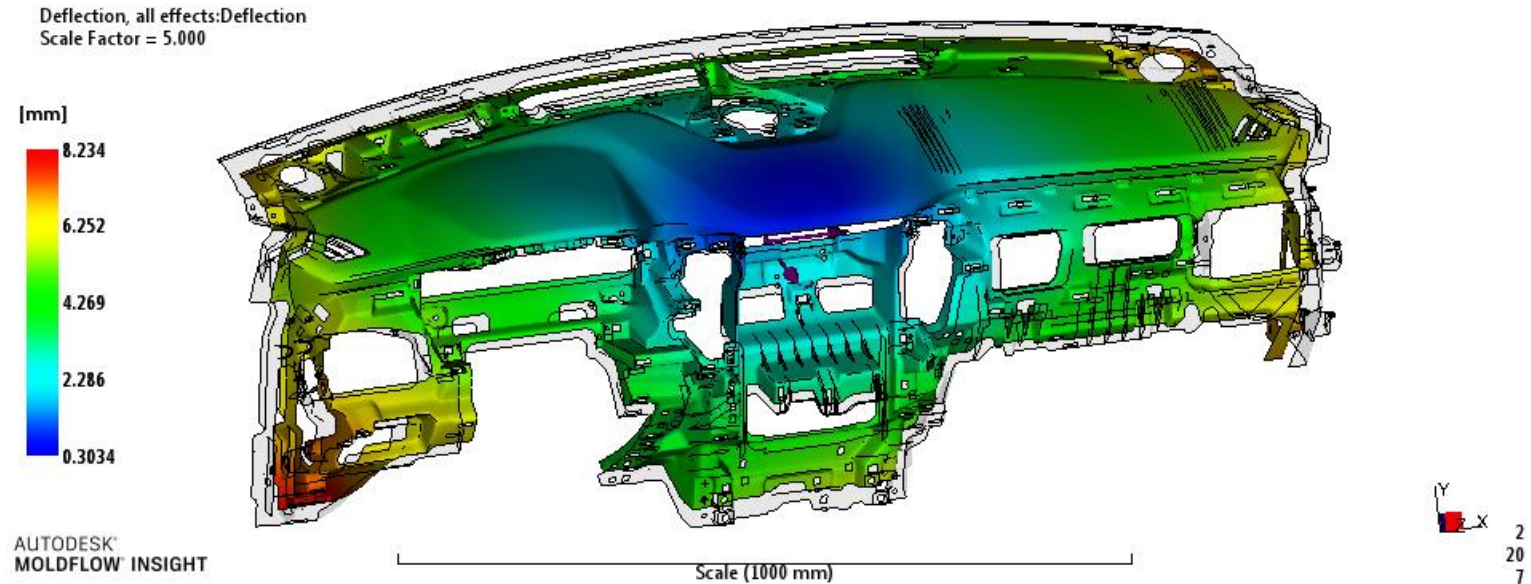
SIMULATION SEQUENCES

IDENTIFY THE CAUSE OF WARPAGE
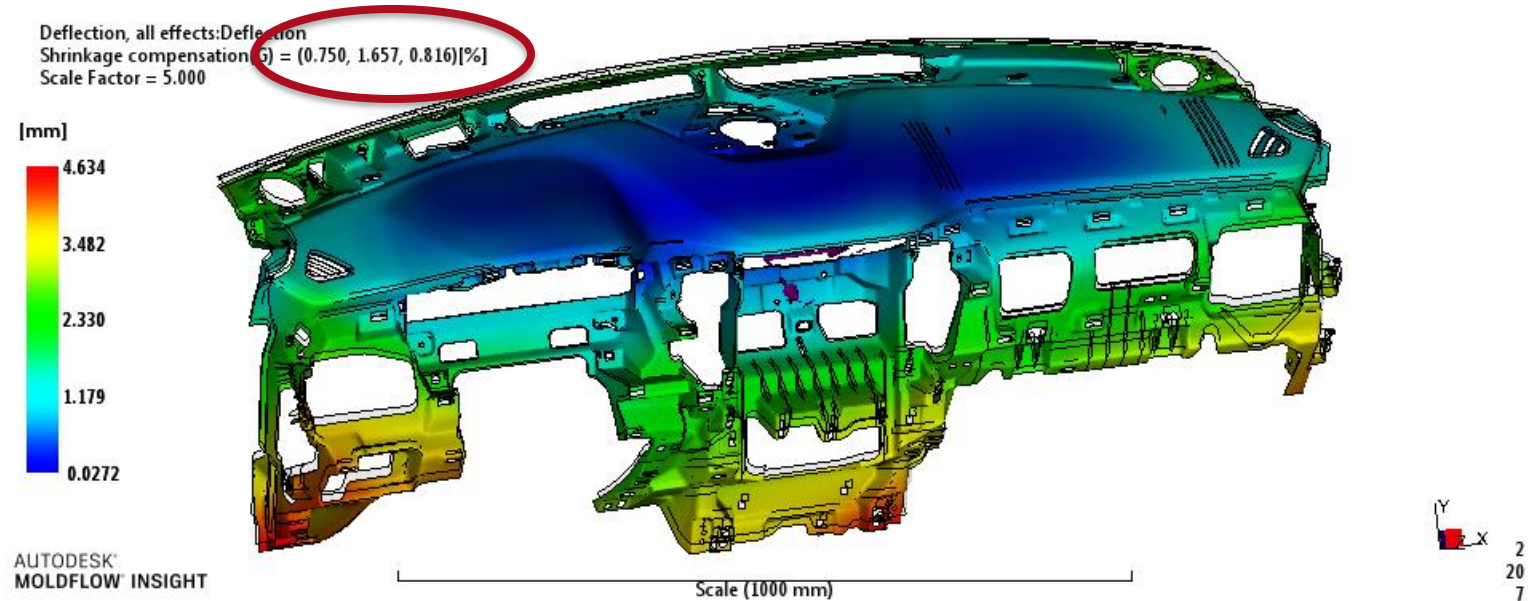
WARPAGE REDUCTION GUIDE

REVIEWING WARP RESULTS

FIRST LOOK – SHRINK + WARP

Is this good or bad?

CAN YOU REMOVE THE SHRINK?

Deflection, all effects:Deflection
Shrinkage compensation (1) = (0.750, 1.657, 0.816)[%]
Scale Factor = 5.000

[mm]

4.634

3.482

2.330

1.179

0.0272

AUTODESK
MOLDFLOW INSIGHT

Scale (1000 mm)

What does the circled region indicate the analyst has done?

IS THAT HOW THE TOOL WILL BE CUT?

On the previous slide the analyst compensated the shrinkage automatically
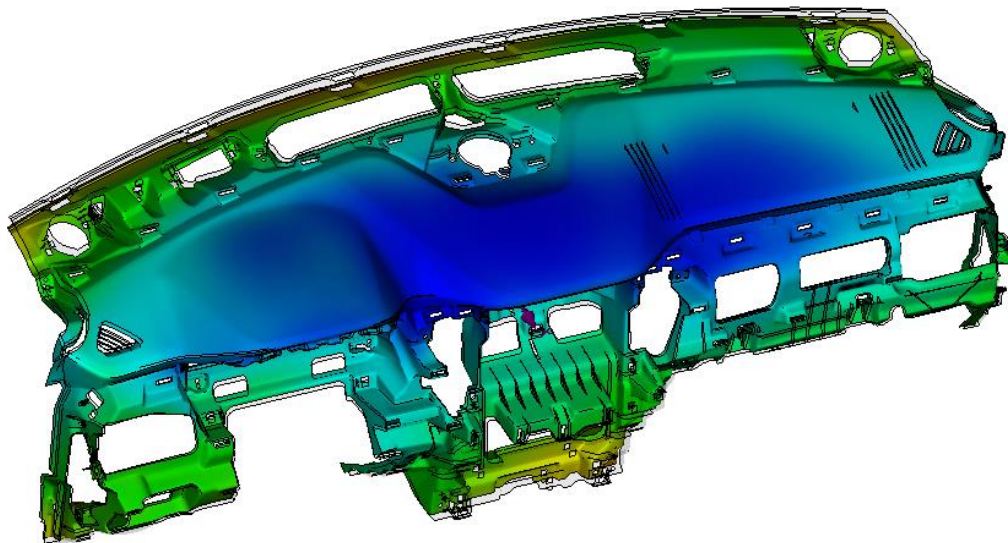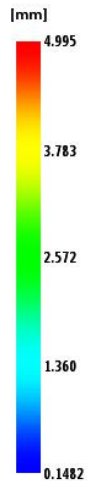
- Moldflow takes the average shrink in each direction x, y, and z and removes it from the plot
- As a reviewer does this make sense?

COMPENSATE APPROPRIATELY

Deflection, all effects:Deflection
Shrinkage compensation(G) = 0.825[%]
Scale Factor = 5.000

[mm]
4.995

3.783

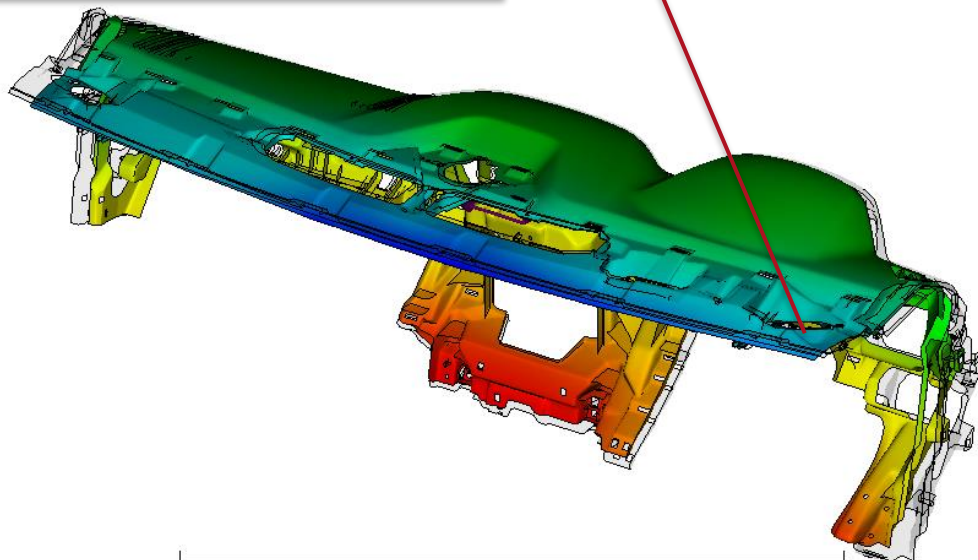2.572

1.360

0.1482

AUTODESK
MOLDFLOW INSIGHT

Scale (1000 mm)

HOW TO IDENTIFY THE CAUSE

Deflection, all effects: Y Component : -4.49 mm
Deflection, Diff Cool: Y Component: -0.64 mm
Deflection, Diff Shrink: Y Component: -4.12 mm
Deflection, Orientation: Y Component: 1.83 mm
Deflection, Corner effects: Y Component: -1.66 mm

[mm]

5.353

2.408

-0.5367

-3.482

-6.427

Scale (1000 mm)

-53
153
-18

DIFFERENTIAL SHRINKAGE
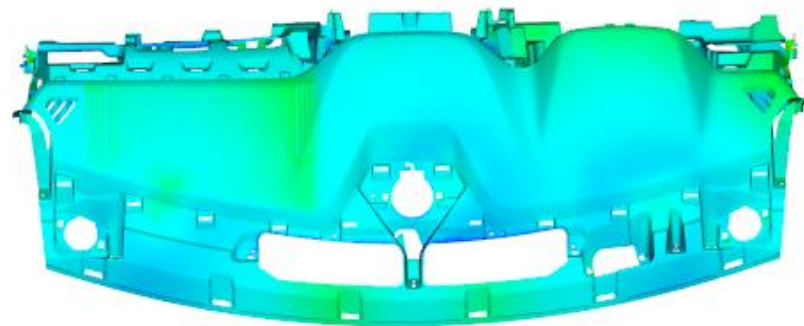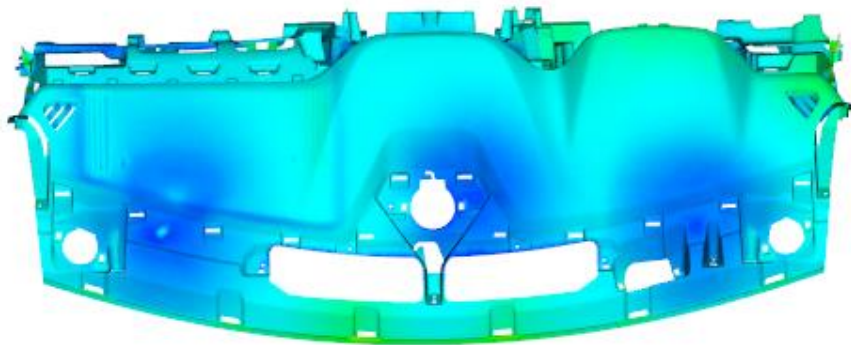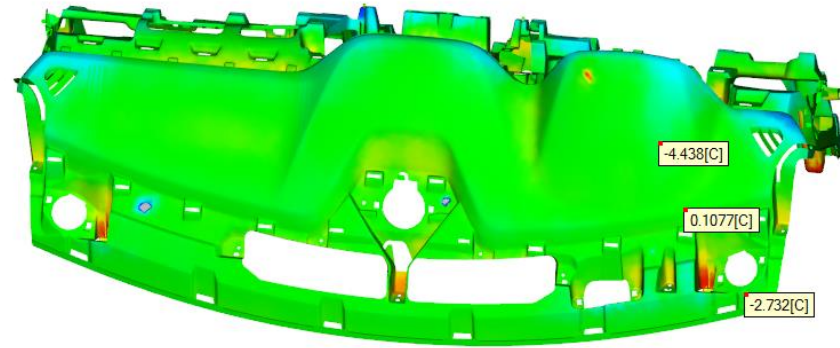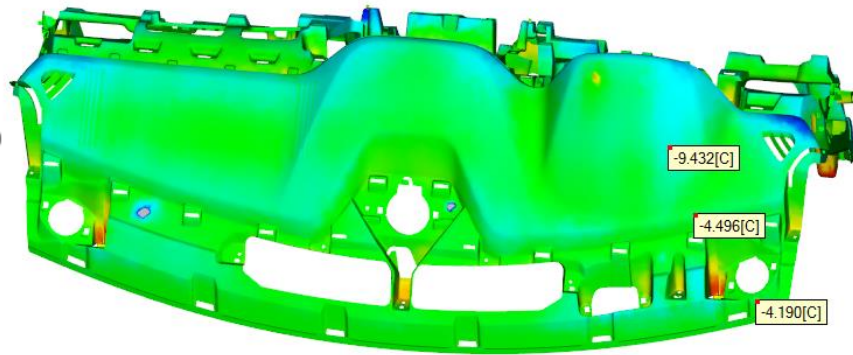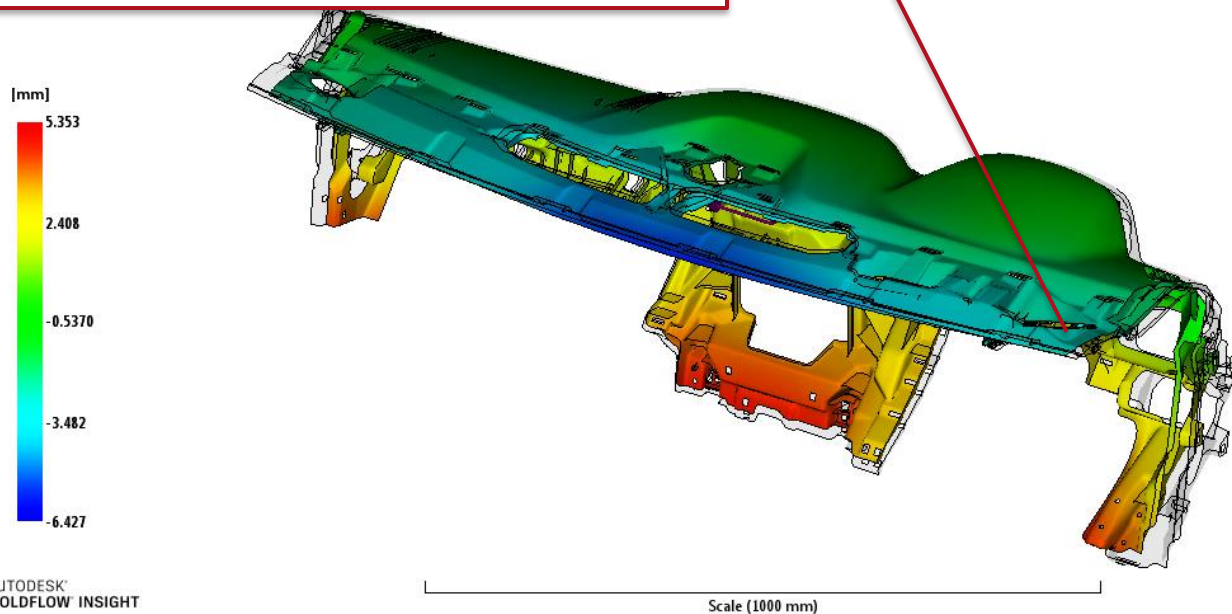
DIFFERENTIAL COOLING

RECHECK DISPLACEMENT RESULTS

Deflection, all effects: Y Component : -2.9 mm
Deflection, Diff Cool: Y Component: -0.26 mm
Deflection, Diff Shrink: Y Component: -1.82 mm
Deflection, Orientation: Y Component: 0.99 mm
Deflection, Corner effects: Y Component: -1.81 mm

[mm]
5.353
2.408
-0.5370
-3.482
-6.427

AUTODESK
MOLDFLOW INSIGHT

Scale (1000 mm)

-53
153
-18

Q & A