Autodesk® Simulation 360 Ultimate: Experience the New World

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Articulinx®

Class Summary: *Agenda*

In this lecture we will …

- Explore Autodesk® Simulation Moldflow® 360 Ultimate
  - Use in the Articulinx product development process
- Explore the power of cloud-based computing
  - Show DOE structure; run with Autodesk Simulation Moldflow 360
  - Live software demonstration

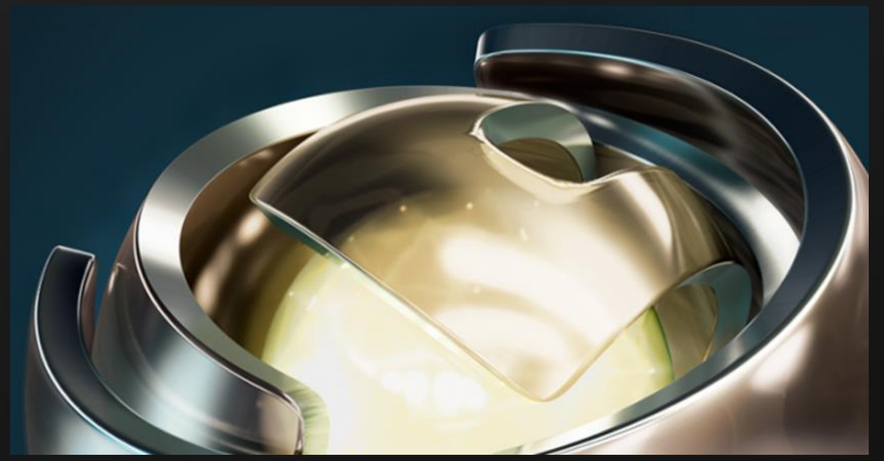
Learning Objectives

At the end of this class, you will …

- Understand the benefits of moving your simulation resources to the cloud
  - See cloud-based simulation in action
- Witness how Autodesk Simulation 360 Ultimate gives you the tools to design better products … *faster*
- Understand how Autodesk Simulation 360 Ultimate increases productivity and user mobility

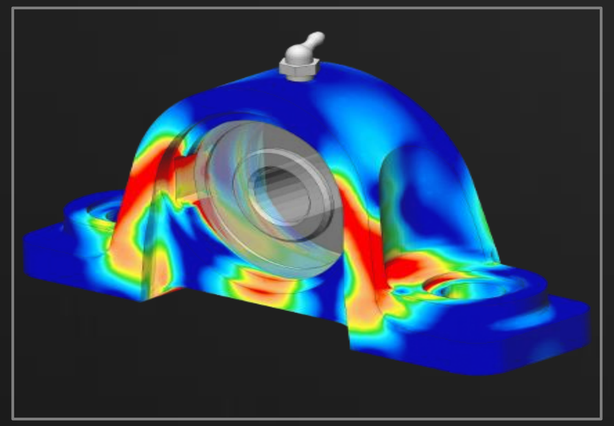
Introduction – Bankim Charegaonkar

Product Manager – Simulation 360

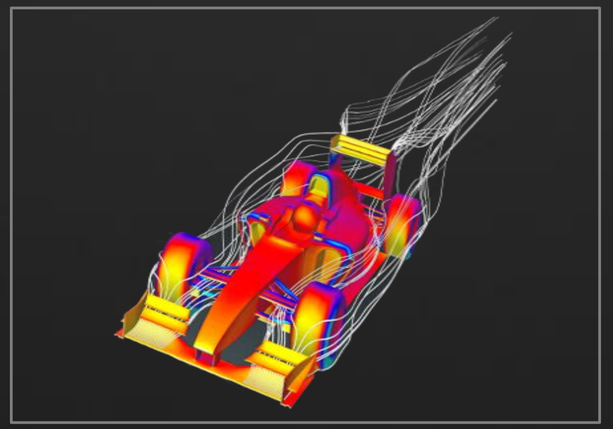


Autodesk Simulation

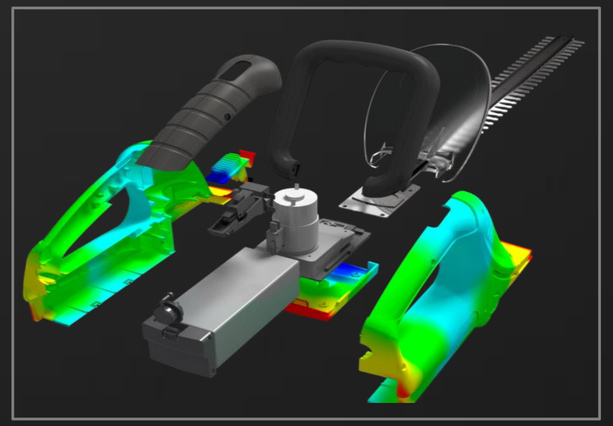
Powered by a World-Class Platform



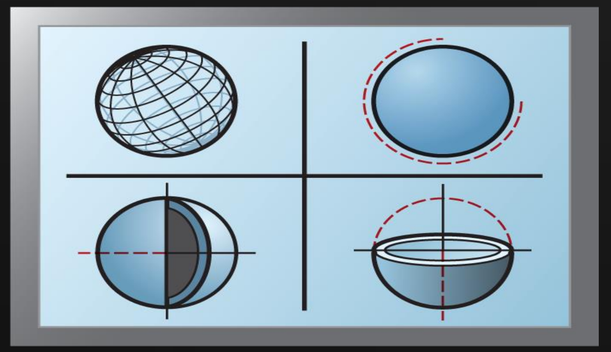
Mechanical



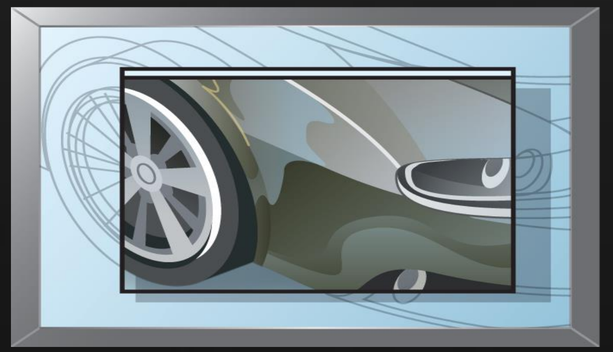
CFD



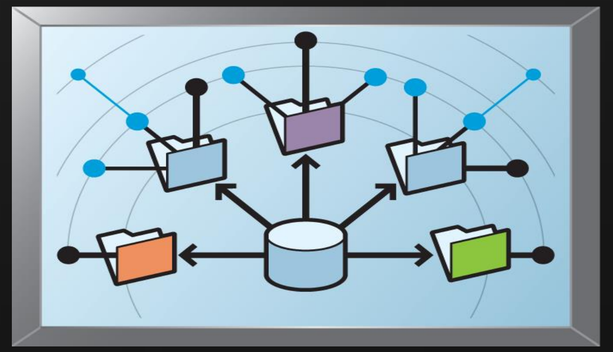
Injection Molding



Geometry

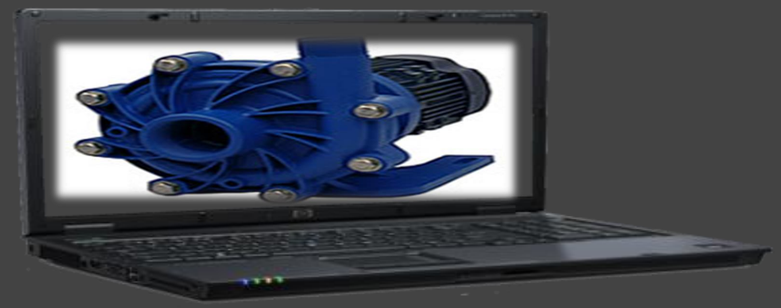


Visualization



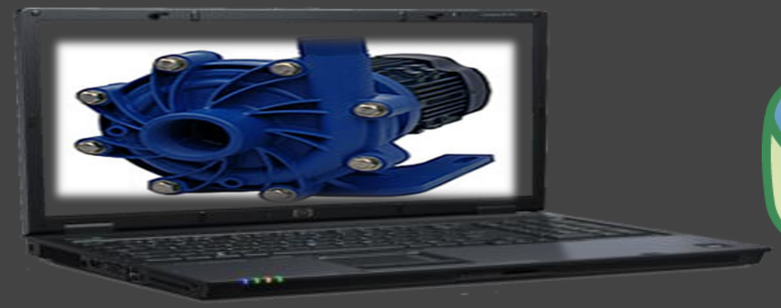
Data Management

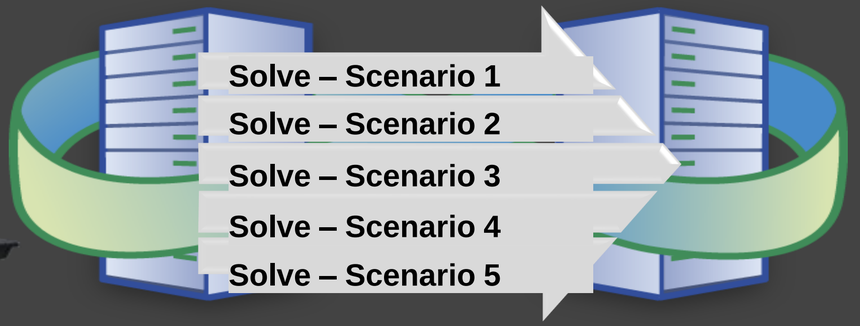
Infinite Computing Power in the Cloud



Solve – Scenario 1

Desktop



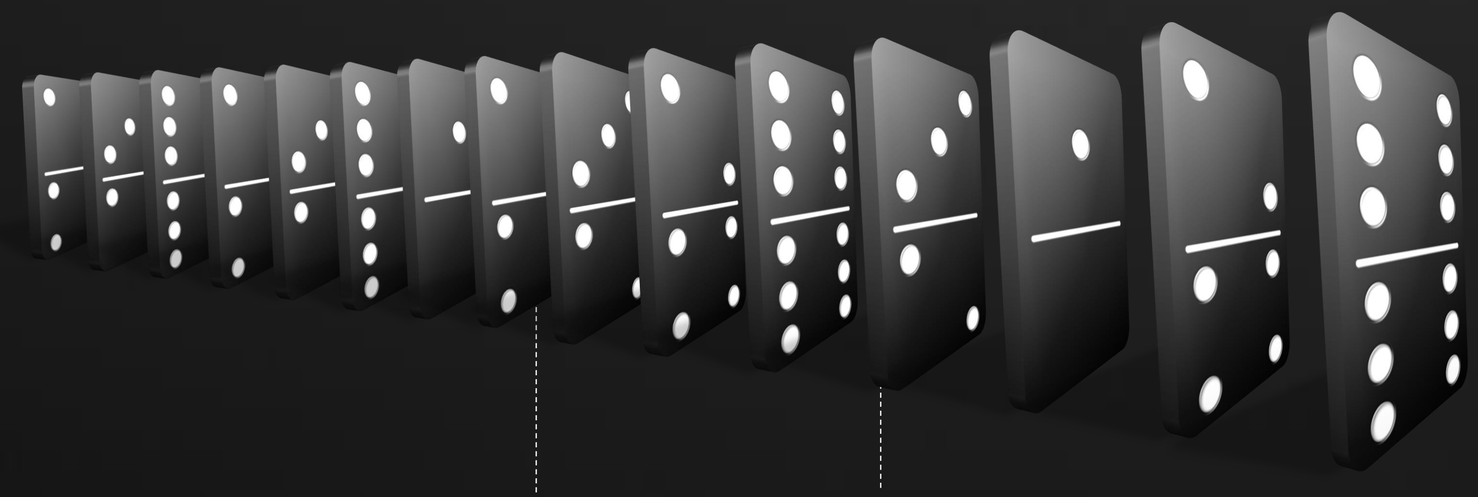


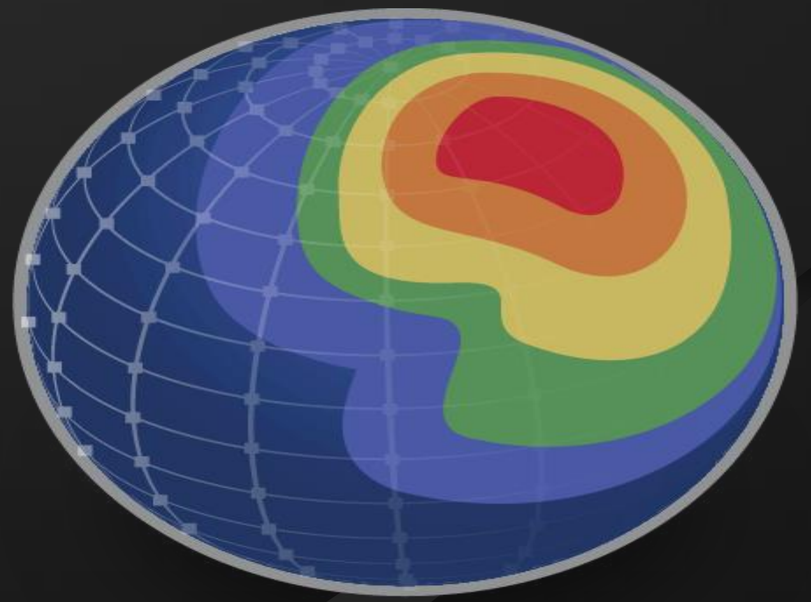
Solve – Scenario 1
Solve – Scenario 2
Solve – Scenario 3
Solve – Scenario 4
Solve – Scenario 5

Cloud

Security You Can Trust

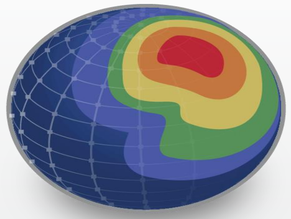
Affordable Access



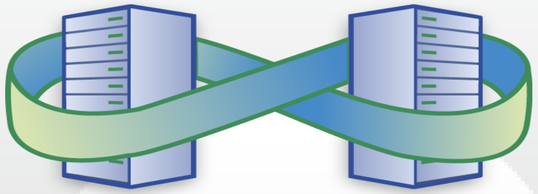


$0 Hardware + **Pay-As-You-Go Software** = **Lower TCO**

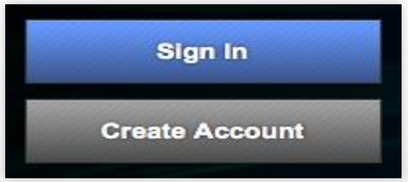
Simulation to the Power of the Cloud



Simulation-Driven Design



Cloud Power & Flexibility



Usage Based Access

Developing Next Generation Technology to Treat Osteoarthritis

Articulinx

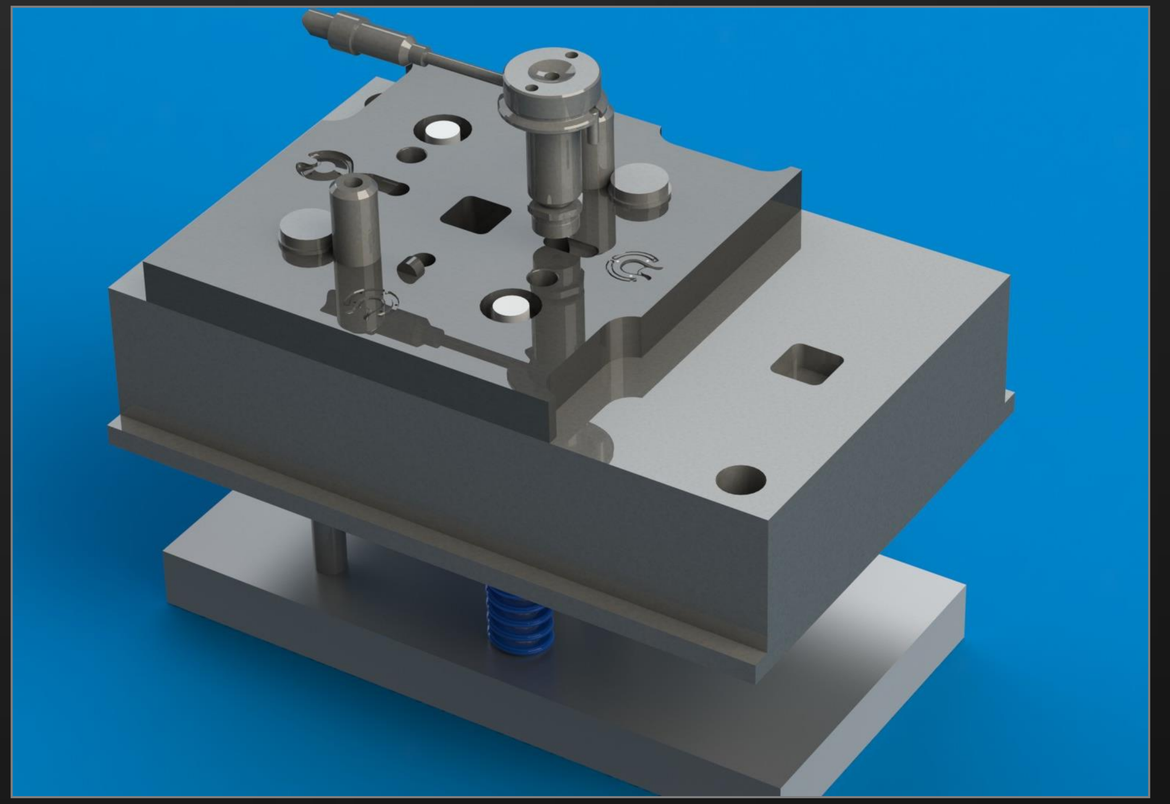
- Start-up medical device company
- Implant to alleviate pain associated with osteoarthritis
  - 14+ Million people in the US
  - 20% over 55 have hand OA
- Applicable to the extremities
  - Hand, feet, shoulders, elbows

Articulinx ICC

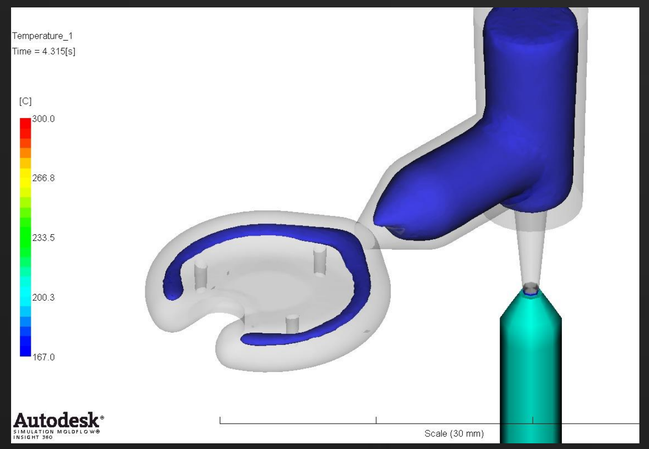
- Intercarpometacarpal Cushion – ICC
  - Implanted via minimally invasive procedure
- Permanent implant
  - Duration measured in years
  - Subject to harsh conditions in the joint
- Polymer-based
- Design requires insert molding

Benefits of Simulation at Articulinx

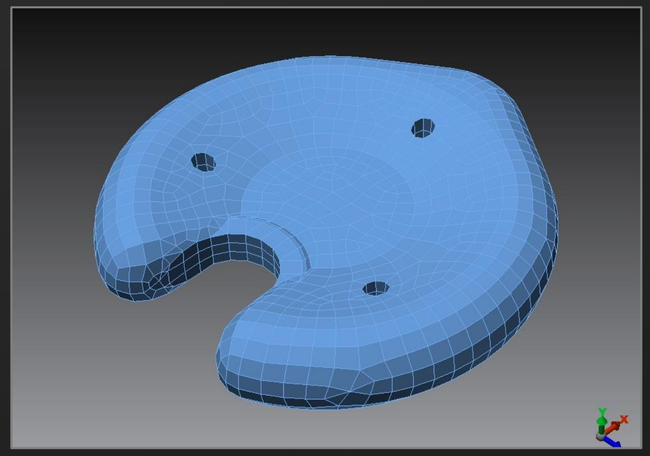
- “Knowing” our device is critical
- Injection molding is a key process in producing the implant
- Expands Articulinx internal knowledge
- Upfront analysis addresses compressed development time



Simulation at Articulinx



Provides Key Insights



Accelerates the Design Process

Facilitates Vendor Collaboration

Accelerates Process validation

Advantages of Autodesk Simulation 360

- Simulation 360 provides flexibility
  - Continuous access provided through the cloud
  - At home, at the office, on the road
  - … Saved my Vacation!
- Simulation 360 increases productivity
  - Computer resources not monopolized
  - Commute time is even used
- Simulation 360 is cost effective
  - Annual Licensing

Autodesk Simulation 360 Ultimate: Demonstration

Autodesk Simulation Moldflow Insight 360

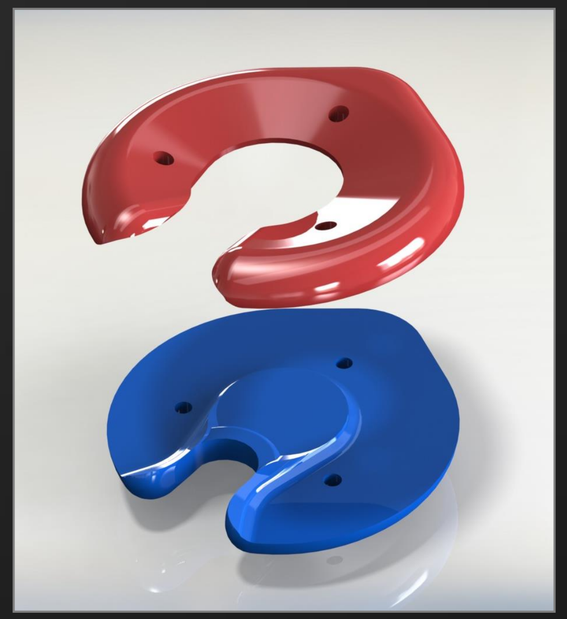
- Autodesk Simulation 360 Ultimate frees resource
  - Run a simulation live, while presenting

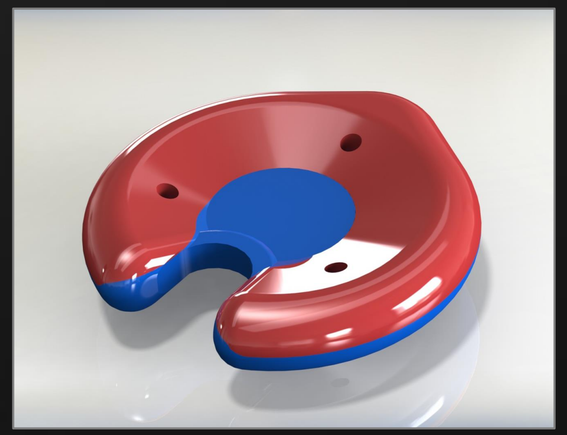
- The cloud allows you to work in new ways
  - Simulation can be run and viewed anywhere
  - Multiple simulations running at once
  - Access to the full suite of simulation products

The Power of the Cloud: New Ways to Perform a DOE

Background

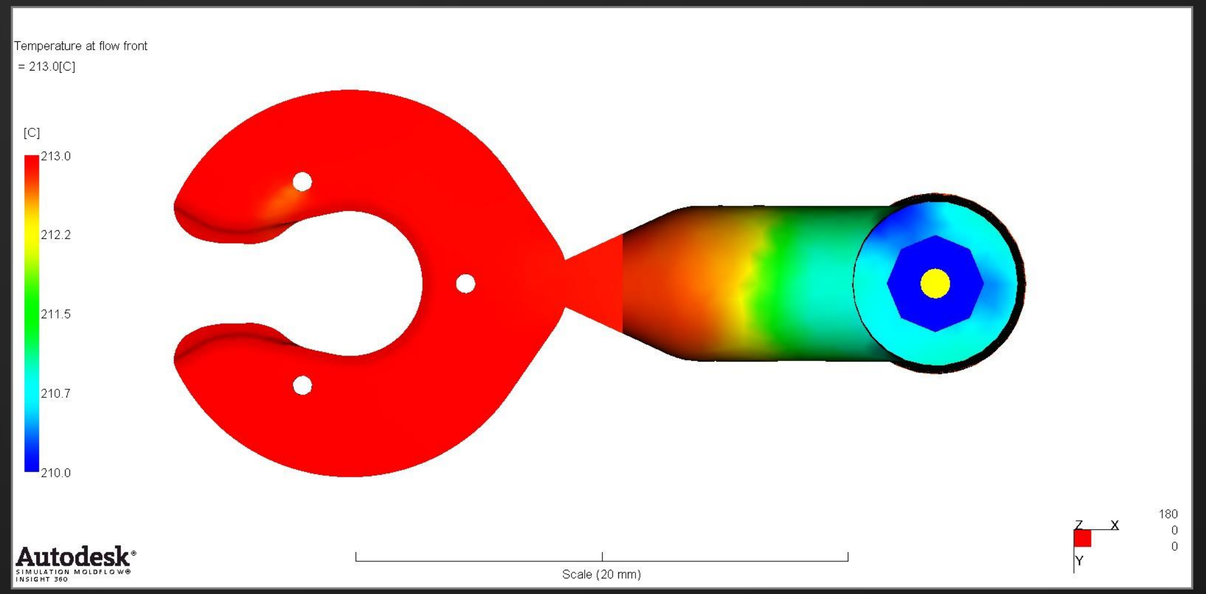
- ICC is created with a laminate construction
  - Bonding between layers is critical
- Part, mold, and process need to be optimized
  - Increase temperature at the part interface





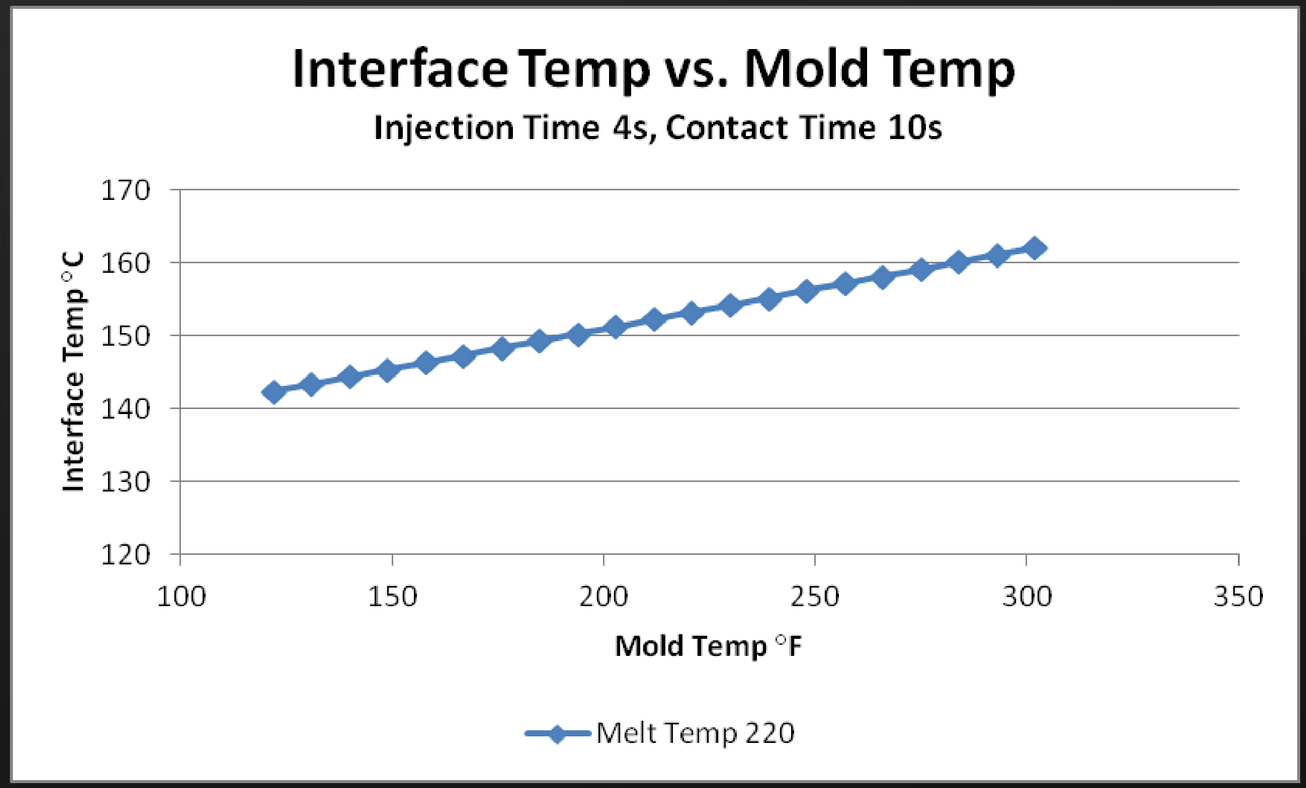
Improving Part Design

- Simulation used early in the design phase
- Optimize the interface between the 2 layers
- Simulation drove critical decision



Optimizing Part Performance with a DOE

- After part and mold are designed, part performance needs to be maximized
- A factorial experiment was implemented through Autodesk Simulation Moldflow
- The power of cloud computing facilitates this analysis.

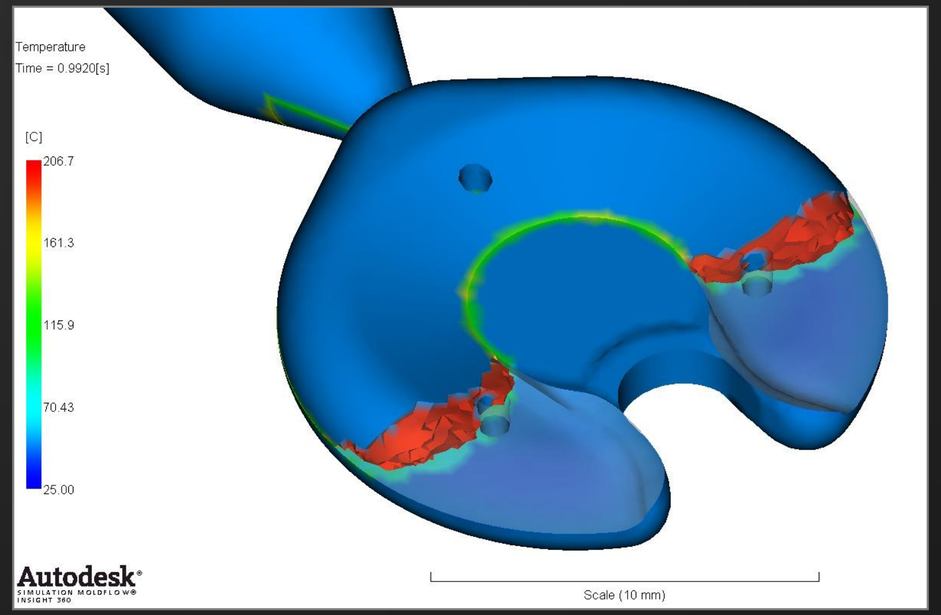


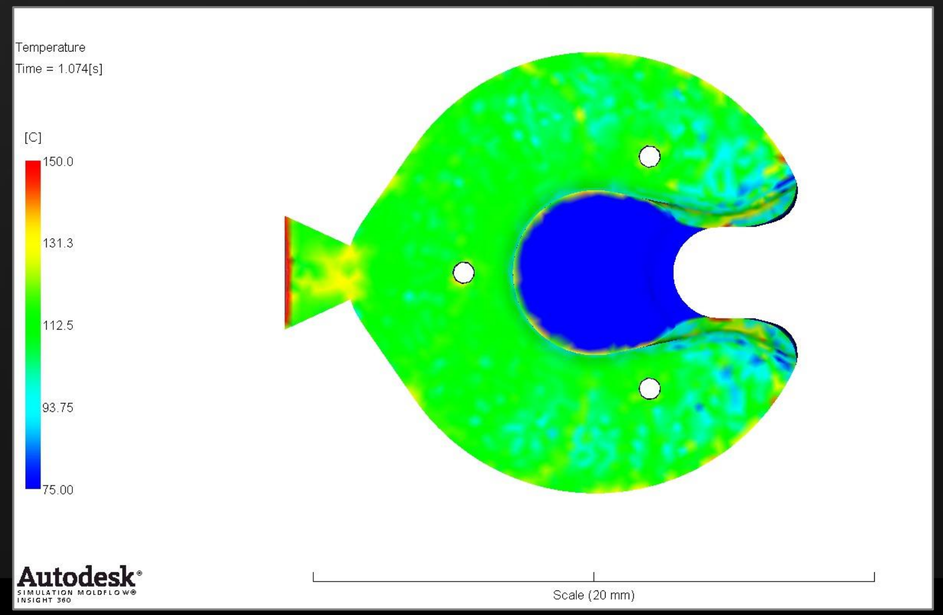
Experimental Design

- 4 factors will be investigated at 2 levels

Factor	High Level	Low Level
Melt Temp	220 °C	190 °C
Mold Temp	50 °C	100 °C
Injection Time	1.0 s	4.0 s
Contact Time	1 s	10 s

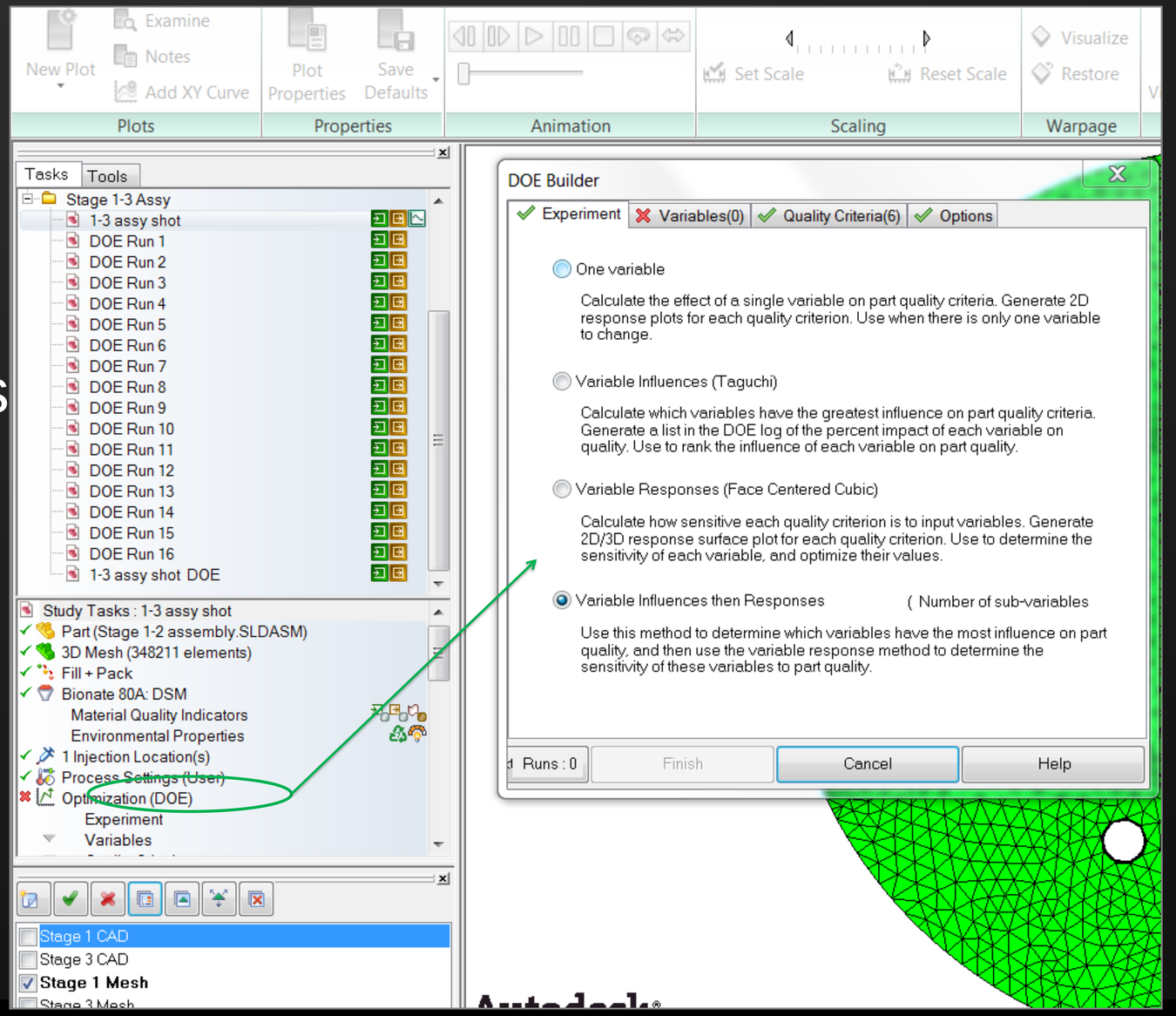
- Full factorial design with 16 runs
- Response variable is the average temperature across 6 specific nodes





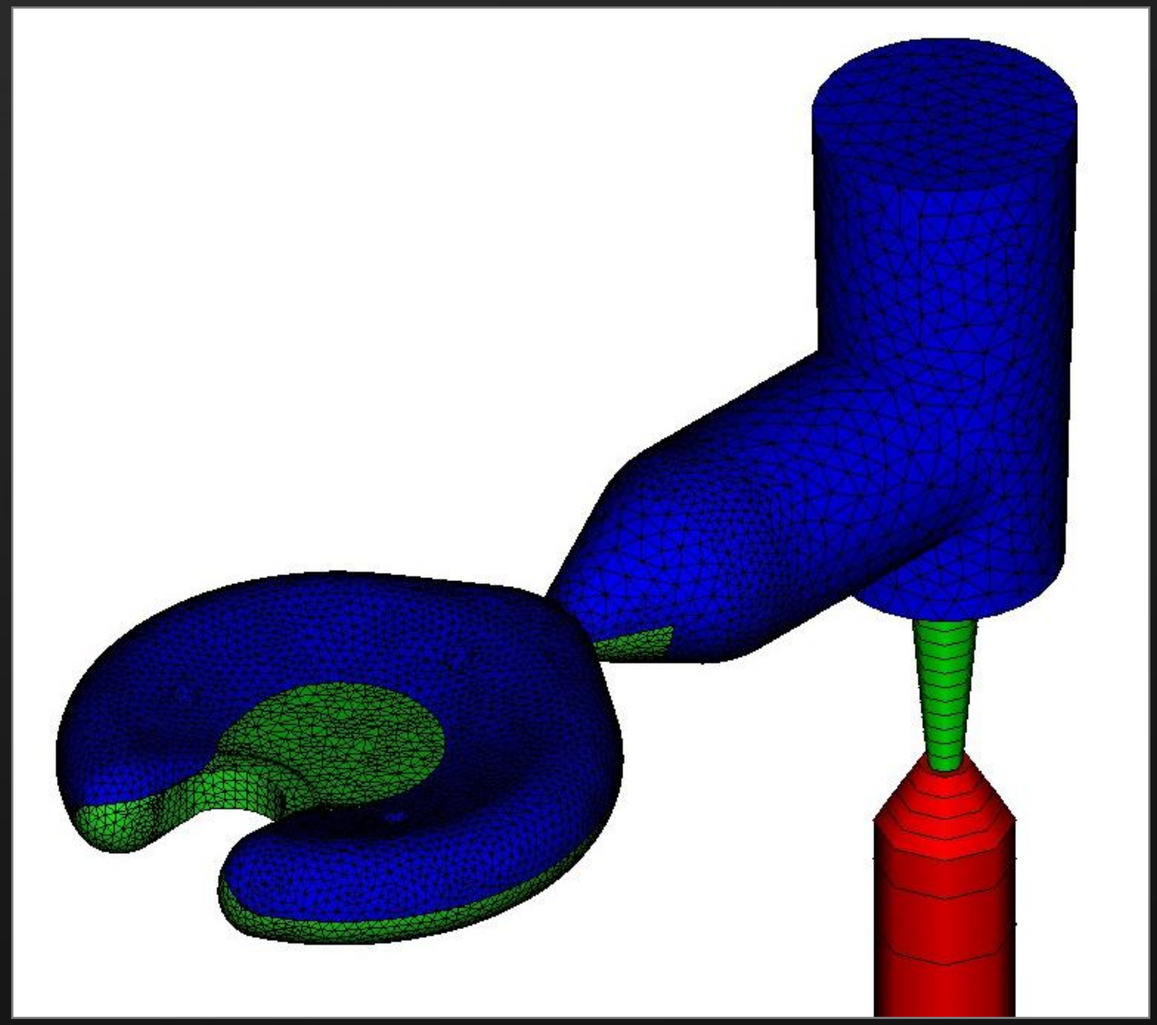
Setting up the DOE

- Moldflow comes with integrated optimization capabilities
- Also define our own experiments
  - Allows for greater flexibility of response variables and factors



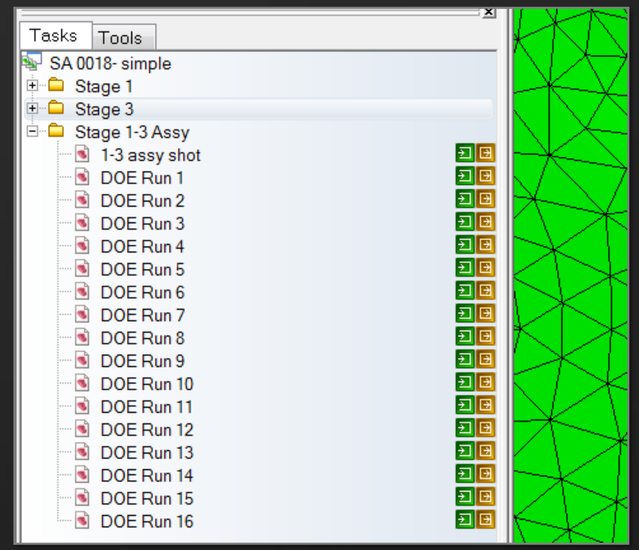
Setting up the DOE (2)

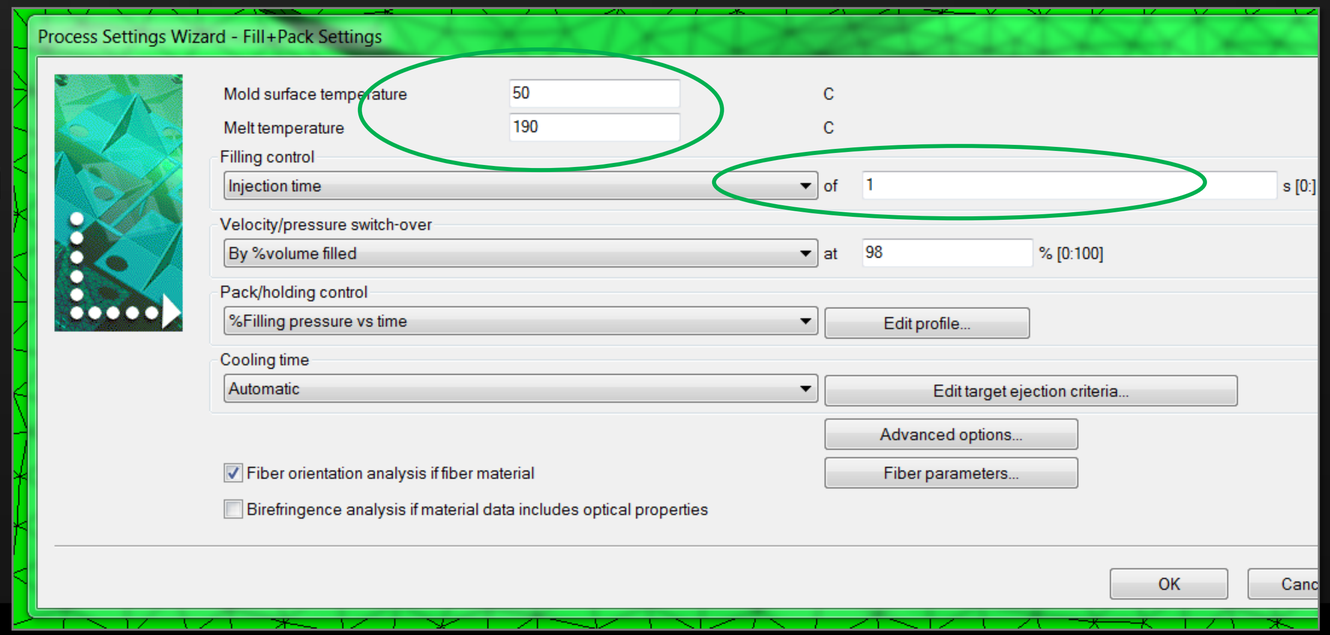
- Geometry is imported
  - Part insert property used
- Mesh is created for both parts of the assembly
- Feed system is created and meshed
- Set injection location



Setting up the DOE (3)

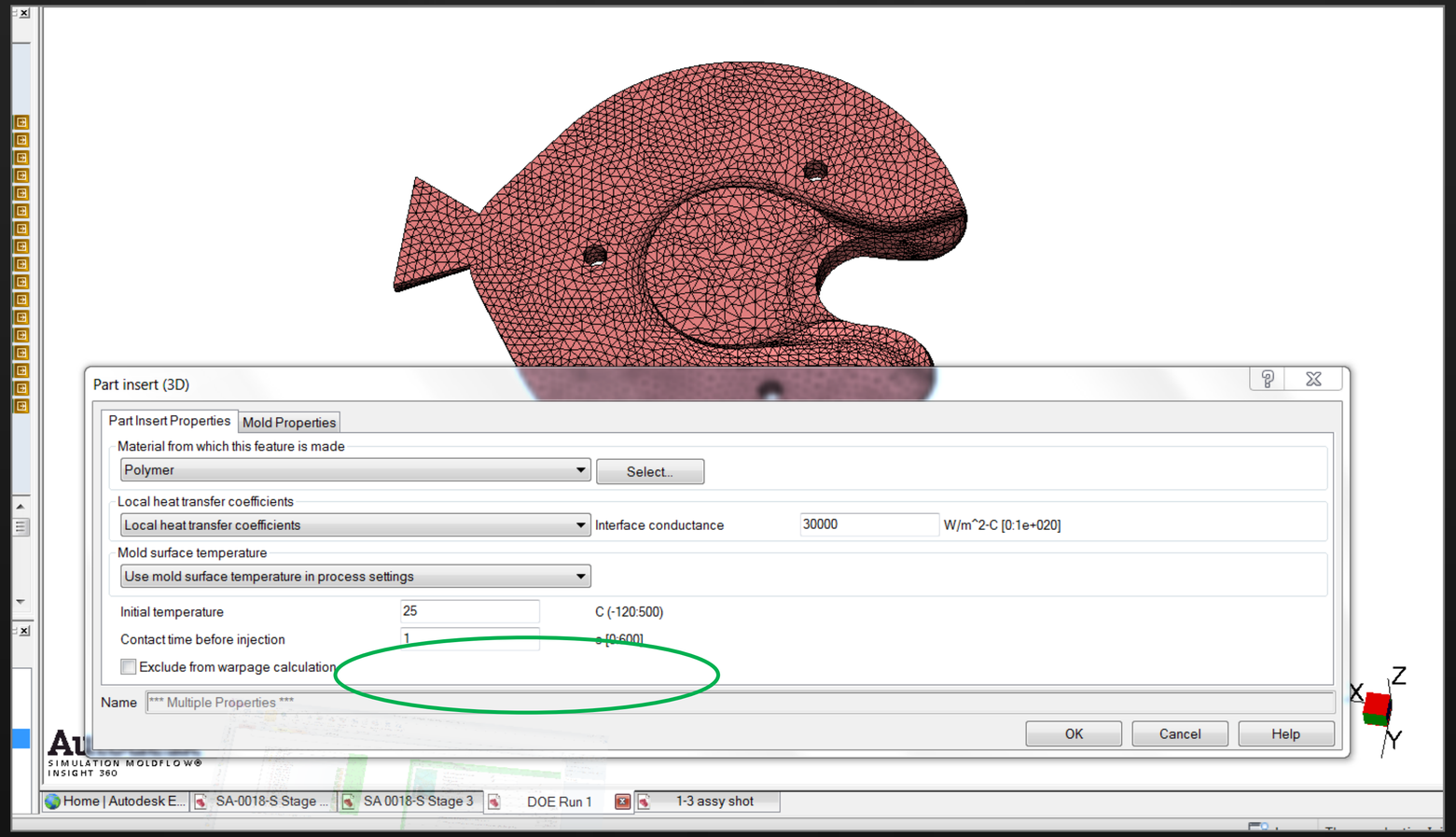
- Study is then duplicated to created the required runs
- Duplication ensures consistency and reduces work
- Factors associated with each run are adjusted as necessary





Setting up the DOE (4)

- Contact time set in the Properties dialogue box

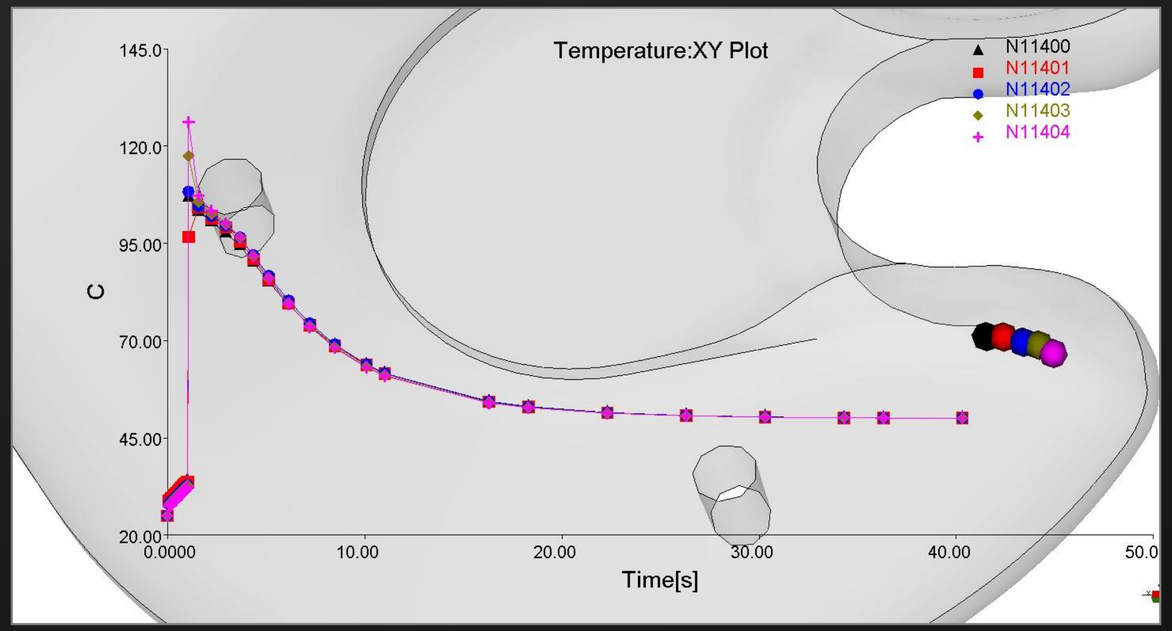


Setting up the DOE (5)

- Other process variables consistent for all runs
- Filling control set to injection time (a factor in the experiment)
- V/P switchover controlled by volume filled and set to 98%
- Packing pressure set to 80% of injection pressure for 10 seconds
- Automatic cooling is selected

Data

- Response variable is the average temperature across 5 nodes in a critical area of the part
- Temperature plot is created and the nodes are selected
- Results from the plot are exported into a text file and analyzed



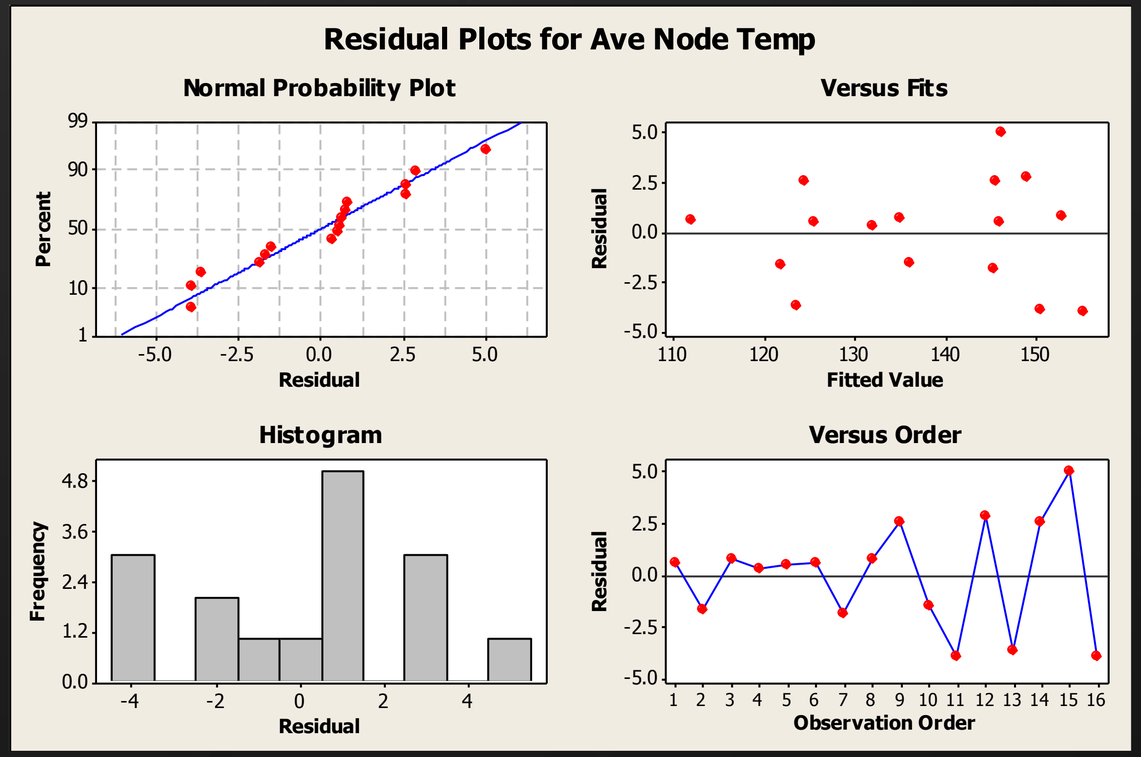
Analysis of Results

- Statistical analysis performed with Minitab® Statistical Software
- Effect values show relative strength of the factors on the response
- This analysis investigate all interaction up to second order

Factor	Effect
Melt Temp	9.49
Mold Temp	16.34
Injection Time	9.94
Contact Time	7.48
Melt Temp*Mold Temp	-6.51
Melt Temp*Injection Time	5.26
Melt Temp*Contact Time	0.82
Mold Temp*Injection Time	-1.65
Mold Temp*Contact Time	1.42
Injection Time*Contact Time	-7.25

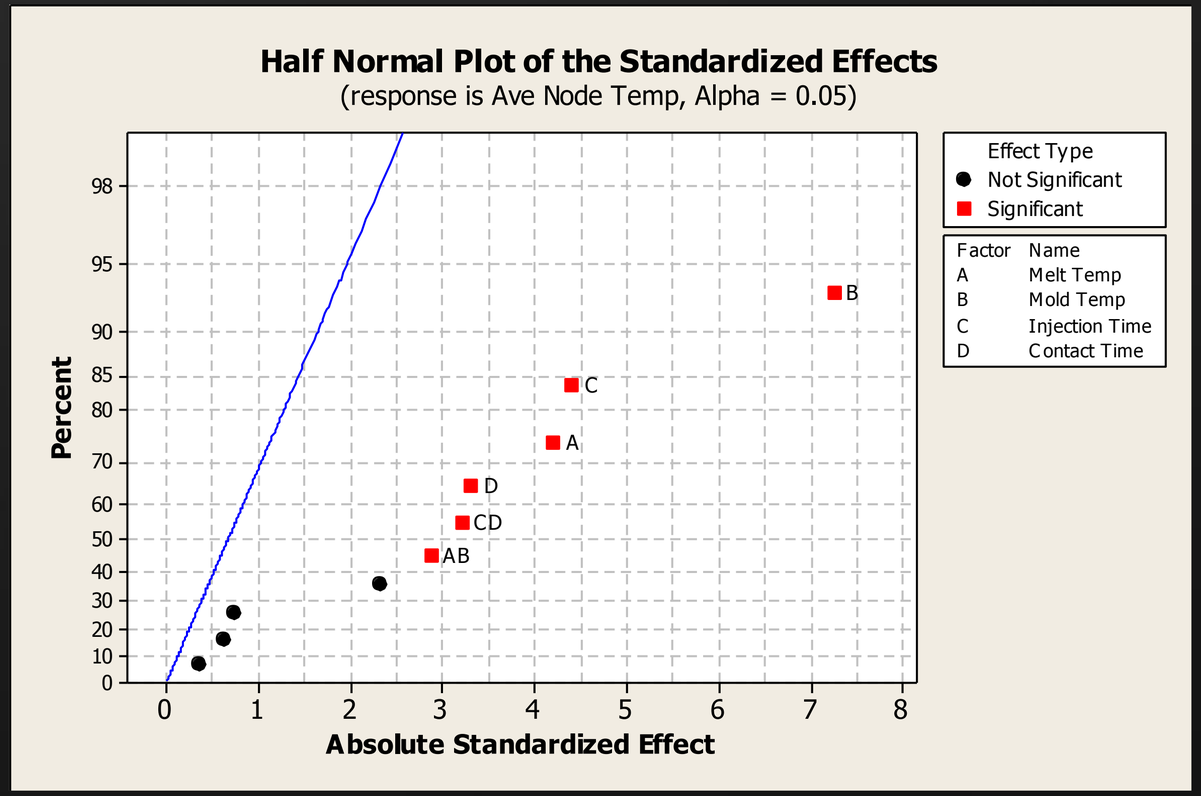
Analysis of Results (2)

- Residual plots investigated to learn about the data



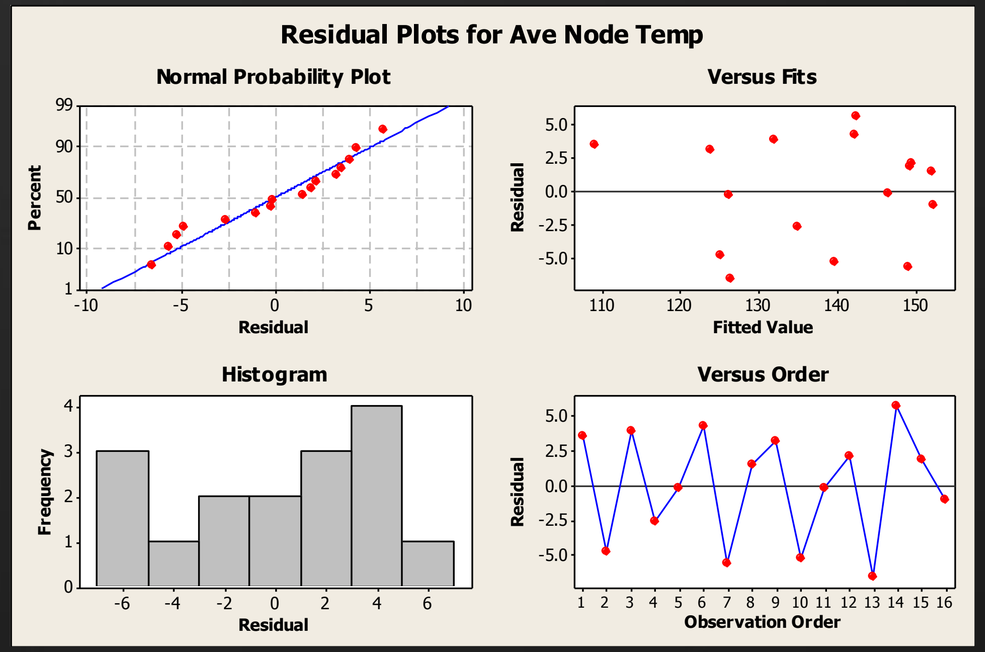
Analysis of Results (3)

- Half normal plot shows significant effects
- Non-significant effects can be eliminated and the analysis rerun



Analysis of Results (4)

- Analysis rerun looking at only 6 effects
  - 4 primary and 2 interaction
- The analysis provides an equation for estimating the response.
- R^2 for this estimation is .9802
- Predicted R^2 is .7086



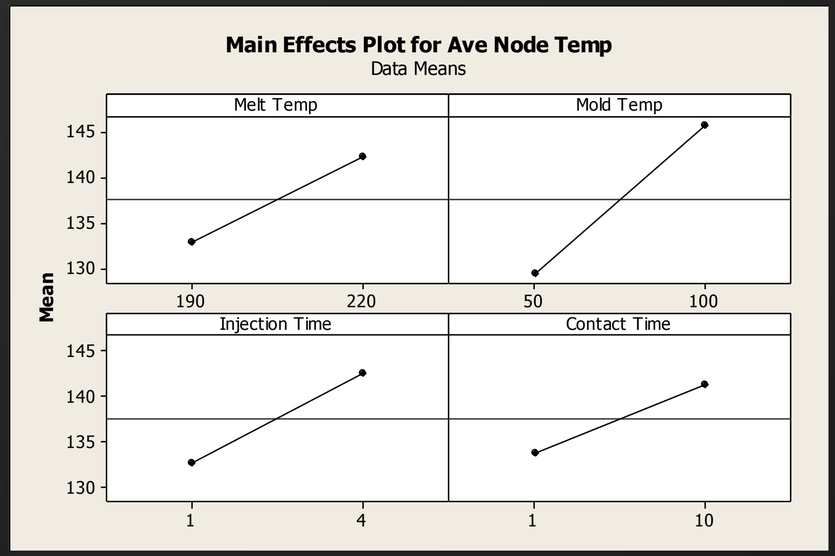
Term	Coef
Constant	-105.5
Melt Temp	0.9675
Mold Temp	2.107
Injection Time	6.269
Contact Time	2.174
Melt Temp*Mold Temp	-0.0087
Injection Time*Contact Time	-0.5371

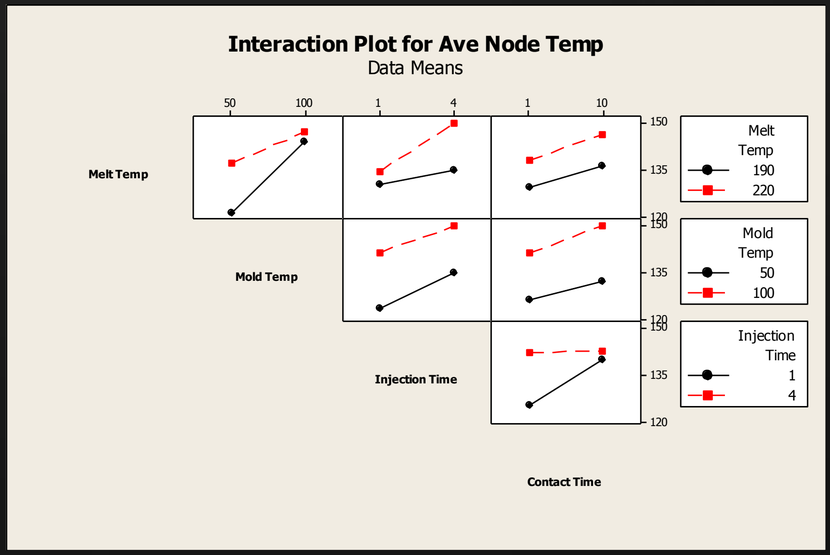
Run the Design Studies

- Studies can be run in parallel or sequentially
- After upload to the cloud computer resources are freed up
- All 16 runs of this analysis ran in less than 90 minutes
- **This would take over 30 hours on a standalone system!**

DOE Conclusion

- All 4 factors have a significant effect on the response
- 2 interactions were also significant
- Mold temperature has the largest effect on the response
- Increasing injection time increases the response





DOE and Autodesk Simulation 360 Ultimate

- Run a DOE using a wide range of factors and response variables
- Cloud computing makes this efficient
  - 1 hour in the cloud = over 30 on the desktop
- Can focus on the data and the results, as opposed to the process of creating the results
- Frees you up to think in new ways