INSPIRING PLASTICS PROFESSIONALS

Safely Navigating Innovative Cooling Strategies in Plastic Injection Molding

WEBINAR

June 18, 2025

simform
A Maya HTT Application

MANTLE

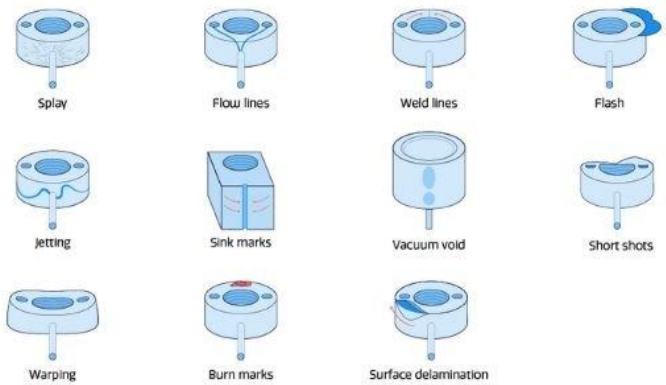
CTD PRODUCTS, INC.

Agenda

- Cooling in plastic injection molds: challenges and opportunities
- Project description and motivation
- Generative cooling design with SimForm
- 3D printing of conformally cooled inserts with Mantle
- PulseCooling with CITO
- Compare simulation with experiment
- Conclusion

Importance of Cooling

- Up to 80% of the cycle is the cooling stage
- Non-uniform cooling leads to part defects



Injection Molding Defects

*"Part defects can add **42%** to the length of the mold trial as the team tries to troubleshoot and correct the issue"*
-Tech-Clarity

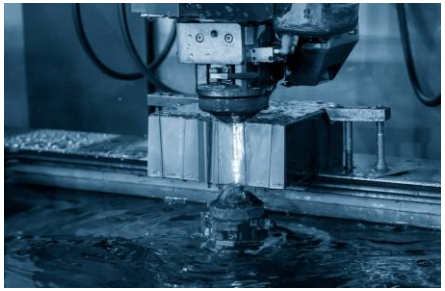
"Molders estimate a short cycle to win the job and then hope for some magic for the mold to meet this cycle time."
-Injection Molding Expert

Challenges:

Shortening lead-times

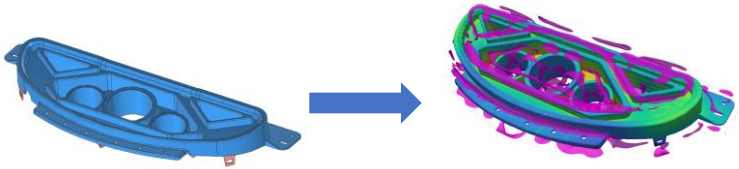
Skilled labor shortage

Sustainability and energy reduction goals

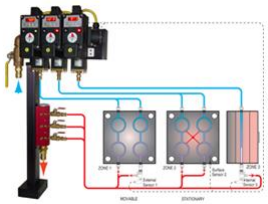


Traditional manufacturing limitations

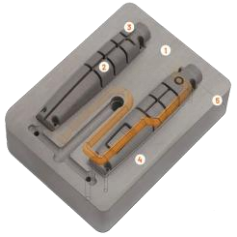
Solutions:



Simulation & Generative design (SimForm)



Closed-loop control (CITO)



Automated Toolmaking (Mantle)

Project Description

Collaboration between SimForm, Mantle, and CITO

Objectives

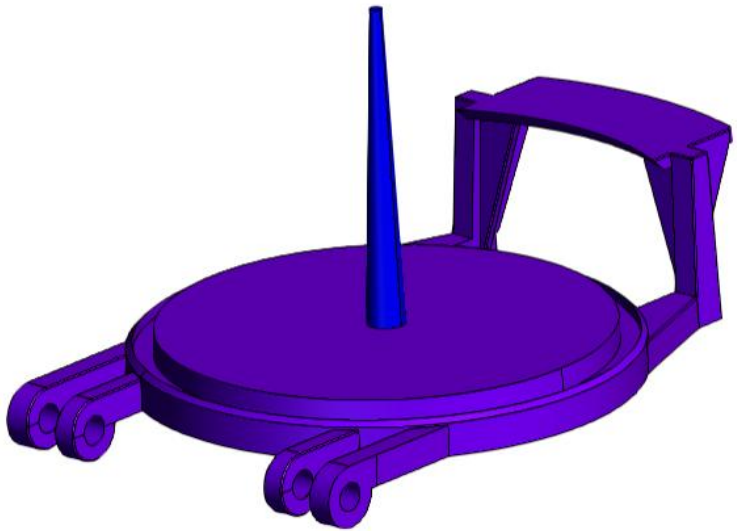
- Present these three technologies
- Demonstrate how they address these challenges
- Showcase how these technology offerings can work together to produce a complete solution

Study Part

CITO Thaw Snap Lid

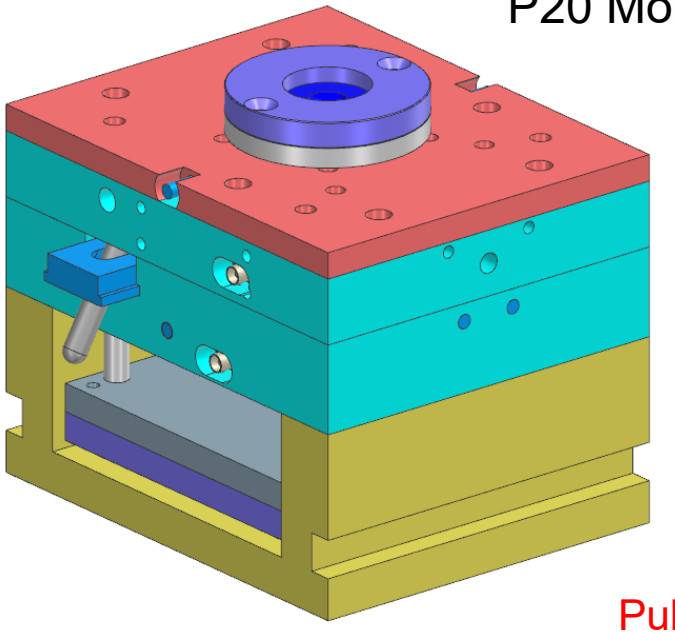
- 30.5 g
- Nylon 1033HL 30% Glass Filled

Density	1,380 kg/m^3
Thermal Conductivity	0.28 W/m-C
Specific Heat	1,670 J/kg-C

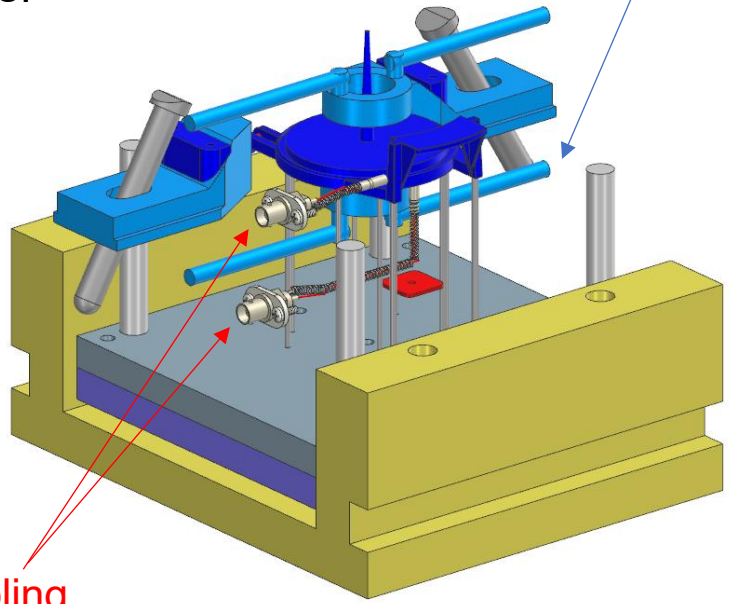


Study Mold

P20 Mold Steel



Machined Channels



PulseCooling
Temperature sensors

Processing Conditions

Injection temperature	280 °C
Ejection temperature	72 °C
Target mold temperature	62 °C
Water temperature	4 °C
Water flow rate	2.1 GPM
Conventional Fill + Pack time	13 s
Conventional Cooling time	35 s
PulseCooling Fill + Pack time	11 s
PulseCooling Cooling time	18 s

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How do we simulate this?

Mold Cooling with SimForm by Maya HTT

Maya HTT

Software-Driven Engineering Solutions for 40+ years

#1 Worldwide Partner Award for Siemens Digital Industries Software

75% of staff are Scientists and Engineers

35+ Software modules authored for Siemens

Find out more

simform Easy Mold Cooling Prediction

Maya HTT

What is SimForm?

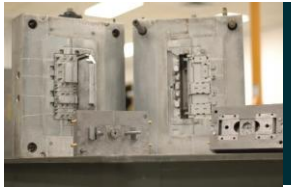
simform
A Maya HTT Application

OEMs / Suppliers

Create manufacturing-ready plastic part designs with fewer engineering iterations

Injection/Compression Molders

Optimize production by reducing cooling cycle time



Mold Makers

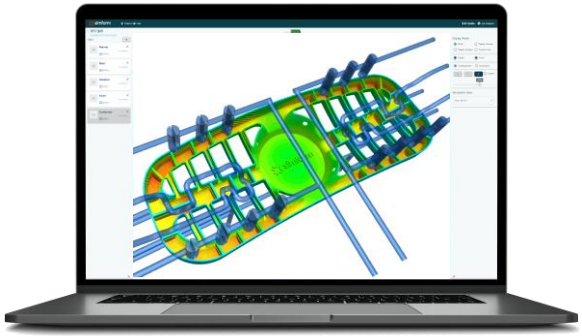
Ensure part quality with uniform temperatures and no hot spots

- In less than 15 minutes, confidently evaluate:
  - **Part and mold temperature**
  - **Cooling channel placement**
  - **Cooling time**
- Save time and money by:
  - Avoiding overdesigns and redesigns
  - Reducing cycle time
  - Justifying the use of more expensive inserts or conformal cooling

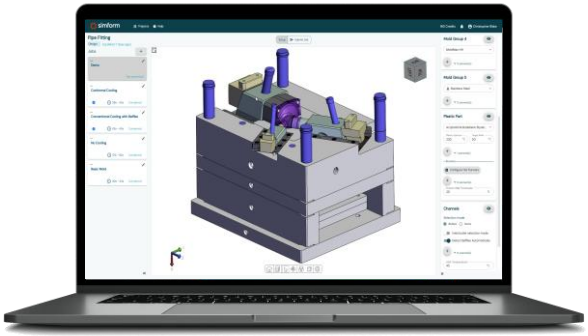
SimForm is mold simulation everyone can use.

Quality Parts Need Effective Cooling

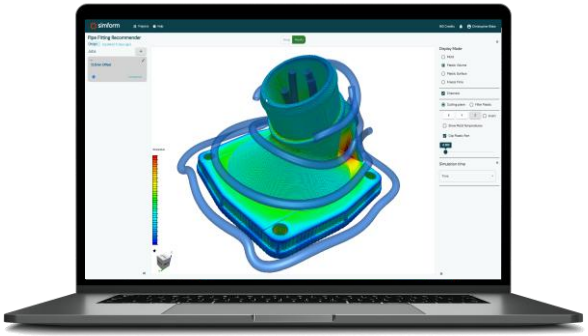
Cloud Simulation



Design for Manufacturing

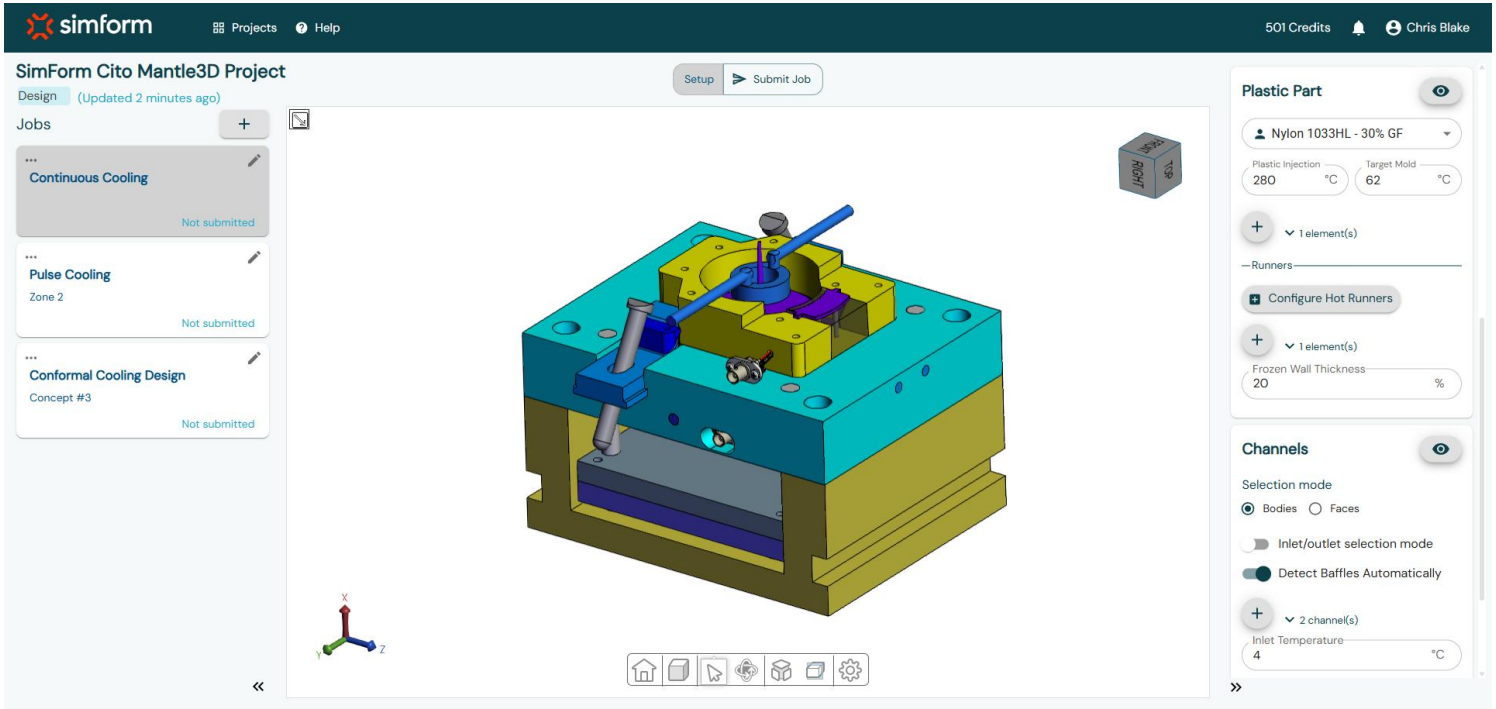


Generative AI



Develop Better Plastic Products and Tools Faster with SimForm

SimForm Setup of Study Mold

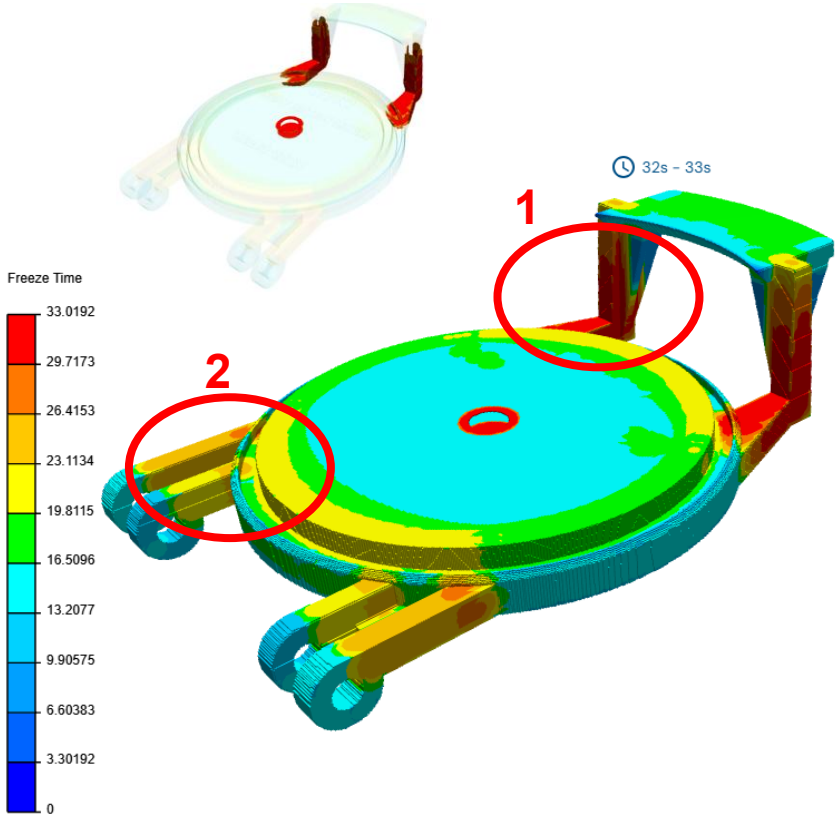


Continuous Cooling Simulation

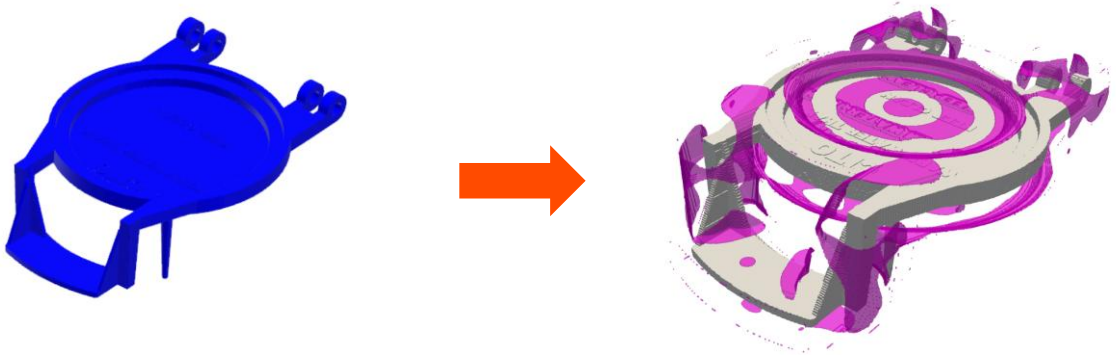
- **Bottleneck study**
  - **14% cooling time reduction opportunity**
  - If the section 1 highlighted is fixed, Pack & Cooling time can be reduced to from 32.5 sec to 28 sec

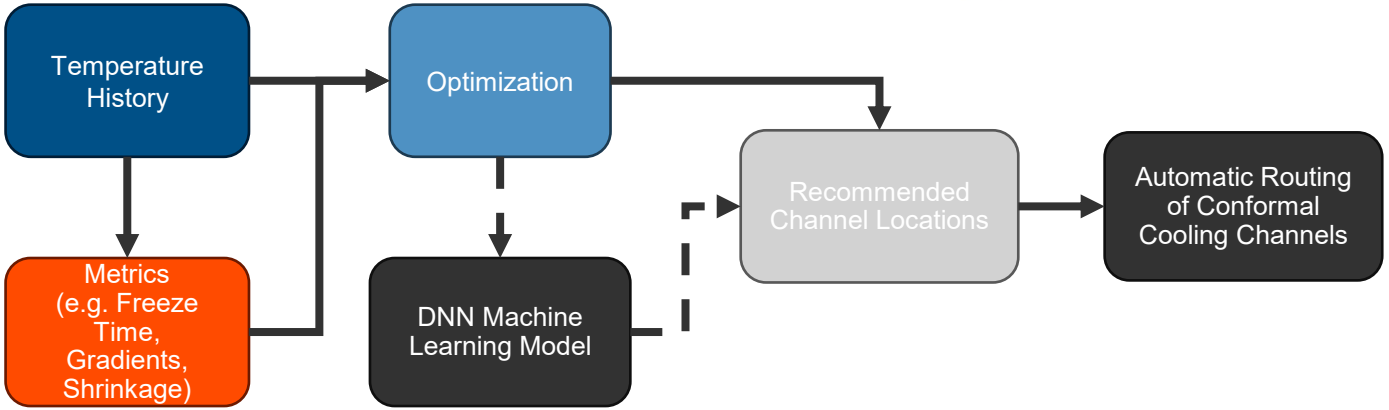
- **Analysis**

Location	Cooling time
Hot spot 1	32.5 s
Hot spot 2	28.0 s (-14%)
Rest of the part	22.0 s (-32%)

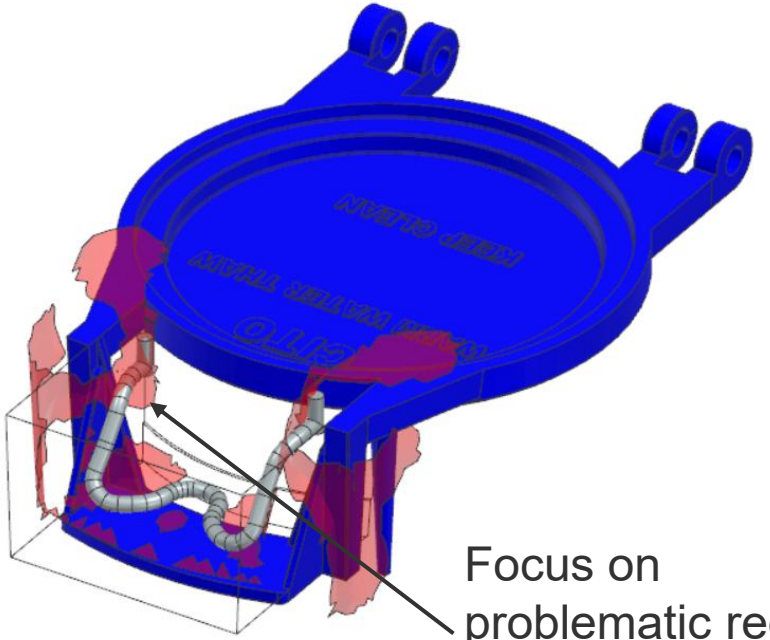


Generative Design of Cooling Channels

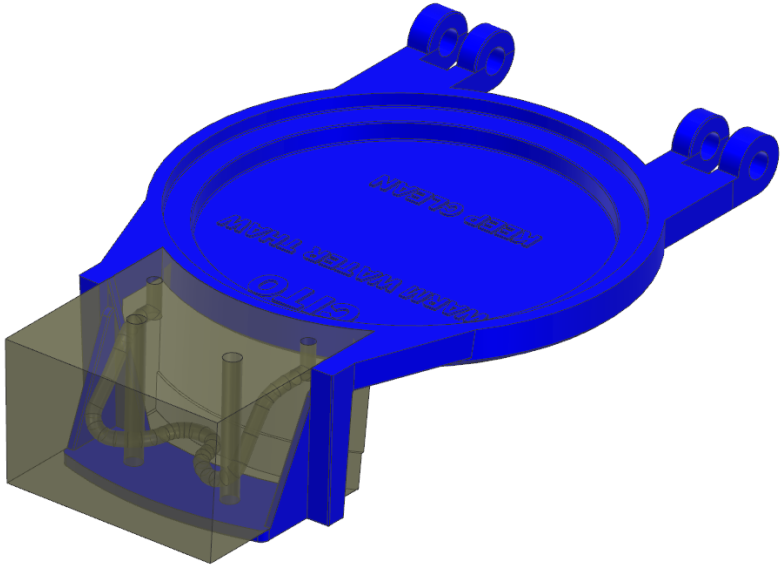




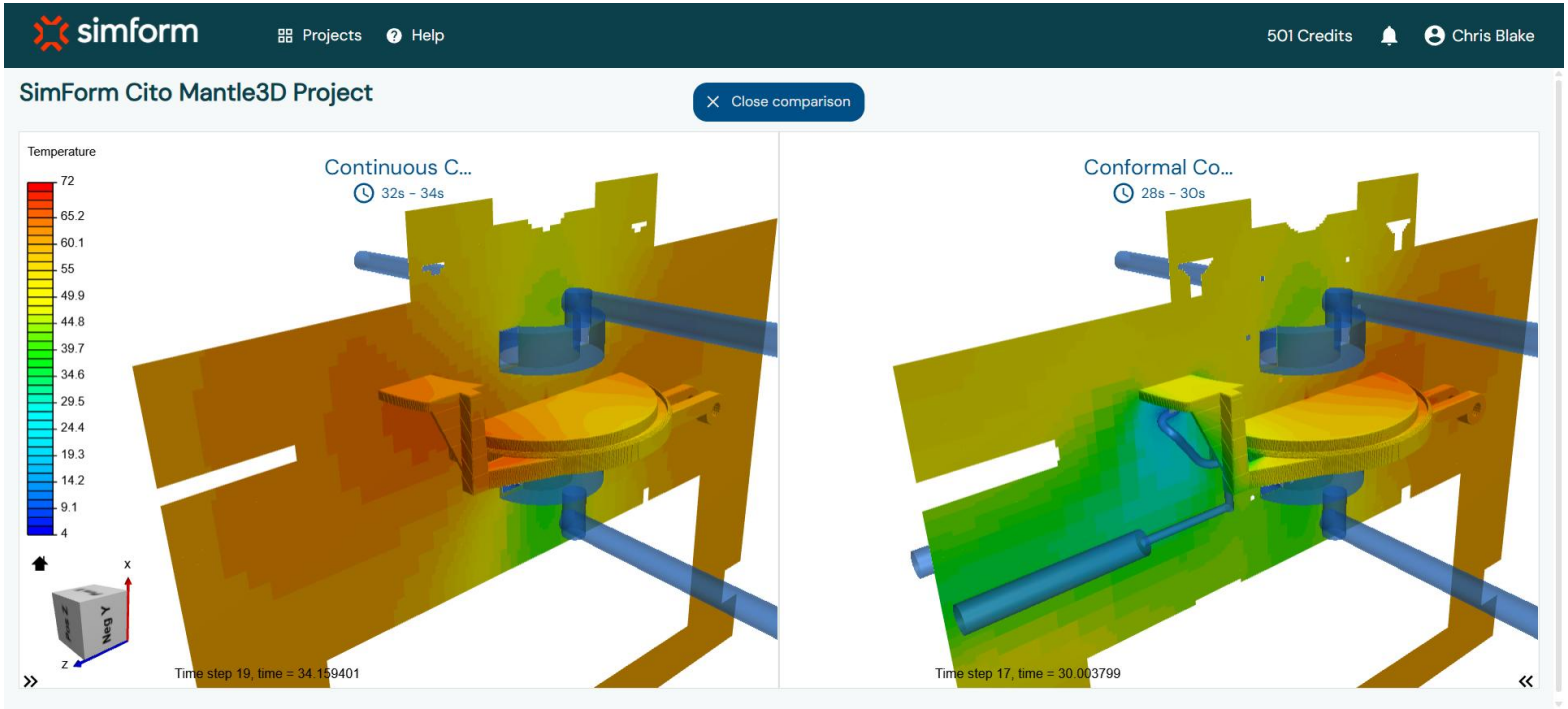
Conformal Cooling Insert Design



Focus on problematic regions within insert



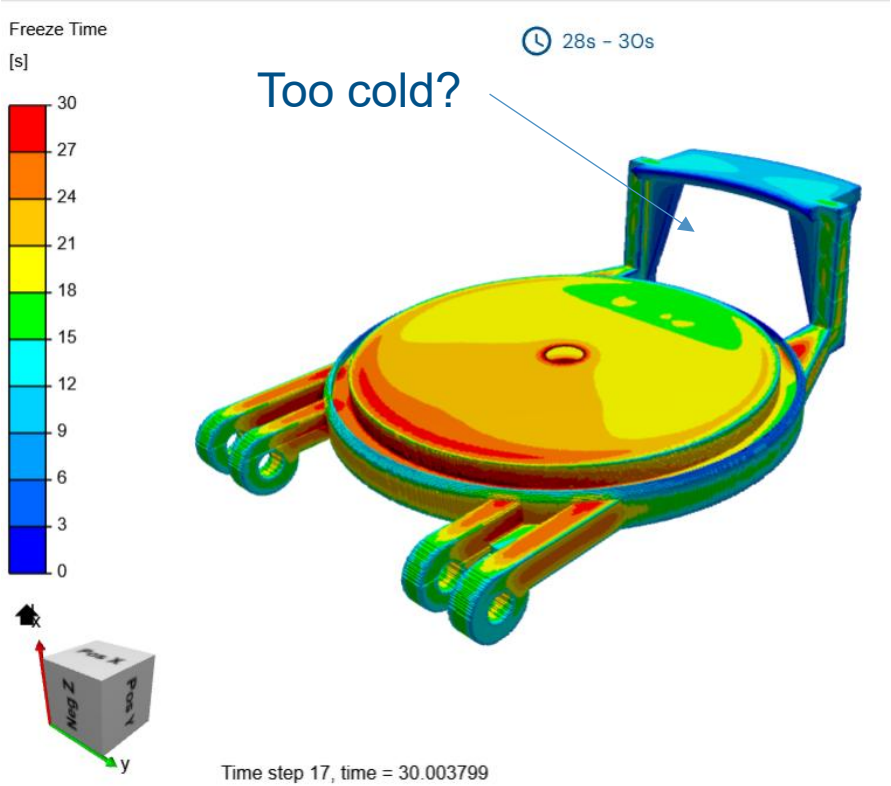
Part & Mold Temperatures with Conformally Cooled Insert



Cycle Time Improvement with Conformal Cooling

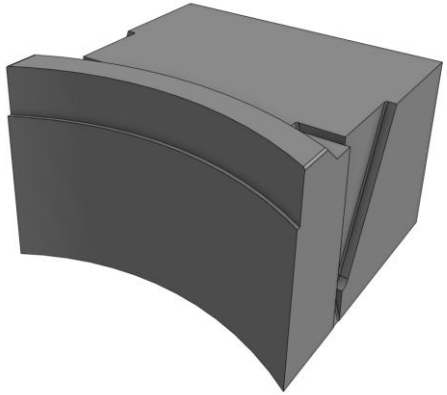
- Pack & Cool time: 28 s
  - 4.5 s / **14% reduction**
- Local freeze time

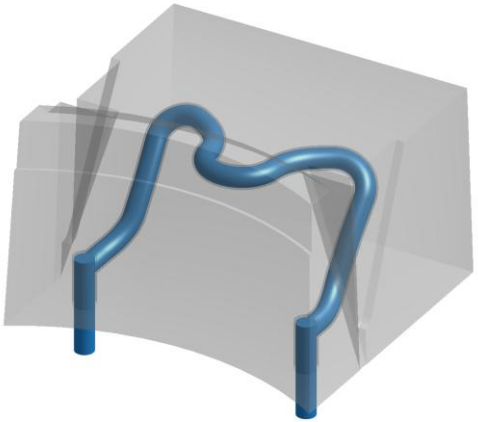
- Threshold (25 s)
  - Hot Spot 1 brought to same level as Hot Spot 2

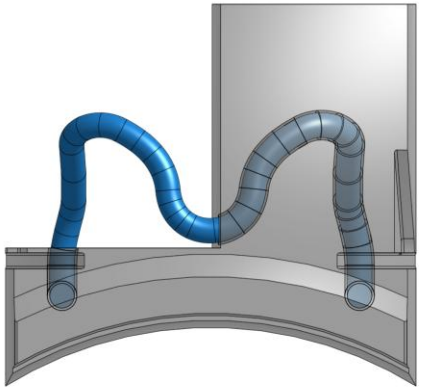


We have a conformal design...

- 14% cycle time reduction







How do we build this?

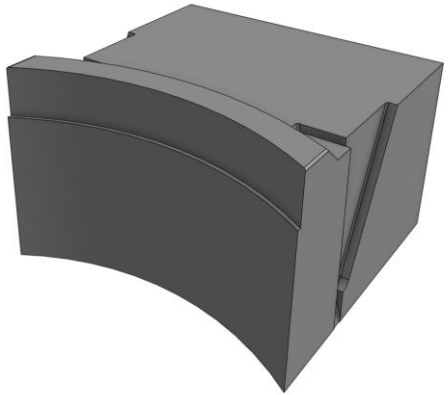
INSPIRING PLASTICS PROFESSIONALS

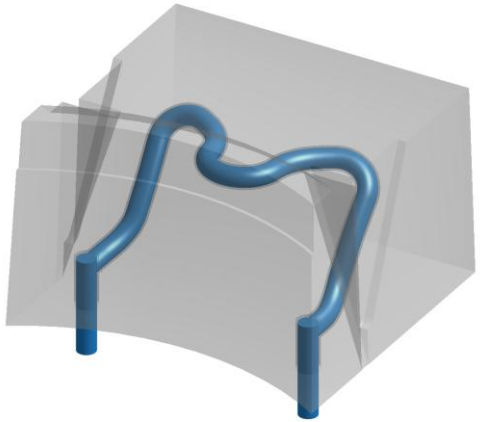
Introduction to MANTLE

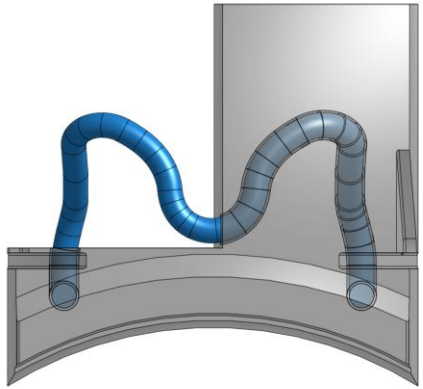
Toolmaking Reinvented

CONFORMALLY COOLED INSERT

How do we build this?







1.6 x 1.6 x 1.1"

Printed in H13 Tool Steel

MANTLE

MANTLE'S AUTOMATED TOOLMAKING SYSTEM
EXPLICITLY DESIGNED FOR TOOLING

Technology

Combines CNC machining, 3D printing, and advanced software

Tooling

Produces precision tool steel components

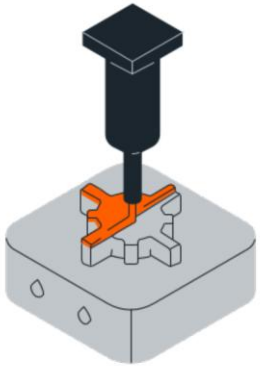
Benefits

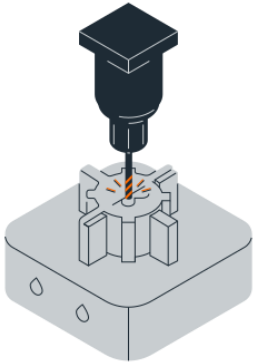
- Save Time
- Save Money
- Optimize Toolmaker Time
- Accelerate Validation
- Increase In-house Capacity
- Improve Cycle Times

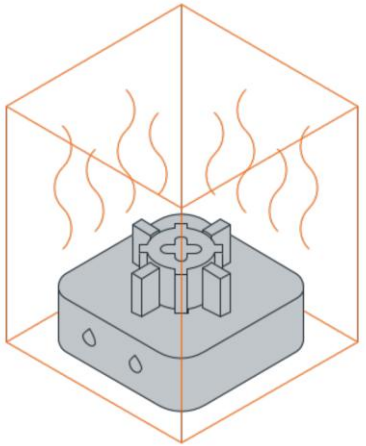
HOW IT WORKS

The solution includes:

PRINT
SHAPE
SINTER





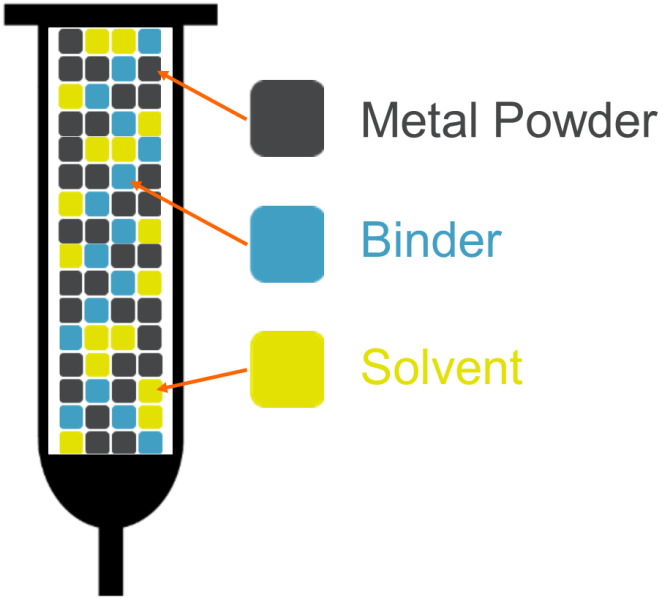


PRINT **SHAPE** **SINTER**

Printer

Furnace

HOW IT WORKS: PASTE



H13 Tool Steel

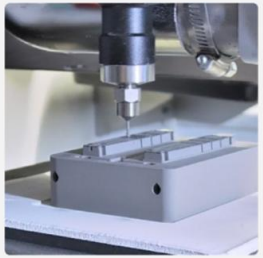
420 Stainless Steel

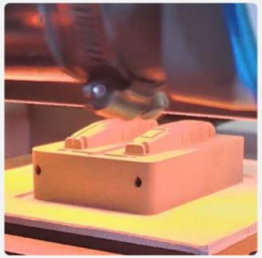
MANTLE

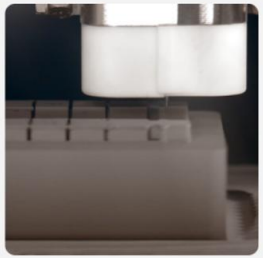
HOW IT WORKS: PRINT + SHAPE

PRINT	DRY	SHAPE

Repeats Every Layer (100um / .004")







// Printer

TECHNOLOGY COMPONENTS

SINTER

// Furnace

SINTER BODY

SHRUNK 9%

AFTER SINTERING

TECHNOLOGY RESULT

1. SINKER EDM FINISH
1-3 um Ra / Charmilles 26 / D2

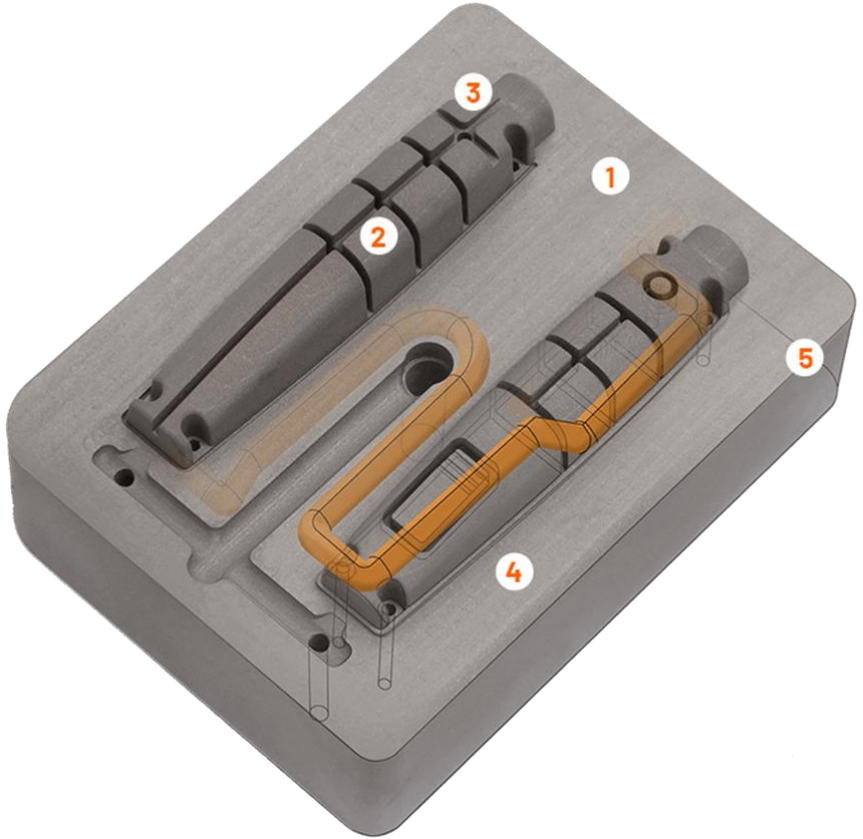
2. BEST IN CLASS PRECISION
+/- .001” per inch

3. FINE FEATURES
.003” corner radii (EDM sharp)

4. STABLE, DURABLE TOOL STEELS
H13 Tool Steel & 420 Stainless

5. EASE OF USE
No programming required

6. CONFORMAL COOLING



WHAT OUR CUSTOMERS REALIZE:

Nicolet Plastics
FAST, FLUID, AND FLEXIBLE™

70%
Lead Time Saving

HEYCO®

60%
Cost Savings

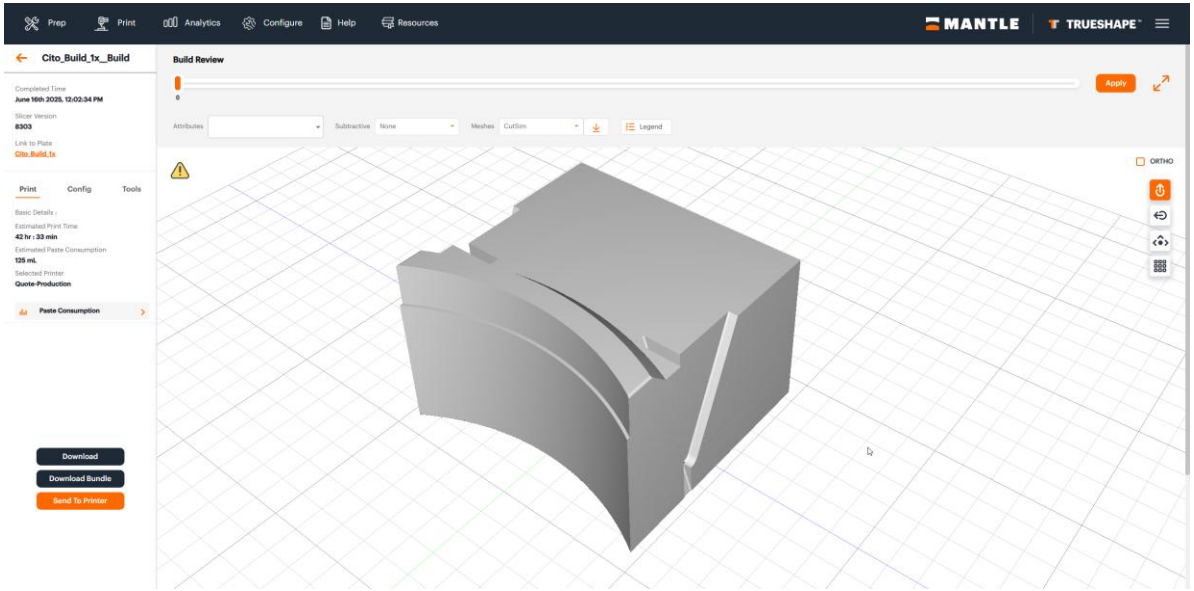
J.W. SPEAKER
Engineered Lighting Solutions

50%
Cycle Time Reduction

Tessy PLASTICS

3.4 M+
Cycles

CITO CONFORMALL COOLED INSERT - 1x



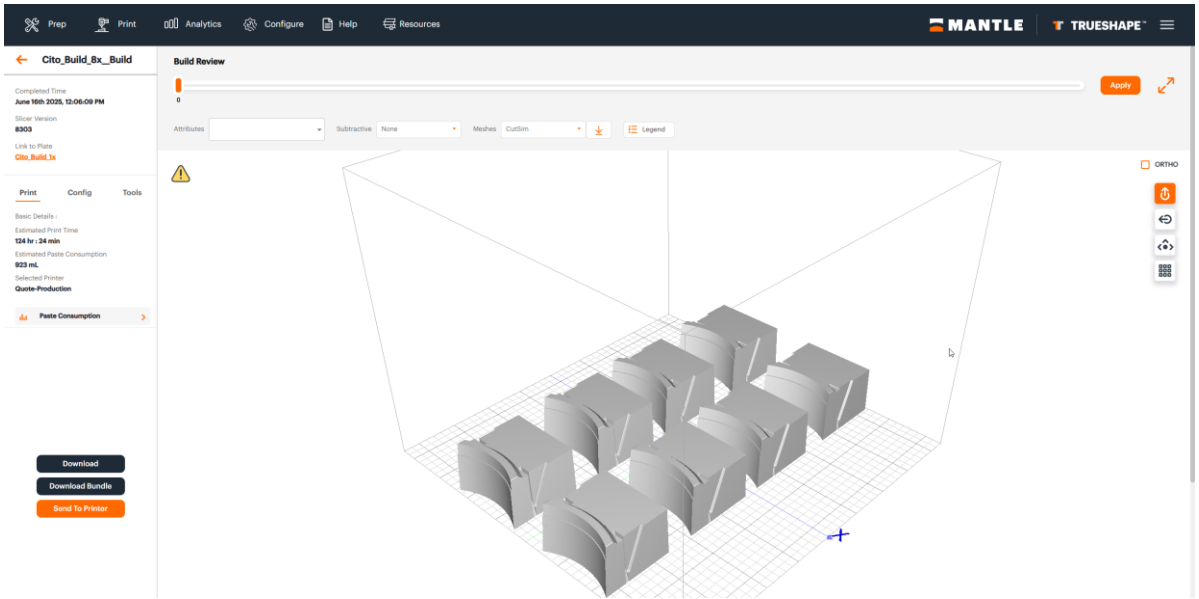
Print time: 40 hrs (1.6 days)

Sinter time: 42 hrs (1.75 days)

Cost: $800 (fully burdened)

Completely unattended process!

CITO CONFORMALL COOLED INSERT - 8x



Print time: 124 hrs (5.1 days)

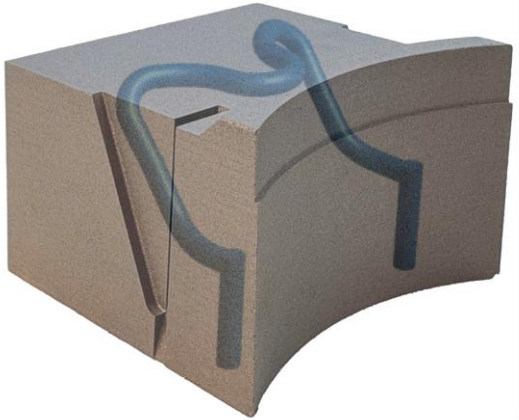
Sinter time: 42 hrs (1.75 days)

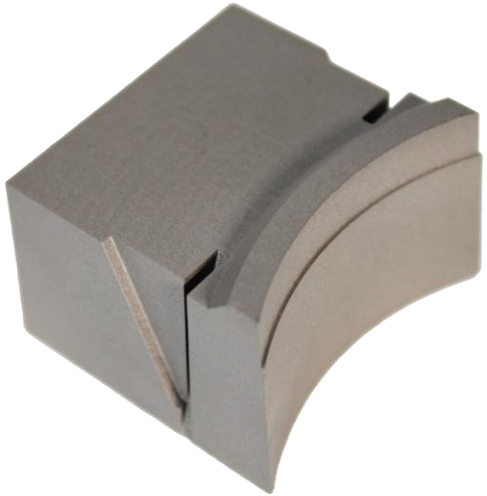
Cost: $278 (fully burdened)

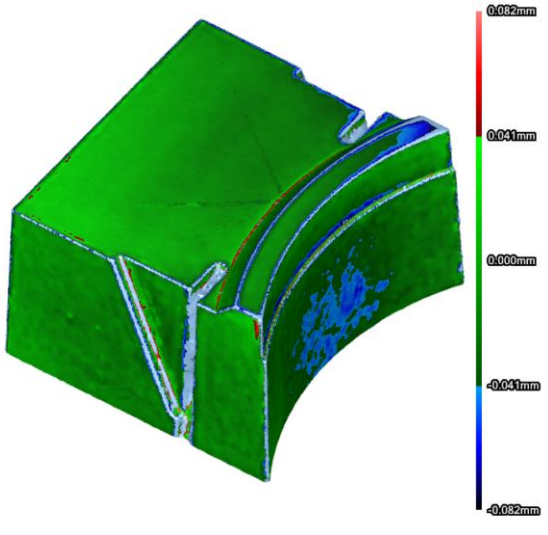
Economies of scale

Completely unattended process!

CONFORMALL COOLED INSERT







Next steps:

Send to CITO for finishing, (grinding and ejector pins) and testing!

Can we reduce the cycle time further?

PulseCooling by CITO

PulseCooling

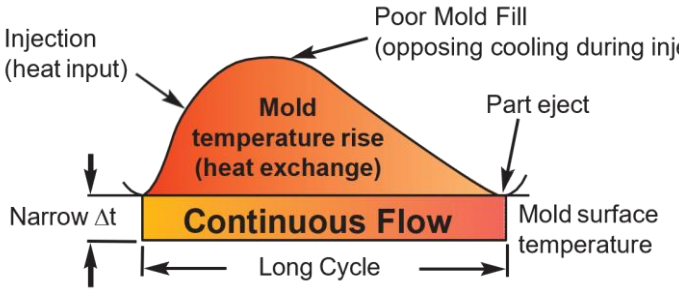
CITO Products, Incorporated

High Performance Process Control Systems

Quality Molding at a Reduced Cost

Conventional "Cooling"

No direct control of the Mold SURFACE Temperature



Continuous Flow Controllers DO NOT Compensate for:

- *Ambient temperature changes*
- *Water temperature changes*
- *Water supply pressure changes*
- *Back pressure changes*
- *Platen and machine temperature changes*
- *Partial plant shut down*
- *Over cooling during cycle interruptions*
- *Part geometry vs. cooling channel layout*
- *Melt temperature variations*

Results of Continuous Flow - Uneven Cooling:

- *Induced stress into molded part*
- *Post ejection warping*
- *Hot / Cold spots in the mold*
- *Thermal expansion – Component Damage*
- *Inconsistent Heat Exchange*
- *Poor mold fill*
- *Inconsistent part quality – Uncontrolled Variables*
- *Mold temperature drift - Temperature Variations*
- *Heated water slows heat removal* - ***Longer cycles***
- *UNPREDICTABLE PARTS AFTER EJECTION*

Control Adjustments are always Retroactive
in response to Visual / Dimensional changes
You are the controller 24/7

PulseCooling

The PulseCooling Controller Automatically makes Pro-Active Adjustments to Maintain Mold Surface Temperature

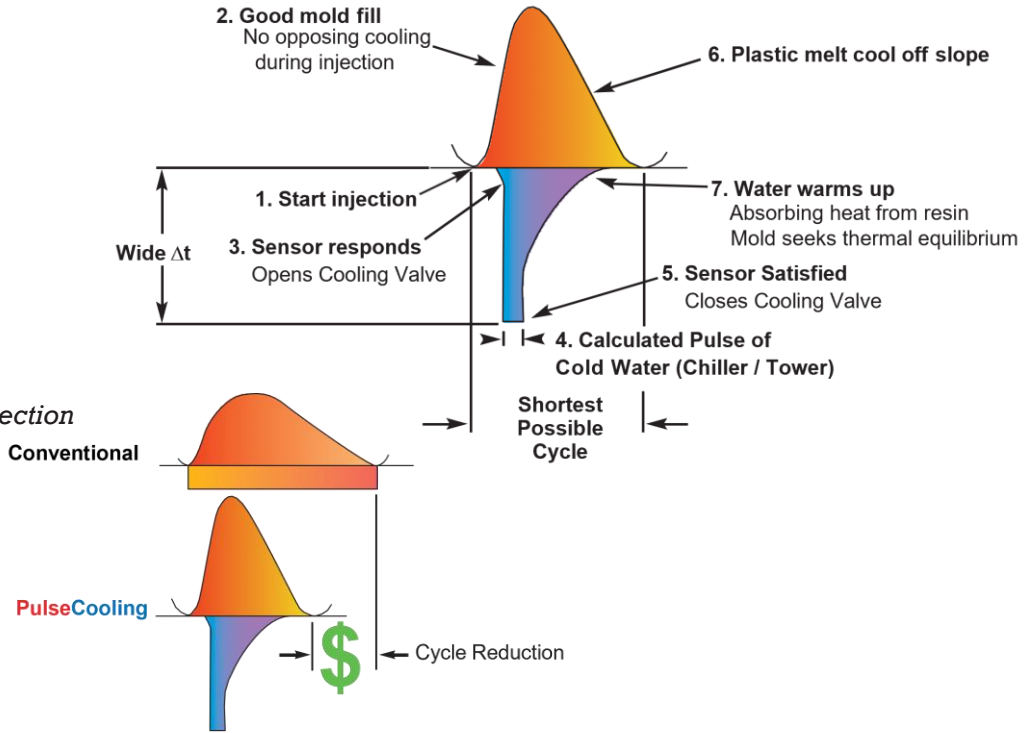
Compensating For:

- *Ambient temperature changes*
- *Water temperature changes*
- *Water supply pressure changes*
- *Back pressure changes*
- *Cycle changes (Manual Unloading)*
- *Platen and machine temperature changes*
- *Day and night shift changes*
- *Partial plant shut down (Pressure Changes)*

Resulting In:

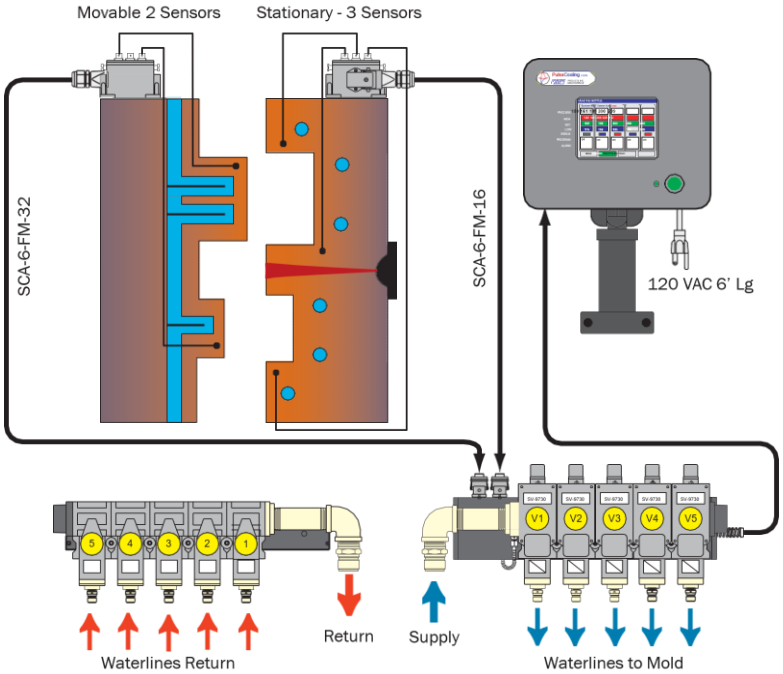
- *Consistent Mold Temperature Profile*
- *Increased Heat Exchange*
- *Excellent Mold fill - No opposing resistance during injection*
- *No uncontrolled Temperature Drift*
- *Efficient Heat Removal -High Δt*
- *Cycle Time Savings - 15% Initial Average*
- *CONSISTENT PART QUALITY - 24/7!*

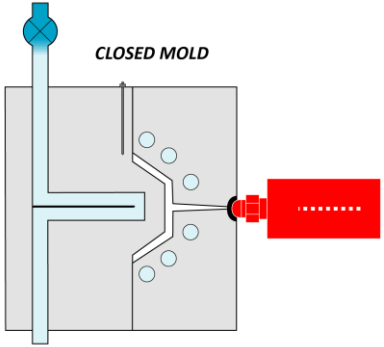
Anatomy of the PulseCooling Cycle



PulseCooling

How It Works

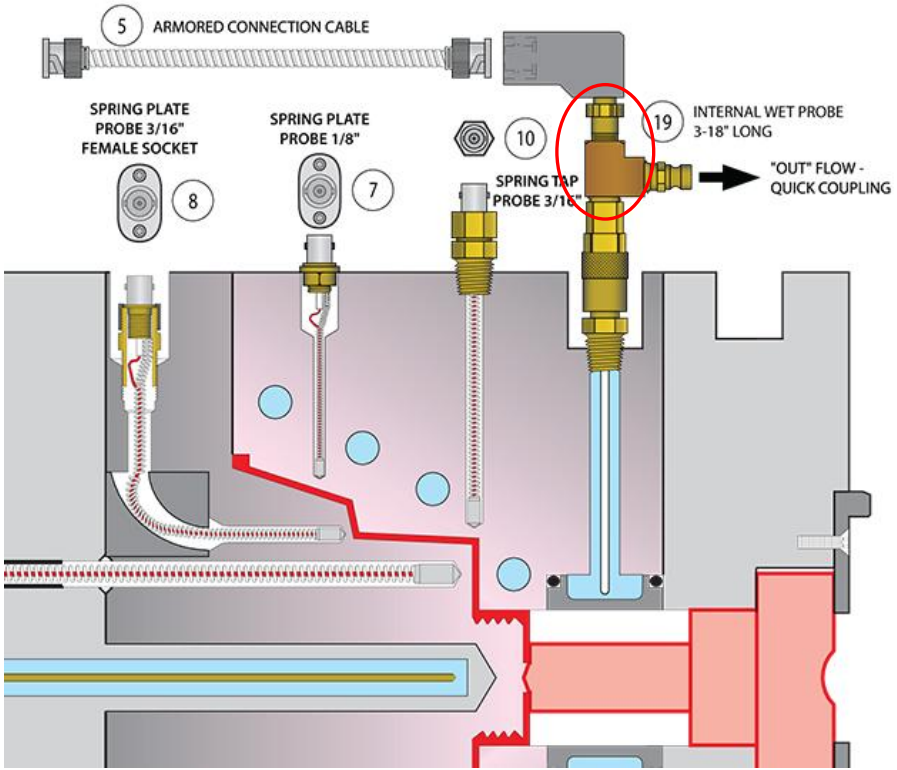




- *Melt is introduced into Tool, Melt Energy Warms Molding Surface*
- *Sensor responds to temperature rise*
- *Sensor opens Cooling Valve once Setpoint is reached*
- *Cooling comes directly from Chiller or Tower*
- *Full Flow Turbulent Cooling until Sensor Setpoint is satisfied*
- *Cooling Valve closes, heat dissipates uniformly*
- *Part Ejection*
- *Complete Repeatability 24/7*

PulseCooling

Adaptation to Existing Tooling



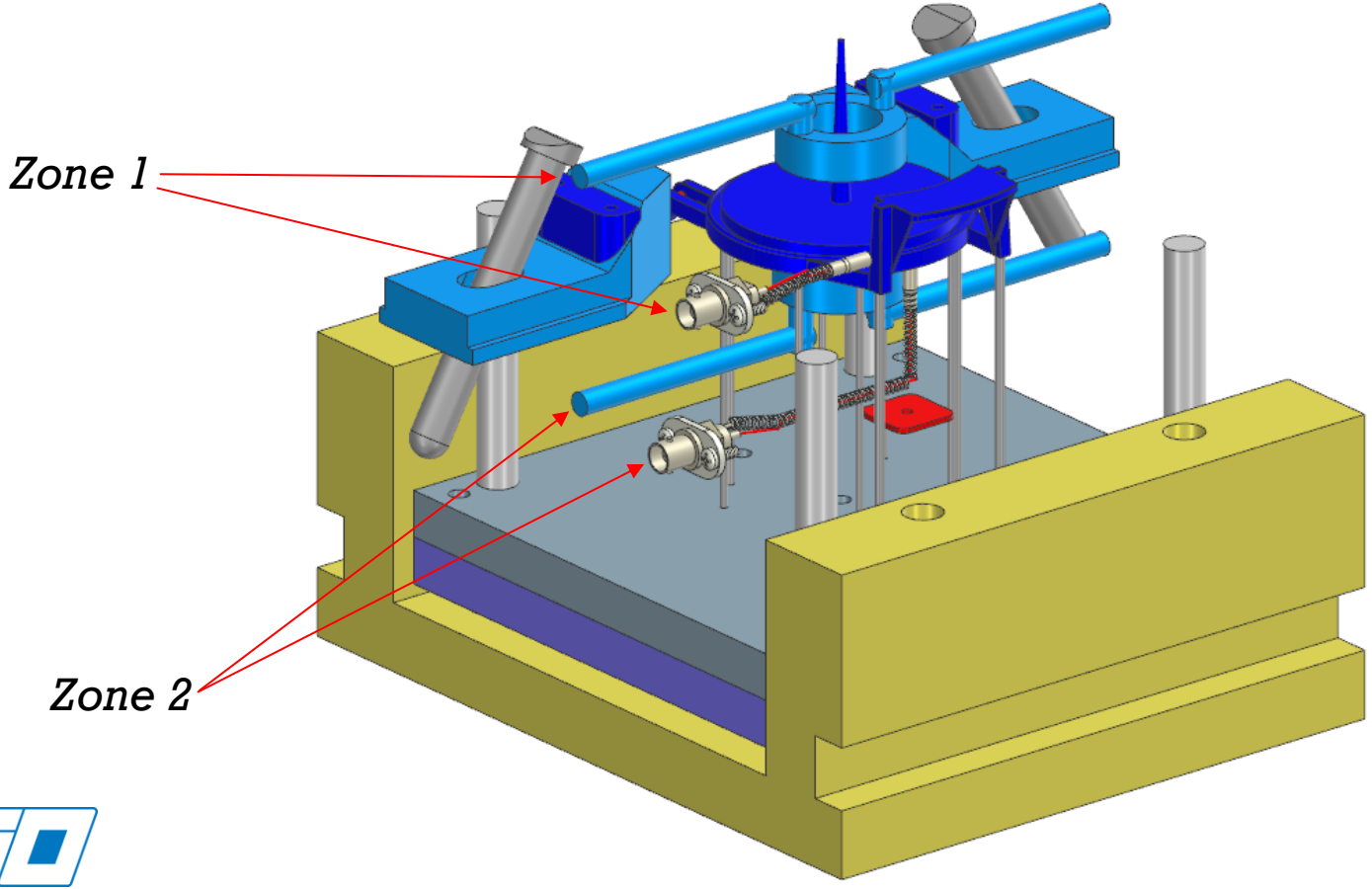
PulseCooling can easily be adapted to existing tooling.

If you do not want to machine sensor holes, or simply do not have the room, accomplish this by using our Internal or External Wet Sensors to be placed directly in the outgoing waterline

PulseCooling Bottom Line

- ***DIRECT CONTROL OVER MOLD SURFACE TEMP***
- ***QUALITY MONITORING AND CONTROL DURING THE MOLDING PROCESS***
- ***CONSISTENTLY HIGHER QUALITY PARTS***
- ***CONSISTENTLY FASTER CYCLE TIMES***
- ***HIGHER PRODUCTION YIELD***
- ***FRACTION OF OPERATIONAL / MAINTENANCE COST***
- ***REDUCED CAPITAL INVESTMENT***
- ***EXCELLENT R.O.I.***

Case Study Mold



PulseCooling vs Conventional Cooling
Process Analysis

Part # / Name:	CT-5620	Thaw Snap Lid			
Tool #:	CT-5620				
Material:	Nylon 1033HL	30% Glass Filled	**Shot Size:**	33	Grams
Melt Temp:	520-550	°F	**Final Weights**		
			Runner/Gate	1.5	grams
Mold Temp:	140-160	°F	Part	30.5	grams

Nearly 50%!!

Cooling / Process Data

Cooling Method	Target Mold Temp (°F) Stationary	Target Mold Temp (°F) Movable	Controller Set Point (° F) Stationary	Controller Set Point (° F) Movable	Cooling supply Temp (°F)	System Pressure PSI	Fill / Pack Time Seconds	Cooling Time Seconds
Thermolator	140	150	145	145	40	40	13	35
PulseCooling	140	150	140	150	40	40	11	18

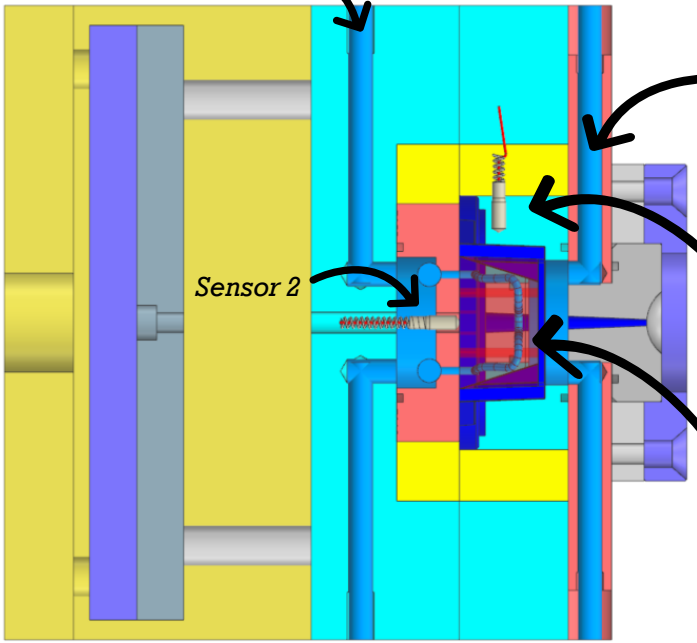
Overall Cycle Time

Conventional 48 sec **PulseCooling** 29 sec

Conclusion: *Cycle time was reduced nearly **40%** when using PulseCooling compared to a conventional thermolator. Parameters were adjusted to reduce cycle time while still maintaining the final dimensional tolerances provided from the part drawing. Final part appearance was also monitored as well as sink, flash and warp areas.*

PulseCooling

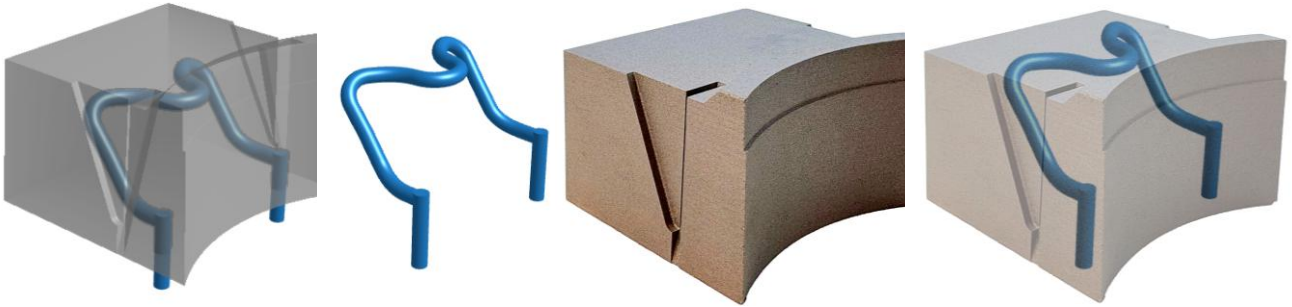
Case Study Mold



One Step Further

Conformal Cooling

Now that we have a preliminary design, our next step is to compare running the conformally cooled insert with and without PulseCooling to show the true output of these three technologies put together.



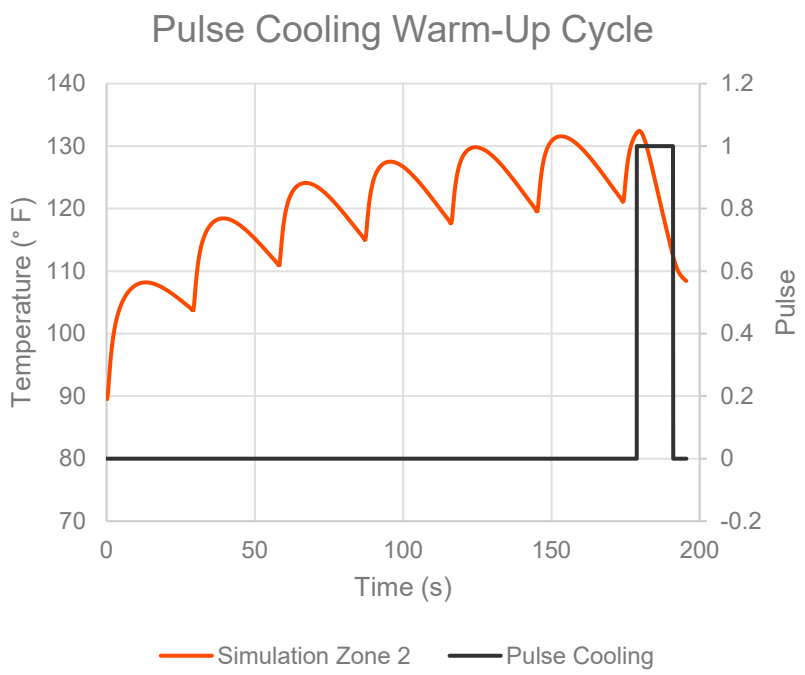
Printed by Mantle
H13 Tool Steel

INSPIRING PLASTICS PROFESSIONALS

Predict the Improvement with PulseCooling

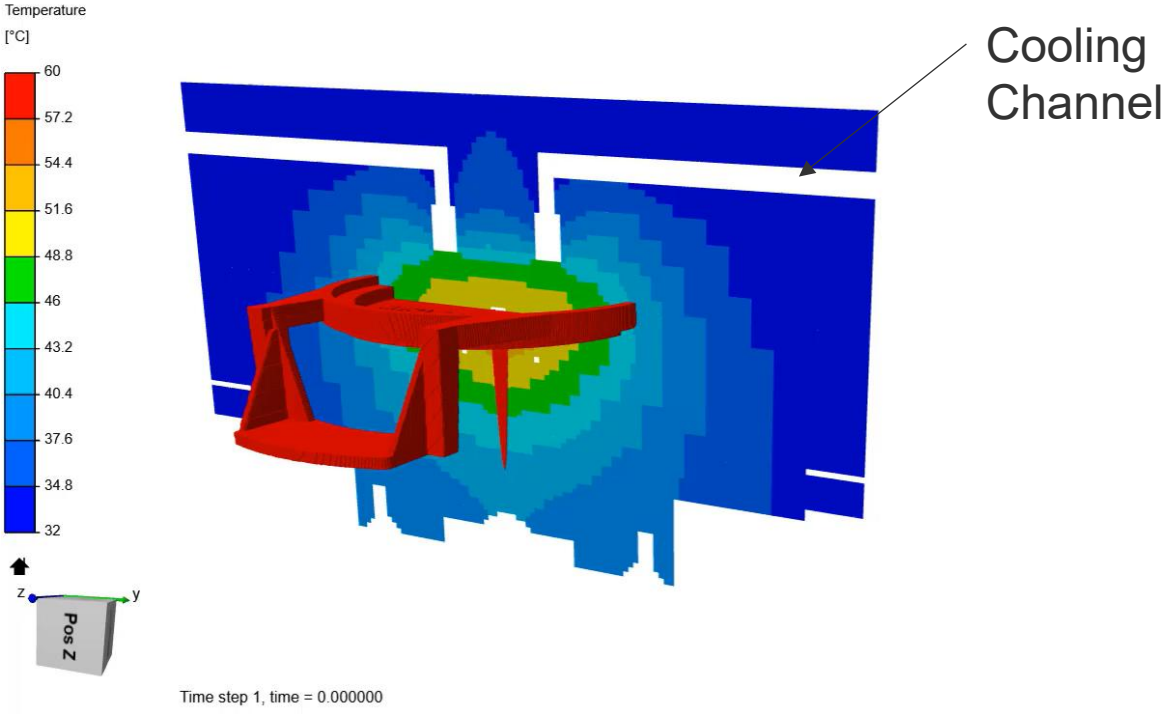
Mold Cooling with SimForm by Maya HTT

Preliminary Results



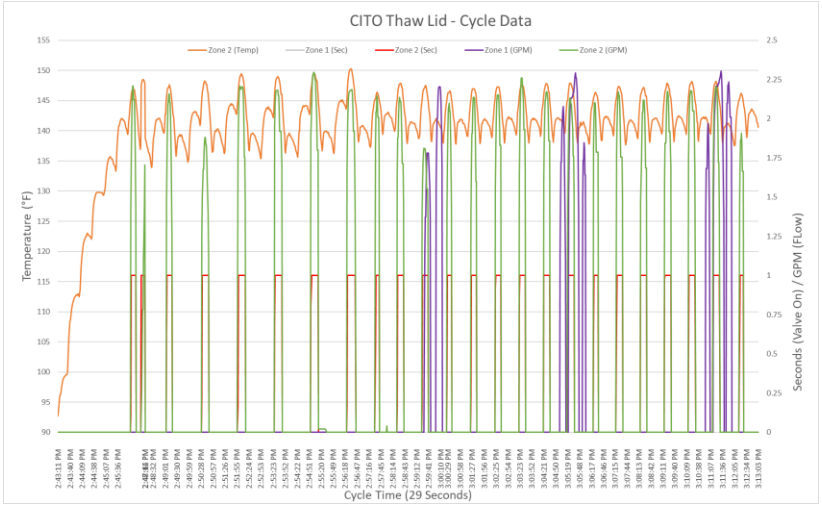
- Prove out the cycle time savings of PulseCooling
- Optimize the set point
- Optimize the sensor location

Preliminary Results



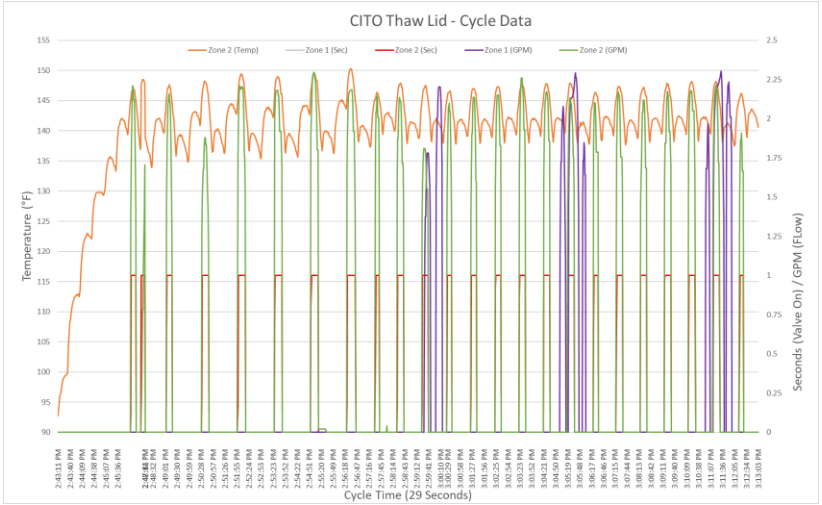
Conclusion

- Generative design of conformal cooling insert
- Fabrication of insert using novel 3D printing technology
- Closed-loop PulseCooling to:
  - Avoid overcooling
  - Reduce cycle time



Next Steps

- Experimental Results:
  - With / Without Conformal Cooling printed by **Mantle**
  - With / Without **PulseCooling**
- Experimental correlation
- Using **SimForm**, optimal selection of:
  - Set point
  - Sensor location
  - Water temperature



Contact Us

Book a free meeting to optimize your next mold design

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