Battle Royale – a clash of injection molding approaches using Simulation Moldflow

Tim VanAst – Cascade Engineering
Jay Shoemaker – Autodesk

Class Introduction

Have you ever wondered if you're a better analyst than your colleague?

What about so-and-so at your competition?

What about Jay Shoemaker?

It's Mano e Mano, Analyisto e analyisto, it's a showdown you don't want to miss.

Class summary

- We will discuss different approaches to injection molding simulations with Autodesk Simulation Moldflow Insight software. Individual users have been given a problem to solve using Moldflow software.

- Their approaches will be presented, then we will compare and contrast the different approaches.

Approach

1. Find “***volunteers***” who would agree to do the project.

2. Send out a model with a request to do a “moldflow” on the part. The analysts then responded with the ***questions*** that they would typically ask about a project.

Approach

3. Their questions came back and were answered, along with an overall ***problem statement***.

4. The analysts went to ***work***.

5. After completing their work, the results were sent back to ***compare and contrast*** the different approaches.

1. “Volunteers”

Find “volunteers” who would agree to do a project to receive fame and glory at AU (sorry, no fortune)

- Thanks to:

  Mike Kowalski – Celanese (resin supplier)

  Gayle Rose – BD (medical)

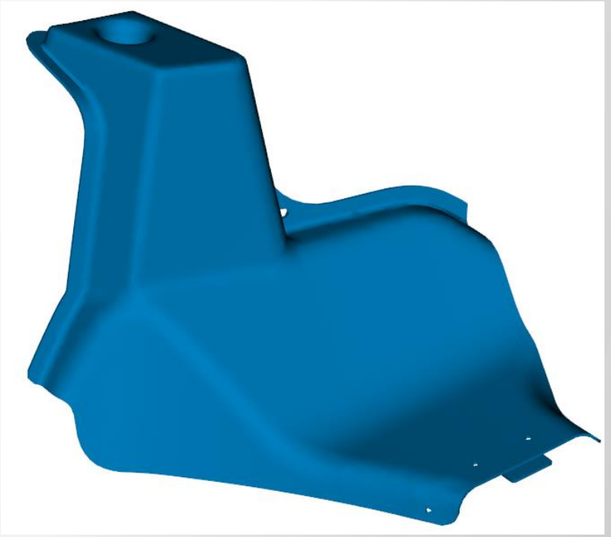
  Peggy Ruddy – DuPont (resin supplier)

  Jay Shoemaker – Autodesk (chief troublemaker)

  George Thompson – Lacks Trim Systems (automotive trim)

2. Questions

- Send out a model with a request to do a “moldflow” on the part. The analysts then responded with the *questions* that they would typically ask about a project.



Questions v1

1. What's the material of the part?
2. Are there any critical dimensions?
3. Where's the parting line in the tool?
4. What type of gating has been decided?
5. Any surface appearance requirements?
6. Single or multi-cavity?
7. Production or Proto-Type Tool?
8. What's the Tool steel material?
9. Cooling lines designed?

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Questions v2

Our approach is to have an ‘interview’ with the ‘client’ before simulation begins. We want to know how the part will be used, the history of the project and any anticipated problems on which the simulation should focus.
What is the client’s objective for this simulation? Often, the answer is ‘general moldability’. This is a fancy term for ‘anything you can tell me’. The rest of the questions asked will depend on the client’s needs from the simulation and his/her understanding of plastics processing.

Questions might include any/all of the following:

- General Information
  1. Is a part like this currently in production?
  2. Reason for simulation
  3. Can the design/geometry/tooling be modified?
  4. What material will be used? (our group does not make material recommendations)
- Mold Information (we do not design molds)
  5. Has a mold vendor been identified?
  6. Cavitation planned
  7. Cooling plans – coolant, conformal layout, straight line drill
  8. Melt delivery – Cold, hot-to-cold, hot tip, hot valve
     - How many gates are planned and what diameter?
     - For the ‘reinforcement’ part, do we have the option of staged valve gates?
  9. Press limitations – max pressure, max screw velocity, max tonnage
- Process Information
  10. Target cycle time
  11. Process sheet for similar part

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Questions v3

1. What is the primary Objective?

Part

2. What is the part and what is its function?
3. Is this a New design, prototype, production?
4. Can the design be modified?
5. What and where are the critical areas/dimensions?
6. Is this an appearance part? How much of the part is seen?
7. Can you provide the assembly of the mating parts?

Material

8. What is the Material?
9. Can the Material be changed?
10. What is the Color? How many colors? Will the part be painted?
11. Can regrind be used?

Tooling

12. Do you have a tool file?
13. How many cavities? (1+1?)Is there a Tool layout concept.
14. What shrink rate will the tool be cut to? (is the data already expanded?)
15. Can a hot manifold be used?
16. Are there specific gating scenarios/types to be used or evaluated?
17. Are there areas where gating should be avoided.(gate vestige)
18. What is the target press size, cycle time?

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Questions v4

Part Definitions

1. Part description and Customer?
2. First time analysis or modified model? What is the reason for the analysis?
3. Is analysis being run for customer or internal use?
4. What is the wall stock and is it uniform?
5. What is the decorating scheme? MIC, painted, plated…..
6. How many cavities?
7. What is the environment around the part? Specifically for gate vestige clearance.
8. Shrink/warp tolerances?
9. Any edges that cannot be gated on?
10. Requirements for types of gates? Edge, Lifter, Sub gate…..
11. What's visible to the end user?
12. Any restrictions on weld line locations.

Material requirements

13. What material?
14. Is there a specific material supplier and grade?
15. Is there a specific melt/mold temp requirement?

Tooling

16. How many drops/gates were quoted?
17. Are Valve gates allowed or cold sprues?
18. Tool size? (if steel has been ordered already)
19. Are cooling channels defined yet by the tool shop? If so, where are they?
20. What size press is this slated for?

Process

21. What type of analysis is required? (C-F-P-W)
22. Cycle time/ Shots per Hour Quoted?
23. Are there cavity pressure limits?
24. What type of report is required?
25. Any specific results/plots needed?

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Questions v5

1. How many cavity tool is it?
2. If more than one cavity, what is the cavity spacing?
3. What is the overall size of the tool?
4. What is the Manufacturer and Trade name of the thermoplastic material to be used?
5. If a specific material is not selected, what material family, PP, ABS, Nylon etc. is required for the part?
6. If a specific material is not selected, who has final approval on the material choice?
7. What are the surface appearance requirements? Is the cavity side Class A?
8. What are the structural requirements of the part? Are any structural requirements necessary to be considered for this project?
9. What type of runner system must be used, cold, hot, a combination, up to me?
10. Are there restrictions on gate locations, if so, what are they?
11. Are there restrictions on gate type, if so, what are they?
12. What is the pressure capacity of the molding machine that is going to be used to mold the parts?
13. What is the clamp force capacity of the molding machine?
14. Is there a preliminary tool design that can be referenced?
15. Are there any locations that water lines cannot be placed near the part due to ejection?
16. What is the temperature range for the coolant used for this tool?
17. What is the coolant medium used for this tool, Water? Something else?
18. …

Questions v5 continued…

18. What is the flow rate capacity of the coolant circulation equipment used for this tool?
19. How many coolant circulation units can be used for this tool? Can each one have a different coolant temperature?
20. What is the pressure capacity for each coolant circulation units?
21. Are there any requirements for the number of cooling circuits in the tool?
22. Are there any requirements for the number of cooling line hookups there are when hanging the tool?
23. Are there any processing conditions (inj time, melt temperature, water temperature, pack pressure, pack time, cycle time, etc.) that will probably be used in production no matter what the recommendations are? If so, what are they?
24. What is the material used for the mold, P20? Is the specific manufacturer/grade known?
25. Are any copper inserts being planned? If so where? If not, can inserts be recommended?
26. Is there a specific grade of copper alloy that is going to be used for any insert?
27. Does the step model given have shrinkage applied to it or is the model the “part” size?
28. What are the critical dimensions/ criteria used to determine acceptability of the warpage for the part?
29. What are the tolerances for all the critical dimensions?
30. How is the part going to be measured for warpage?

Questions v5 continued…

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Compare and Contrast Opening Questions

- Number of questions asked: 9, 11, 18, 25, 30
  - Less concerned about the number of questions asked
  - More interested in the content of the questions
  - Many questions are the start of more questions
- Observations from Caroline Dorin
  - Principal User Experience Designer, Autodesk Moldflow Melbourne

Caroline's Observations:

The items that everyone asked about included

1. Number of cavities
2. Material
3. Critical dimensions
4. Whether the type of gating had been specified or not
5. Surface appearance requirements (4 of 5)
6. Press size (clamp force) (4 of 5)

Caroline's Observations:

The items that not everyone asked about

1. Contextual Info
2. Client's requirements
3. Manufacturing constraints/limitations

1. Contextual Info
   - **What the part is and what would it be used for?**
   - **Who is requesting the analysis?**
   - **What are the objectives of the analysis?**

Caroline's Observations:

The items that not everyone asked about

2. Client's requirements
   - **Can the design be modified?**
   - **Whether the part has shrinkage already applied and what the shrink rate will be**
   - **Can the material be changed if required?**
   - **Areas where gating should be avoided?**
   - **Restrictions on weld line locations**

Caroline's Observations:

The items that not everyone asked about

3. Manufacturing constraints/limitations:
   - **Tool Steel material**
   - **Production or proto-type tool**
   - **Tool size**

3. Problem Statement

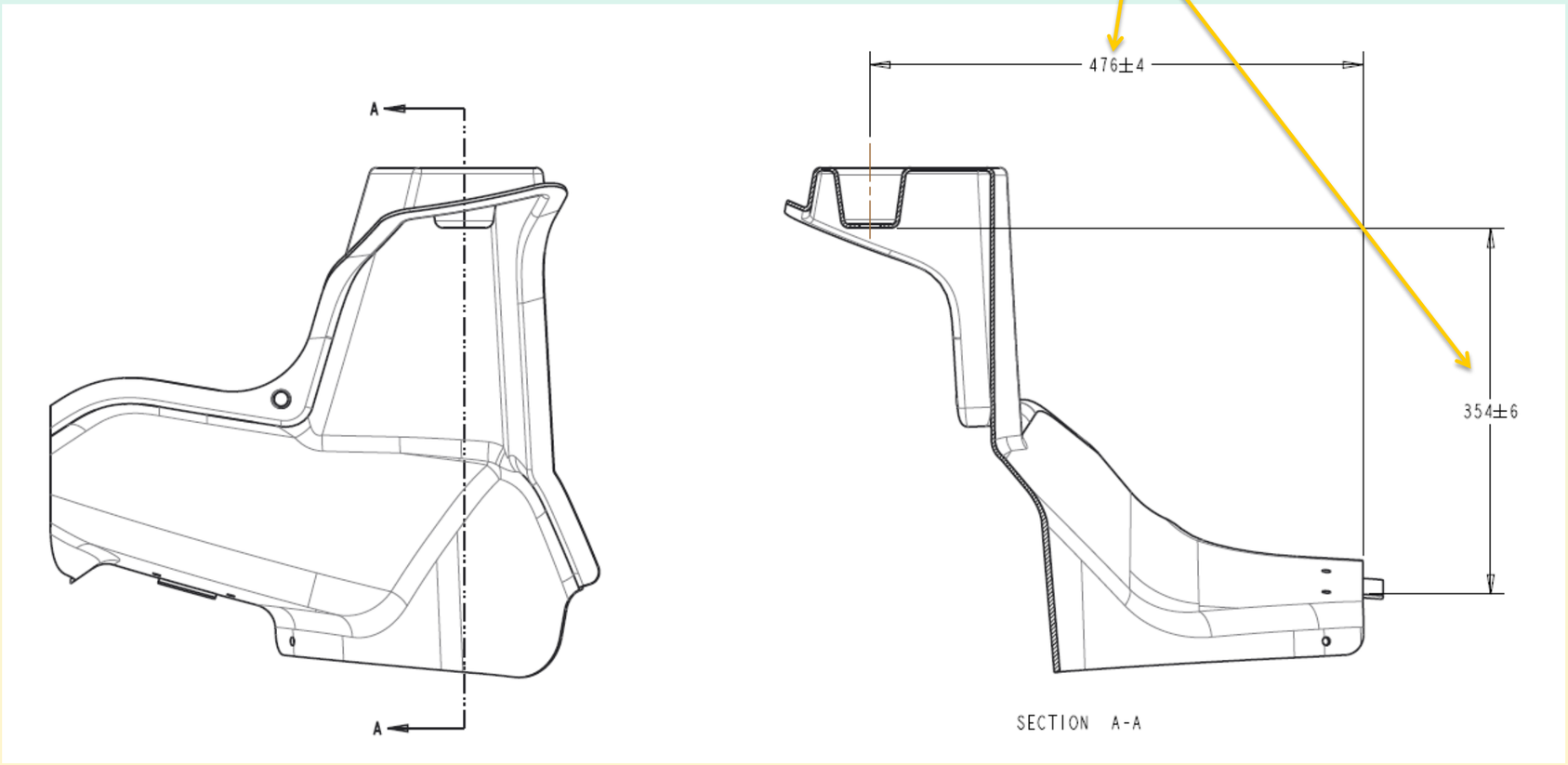
Their questions came back and were answered back to each analyst, along with an overall *problem statement*.

Problem Statement

- The reinforcement is an underbody part we are quoting and need to know:
  - recommended cycle time
  - that it will mold in the quoted machine
  - if we can meet the required critical dimensions.
- The part will be Molded In Color - black. It is visible when looking behind the tire, but it's not a class A show surface.
  - Cavities: 2 (RH and LH)
  - Machine: 750 ton (but would like to get it into a 650 ton)
  - Feed system can be cold or hot and can be gated anywhere on the part that is toolable.
  - Material: DuPont Zytel 70G33L Nylon 33%gf

Critical Dimension

Y & Z dimensions from bolt hole to corner of tab are critical



Final Request

- Lastly, while doing the project, I'd like you to think about ways that the software could be improved to make it better/easier for you. I'm thinking of overall workflow issues (i.e. the way studies are tracked, the way the project flows from importing geometry/mesh to a final report, the steps you take while cleaning up the mesh, etc.)

Follow up Q's

- Can I get the CAD for the LH part?
- There is a thick section in the part at a radii. Is that correct or should it be nominal?
- What is the shrink rate of the material and is the CAD data expanded?

4. Work

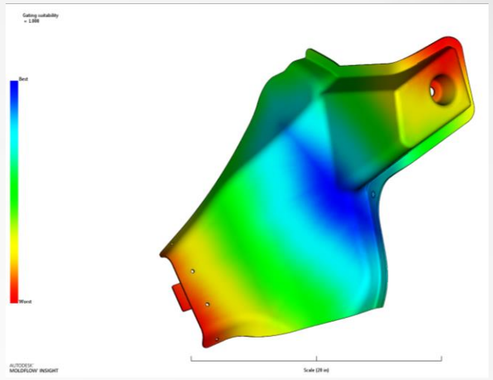
The analysts went to *work*.

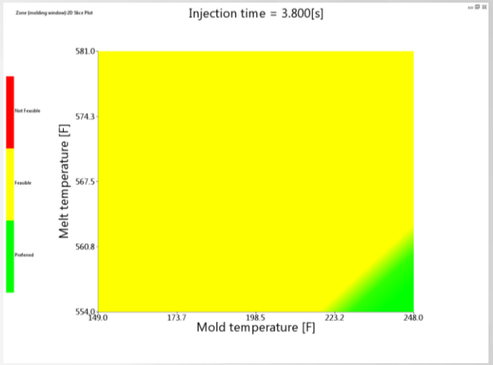
I was looking for their approach

- Where did they start
- What did they do next
- How did they know when they were done
- What was the biggest challenge?

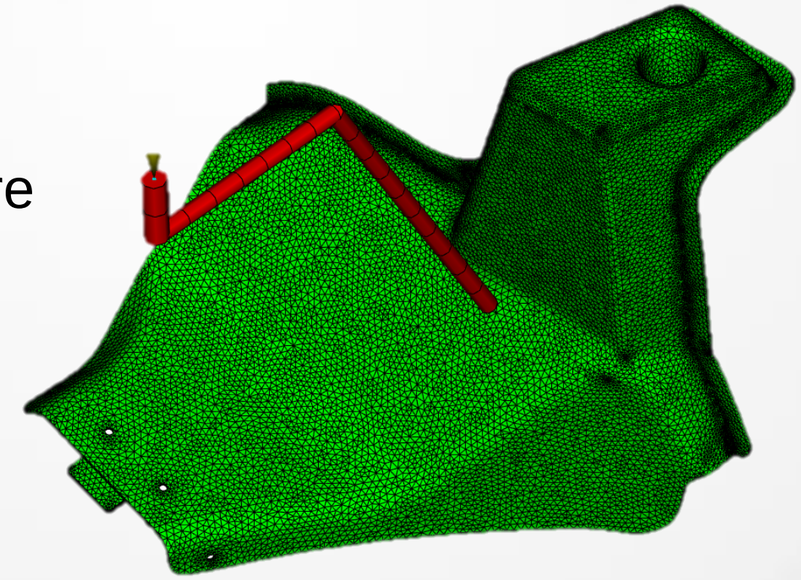
Peggy Ruddy
DuPont Performance Polymers

Steps for Analysis

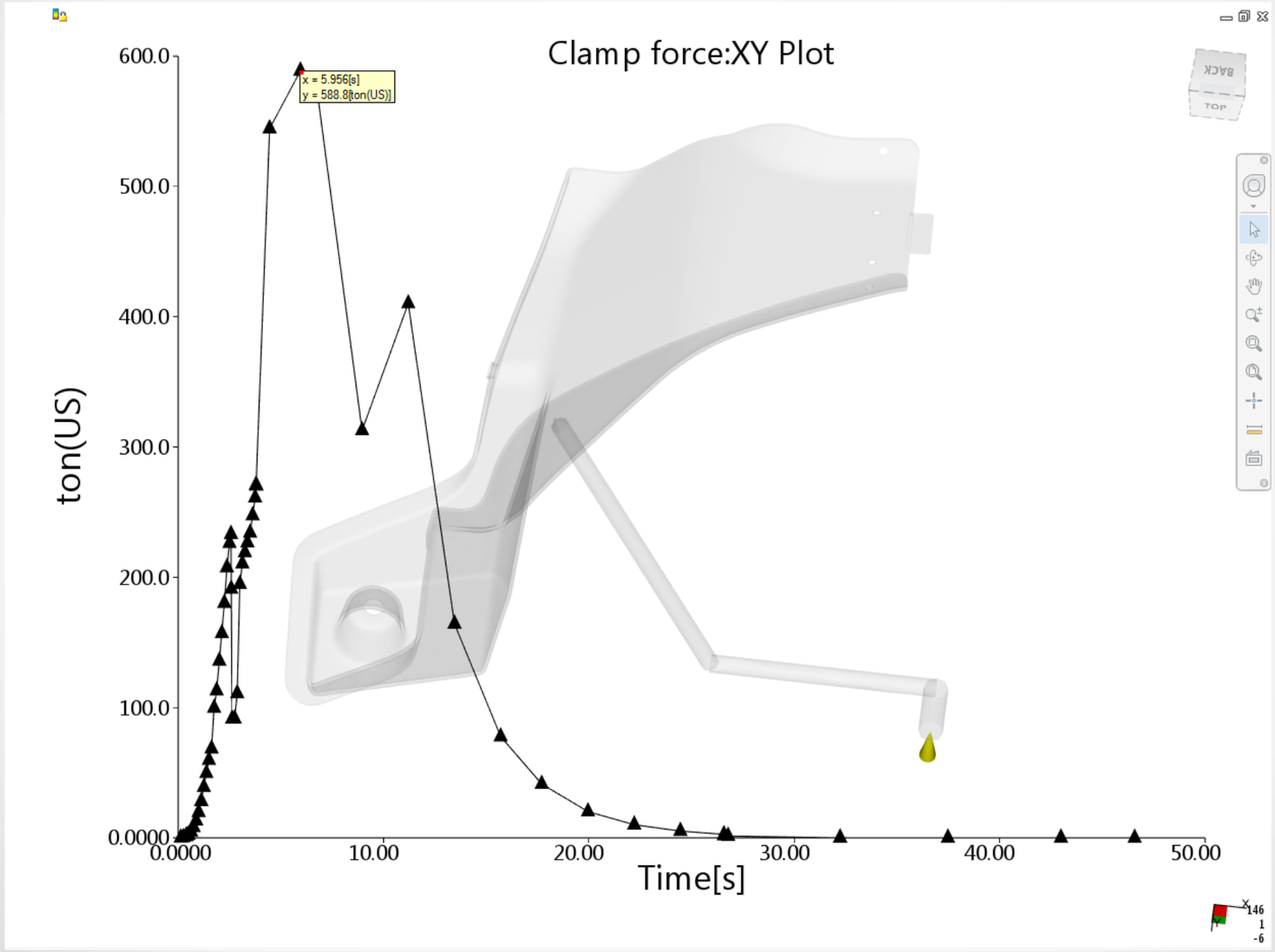




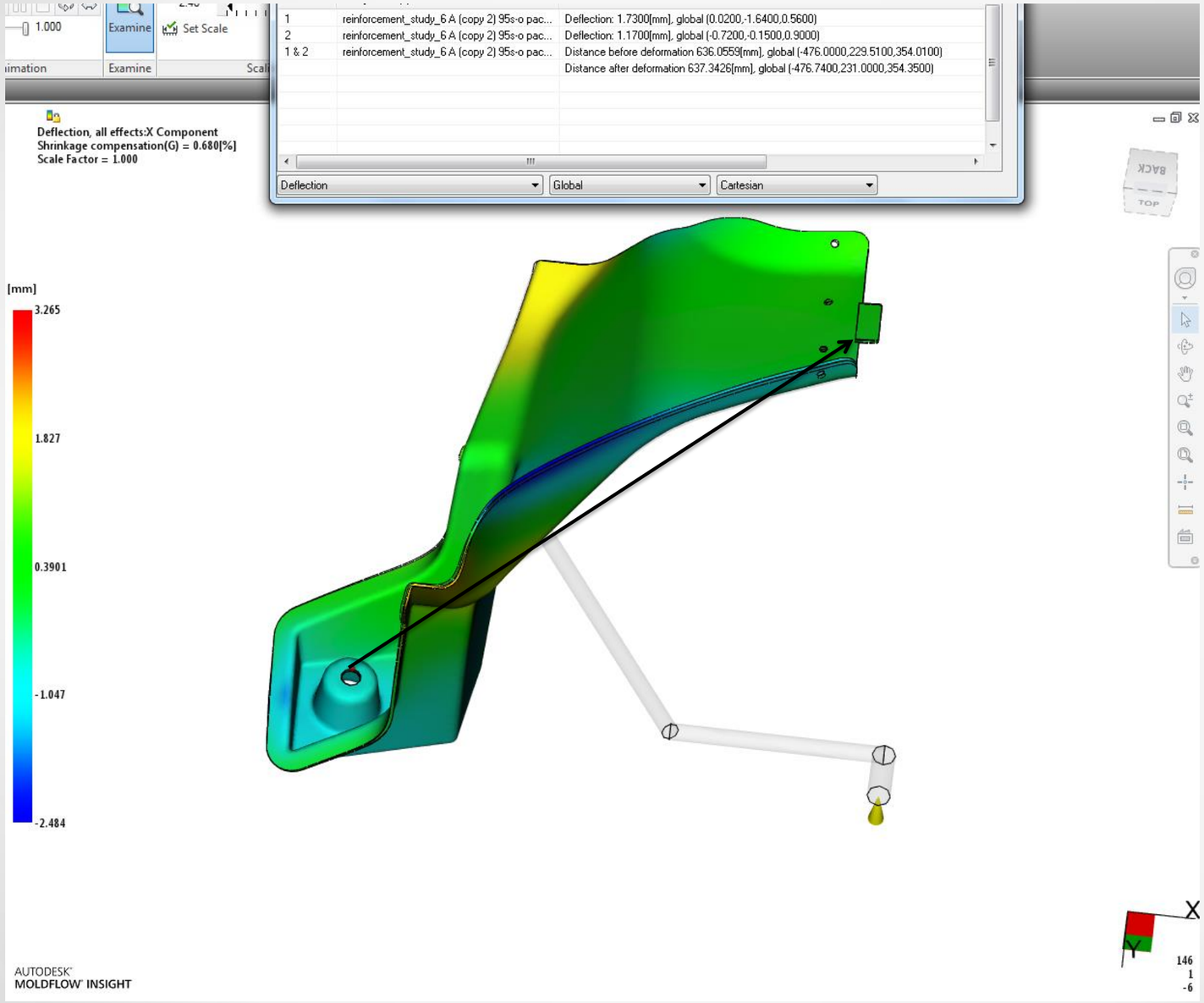
- Gate Location Analysis
- Molding Window Analysis
- Filling Analysis for Balanced Fill
- Added Gate and Runner System with the Occurrence of 2
- Filling, Packing & Warp Analysis for Clamp Tonnage and Deflection
  - Reduce Clamp Tonnage
    - Profiled Flow Velocity
    - Reduce Packing Pressure



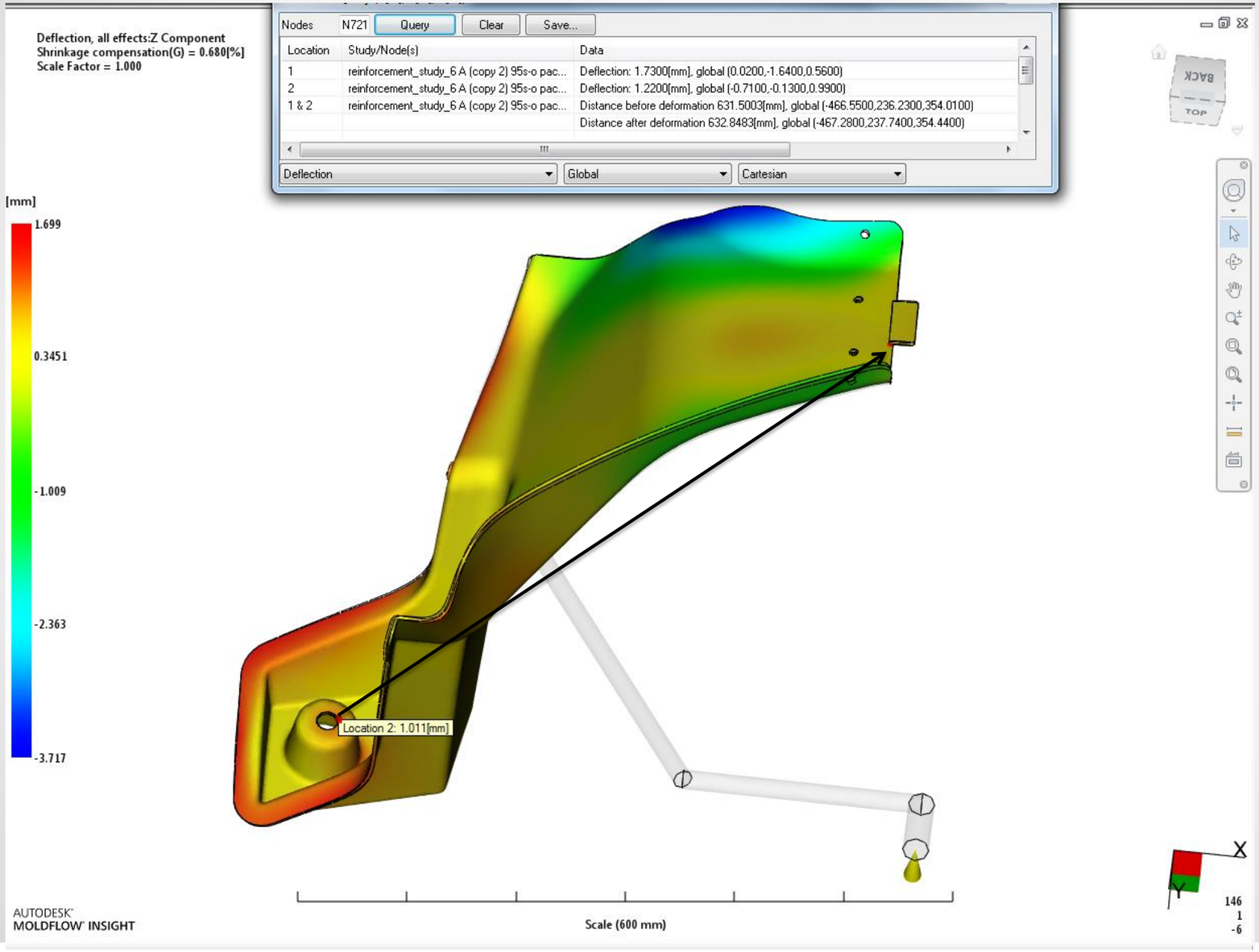
Clamp Force = 588.8 U.S. Ton
Cycle Time = 46.57 seconds



Deflection from Bolt Hole to Corner Tab = +0.74 mm



Deflection From Tab to Bottom of Bolt Hole = +0.44mm



Results Summary

- Cycle Time is 46.57 seconds
- Clamp Tonnage – 588.8 US. Tons
- Deflection – New Dimension of bolt hole centerline to corner of tab = 476.74 mm in Y
  - New Dimension of bottom of bolt hole to corner of tab = 354.44 mm in Z

George Thompson
Lacks Trim Systems

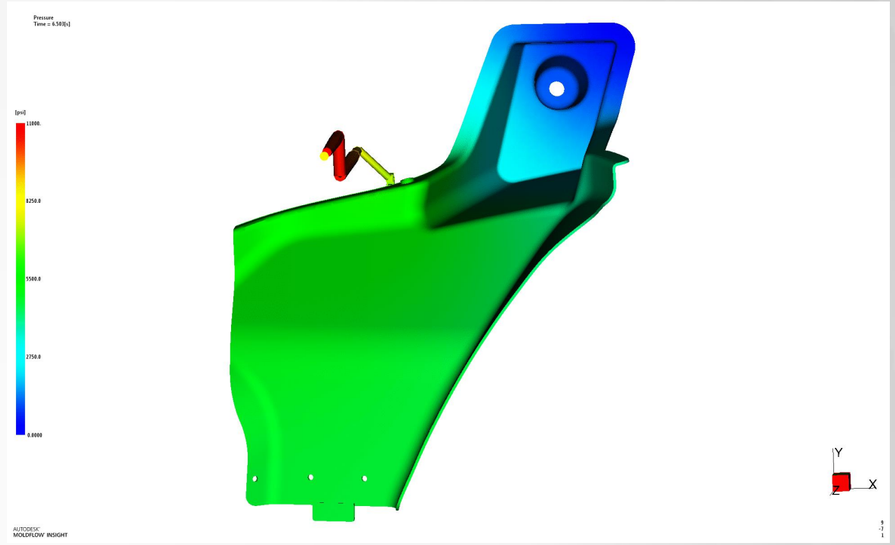
Senior Process Engineer / Certified Expert Moldflow user

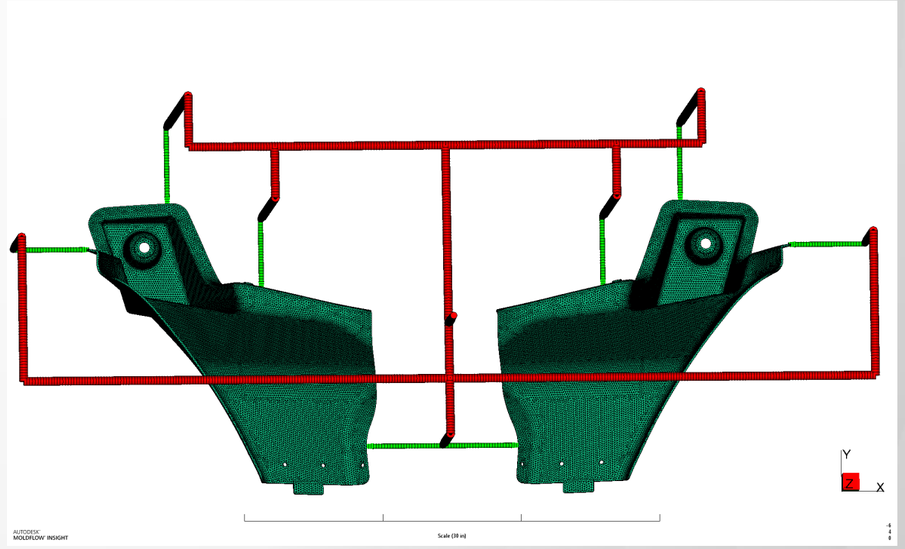
Work Flow - Pre-analysis

- Fact Finding for Project:
  - Reviewed
    - Clamp tonnage
    - Cycle time
    - Number of drops and gates
    - Type of gates
  - Discuss with Design Engineer critical results
- CAD meshing:
  - Used Altair's "Simlab"
  - Edge length = 4 mm
  - Element count = 93,396
  - Clean mesh
  - Part in tool position
- Design Philosophy
  - Use valve gate to minimize cosmetic issues
  - Flexible filling options

Work Flow - Gate and Drop Layout

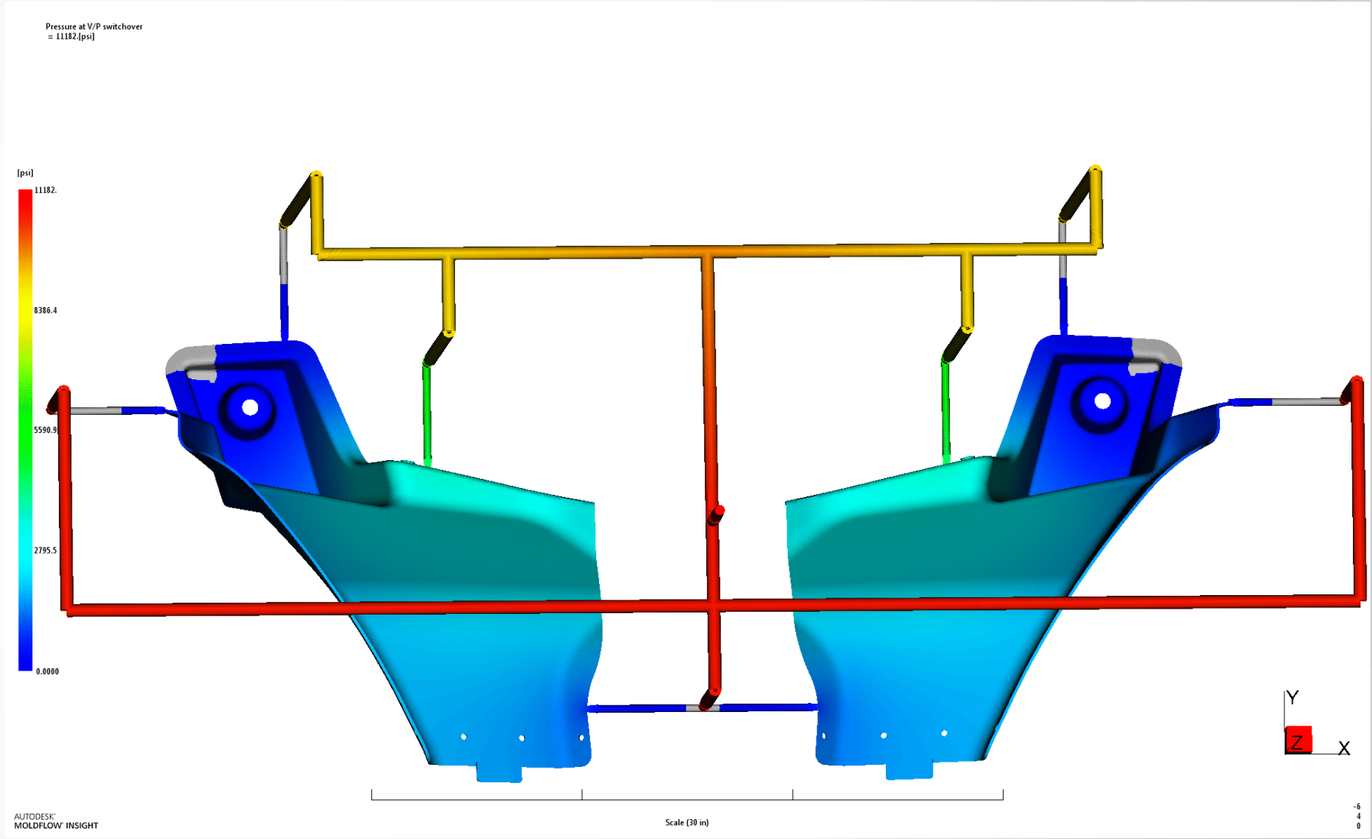
- Fill Preview
  - Looked for balanced filling
- Modeled gate, runner and drop
  - Checked fill pressure and shear
  - Sized gates 0.300” wide, thickness of 80% of wall stock
- Added
  - Three additional gates
  - Manifold, drops
  - Second cavity





Work Flow - Fill Analysis

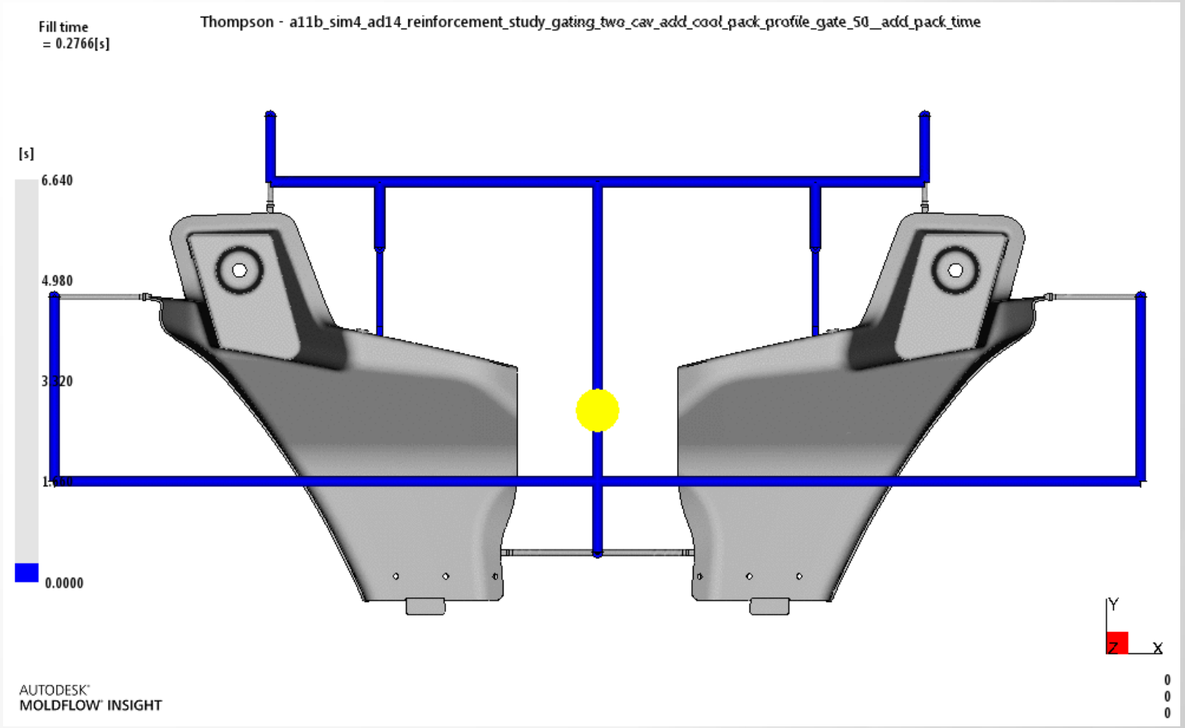
- Processing conditions
  - Default mold & melt
  - Fill time = 6 seconds
  - V/P switch over 98%
  - Pack pressure 11,000 psi, for 18 seconds
  - One gate open
- Checked
  - Fill balance
  - Peak pressure



Work Flow - Fill + Pack + Warp Analysis

- Added
  - Valve gate timing to all drops
- Results
  - Max pressure 11,000 psi
  - Clamp force 2700 tons
  - Small gas trap
  - Gate freezing after part
- Next Steps
  - Lowered pack pressure to lower clamp force
  - Added generic water lines
  - Optimized for gate freeze

- Results
  - Clamp < 700 tons
  - Dimensions within tolerance

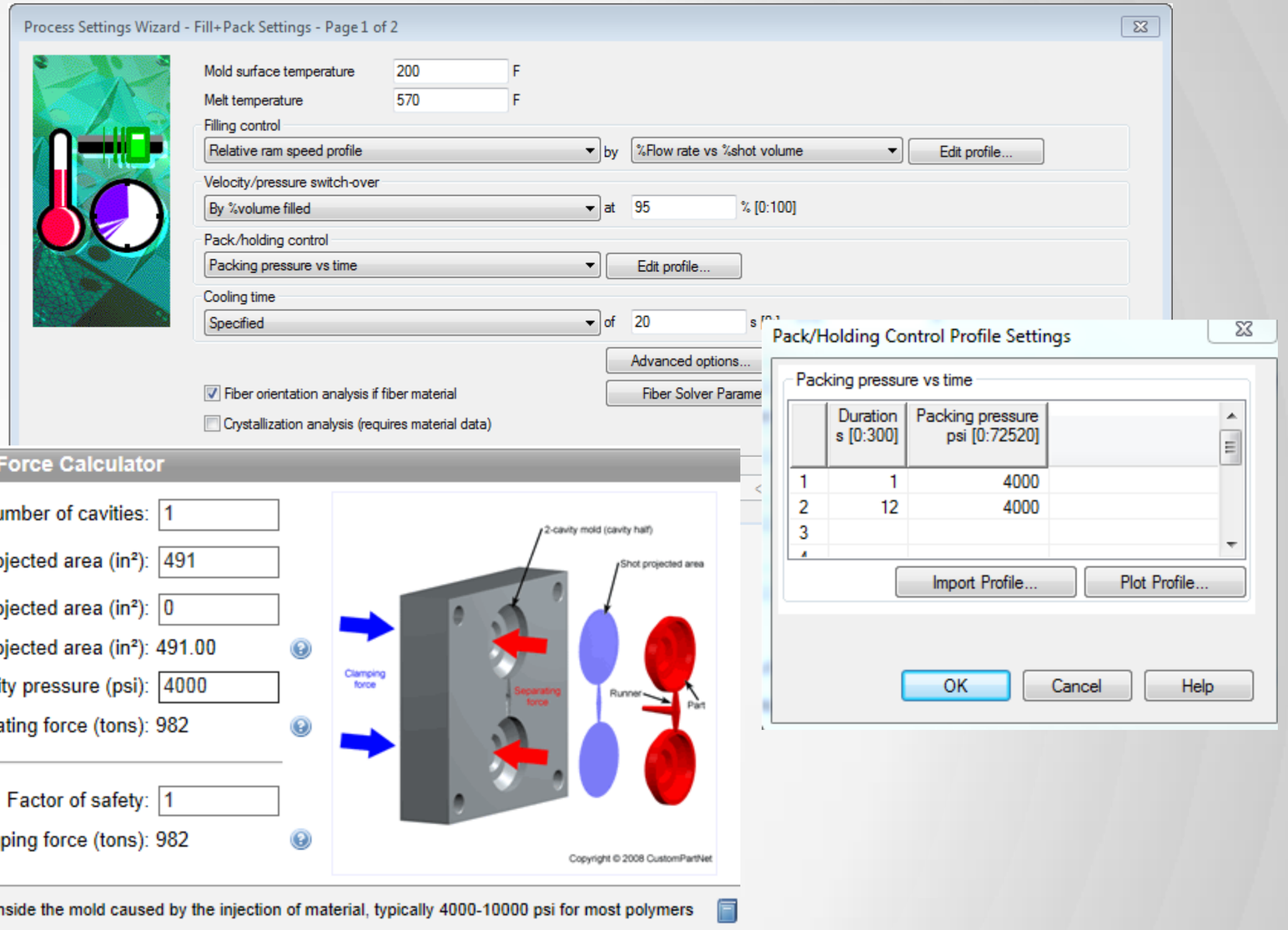


Work Flow - Next Steps

- Optimize gate size/type
- Verify
  - Gate locations can be tooled
  - Mold positions
- Get actual cooling line locations
- Eliminating air trap at top hole
- Reduce clamp force to under 650 tons.
- Reduce cycle time to achieve or surpass target

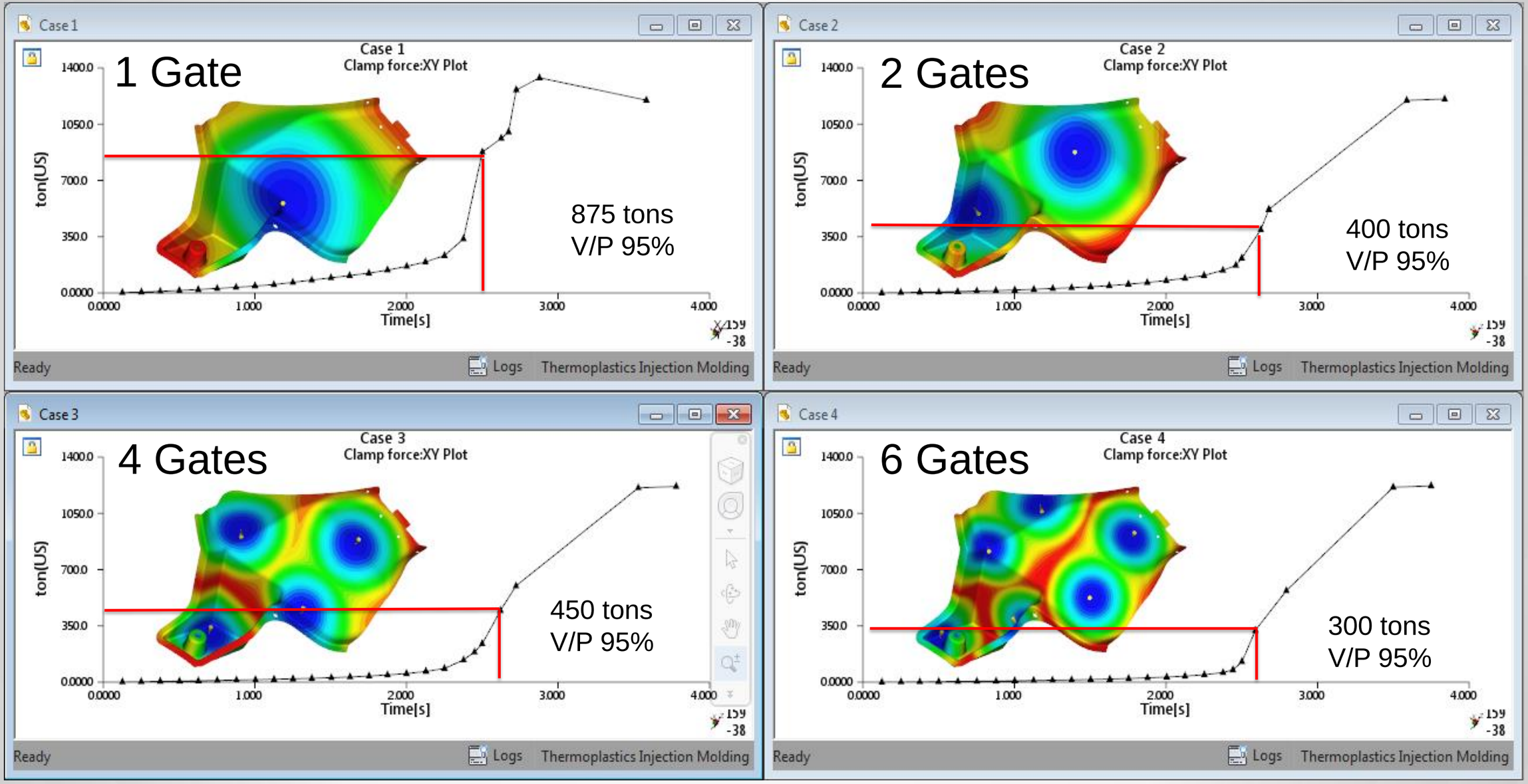
Mike Kowalski
Celanese

Process Parameters/Part Details



Based on a 2 cavity mold
Part volume 204 in^3
Projected area 491 in^2 (Rule of thumb clamp force is 3 to 5 times projected area)
Wall thickness 3.5mm

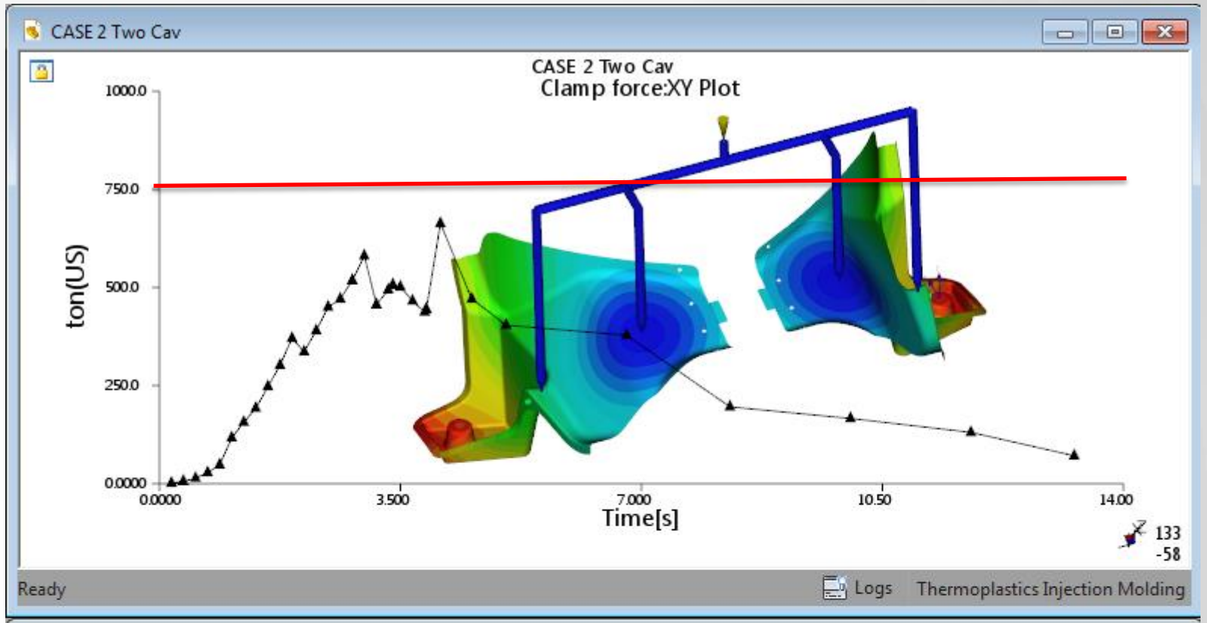
Gate Location Results



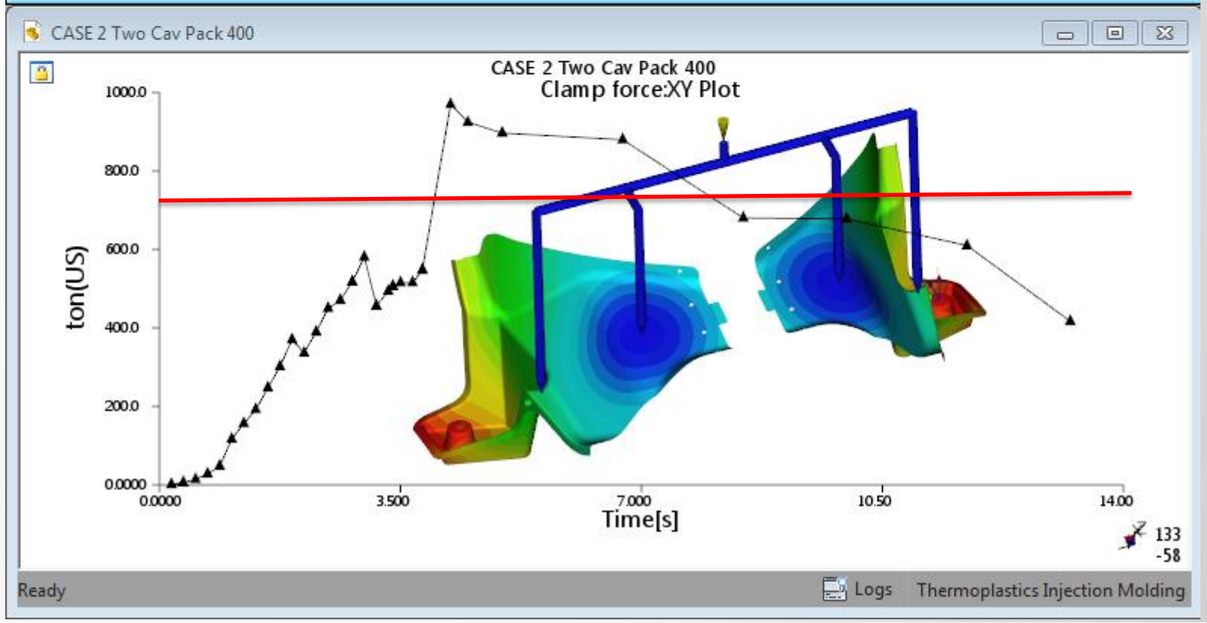
Note: Gate locations were not optimized.

Two gate approach

Two cavity mold
4 valve gate (Cascade Filling)
Ram speed profile
Pack Pressure 2000 Psi
Clamp Force ~700 tons
Pack pressure is to low.

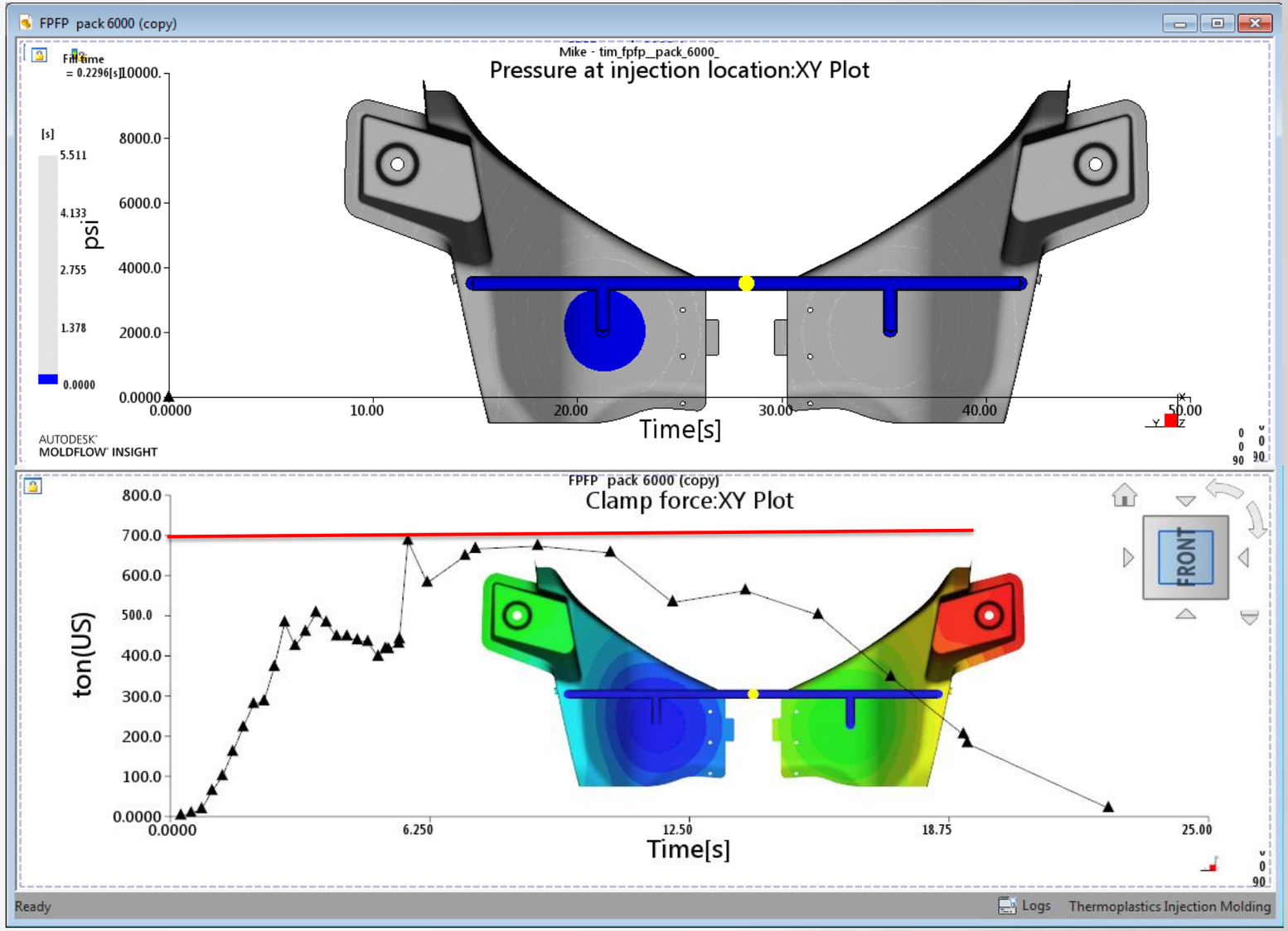


Two cavity mold
4 valve gate (Cascade Filling)
Ram speed profile
Pack Pressure 4000 Psi
Clamp Force ~1000 tons



Two gate approach
Fill Pack Fill Pack

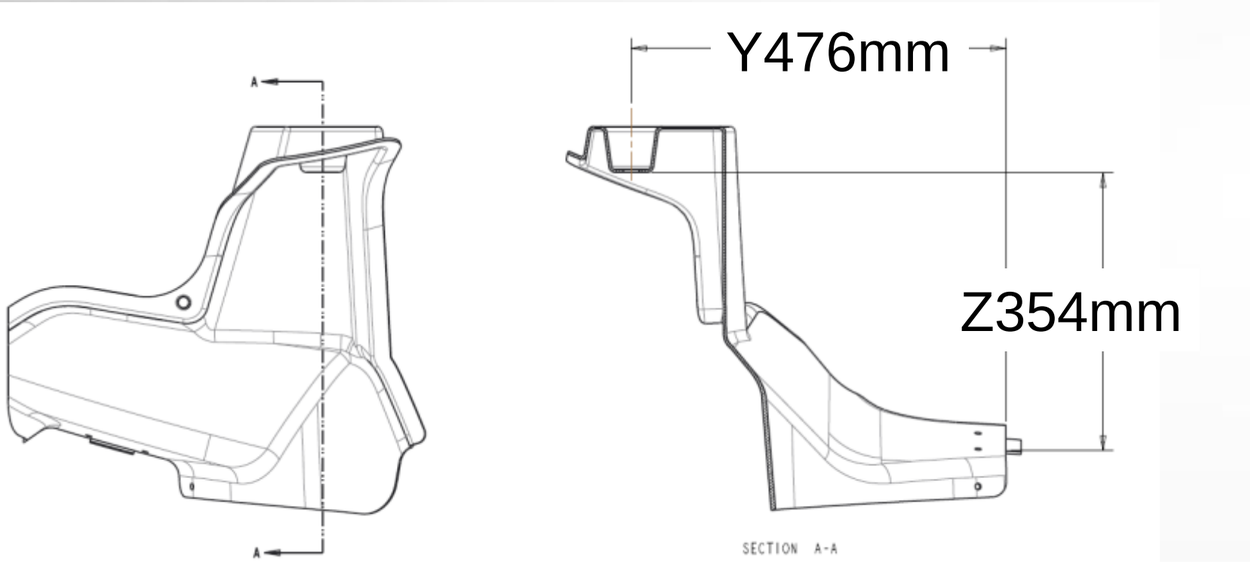
Two cavity mold
4 valve gate (cascade filling)
Fill Pack - Fill Pack
Ram speed profile
Pack Pressure 6000 Psi
Clamp Force ~700 tons
Cycle time would increase.

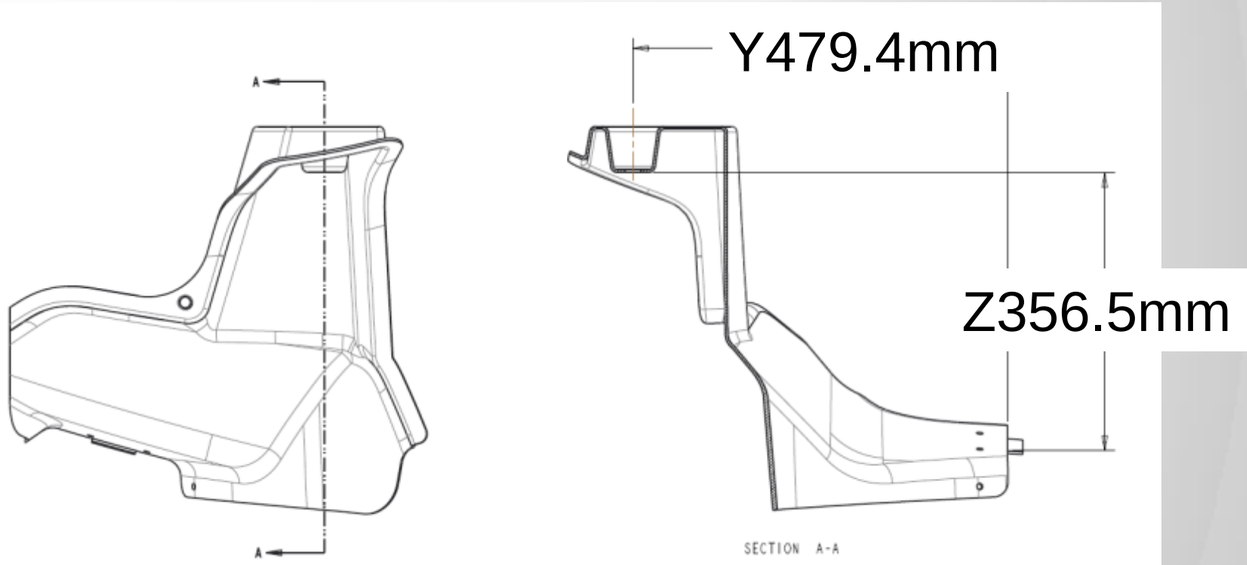


Critical Dimension

Y & Z dimensions from bolt hole to corner of tab are critical.
Y 476 +/- 4 (472 - 480)
Z 354 +/- 6 (348 - 360)

Tool was cut with a shrink rate of 0.7%
Mesh was expanded 0.7%
Y 476 +/- 4 (479.4) 3.4mm
Z 354 +/- 6 (356.5) 2.5mm





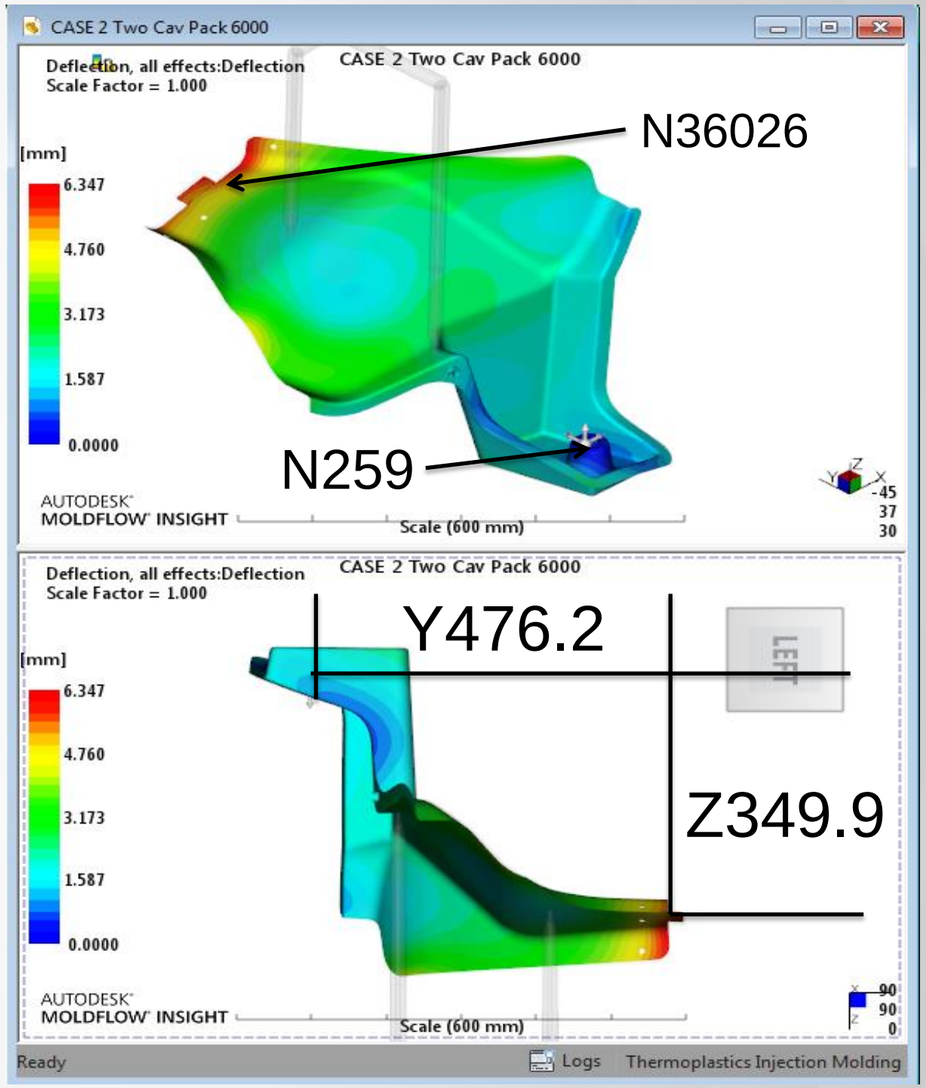
Think about it??
If we used a Material with a shrink rate of ~2.0%
Y 476 +/- 4 (485.5) 9.5mm
Z 354 +/- 6 (361.0) 7.0mm

Critical Dimension

Y 476 +/- 4 (472 - 480)

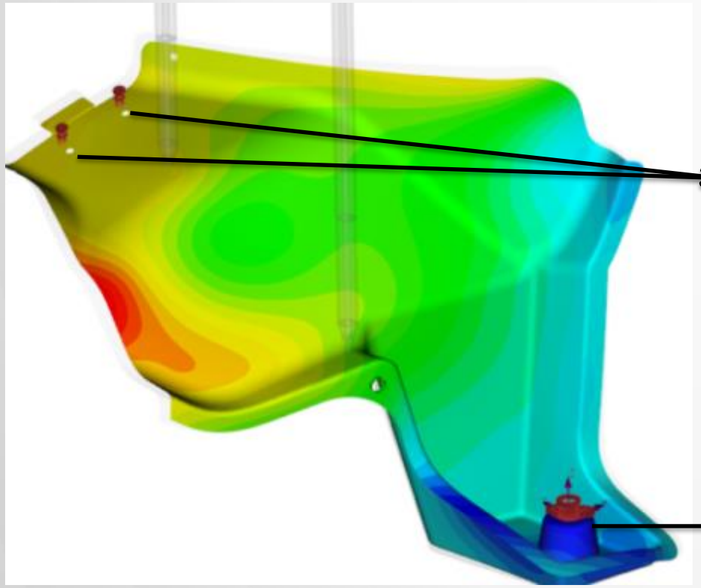
Z 354 +/- 6 (348 - 360)

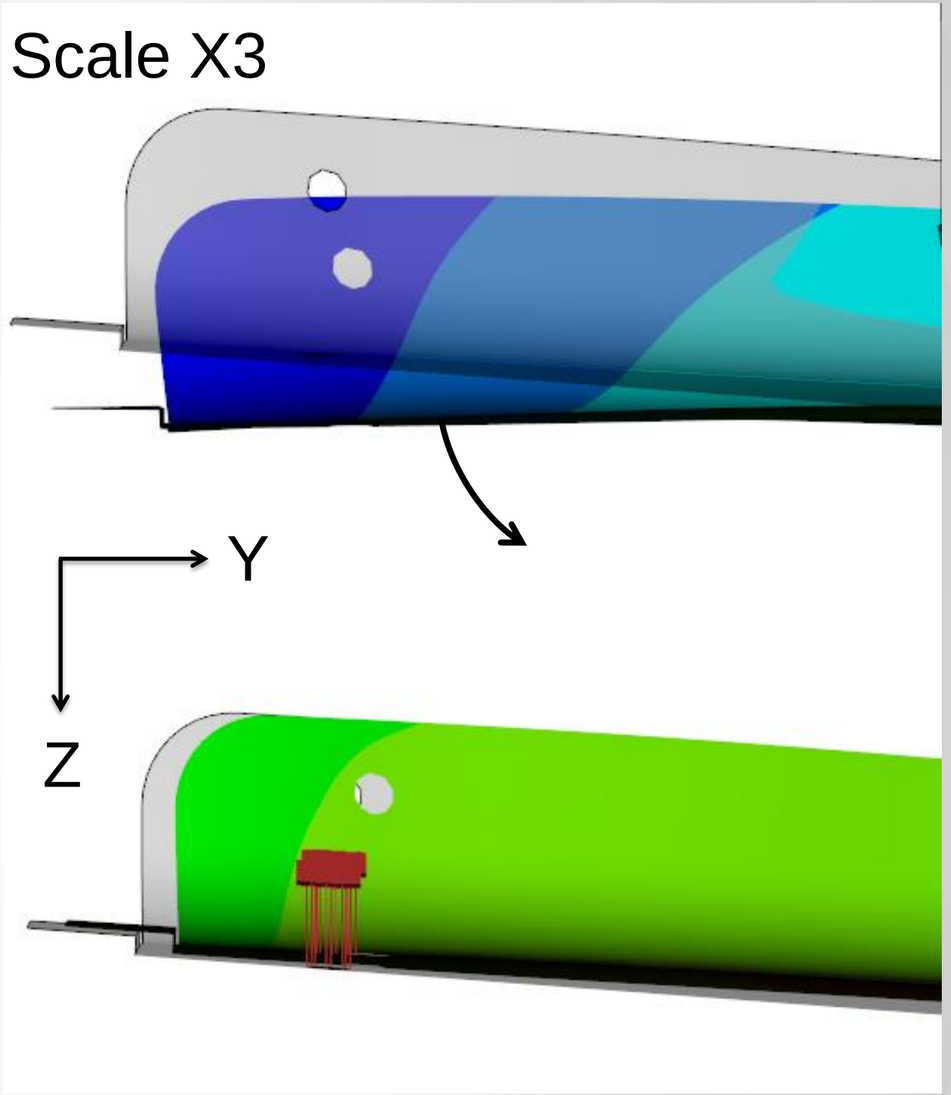
	Expanded	Unexpanded	Expanded	Unexpanded
	Y Direction	Y Direction	Y Direction	Y Direction
Using N259 N36026	**Pack 2000PSI**	**Pack 2000PSI**	**Pack 6000PSI**	**Pack 6000PSI**
Distance Before	479.4	476	479.4	476
Distance After	476.2	472.9	476.9	473.5
Delfection	3.2	3.1	2.5	2.5
Target Distance 476	0.2	-3.1	0.9	-2.5
	Z Direction	Z Direction	Z Direction	Z Direction
Distance Before	356.5	354	356.5	354
Distance After	349.9	347.5	351.8	349.3
Delfection	6.6	6.5	4.7	4.7
Target Distance 354	-4.1	-6.5	-2.2	-4.7
Weight	**3092g/109oz**		**3135g\110oz**	



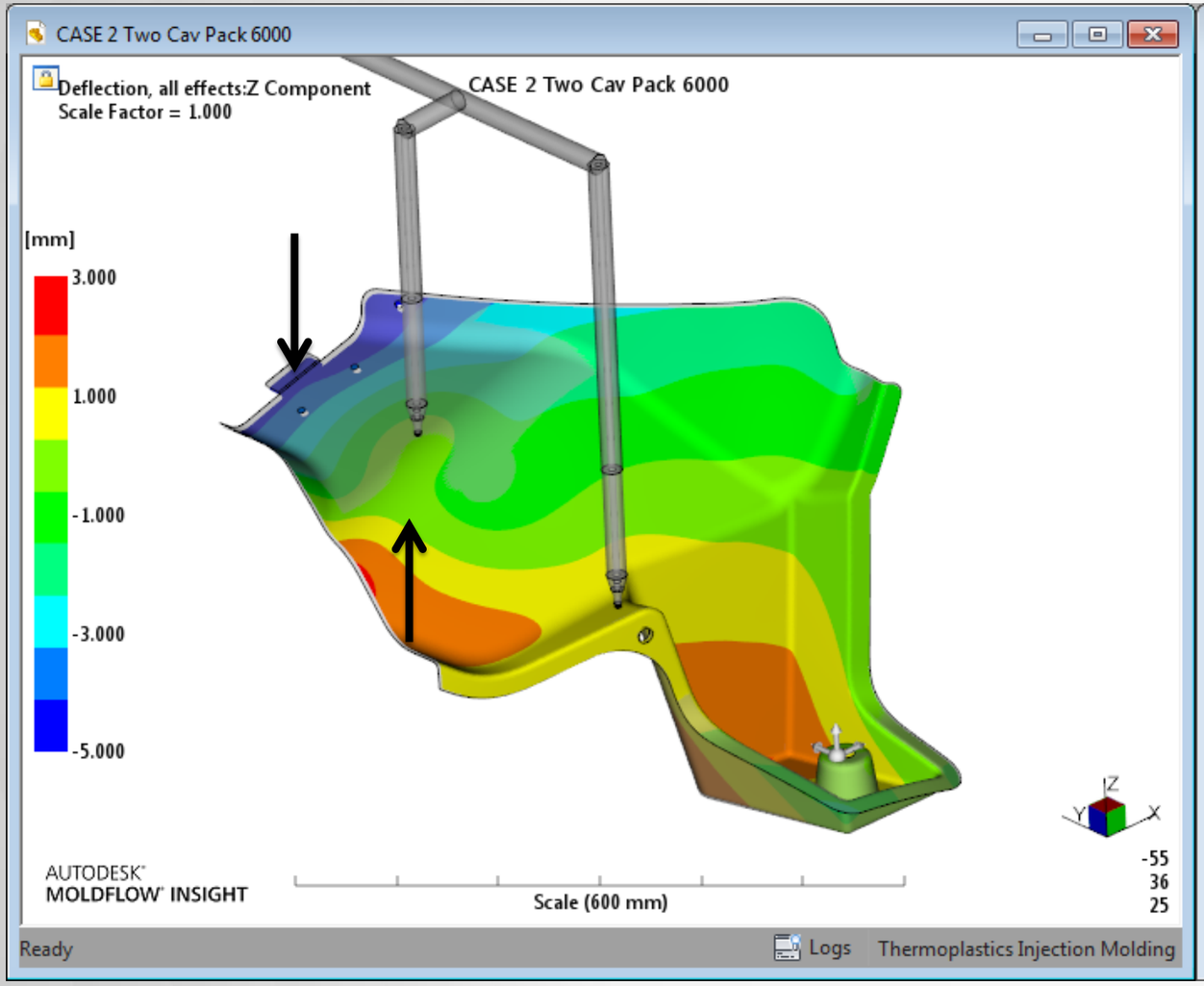
Critical Dimension

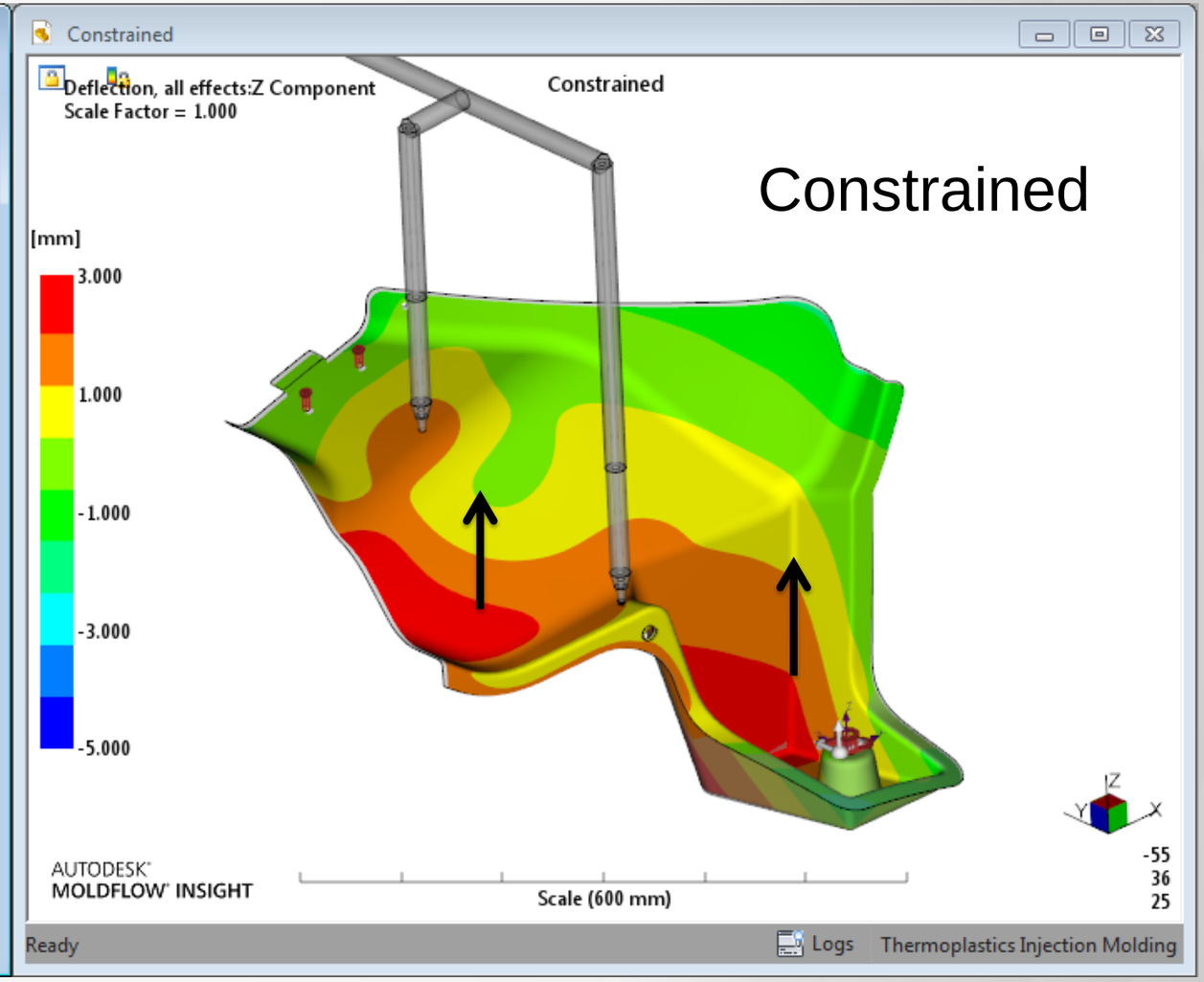
		Constrained
	Z Direction	Z Direction
Using N259 N36026	**Pack 6000PSI**	**Pack 6000PSI**
Distance Before	356.5	356.5
Distance After	351.8	356.2
Delfection	4.7	0.3





Critical Dimension





Summary

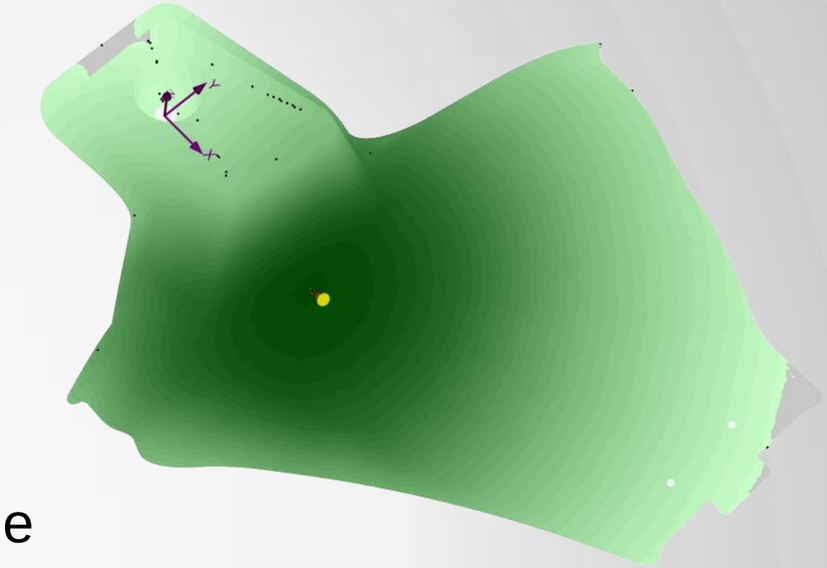
Next steps:
Design Modifications
Optimize Process (DOE)
Add Cooling lines

Jay Shoemaker
Autodesk

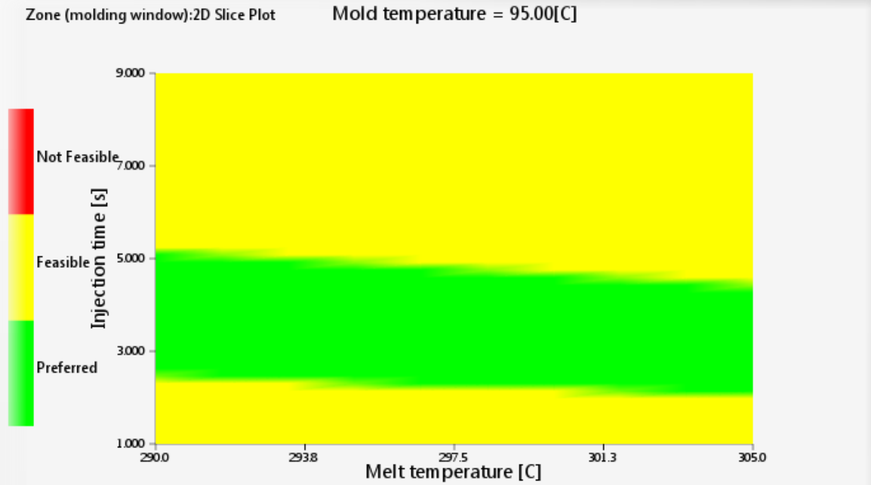
Jay's Philosophy

- Follow Moldflow Philosophy as much as possible
- Assumed I would do things that would not work
- Tried to keep an open mind
- Keep in mind Tim's
  - Goals
  - Restrictions
  - Things we can change

Workflow

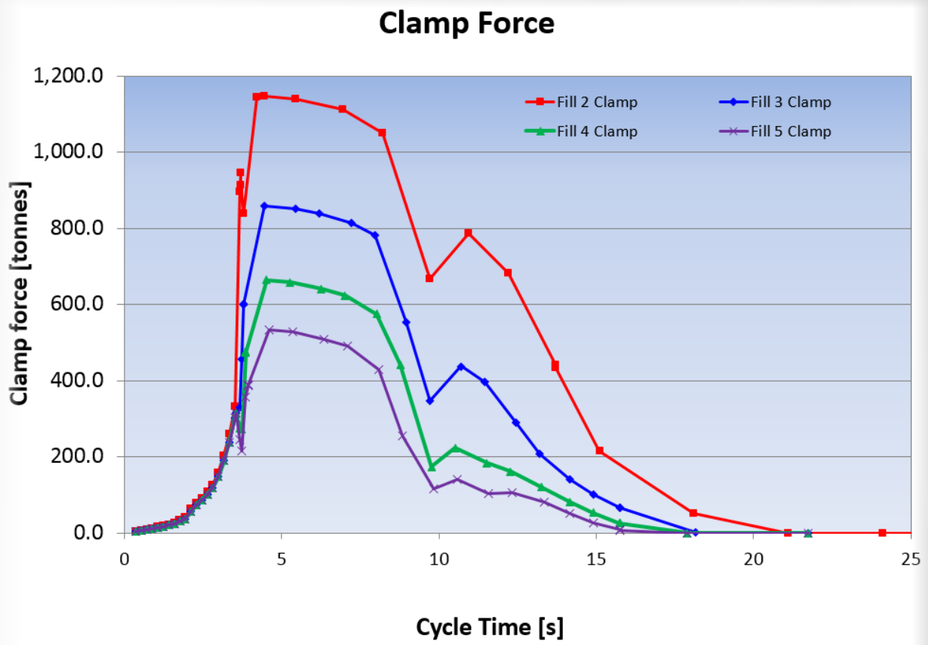


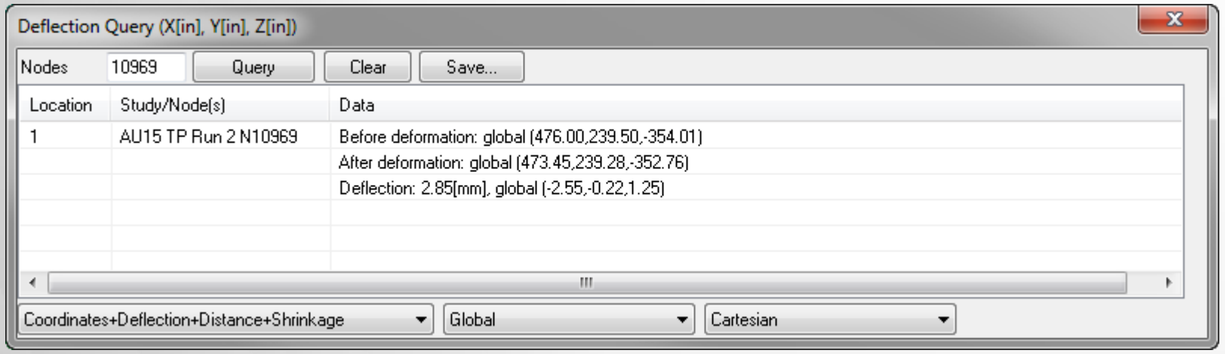
- Moved part so center of critical hole was origin (0, 0, 0)
- Meshed at different densities
  - Worked with a rather course mesh to save analysis time
- Did NOT apply shrink to the model
  - I assumed I would need to at some point
- Used **Fill preview** to find a single gate location
- Used molding window to determine if single gate possible



Workflow

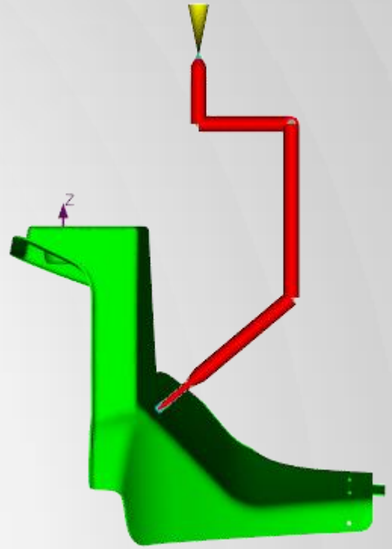
- One gate works, who knew?
- No runners
  - Lower clamp force
  - Monitor critical dimensions
    - Query one node to get both critical dimensions
      - X – Dimension tolerance 472 - 480, analysis **473.45**
      - Z – Dimension tolerance 348 – 360, analysis **352.7**

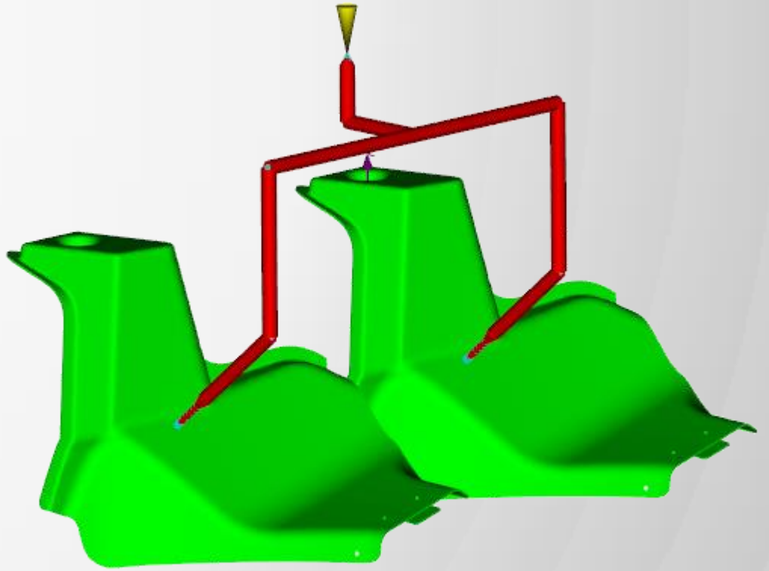




Workflow

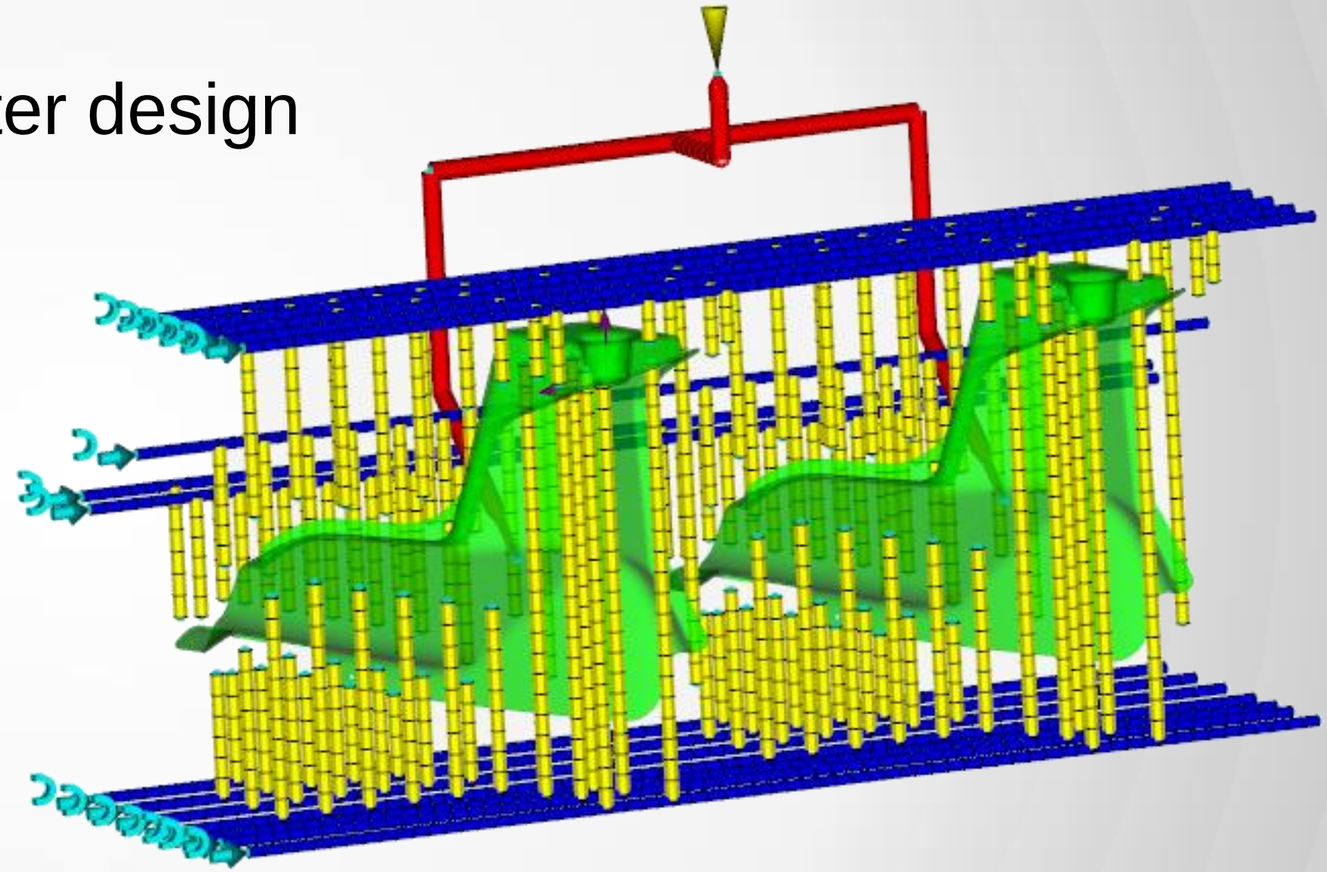
- Add Runners
  - Get advice how to get a hot drop in desired location
    - Dan Ward, Synventive
  - Worked on single and 2 cavity versions
  - Monitored
    - Clamp force
    - Critical dimensions





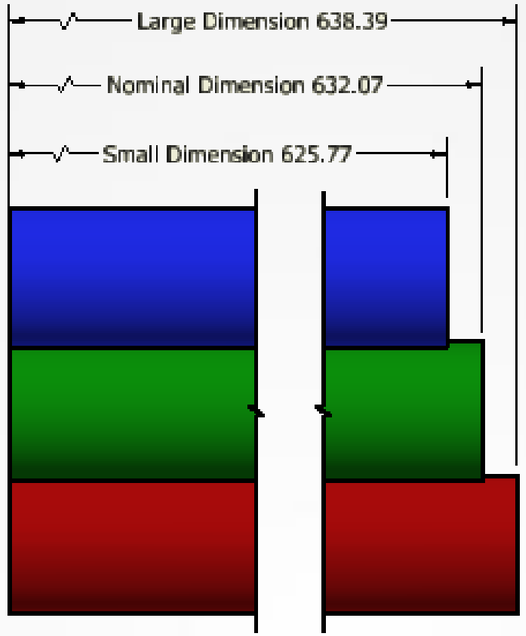
Workflow

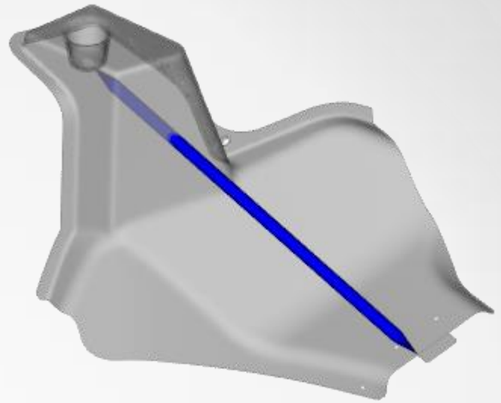
- Added cooling system
  - Cavity layout based on water design
- Iterated
  - Cooling line placement
  - Baffle length
  - Coolant temperature
  - Coolant flow rate
    - Finalized on total flow rate
- Monitored
  - Critical dimensions
  - Temperature, mold

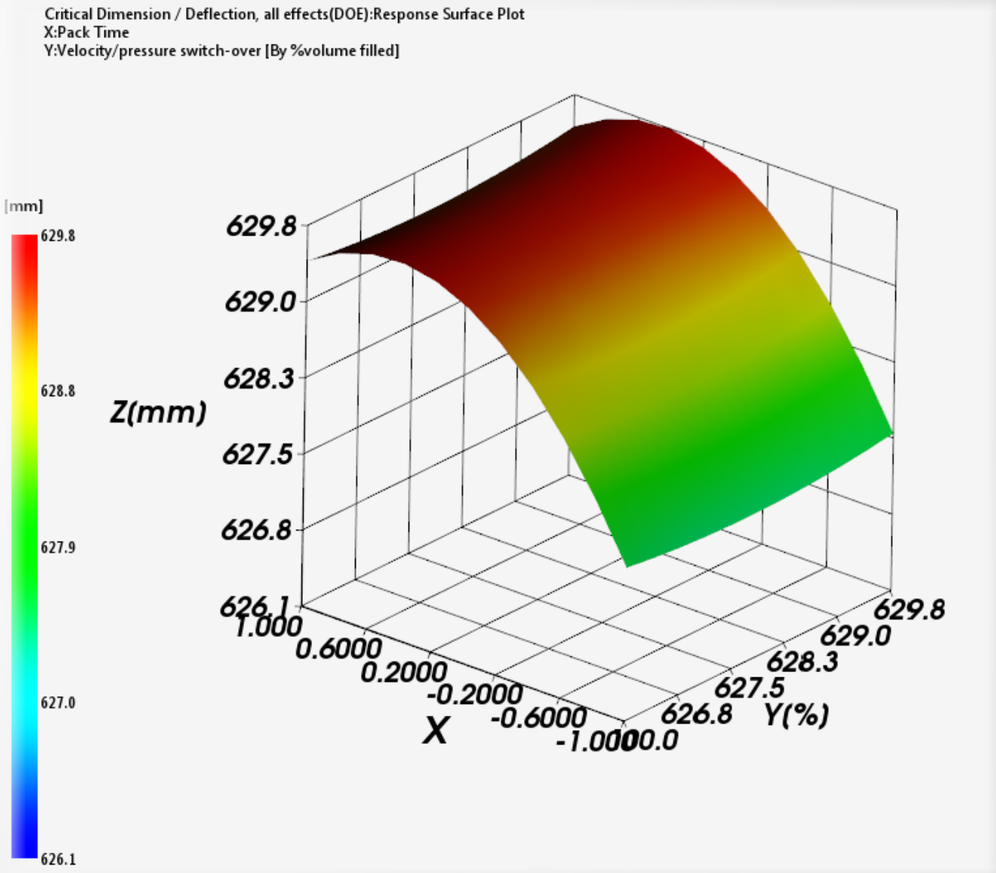


Workflow

- Ran DOE
  - Variables
    - Melt T
    - Fill Time
    - V/P Switchover
    - Pack Time, Pressure
    - Coolant Temp
  - Quality Criteria
    - Clamp force
    - Volumetric shrinkage at ejection
    - Critical dimension







Gayle Rose
BD

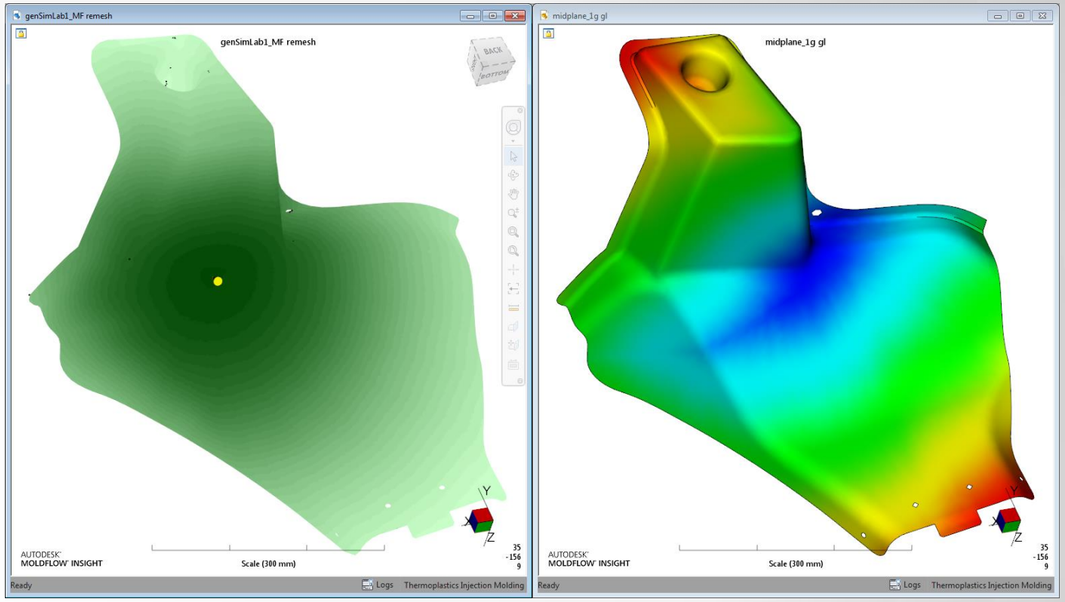
5. Compare and Contrast

After completing their work, the results were sent back to *compare and contrast* the different approaches.

Setup Comparison

- Meshing software:
  - Moldflow = 2
  - Hypermesh (Altair) = 2
  - SimLab (Altair) = 1

- Fill Preview = 2
- Gate Location Analysis = 3
  - 1 gate
  - 1, 2, 4, 6 gates
  - 1, 2, 3, 4, 5 gates



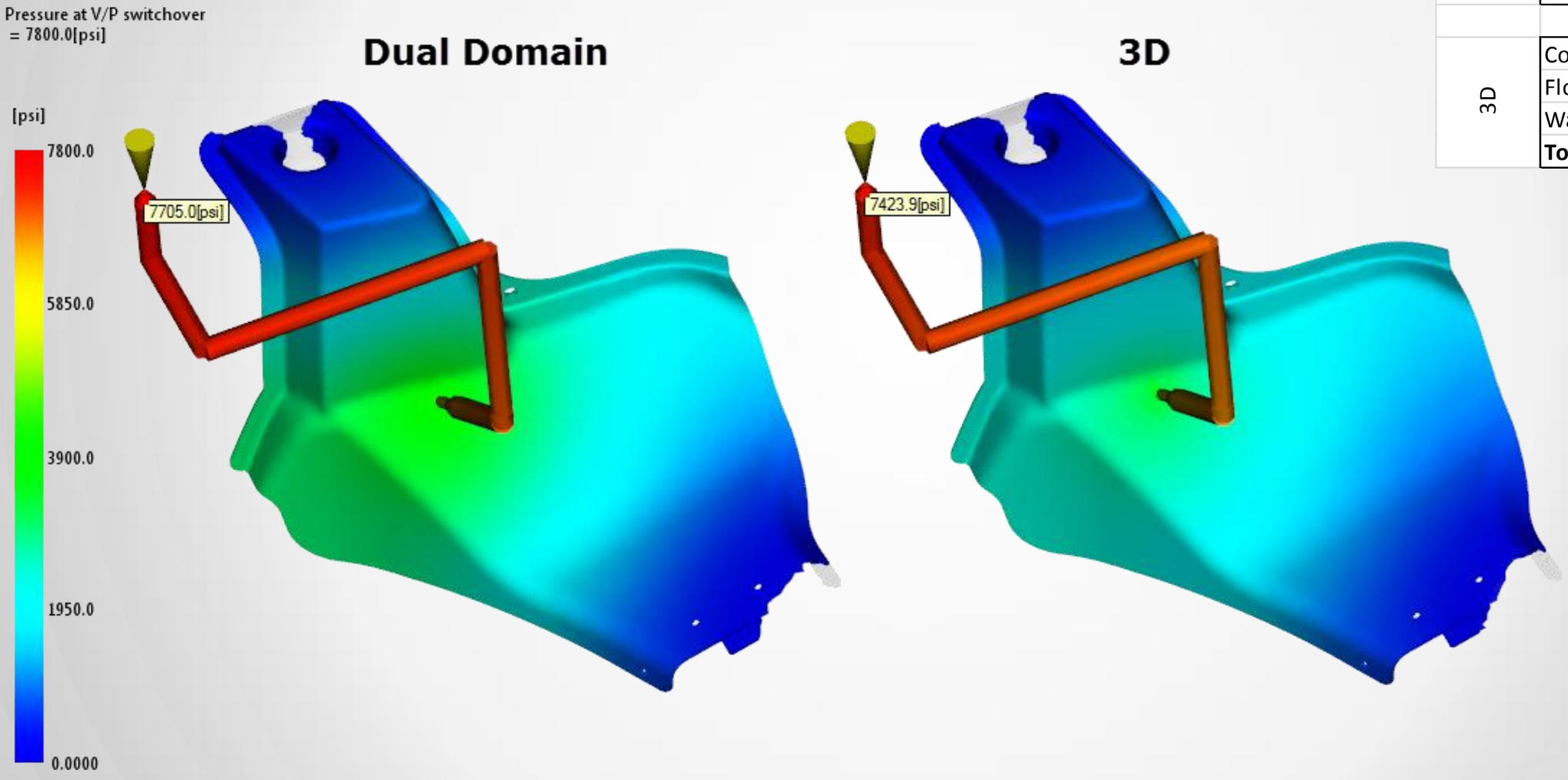
- Molding Window Analysis= 2

Model Comparison

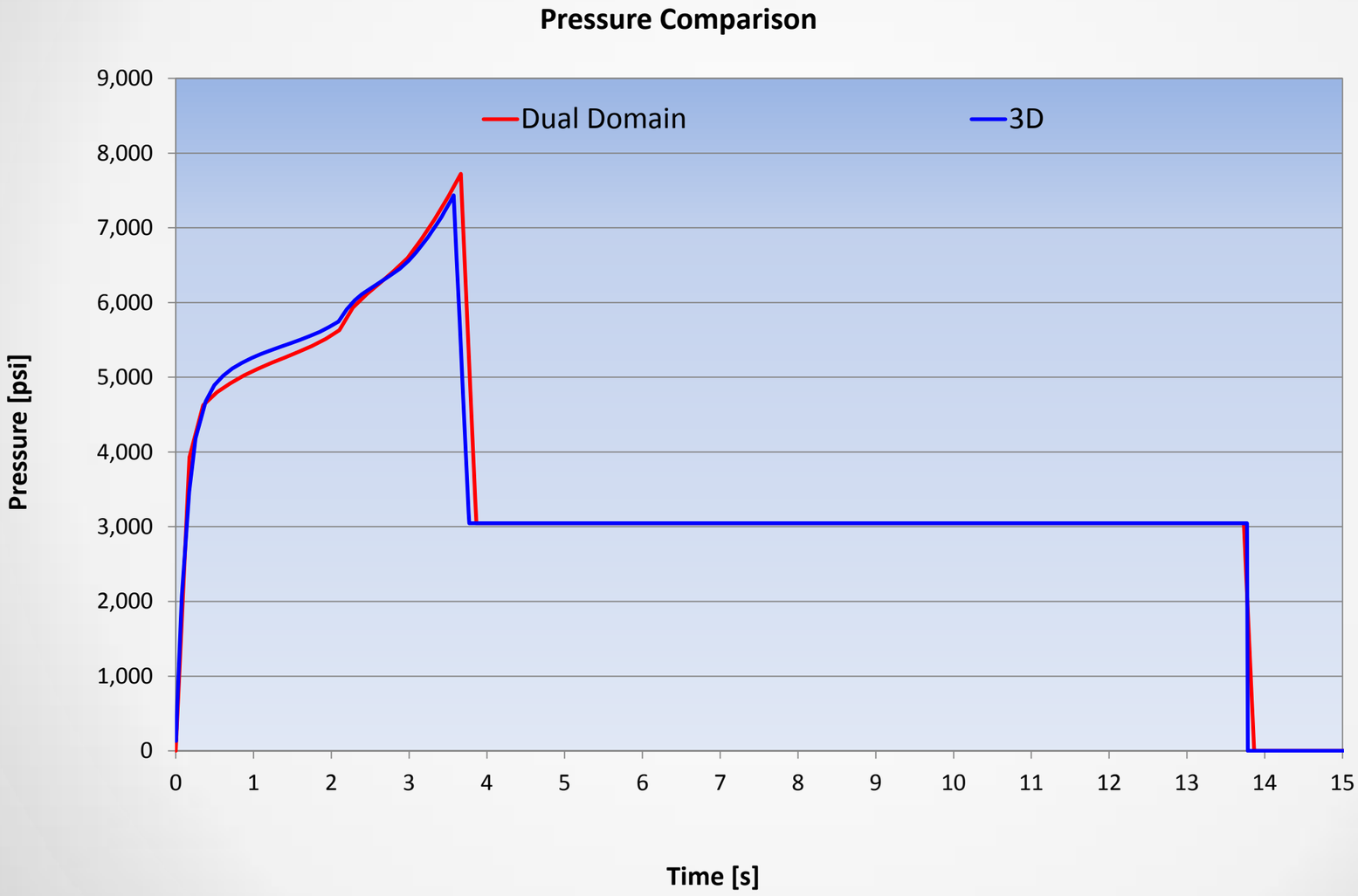
- Mesh
  - Mid-plane: 2 of 5
  - Dual Domain: 3 of 5
  - Elements:
    - 14,880
    - 31,242
    - 61,182
    - 152,880
    - 187,280
- 2 modeled 2 cavities, all others used Occurrence #
- What about 3D mesh?

Model Comparison: DD vs 3D

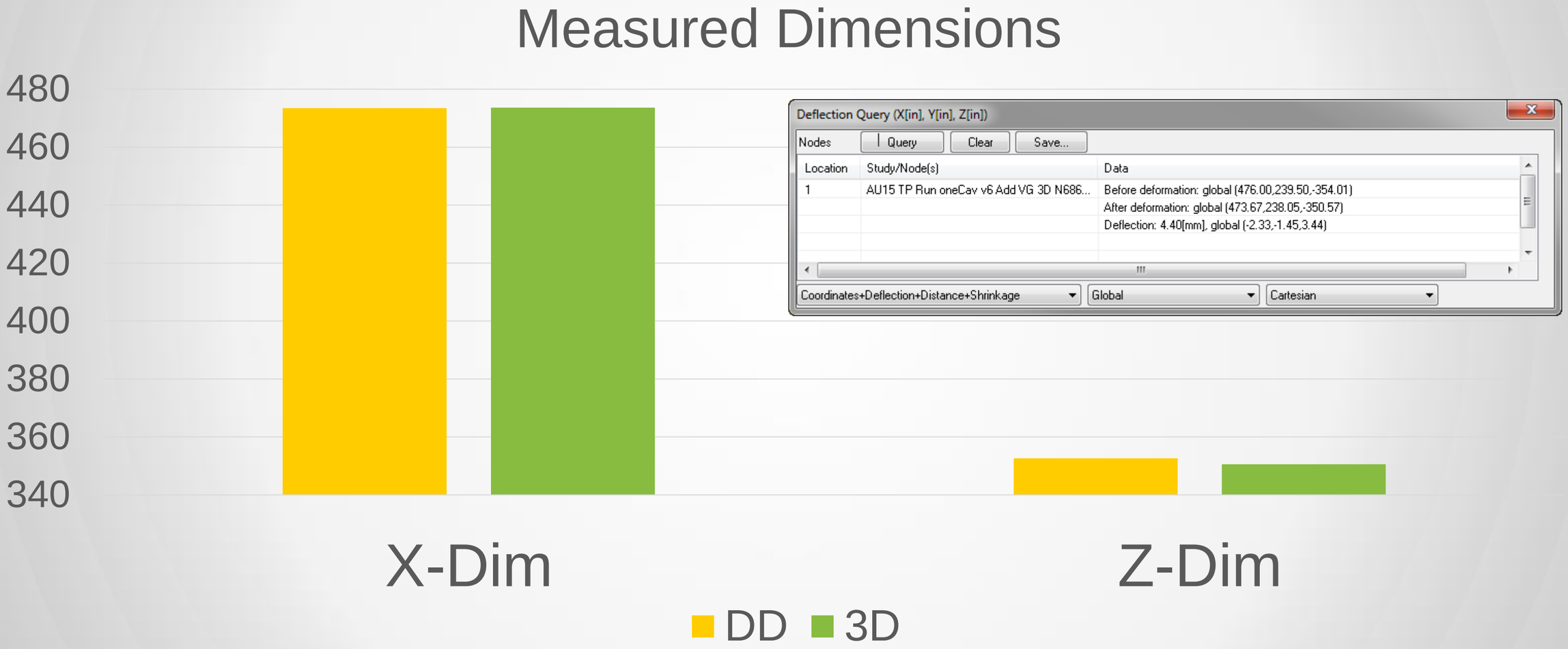
		Seconds	Minutes
Dual Domain	Cool	472	
	Flow	18335	
	Warp	73	
	Total	18880	**315**
3D	Cool	714	
	Flow	8657	
	Warp	1244	
	Total	10615	**177**



Pressure Comparison DD to 3D Single Cav w Run

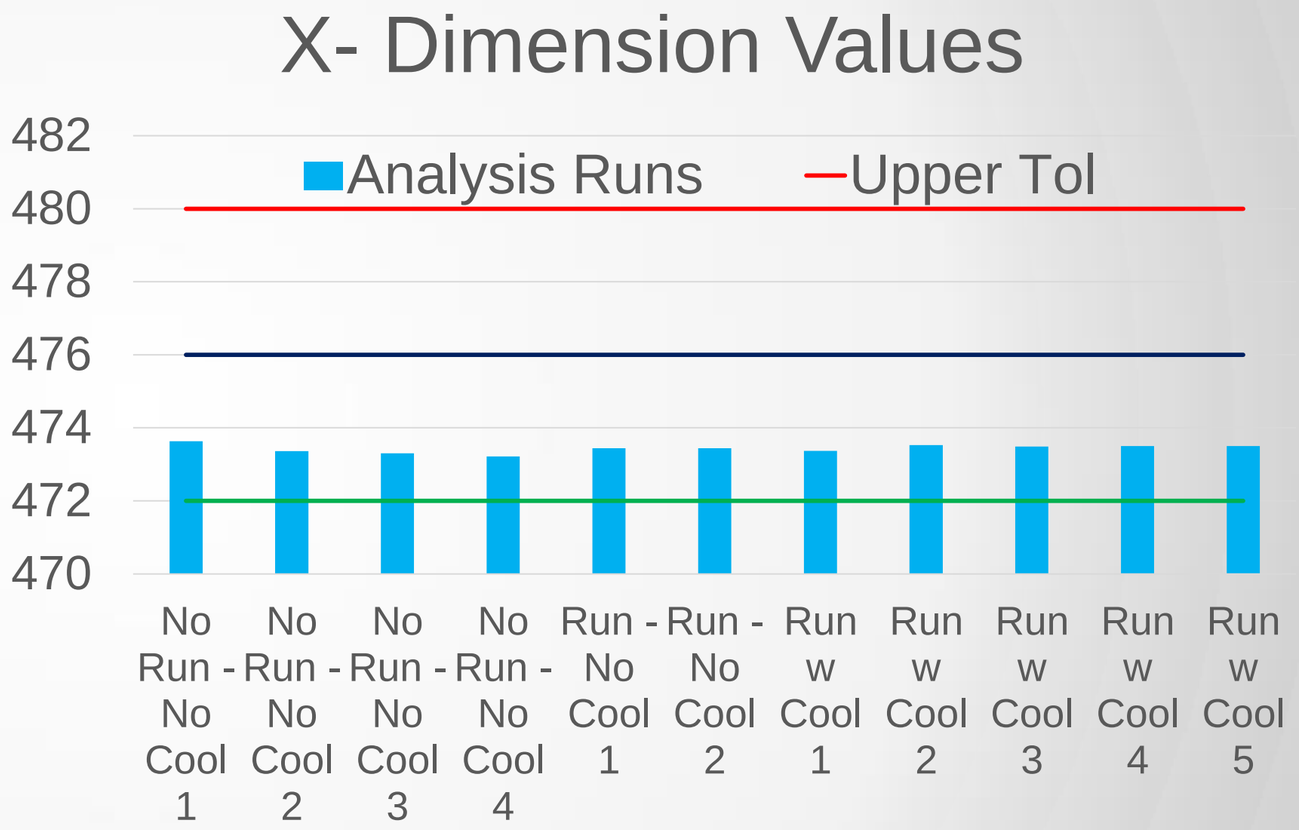


Critical Dimension Comparison – DD to 3D

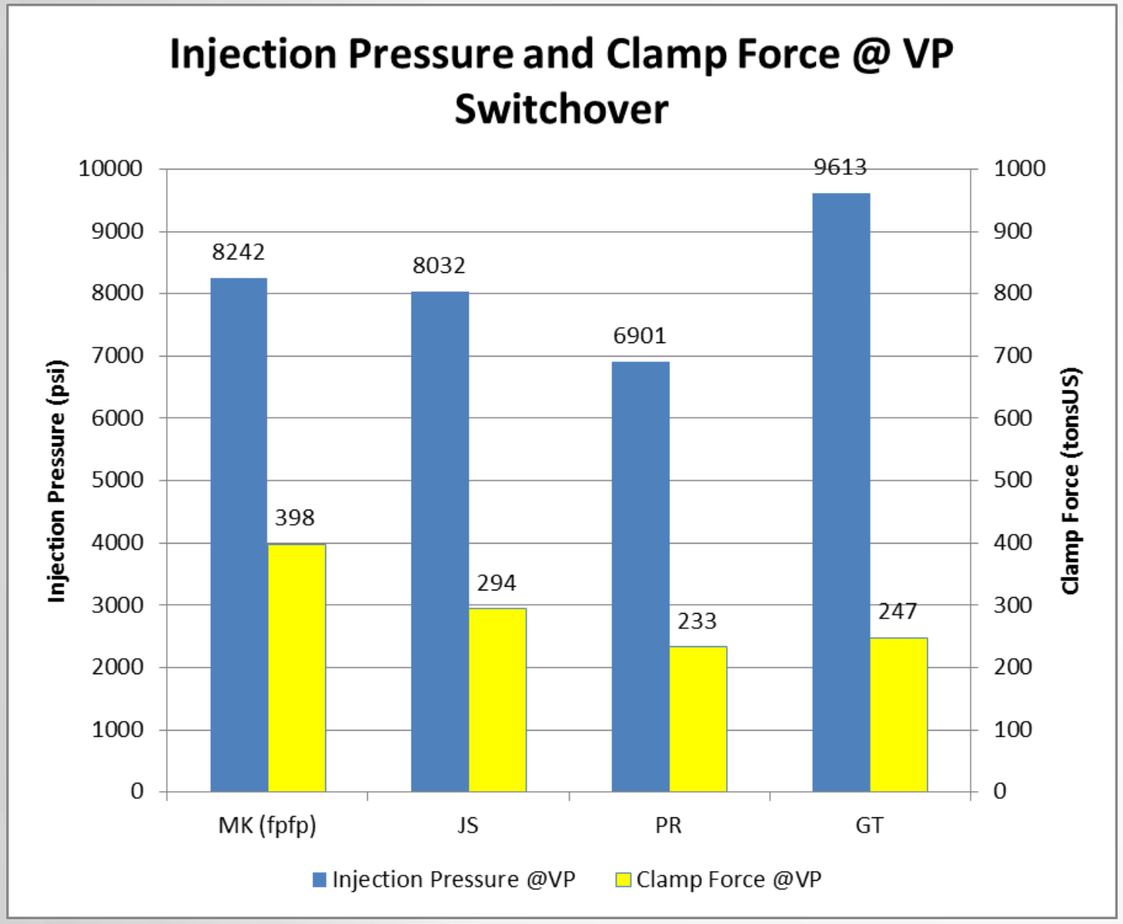


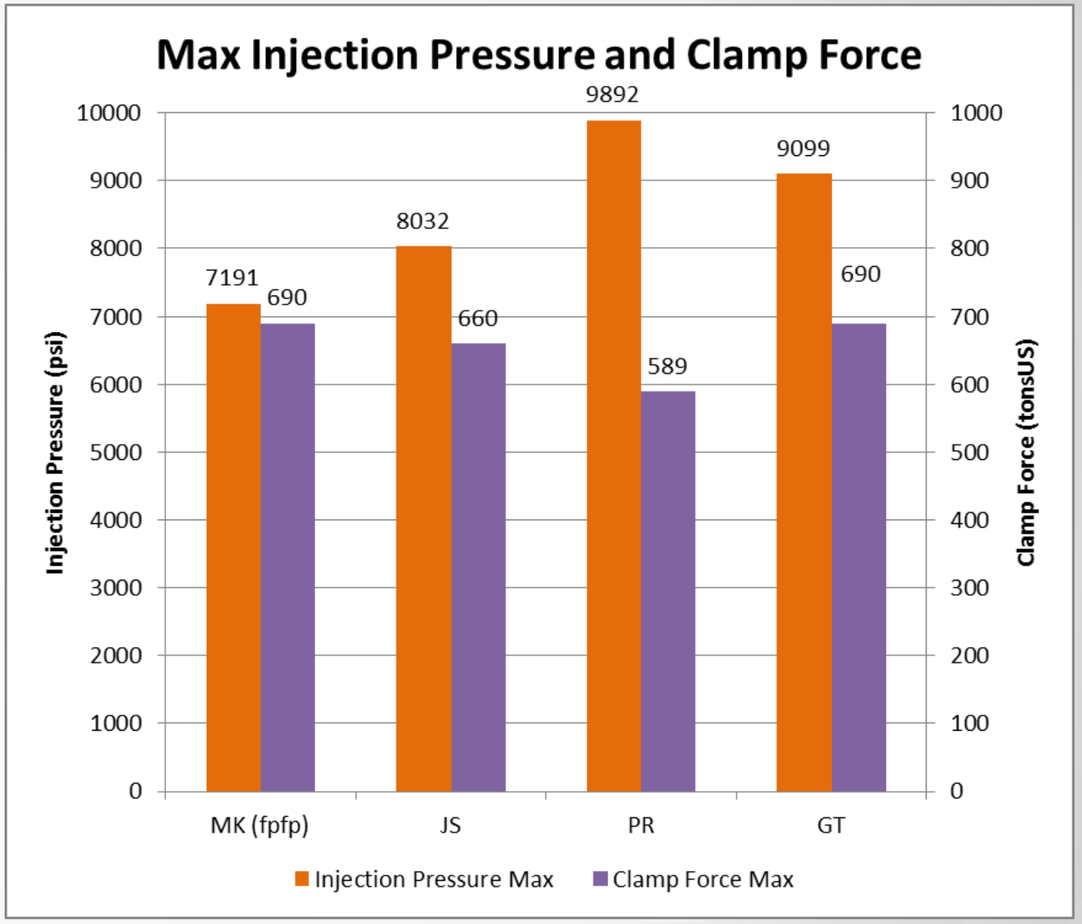
Model Comparison

- Cooling analysis
  - 2 of 4
    - Why? Time, effort, cooling design knowledge?
    - Was it worth the effort?



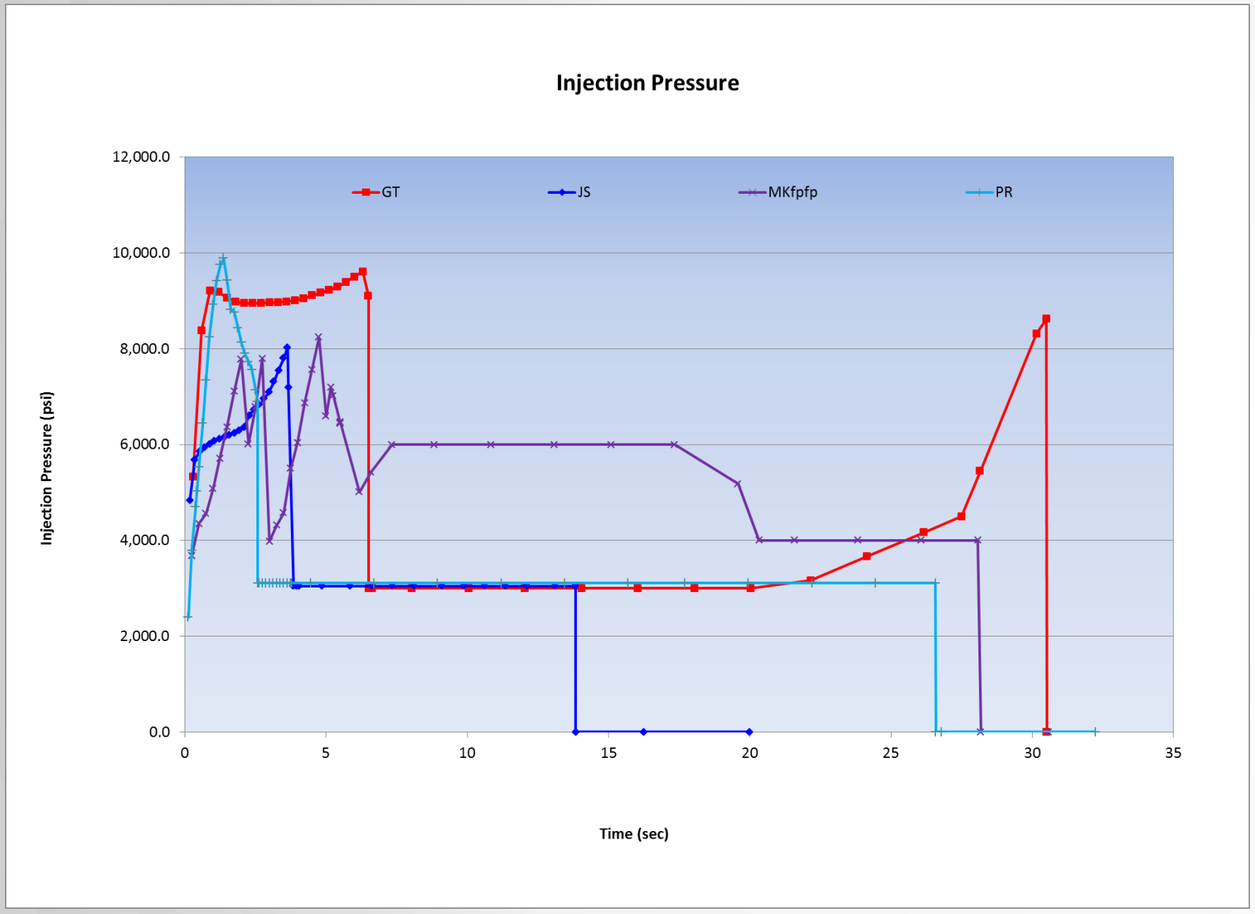
Results Comparison: Injection Pressure and Clamp Force

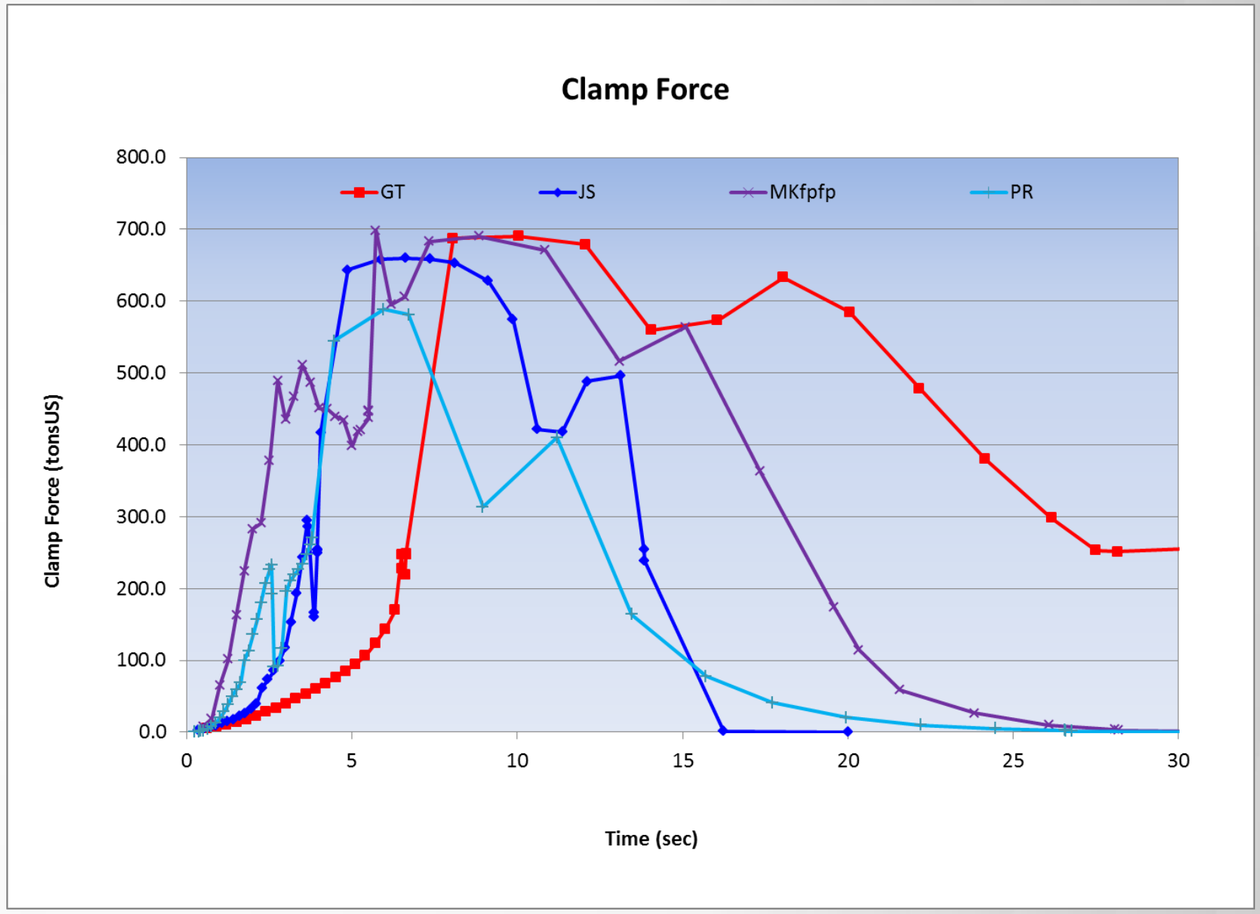




Clamp force is easy during fill, but not during pack

Results Comparison: Injection Pressure and Clamp Force

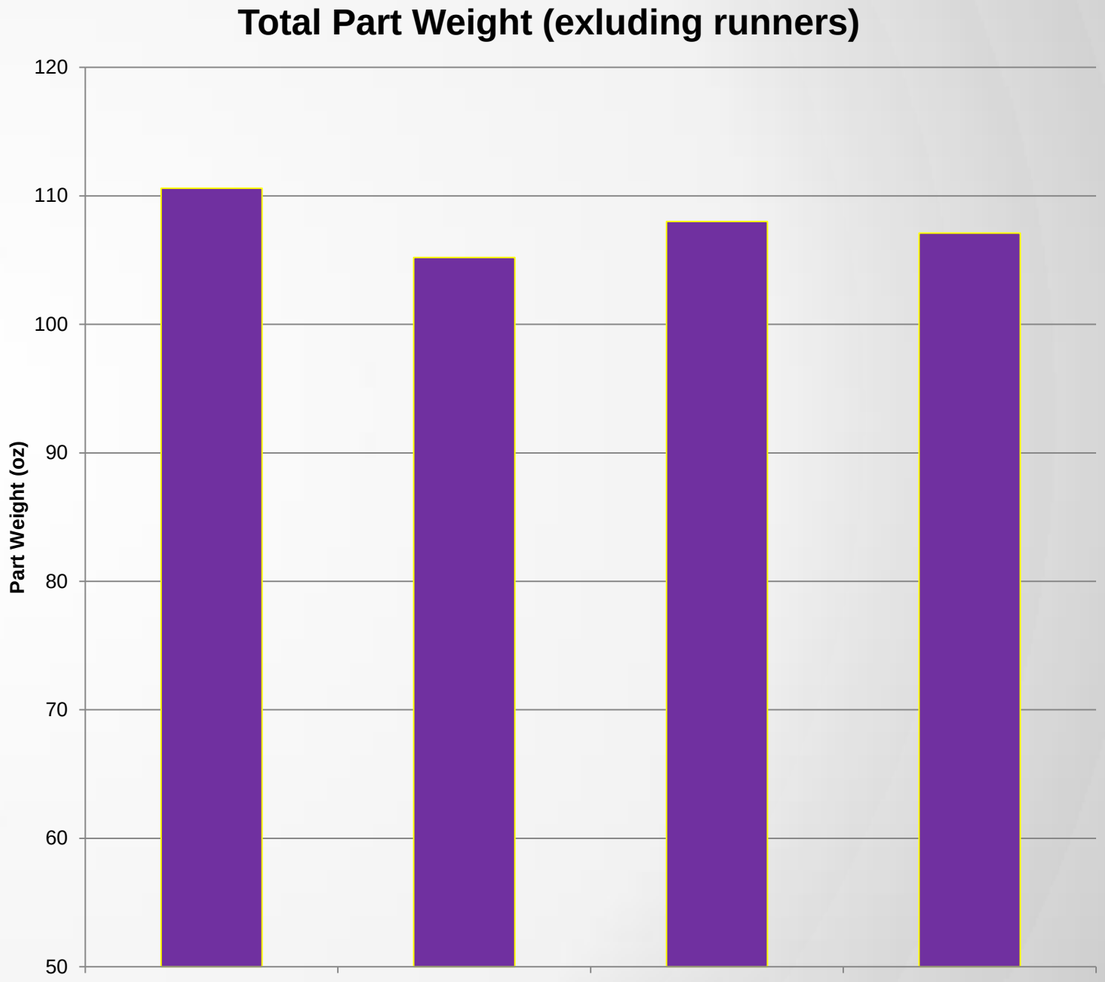




Notice the difference in the pack profiles and the effect on the Clamp Force

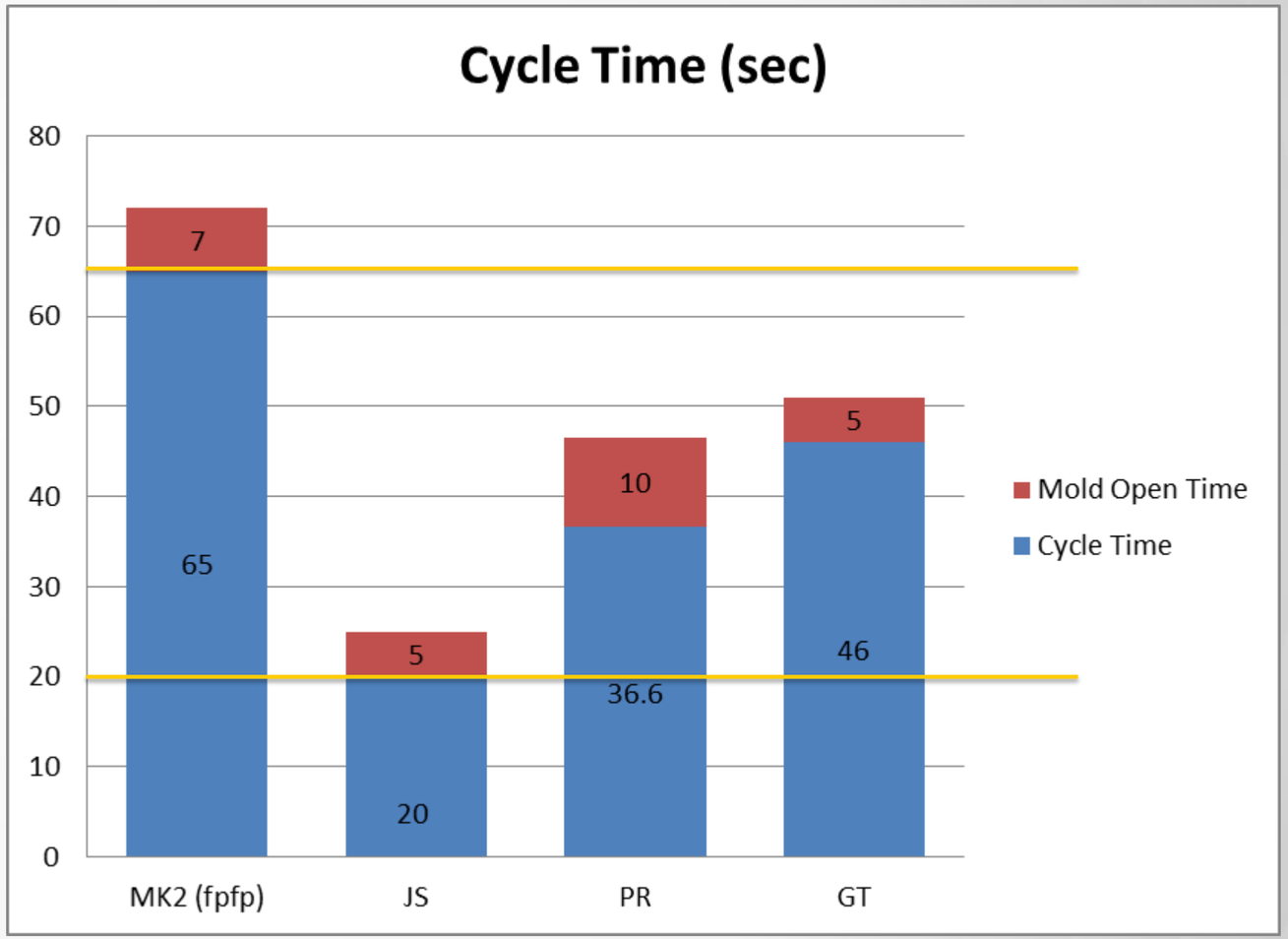
Results Comparison: Part Weight

- Part Weight variation
  - But all are within warpage tolerance, so does it matter?
- 5% difference between max and min weight



Results Comparison: Cycle Time

- Cycle Times varied from 25 – 72 seconds



Results Comparison: Warpage

- How was warp measured
  - JS – moved hole in geometry to 0,0,0, then measured in free state
  - PR – measured node at side of hole, then measured in free state
  - GT – used node on side of hole, then measured in free state deflection at hole and tab
  - MK – picked node on side of hole, then measured in free state

Results Comparison: Deflection

	MK fpfp	GT	JS	PR
	Y Direction	Y Direction	Y Direction	Y Direction
Distance Before	479.4	476	476	476
Distance After	476.2	477.77	473.5	476.74
Delfection	3.2	-1.8	2.5	-0.7
Target Distance 476	0.2	1.8	-2.5	0.7
	Z Direction	Z Direction	Z Direction	Z Direction
Distance Before	356.5	354	354	354
Distance After	349.9	356	352.6	354.44
Delfection	6.6	-2	1.4	-0.44
Target Distance 354	-4.1	2	-1.4	0.44

Results Comparison: Mesh Statistics

- Just in case you're curious

	Kowalski		Shoemaker		Ruddy		Thompson	
Entity counts:								
Triangles	152880		31242		61182		187280	
Connected nodes	77318		15613		30581		93622	
Connectivity regions	2		2		1		3	
Area:								
Surface Area:	1072.87 in^2		1071.34 in^2		1072.26 in^2		2144.47 in^2	
Volume by element types:								
Triangle:	148.128 in^3		73.0359 in^3		73.0249 in^3		146.083 in^3	
Aspect Ratio:								
	Max Average Min		Max Average Min		Max Average Min		Max Average Min	
	3.85 1.95 1.16		16.21 1.63 1.16		4.96 1.60 1.16		9.99 1.45 1.16	
Edge details:								
Free edges	1776		0		0		0	
Manifold edges	228,432		46,863		91,773		280,920	
Non-manifold edges	0		0		0		0	
Match percentage:								
Match percentage			93.50%		93.30%		93.40%	
Reciprocal percentage			90.60%		90.60%		88.60%	
Total Part Weight (exluding runners)	110.6	107.7	105.2		108.0		107.1	
	FP	FPFP						
Volumetric shrinkage - max	11.3015	11.28	12.6534		8.1398		11.9189	
Volumetric shrinkage - 95th %	11.3015	11.28	8.9588		6.9246		10.5376	
Volumetric shrinkage - 5th %	6.0136	5.992	6.3982		5.7144		8.2115	
Volumetric shrinkage - min	6.0136	5.992	4.607		3.7726		5.943	
Volumetric shrinkage - ave	9.6039	9.788	7.4529		6.265		8.9452	
Volumetric shrinkage - root-mean-s	2.0998	1.716	0.8661		0.3941		0.8731	

Summary

- This has not been about right or wrong. There are many ways to approach a problem. These differences are based on the analysts back ground and their companies requirements.

A Special Thanks

- Mike Kowalski - Celanese
- Gayle Rose - BD
- Peggy Ruddy - DuPont
- George Thompson – Lacks Trim Systems
- Jay Shoemaker – Autodesk

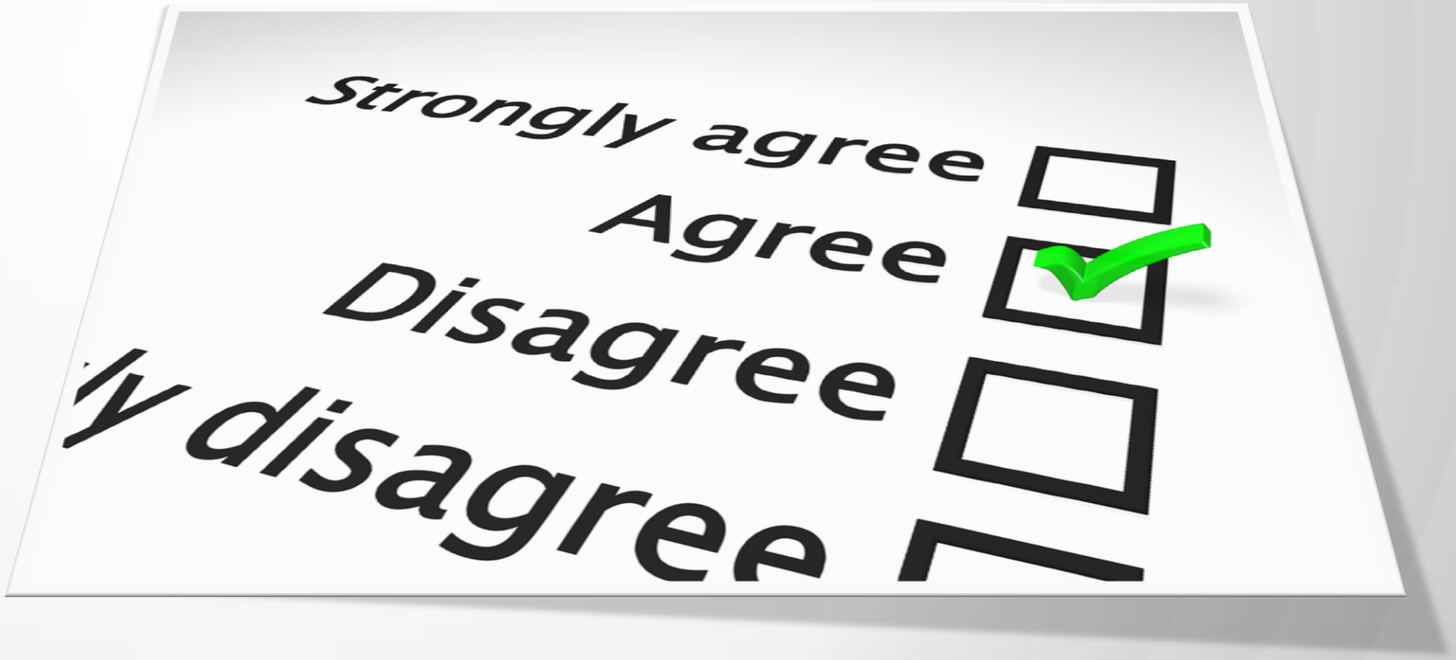
- Caroline Dorin – Autodesk
- Linda Umlor – Cascade Engineering

QUESTIONS?

Tim.VanAst@cascadeng.com
Jay.Shoemaker@autodesk.com

Be heard! Provide AU session feedback.

- Via the Survey Stations, email or mobile device.
- AU 2016 passes awarded daily!
- Give your feedback after each session.
- Give instructors feedback in real-time.



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Software Improvement Ideas

Software Improvement Ideas- Gayle

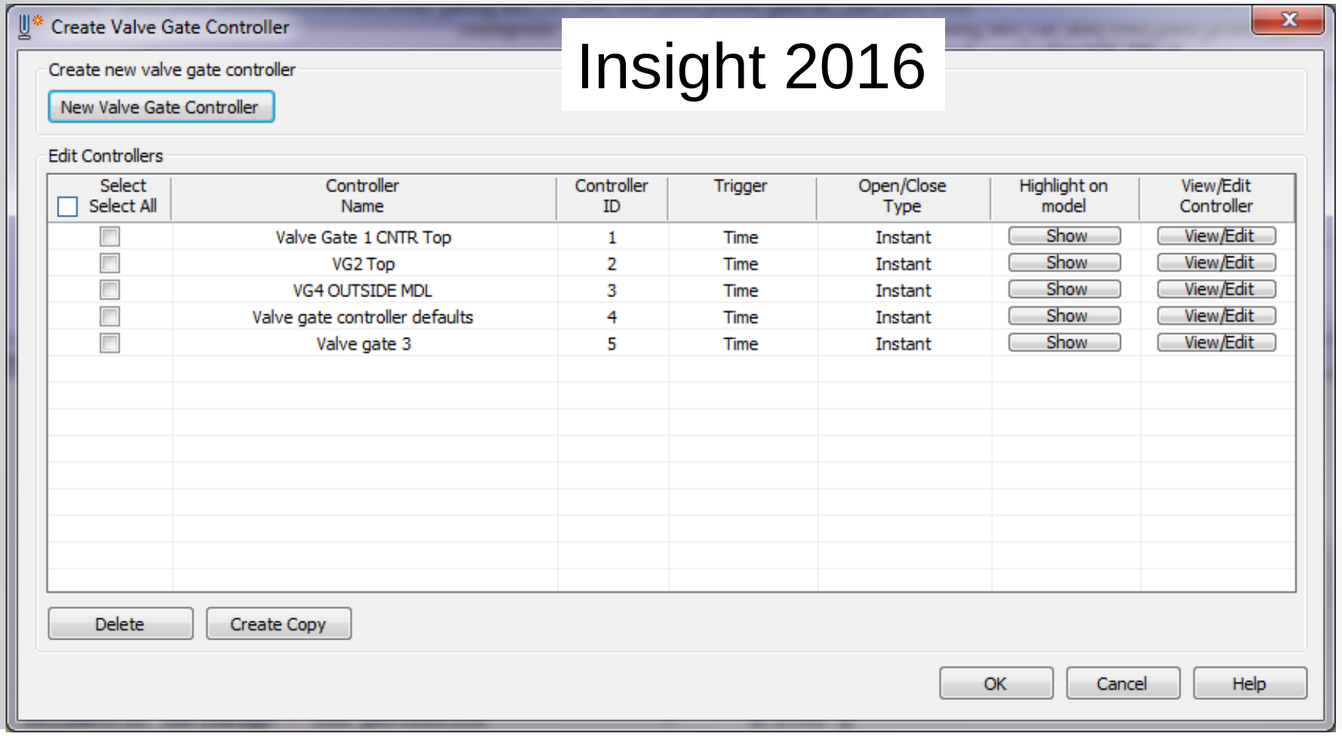
- Pop up warnings when running warp without proper material data
  - Especially important for newer users, and a good reminder us seasoned users
- Visualization tools to compare CAD and warp data (and 3D scan data)
    - Ability to cut sections and measure

Software Improvement Ideas- Peggy

- Measure from Center Line of Hole
- Cooling Line Construction
  - Time consuming
  - Unique part geometry

Software Improvement Ideas- George

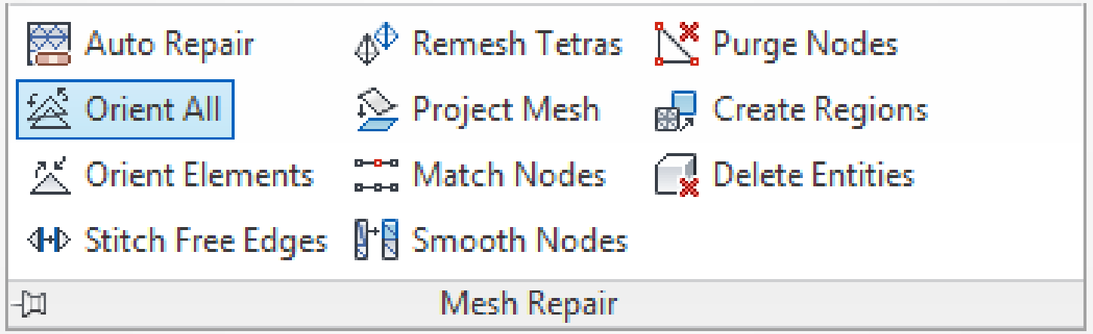
- In Valve Gate dialog box, show if gate is open or closed and the time. It used to show, but doesn't in Insight 2016.
  - We sometimes have up to 20 valve gates. It can be very time consuming and error prone to pick each View/Edit controller.



Able to see Open/Close at a glance

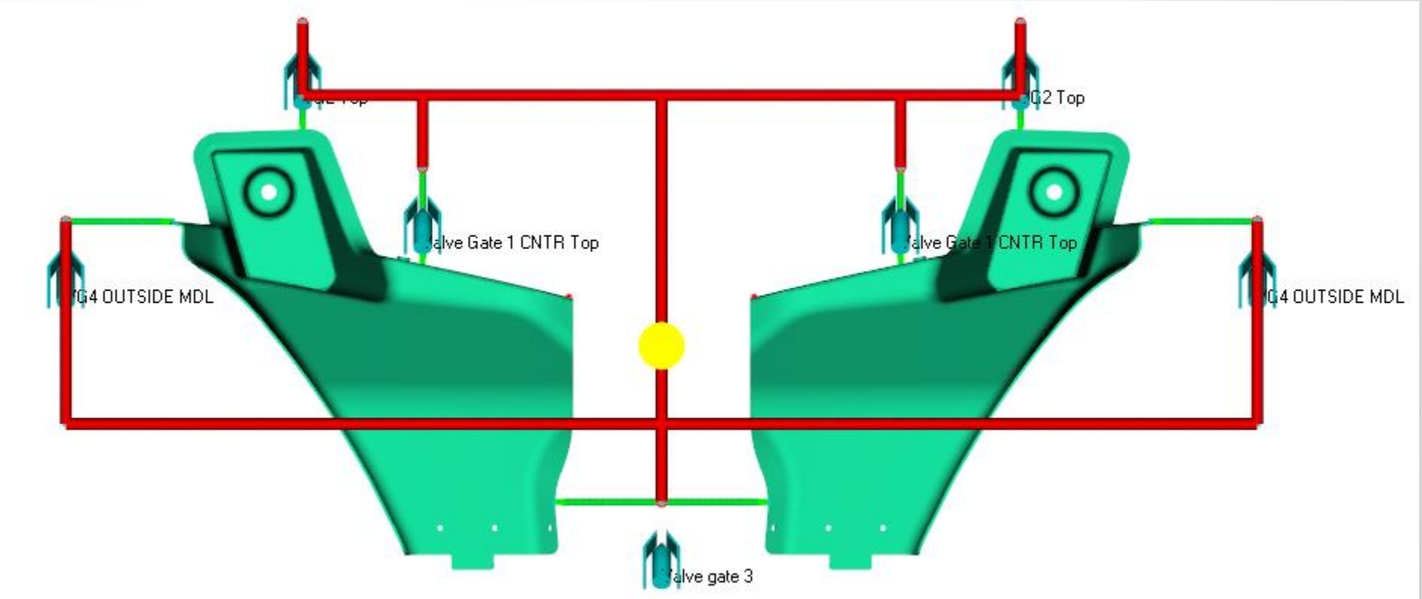
Software Improvement Ideas- George

- Mesh Orient All Improvement:
  - Each time we work on a new model we have to “orient mesh” before the analysis will run. Why doesn’t the software automatically orient mesh each time we hit analyze if it’s a requirement to run?



Software Improvement Ideas- George

- Glyphs on valve gates:
  - I love it that they added the labels to the glyphs but can they move the label over so that it's not on top of the glyph. Also, would be nice to double click the glyph to open the properties for that drop.

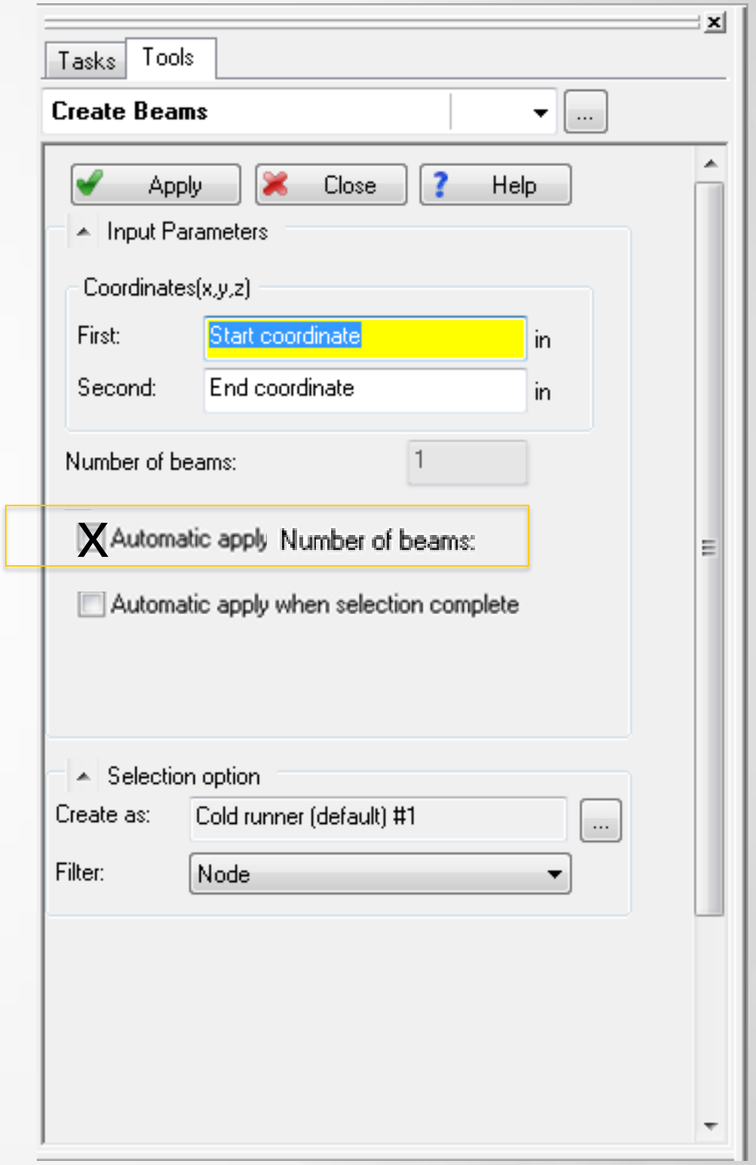


Software Improvement Ideas- Mike

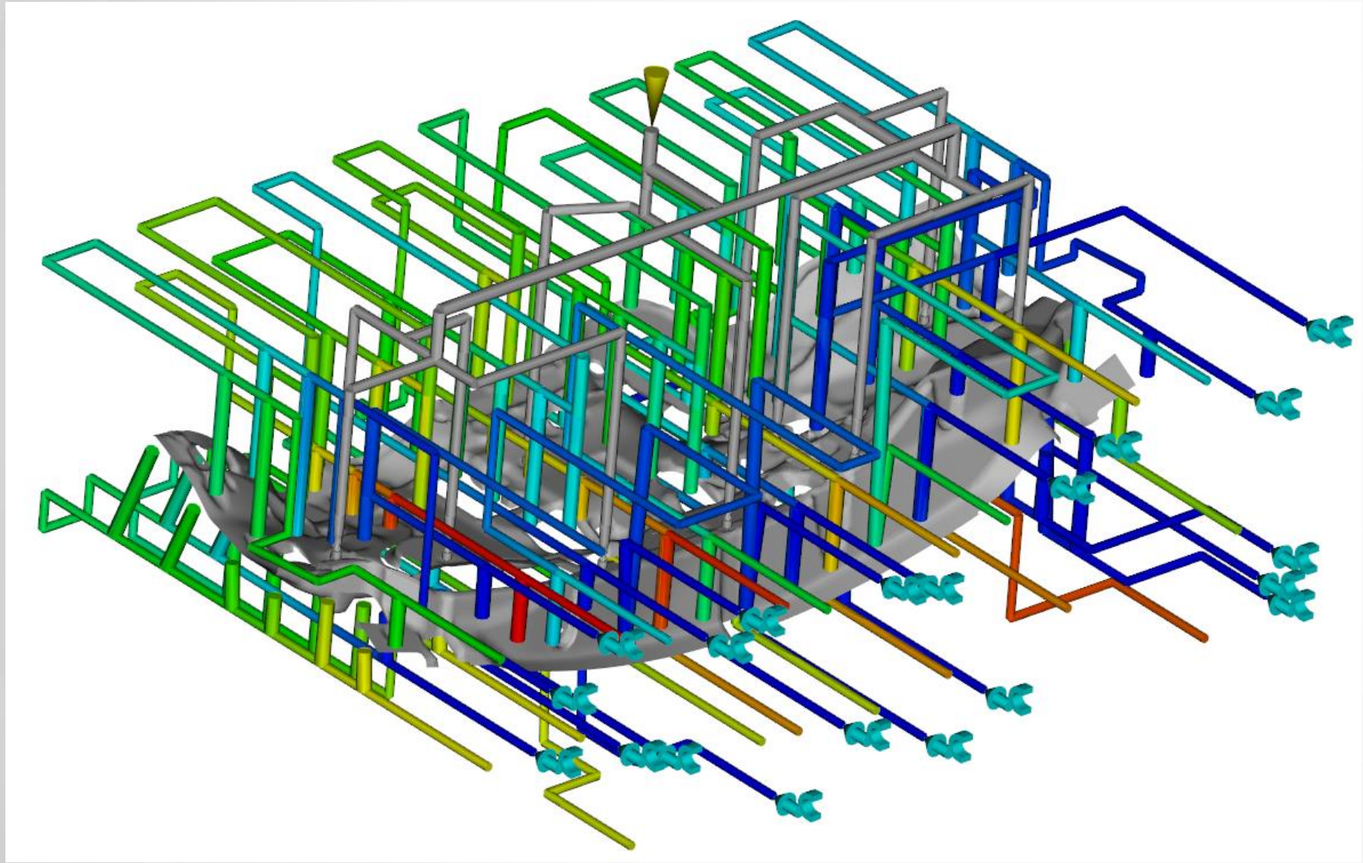
- Create a node or point without losing results. (LCS)
- The ability to link results with overlay on Multiple Studies
- Automatically launch analysis after running gate location analysis.
- The ability to change pack pressure without having to rerun filling.
- The ability to run an analysis by fill and packing one part then fill and packing the second.
- The ability to run sequential gating by using injection location only. Just pick a point and set the time. No beams required

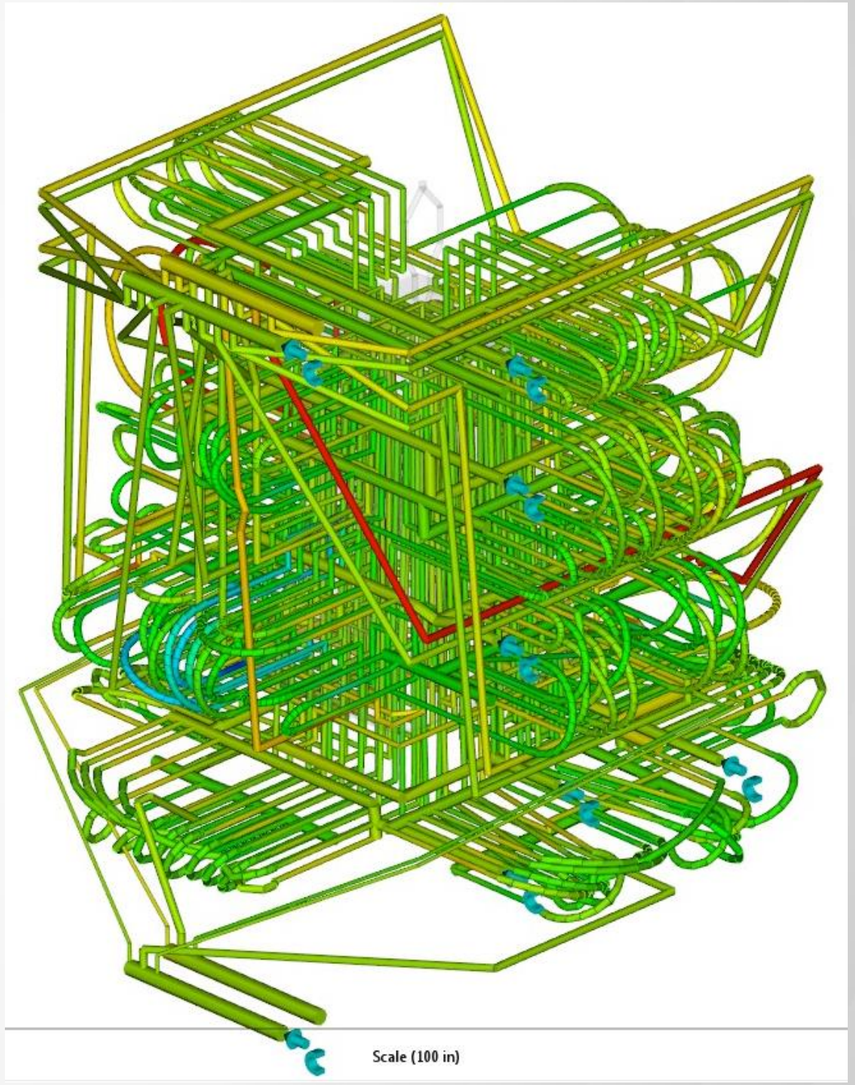
Software Improvement Ideas - Tim

- Auto Assign Beam element #’s:
  - Beam count would follow recommended rules using either auto mesh or Create Beam commands.
  - **cooling channel**: dia is assigned, so create correct # of beams to meet 2.5-3 L/D ratio.
  - **cold gate**: create 5 beams, no matter the L/D ratio.
  - **Baffle**: follow 2.5-3 L/D ratio, but minimum created would be 3.
- This would be a big time saver when creating cooling lines for tool with many baffles.



Cooling Channels Examples





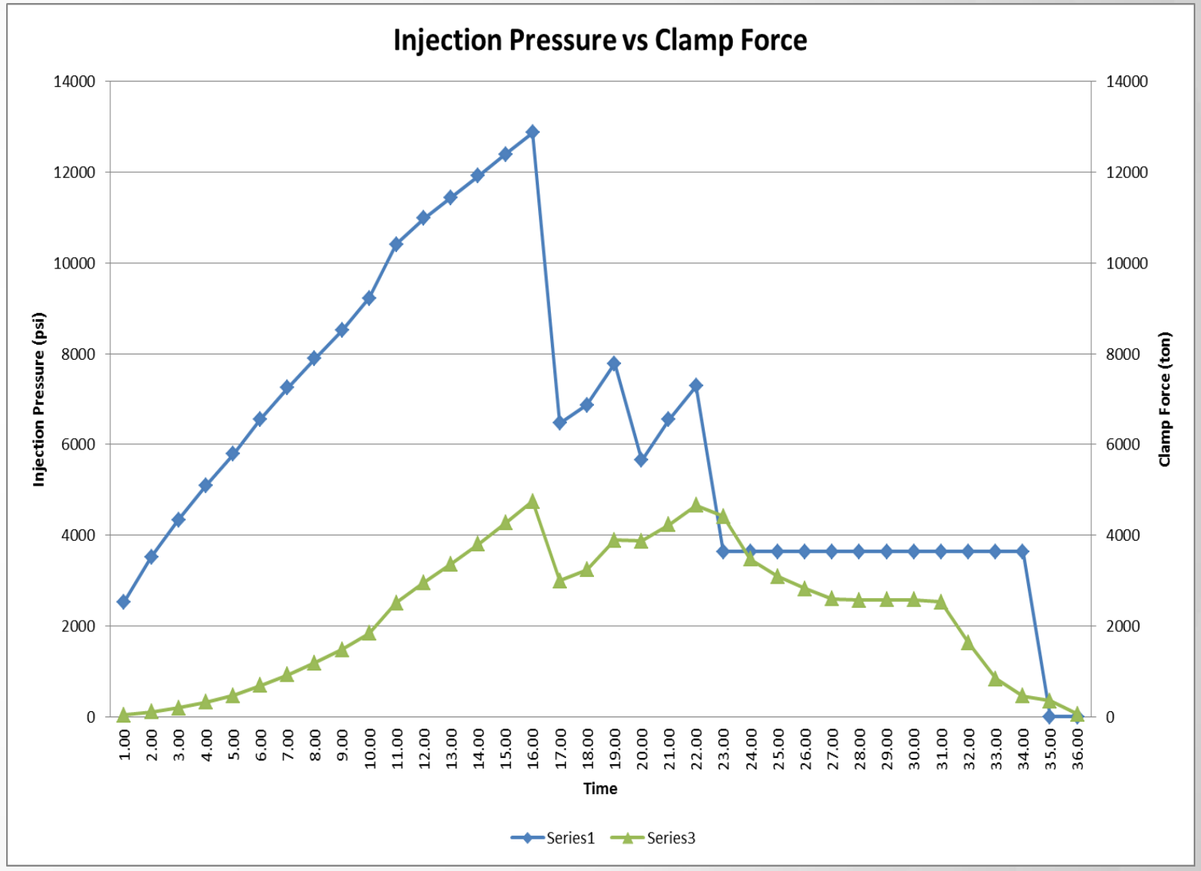
Software Improvement Ideas - Tim

- Enhancements to Gate Location analysis:
  - Set all gate options at once (1, 2, and 4). This would launch 3 GL analyses.
  - Allow auto-launch of results including option to run fill, fill+pack and fill+pack+warp
  - Allow preset gate location(s) and then find X new locations
  - Include max angle (from die draw (Z axis)) allowable for gates to be located
  - Increase max number of gates to 20 (currently is 10)
  - Note: Prohibiting gate nodes would be critical for solve time reasons (maybe cap # of possible elements?)

- Can GL be part of DOE by setting desired outcomes (low pressure, low warp, etc)?

Software Improvement Ideas - Tim

- Enhancements to Gate Location analysis:
  - Gate Location for sequential filling pattern
  - Locate gates based on peak pressure (or tonnage?) to keep peaks similar (unlike picture on right)



Software Improvement Ideas - Tim

- Automatic Pack Optimization
  - Create a Pack Optimization analysis
  - Would need to set goal of:
    - Volumetric shrink uniformity
    - Warpage reduction
    - Tonnage limit
- Something like ram speed profile output