



Topic:

CONFORMAL COOLING

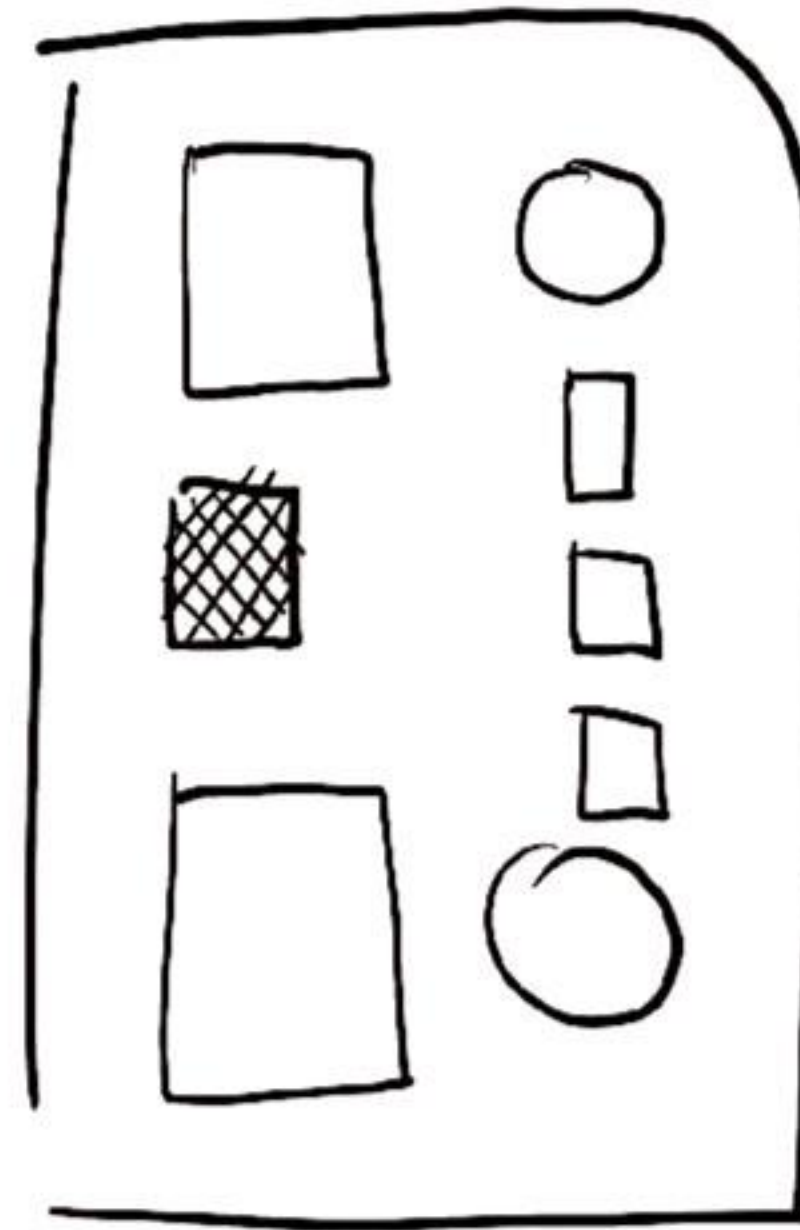


CONTURA[®]
MOLD TEMPERATURE CONTROL

The key to significant cost savings in injection molding is

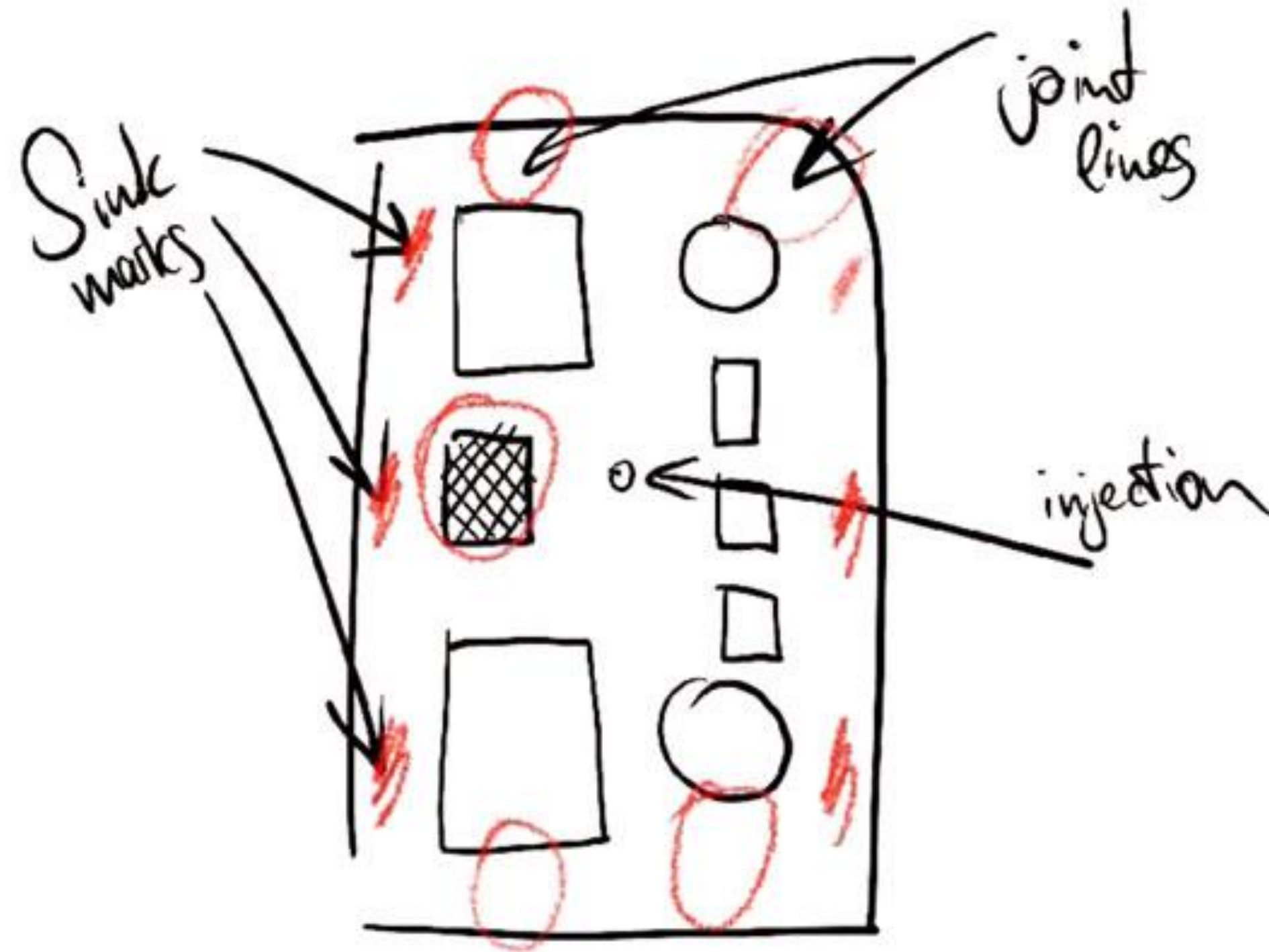
CONFORMAL COOLING

OUR SERVICE



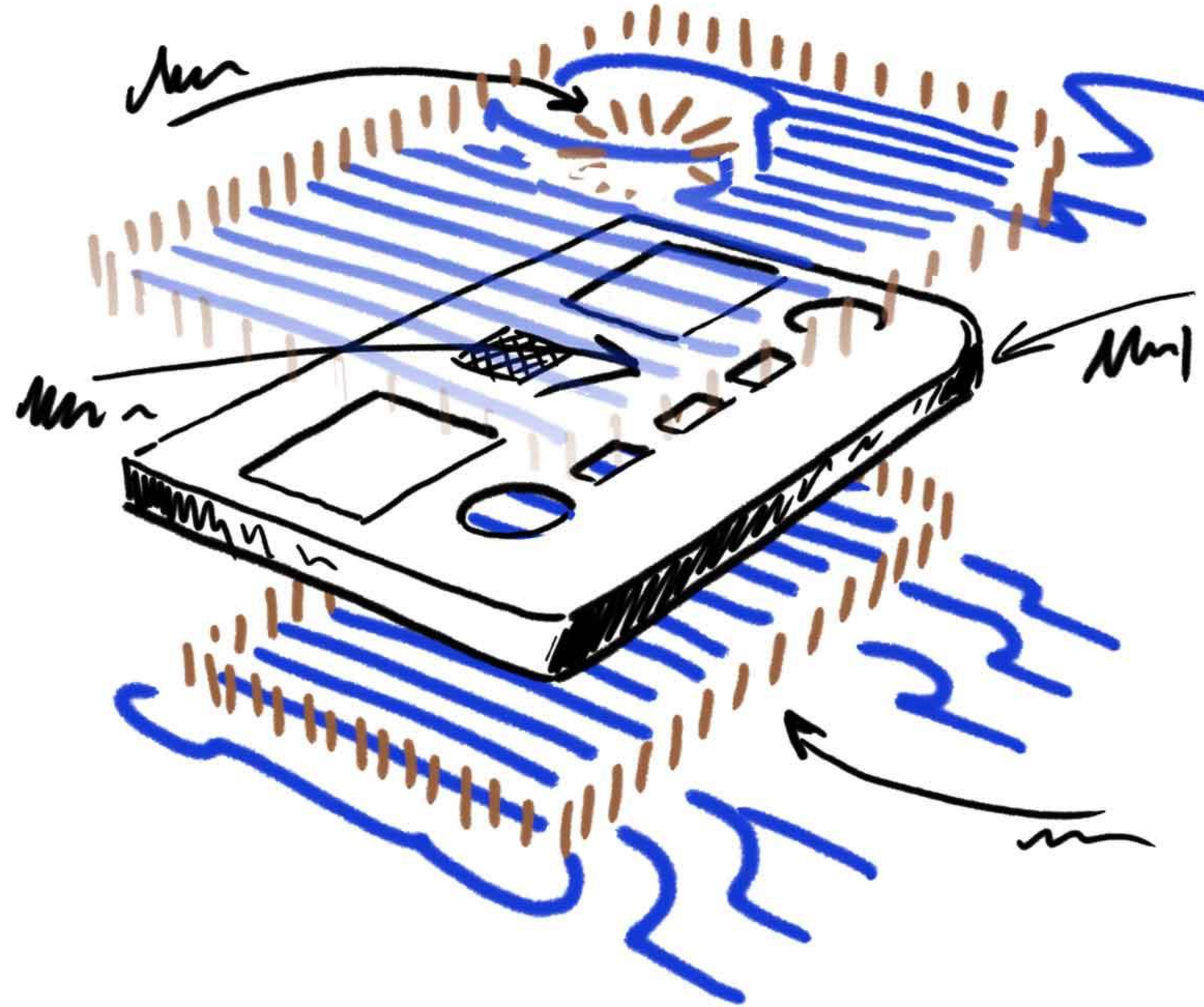
Starting with your Product ...

OUR SERVICE



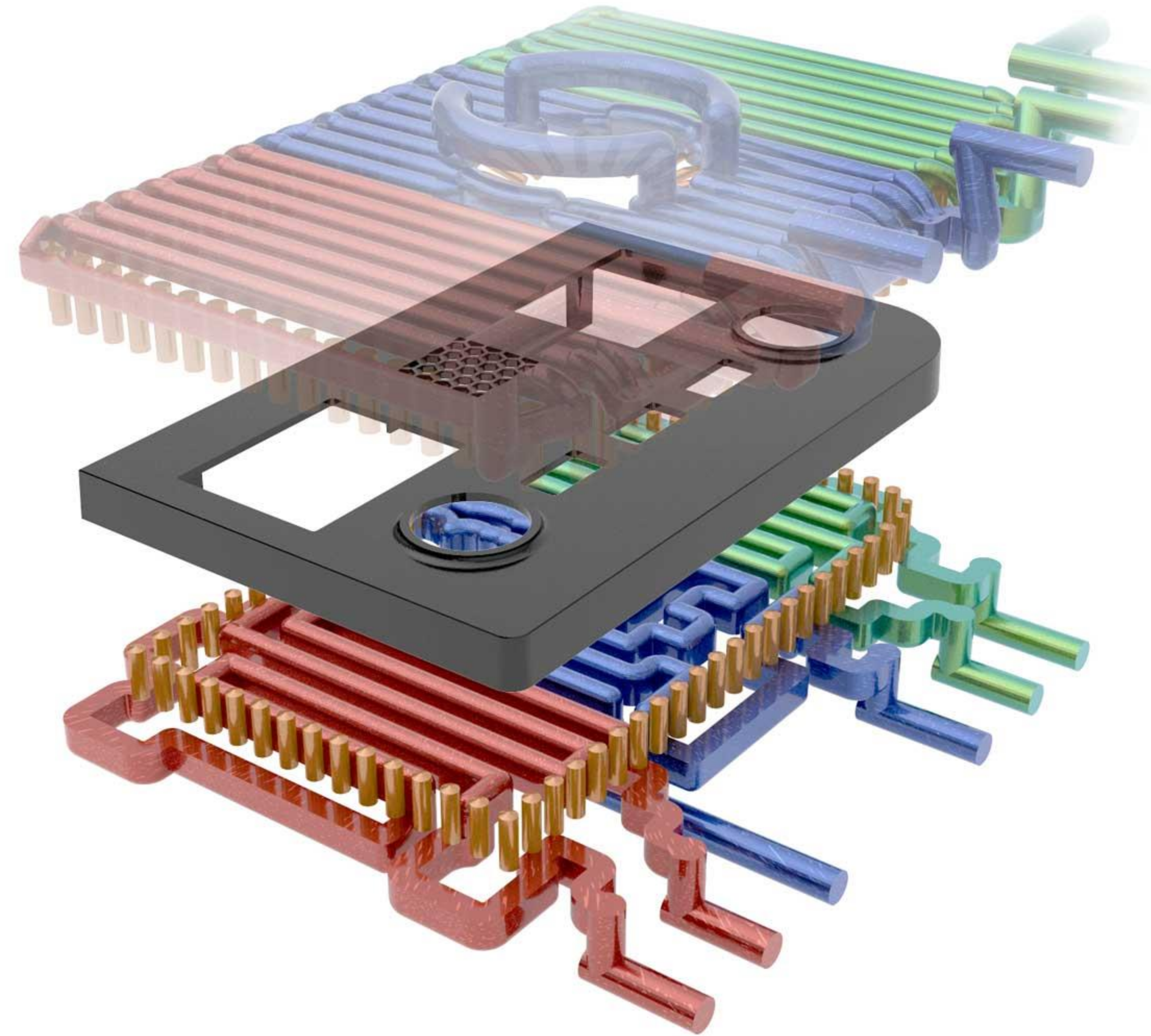
We analyze the project for possible problem areas,

OUR SERVICE



Developing an optimal solution,

OUR SERVICE



Design this solution and manufacture the mold insert,



OUR SERVICE

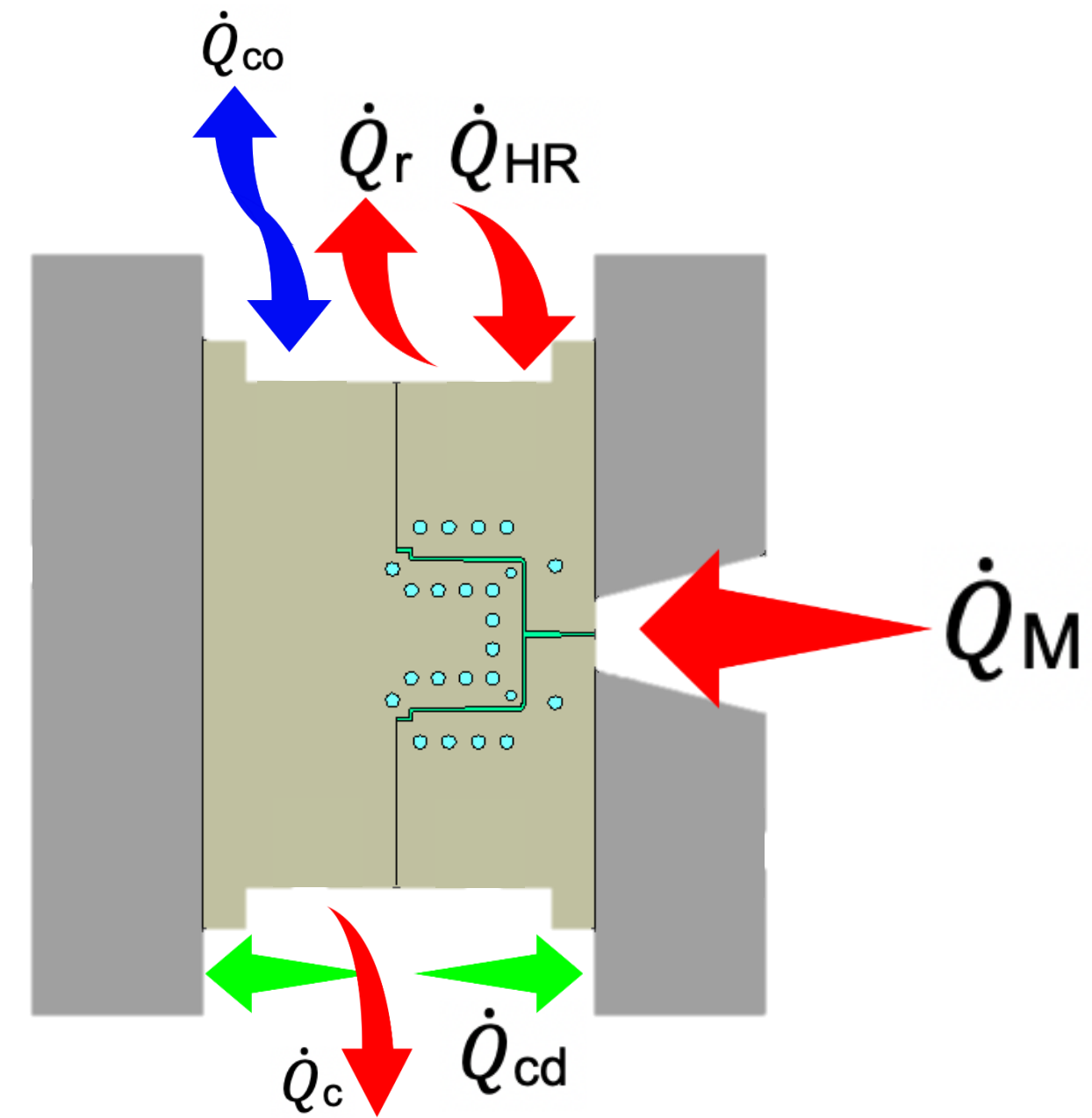


For a perfect product!

HEAT BALANCE ROOM INJECTION TOOL

- \dot{Q}_M Heat content Plastic Melt
- \dot{Q}_{HR} Heat loss Hot Runner
- \dot{Q}_r Heat loss radiation
- \dot{Q}_c Heat loss convection
- \dot{Q}_{cd} Heat loss conduction
- \dot{Q}_{co} Heat content Coolant

$$\dot{Q}_M + \dot{Q}_{HR} - \dot{Q}_r - \dot{Q}_c - \dot{Q}_{cd} \pm \dot{Q}_{co} = 0$$

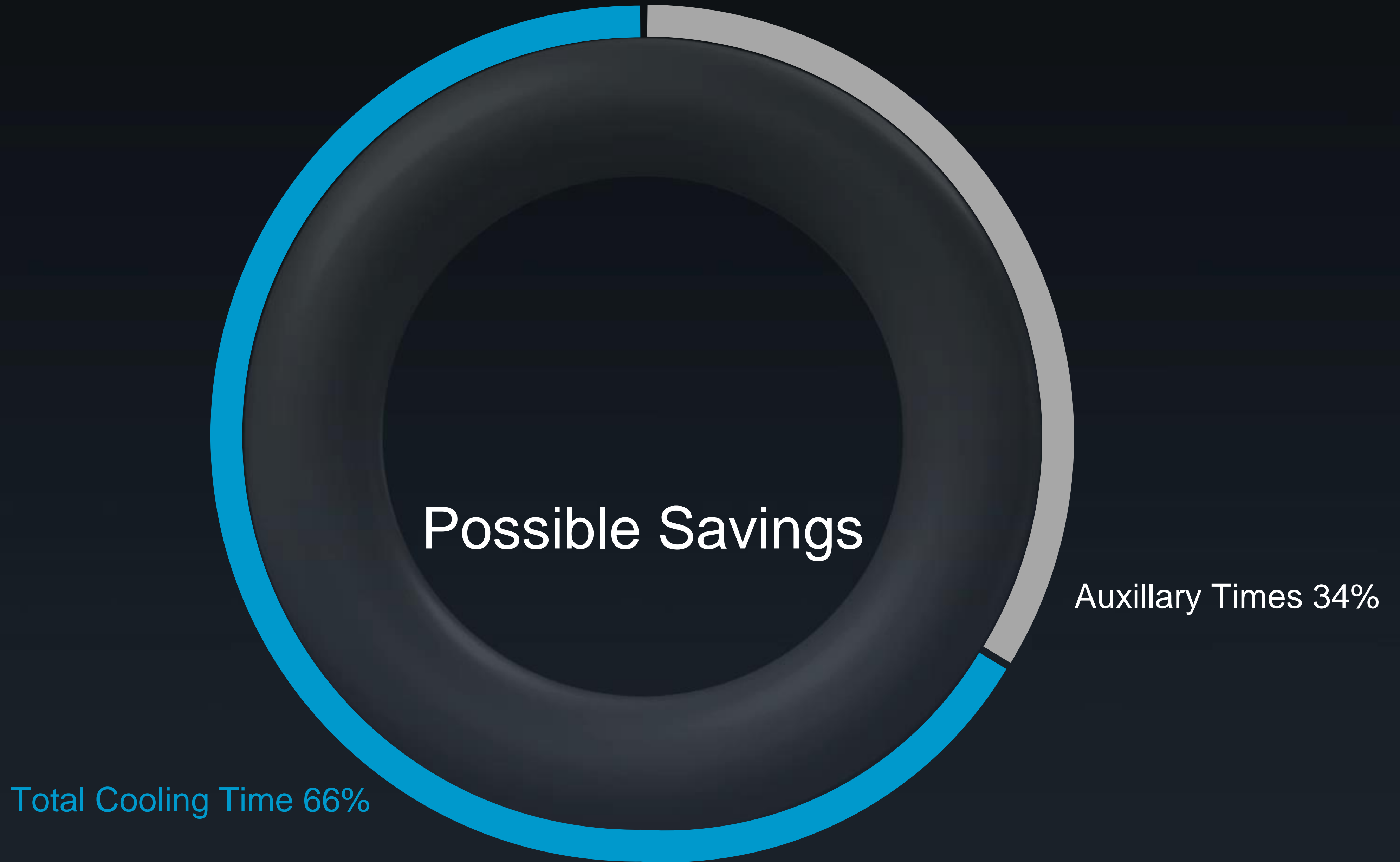


EQUATION FOR THE COOLING TIME OF A FLAT PLASTIC PART

$$t_k = \frac{s^2}{\pi^2 * aeff} * \ln\left(\frac{4}{\pi} * \frac{\vartheta_M - \bar{\vartheta}_W}{\hat{\vartheta}_E - \bar{\vartheta}_W}\right)$$

Wall thickness points to s^2 .
Melt temperature points to ϑ_M .
Average Wall temperature points to $\bar{\vartheta}_W$ in the numerator.
Effective thermal conductivity of the plastic resin points to $aeff$.
Ejection temperature points to $\hat{\vartheta}_E$.
Average Wall temperature points to $\bar{\vartheta}_W$ in the denominator.

WHAT DETERMINES CYCLE TIMES?



TEMPERATURE SITUATION ON THE MOLD SURFACE IN A MOLD

Messured Temperature in the Mold



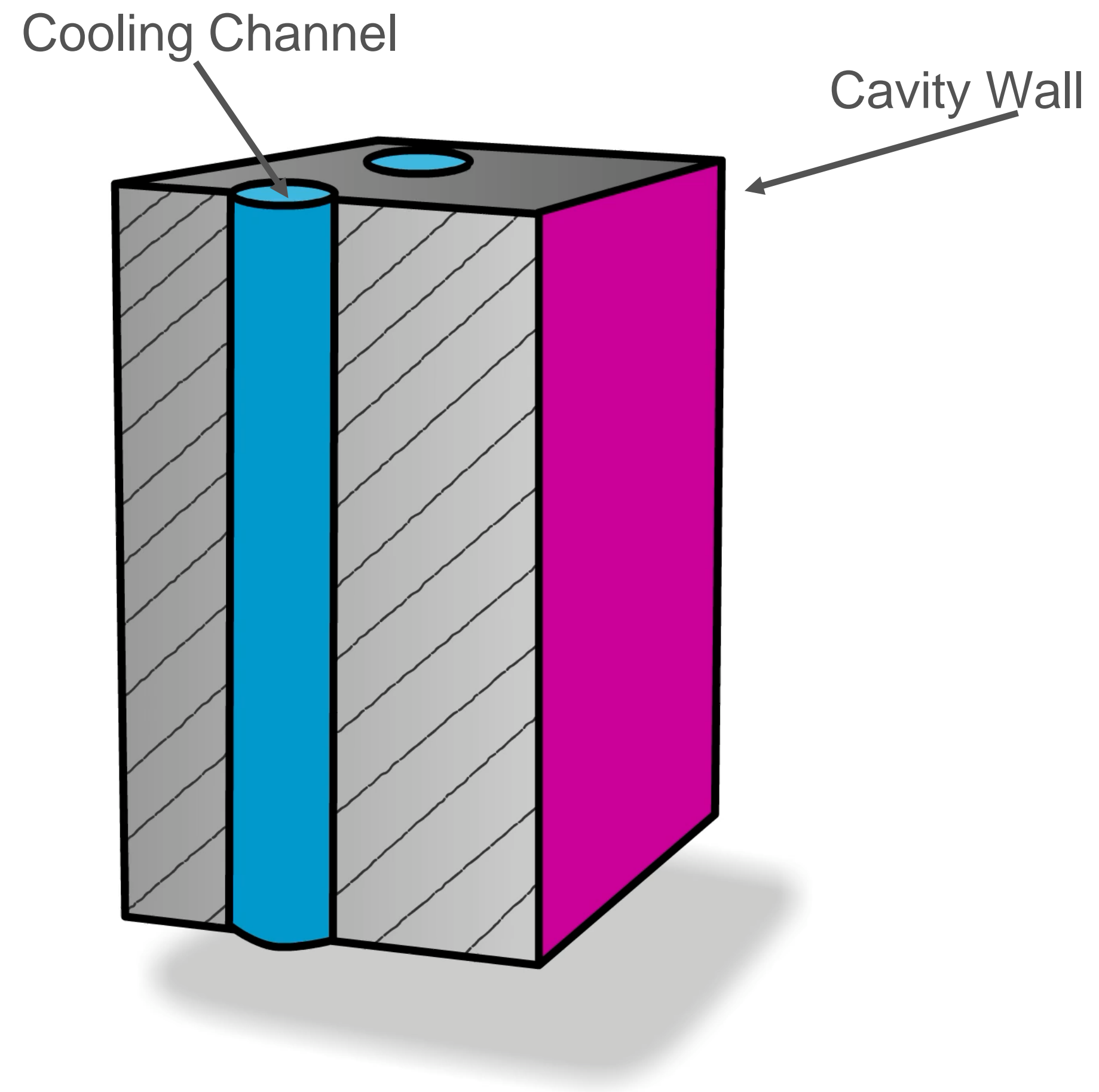
Settings on the TCU



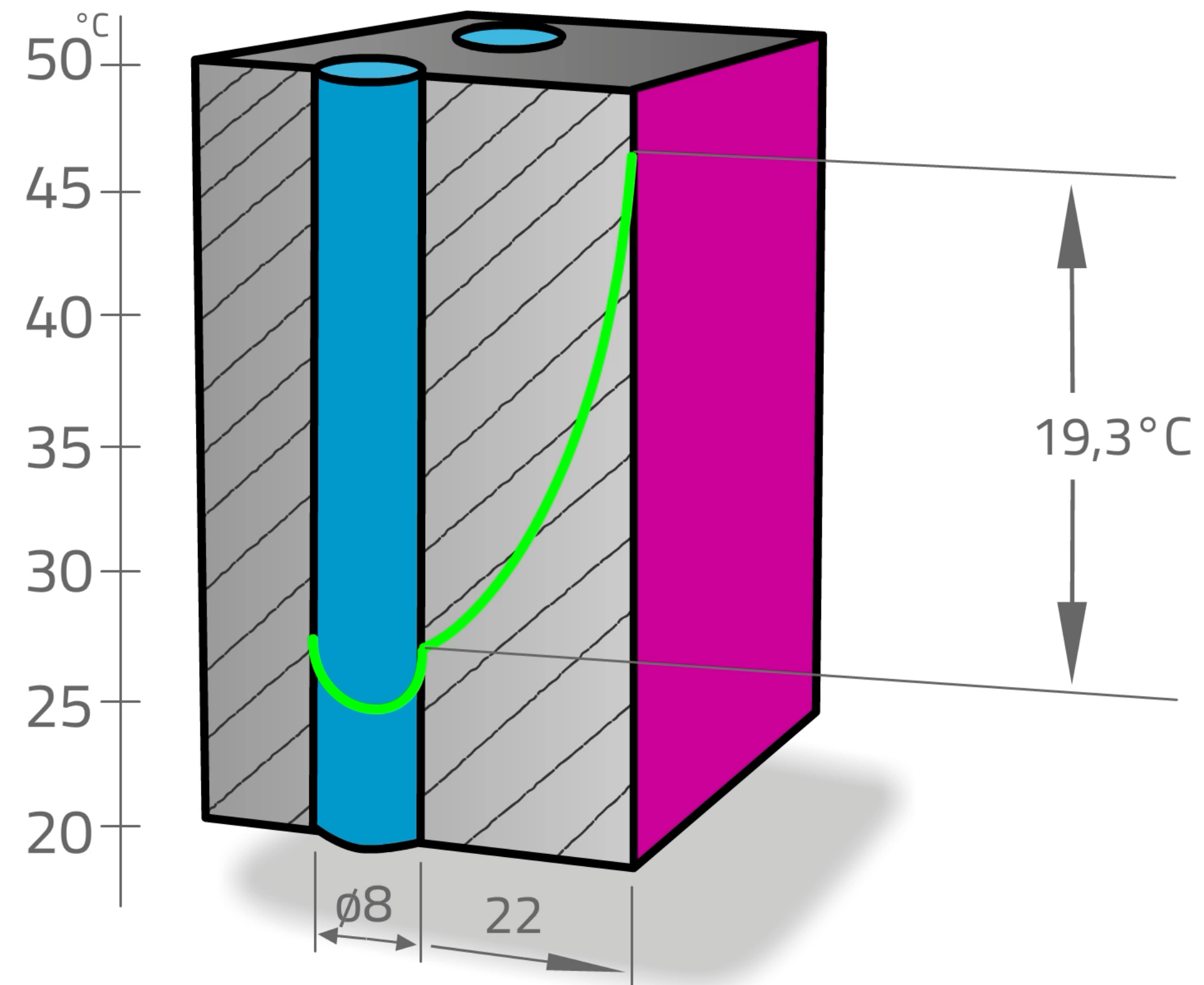
Quality Issues on the Plastic Part



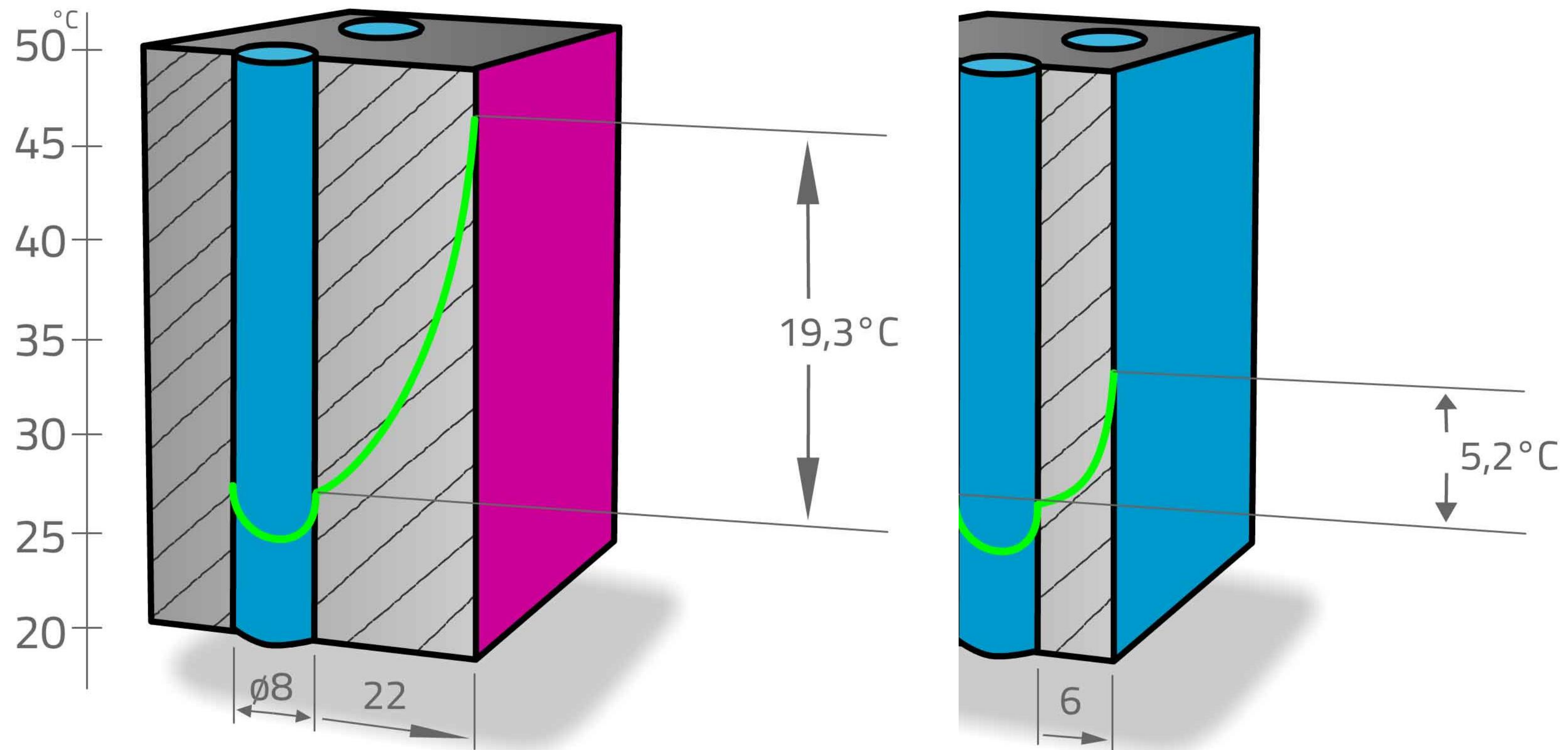
CONVENTIONAL LAYOUT



CONVENTIONAL LAYOUT



CONVENTIONAL LAYOUT



CALCULATION OF THE PHYSICAL COOLING TIME

Material:

Gruppe:
Material:
Bezeichnung:
Hersteller:
Glasfaseranteil: %
Massetemperatur: °C (280 - 320 °C)

Formteil:

Geometrie:
Wanddicke: mm
Werkzeugwandtemperatur: DS °C (80 - 120 °C)
 AS °C

Zeiten:

Theoretische Kühlzeit:	10,0 s
Summe der Nebenzeiten:	0,0 s
Zykluszeit:	10,0 s

Kunde:

Name:
Auftrag:
Formteil:
Werkzeug:

Nebenzeiten:

Einspritzzeit: s
Werkzeug öffnen: s
Formteil auswerfen: s
Formteil entnehmen: s
Werkzeug schließen: s
Sonstiges: s

Berechnungen:

manuelle Eingabe:

Mittlere Entformungstemperatur: 111,86 °C
Effekt. Temperaturleitfähigkeit: 0,1096 mm²/s
Max. Entformungstemperatur: 130,05 °C

CALCULATION OF THE PHYSICAL COOLING TIME

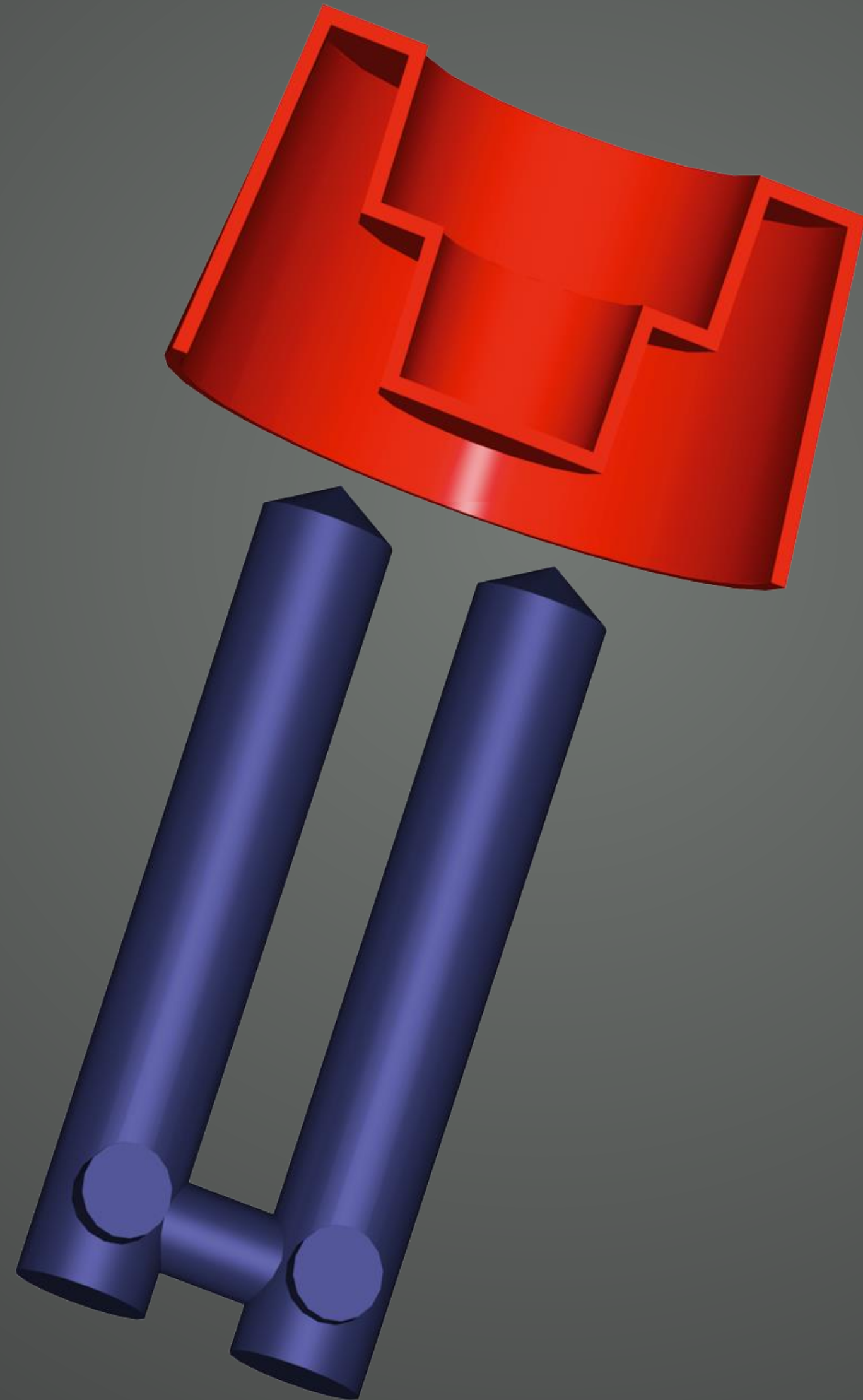
<u>Material:</u>		<u>Kunde:</u>	
Gruppe:	PC	Name:	
Material:		Auftrag:	
Bezeichnung:		Formteil:	
Hersteller:		Werkzeug:	
Glasfaseranteil:	0 %	<u>Nebenzeiten:</u>	
Massetemperatur:	280 °C (280 - 320 °C)	Einspritzzeit:	0 s
<u>Formteil:</u>		Werkzeug öffnen:	0 s
Geometrie:	Platte	Formteil auswerfen:	0 s
Wanddicke:	2,5 mm	Formteil entnehmen:	0 s
Werkzeugwandtemperatur:	DS 110 °C (80 - 120 °C)	Werkzeug schließen:	0 s
	AS 110 °C	Sonstiges:	0 s
<u>Zeiten:</u>		<u>Berechnungen:</u>	
Theoretische Kühlzeit:	26,0 s	<input type="checkbox"/> manuelle Eingabe:	
Summe der Nebenzeiten:	0,0 s	Mittlere Entformungstemperatur:	111,86 °C
Zykluszeit:	26,0 s	Effekt. Temperaturleitfähigkeit:	0,1109 mm ² /s
		Max. Entformungstemperatur:	112,92 °C

$\Delta t_{\text{Mo-Surface}} = +30^\circ\text{C}$ Cooling Time +160%!!!

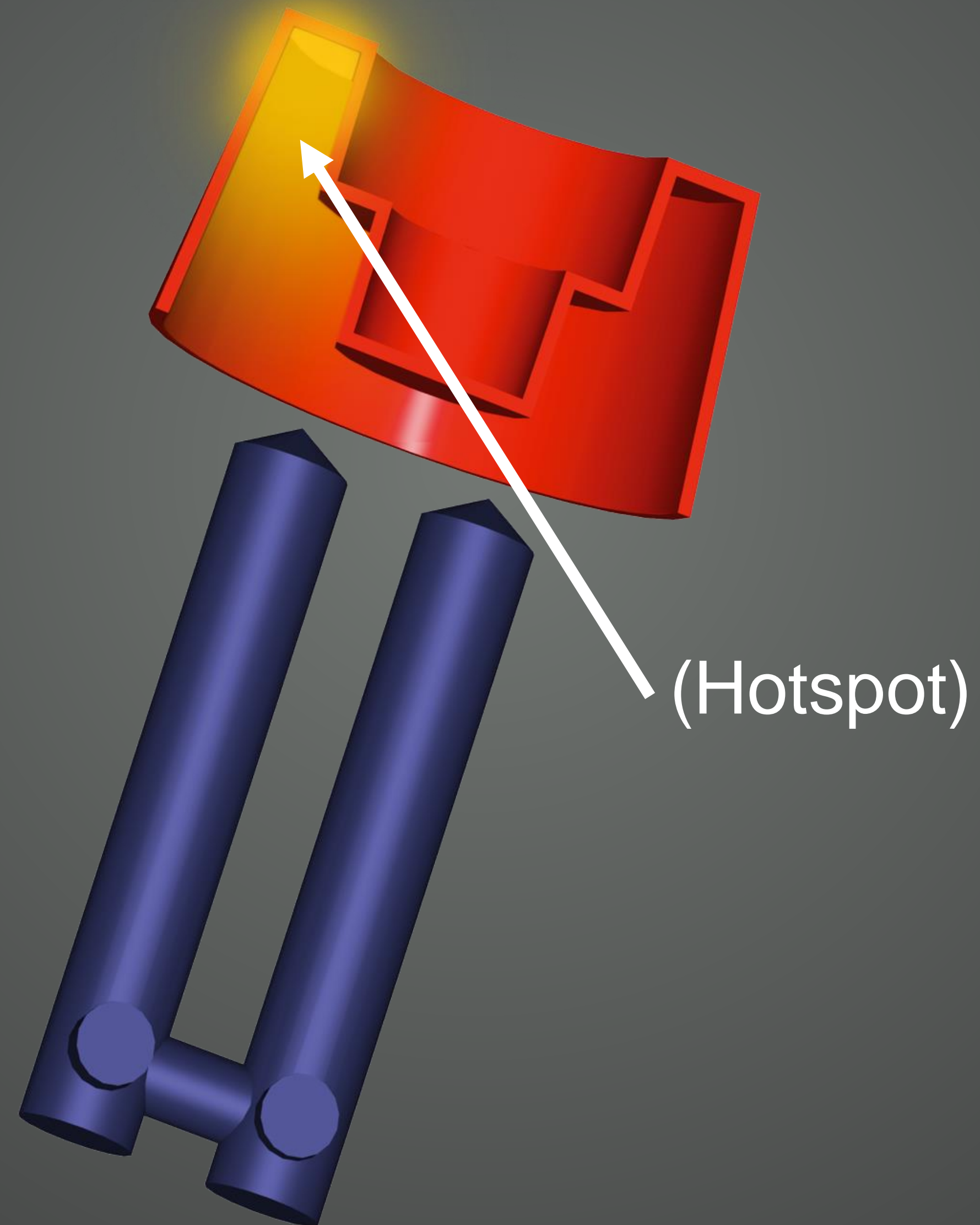
SAMPLE PART



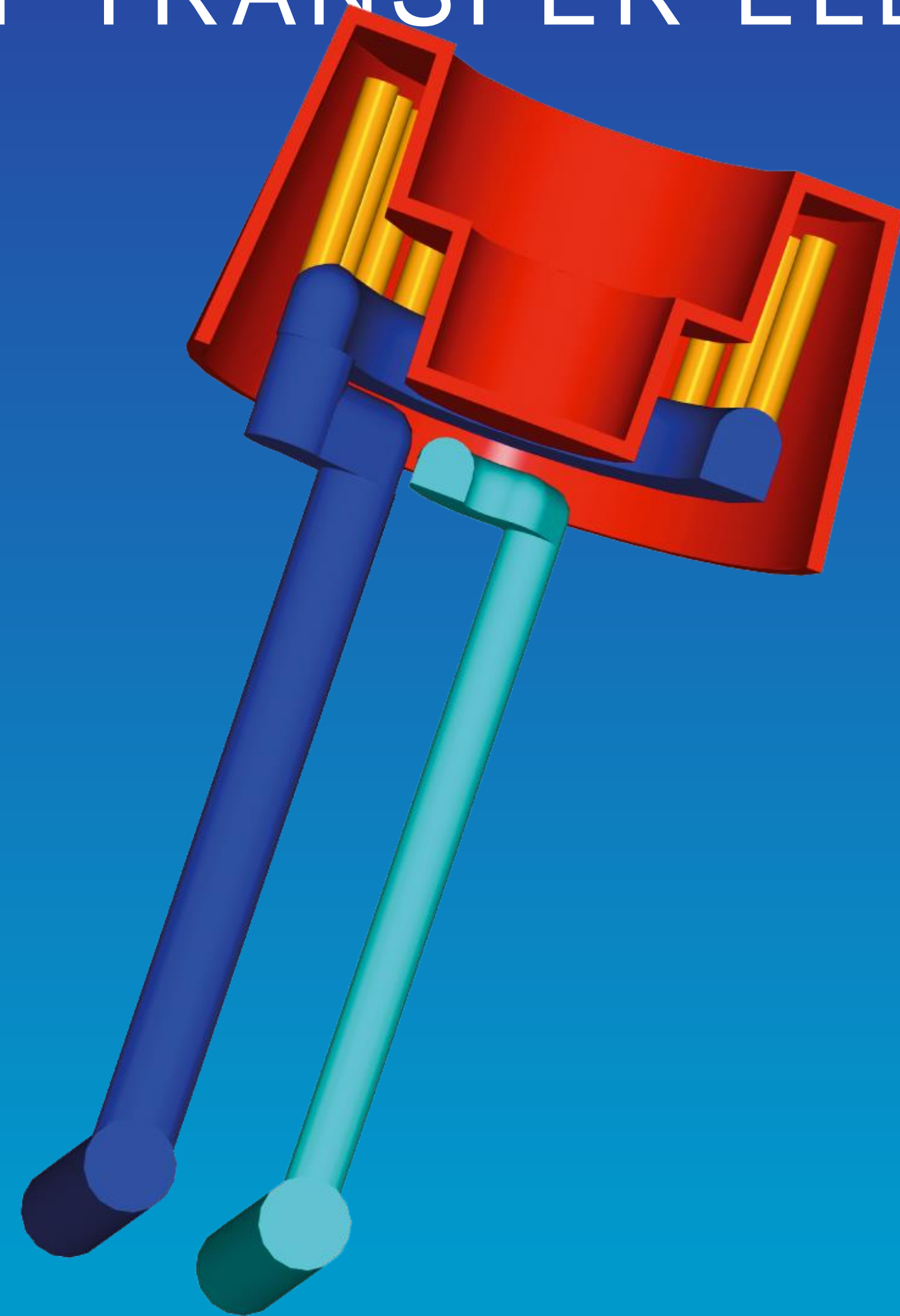
CONVENTIONAL COOLING LAYOUT



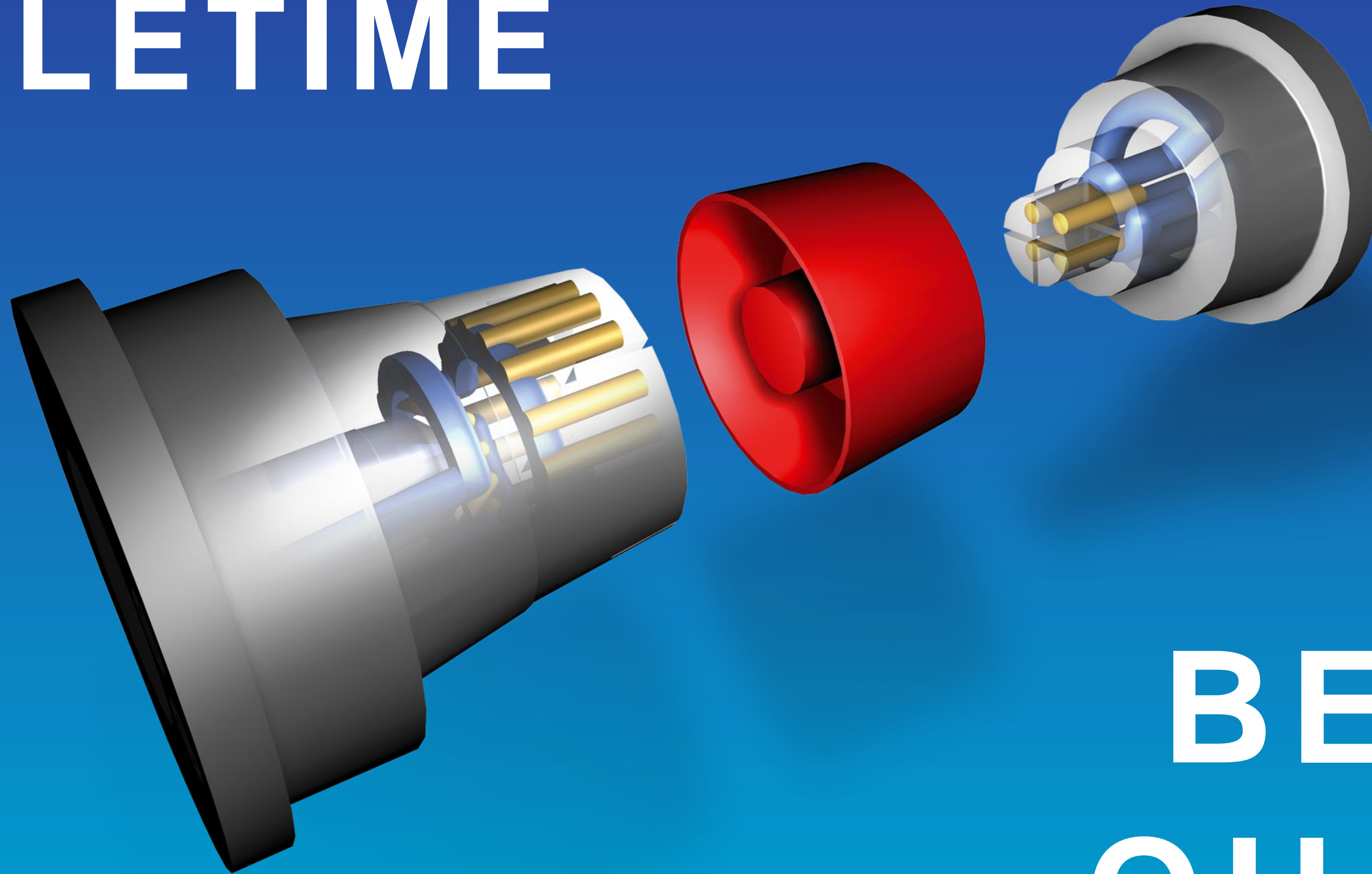
CONVENTIONAL COOLING LAYOUT



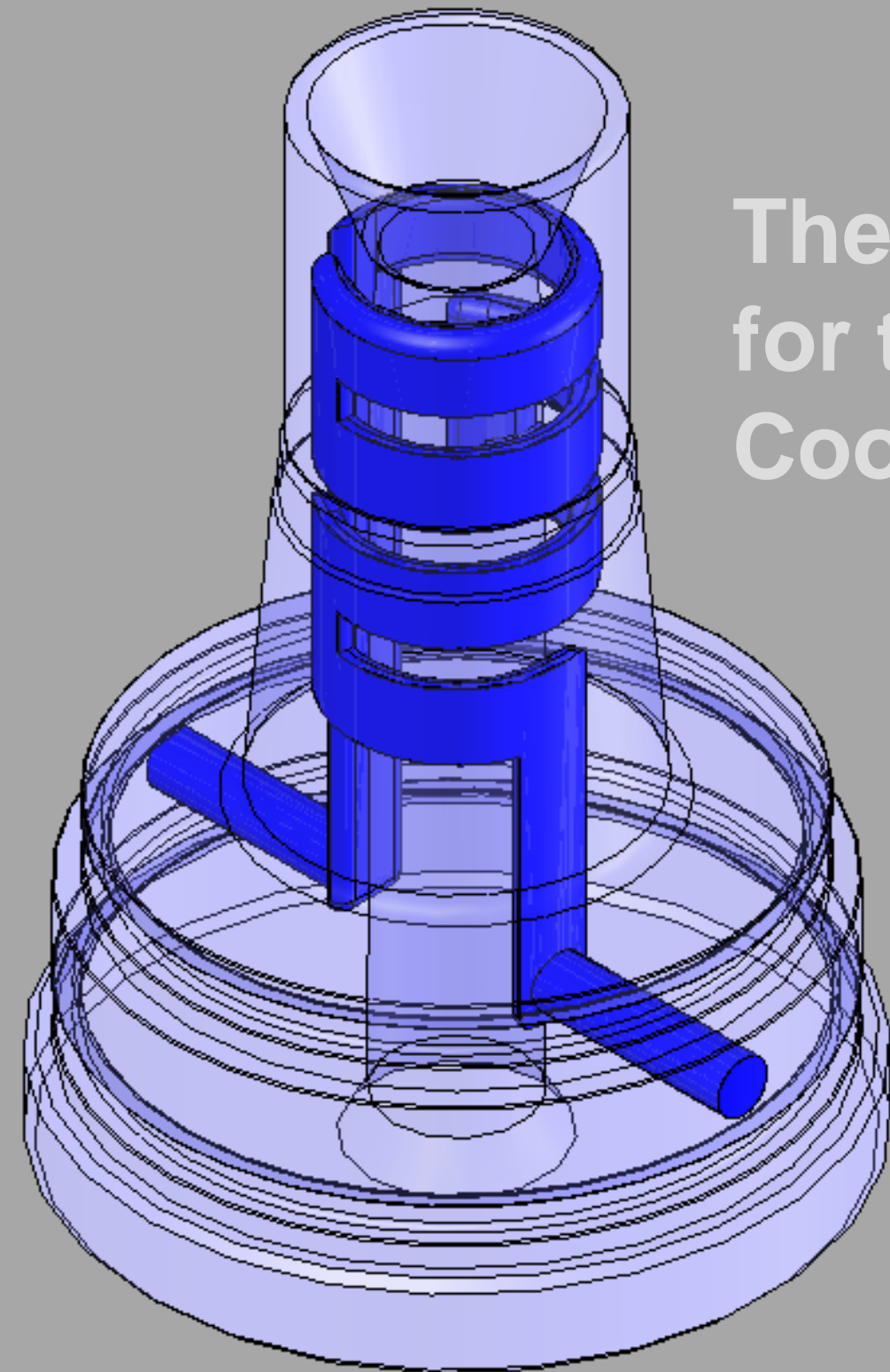
CONFORMAL COOLING LAYOUT WITH HEAT TRANSFER ELEMENTS



**SHORTER
CYCLETIME**



**BETTER
QUALITY**



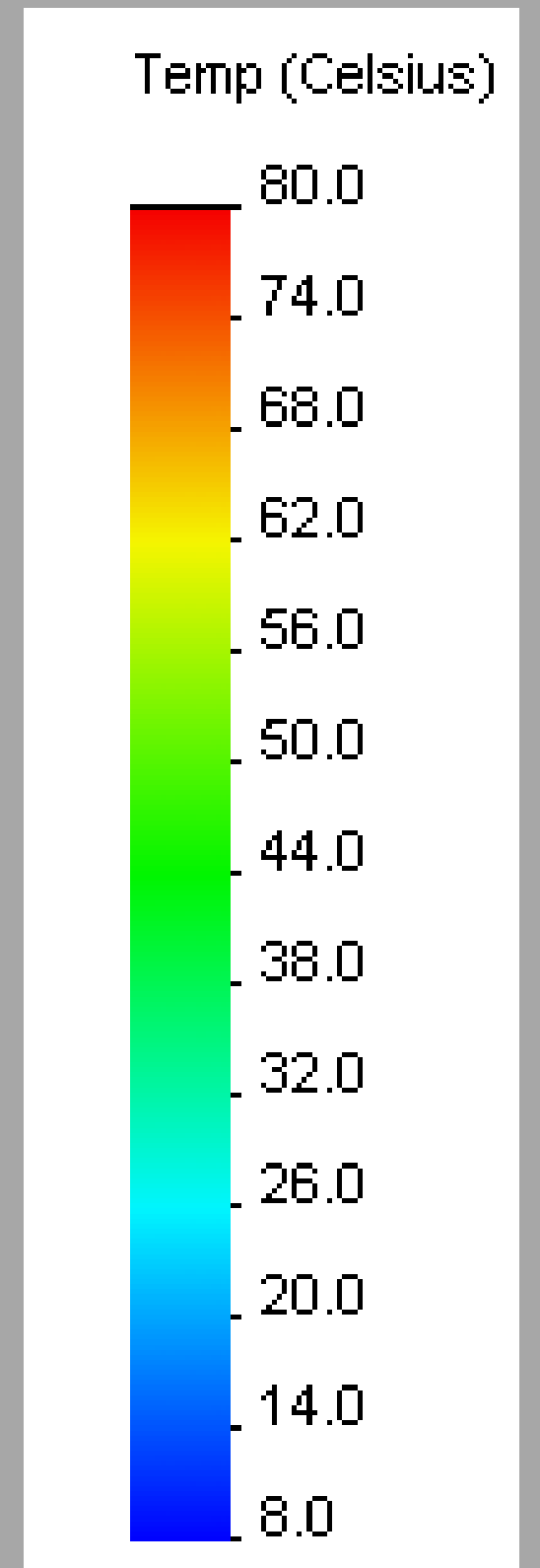
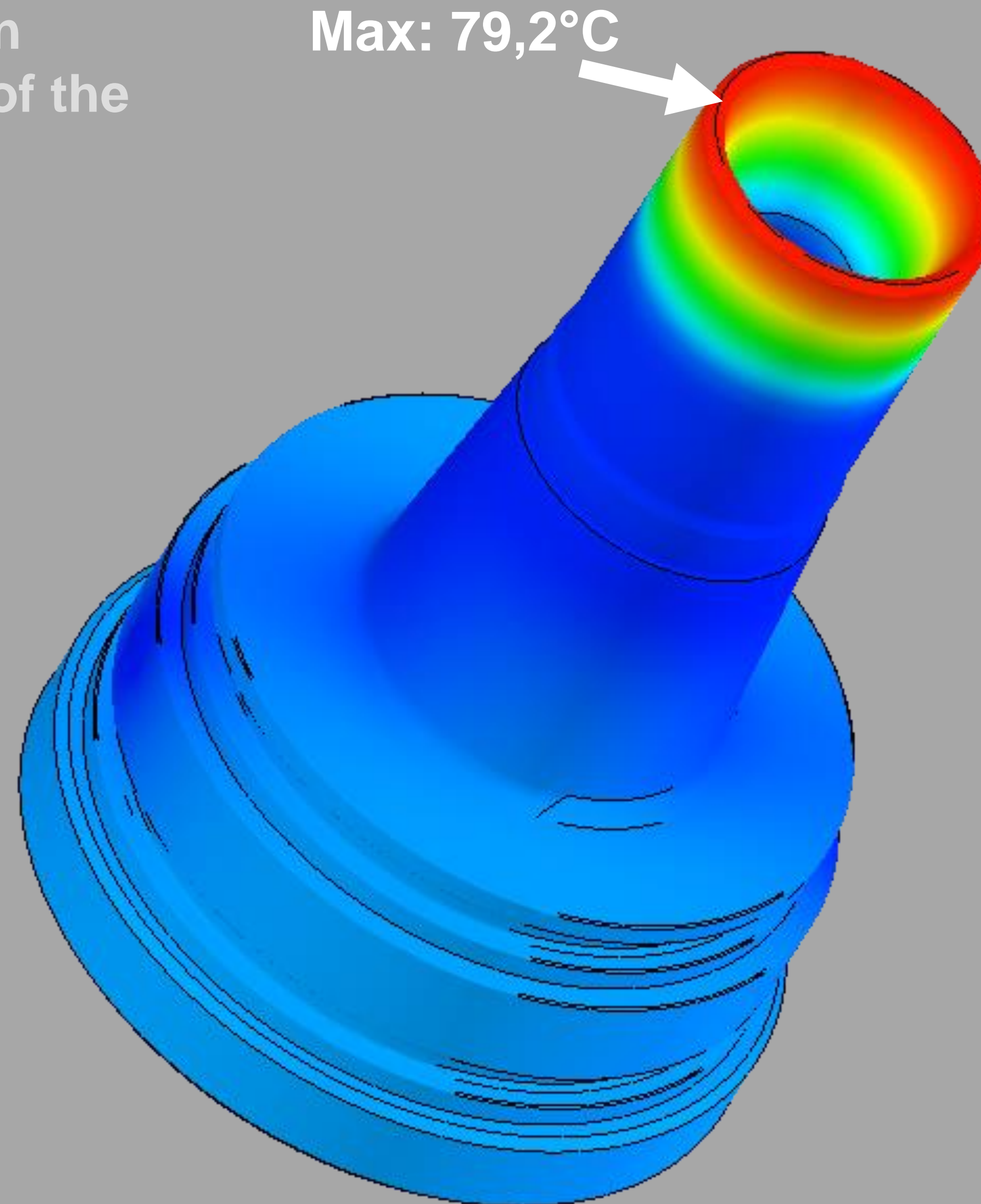
Thermal Simulation
for the evaluation of the
Cooling Layout

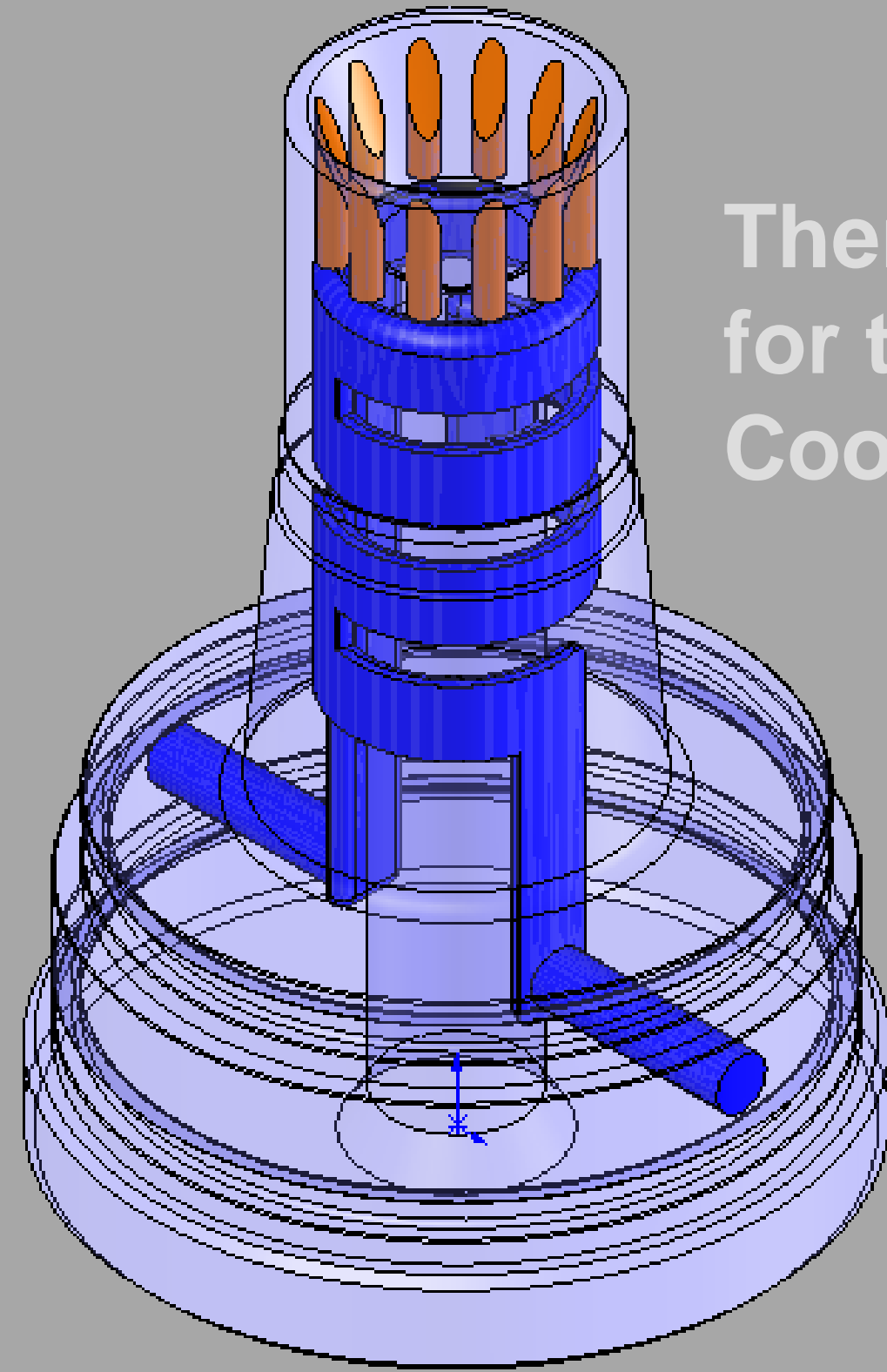
Bases for Simulation

Tool Material: 1.2344 ESU

Feeding Water: 20°C

Plastic Material: POM



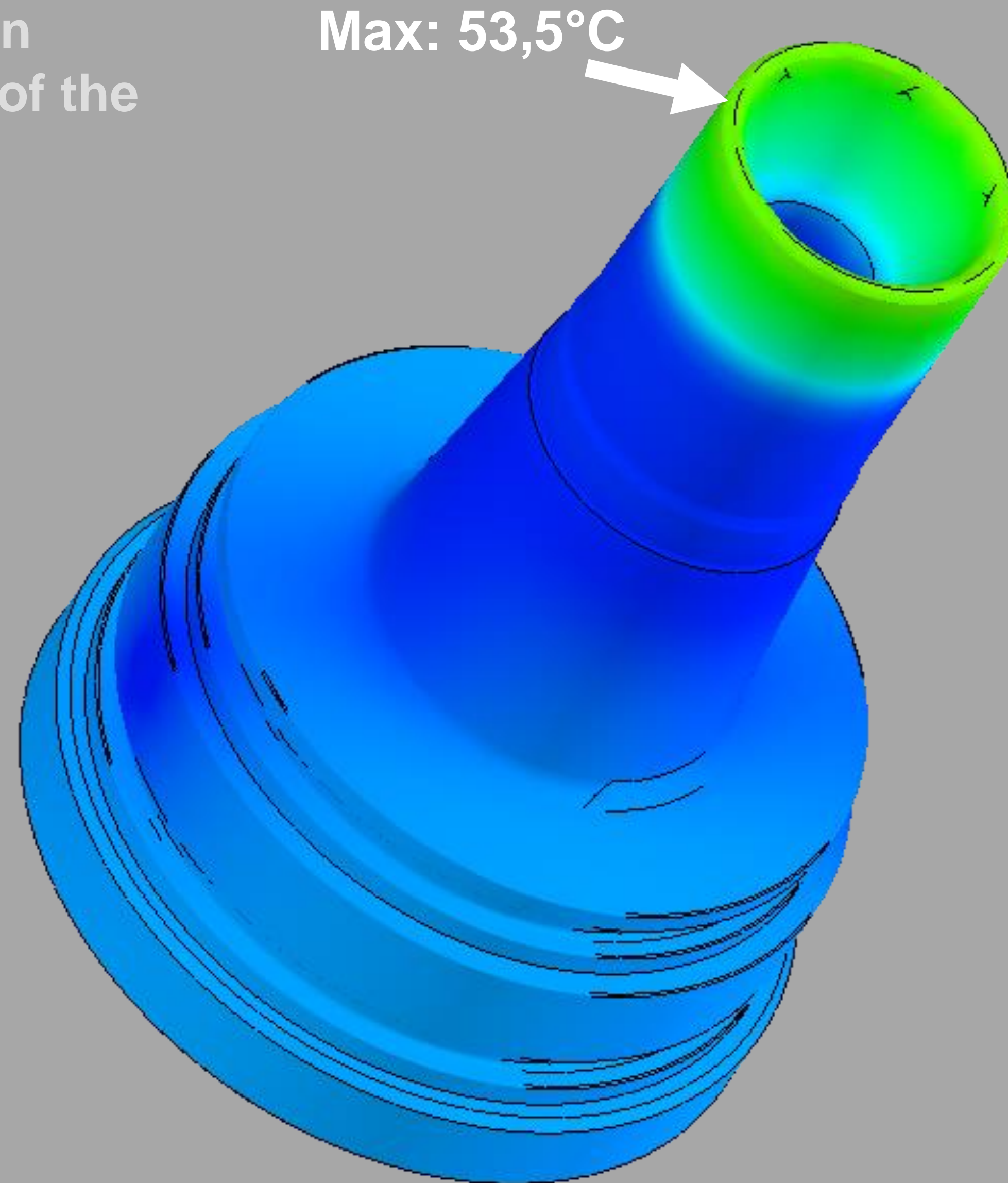


Thermal Simulation
for the evaluation of the
Cooling Layout

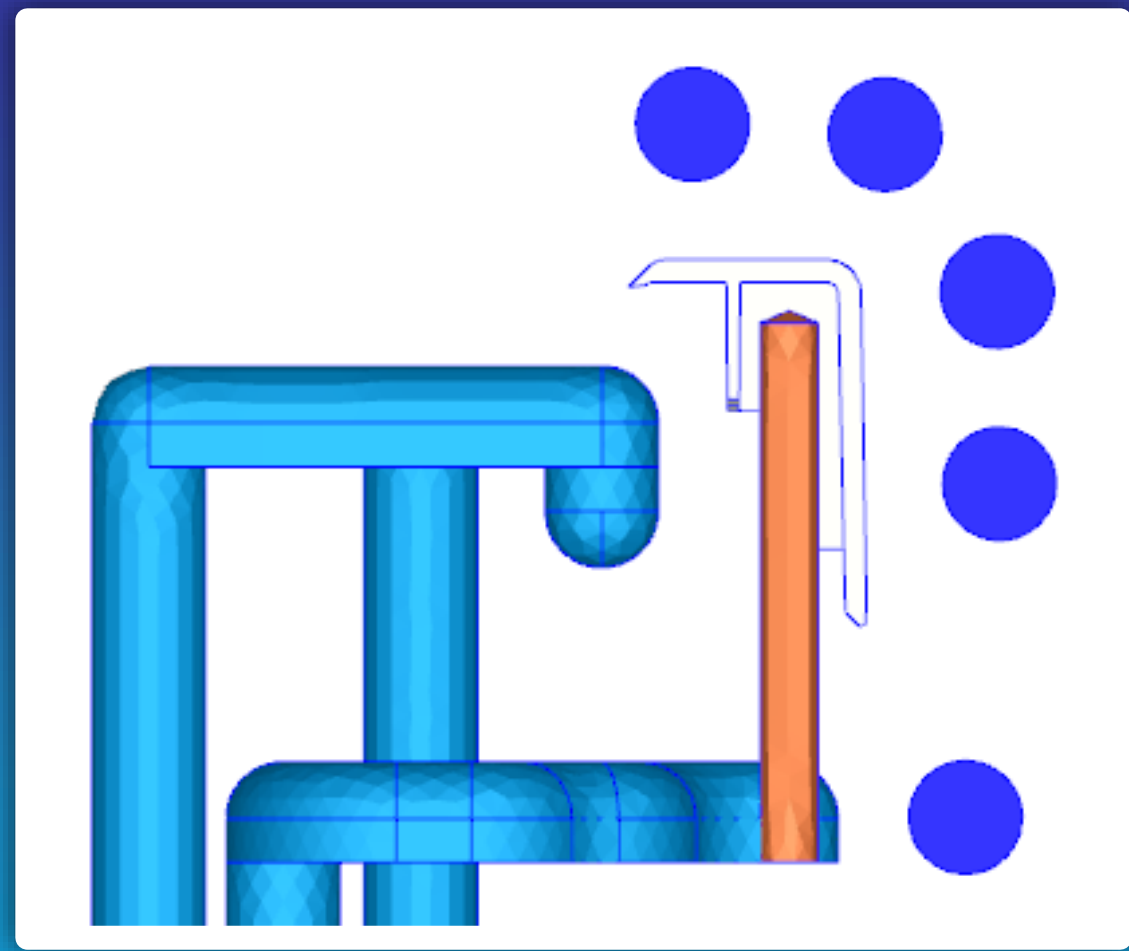
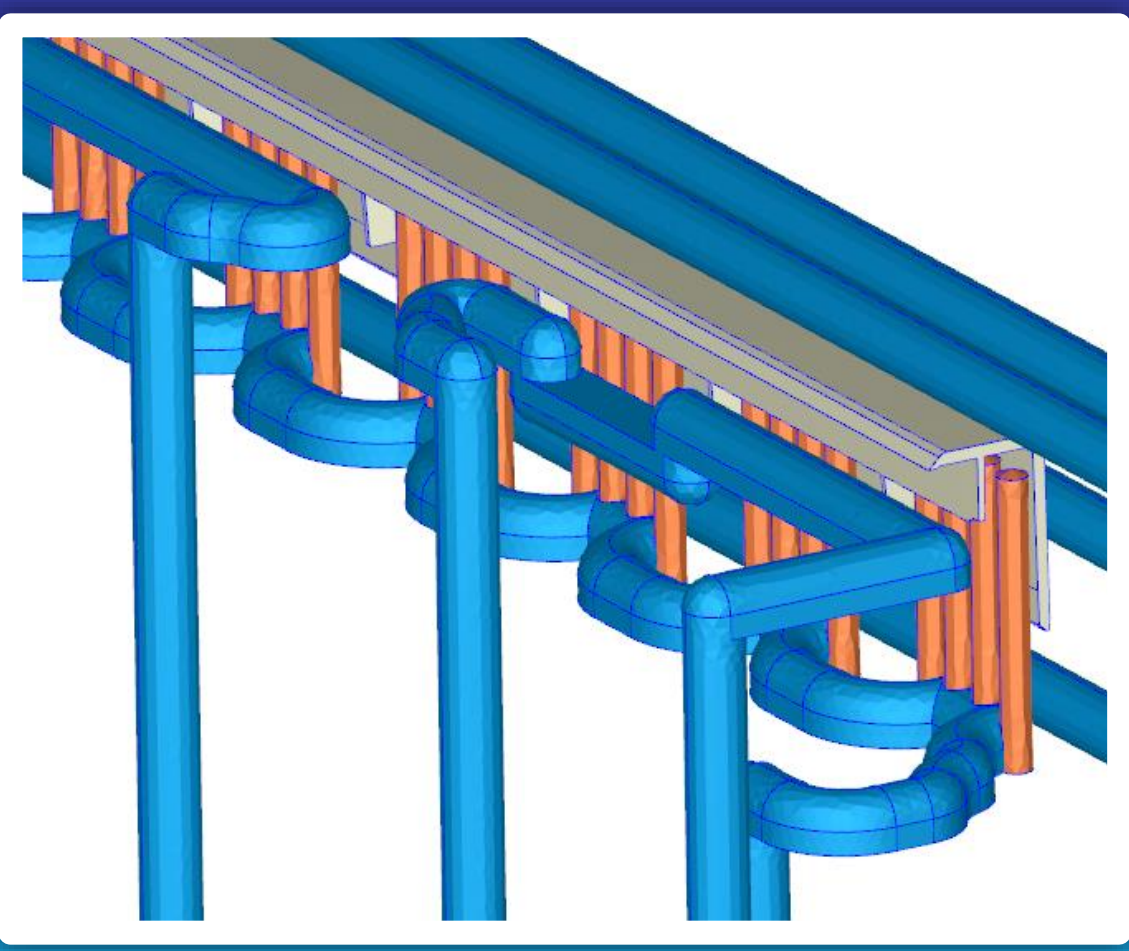
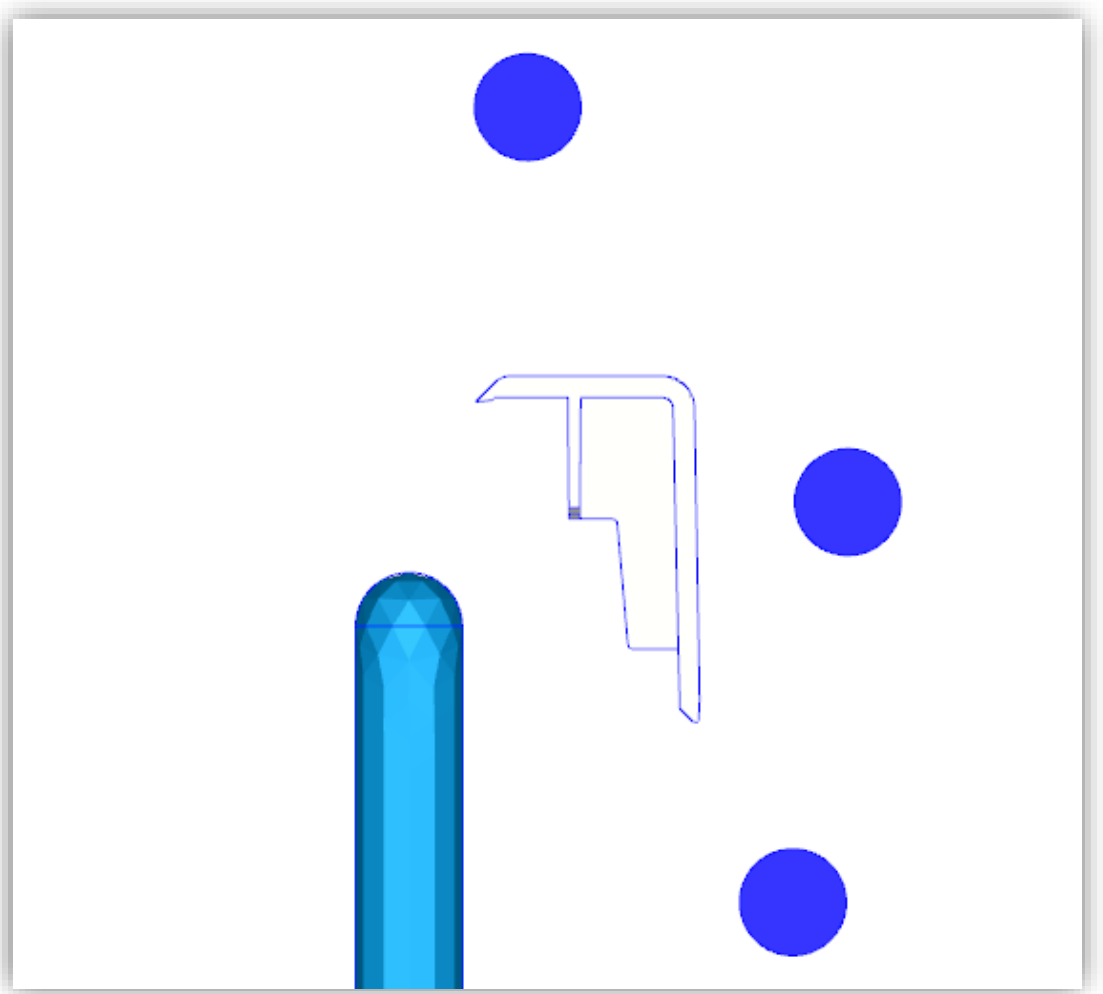
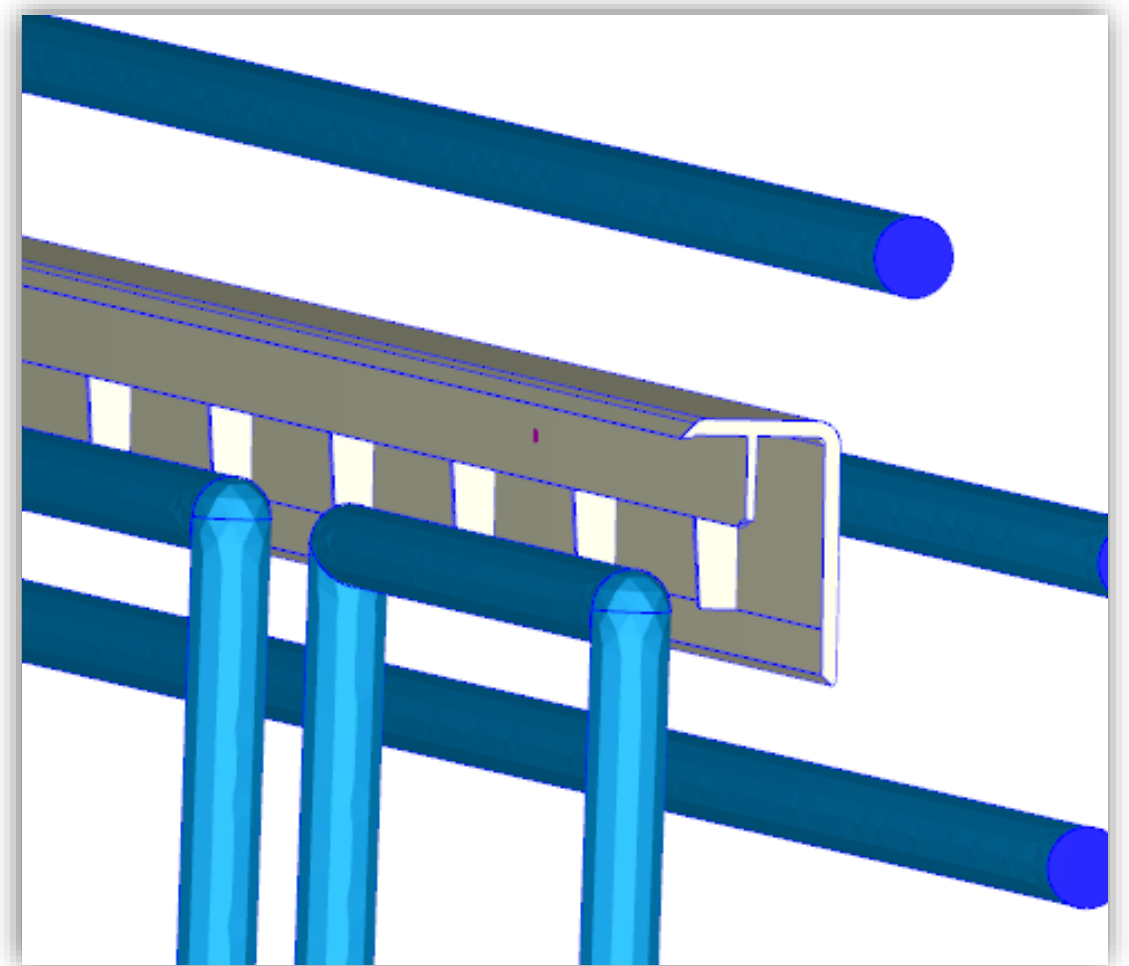
Bases for Simulation

Tool Material: 1.2344 ESU
Feeding Water: 20°C

Plastics Material: POM

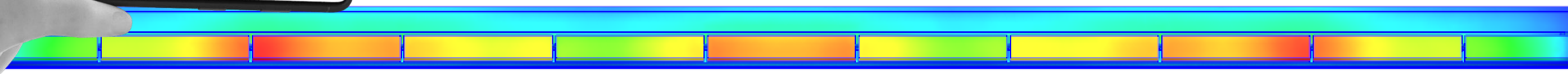


FEM ANALYSE OF THE COOLING LAYOUT

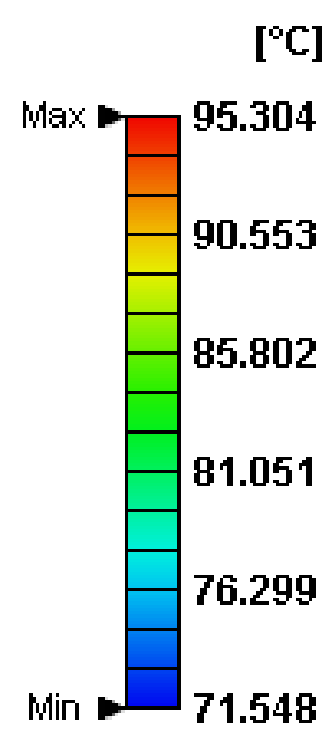


FEM ANALYSE OF THE COOLING LAYOUT

16 sec
Total Cooling

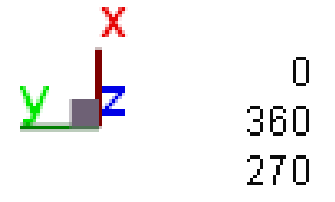


Run 10
Cooling_Temperature
Final Cycle
Time = 16.113 sec (EOC)



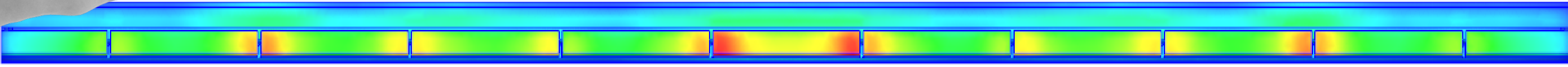
20.00 mm

Moldex3D



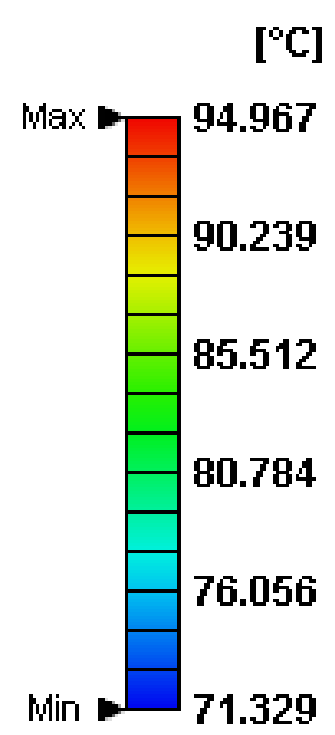
WCS My View1

10 sec
Total Cooling



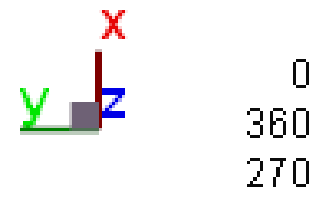
CONTURA®

Run 12
Cooling_Temperature
Final Cycle
Time = 10.006 sec (Cool)



20.00 mm

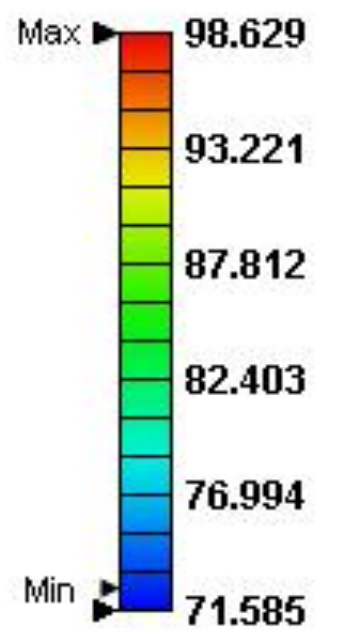
Moldex3D



FEM ANALYSE OF THE COOLING LAYOUT

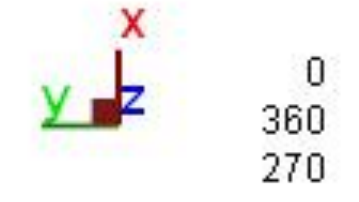


Run 10
Cooling_Max. Temperature
Final Cycle
Time = 16.113 sec (EOC)
[°C]

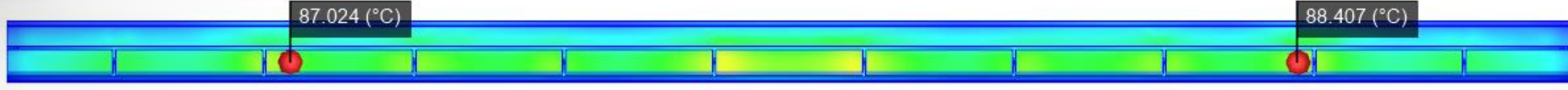


10°C ΔT
At the End of Cooling

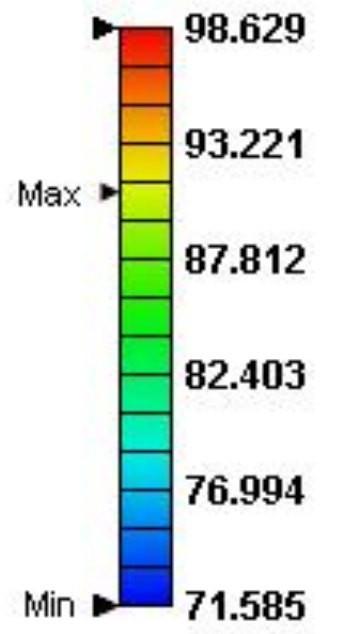
30.00 mm | Moldex3D



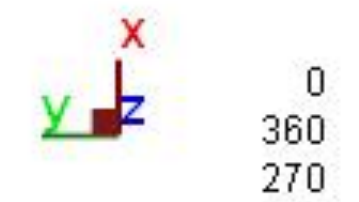
WCS | My View1



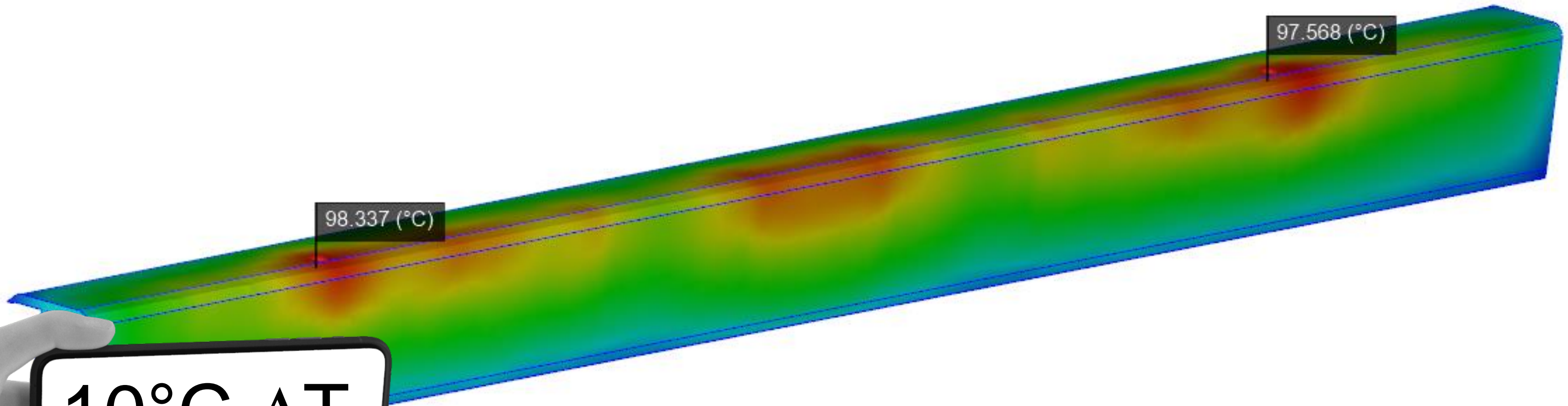
Run 12
Cooling_Max. Temperature
Final Cycle
Time = 16.135 sec (EOC)
[°C]



30.00 mm | Moldex3D



FEM ANALYSE OF THE COOLING LAYOUT



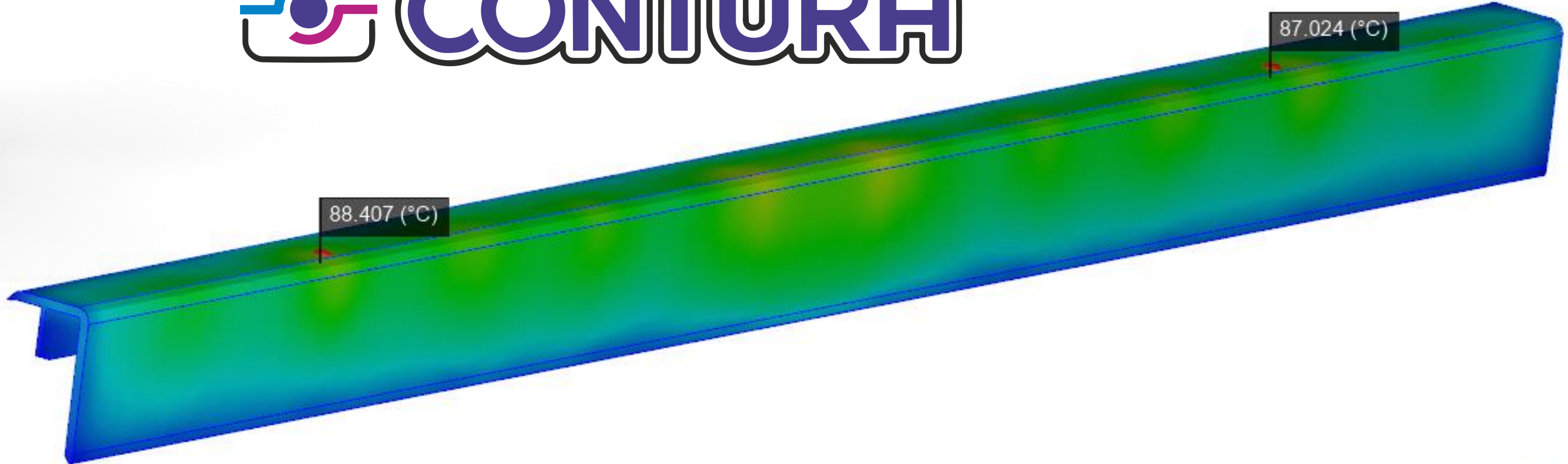
Run 10
Cooling_Max. Temperature
Final Cycle
Time = 16.113 sec (EOC)
[°C]

Max 98.629
93.221
87.812
82.403
76.994
Min 71.585

10.00 mm

Moldex3D

257
8
146



Run 12
Cooling_Max. Temperature
Final Cycle
Time = 16.135 sec (EOC)
[°C]

Max 98.629
93.221
87.812
82.403
76.994
Min 71.585

10.00 mm

Moldex3D

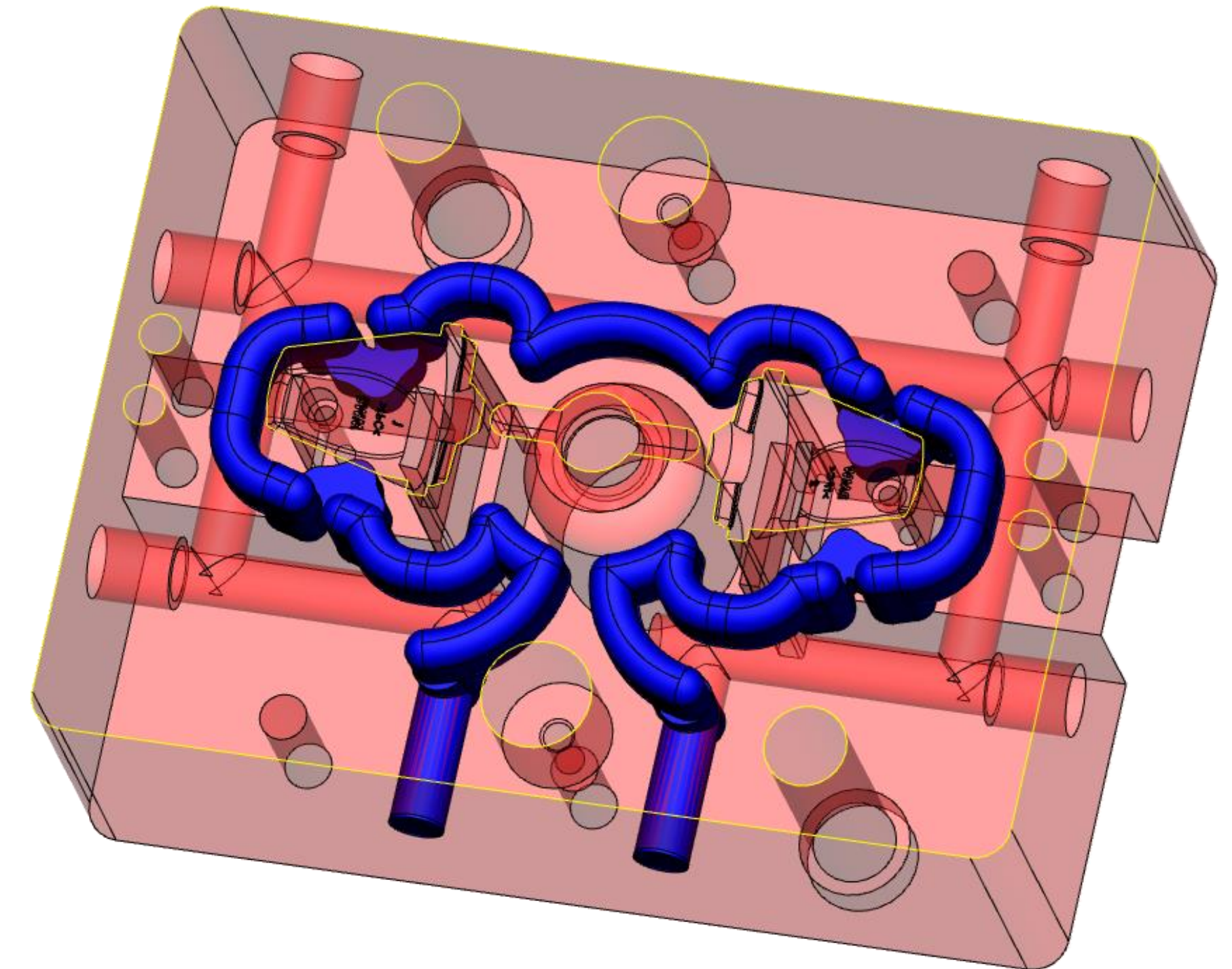
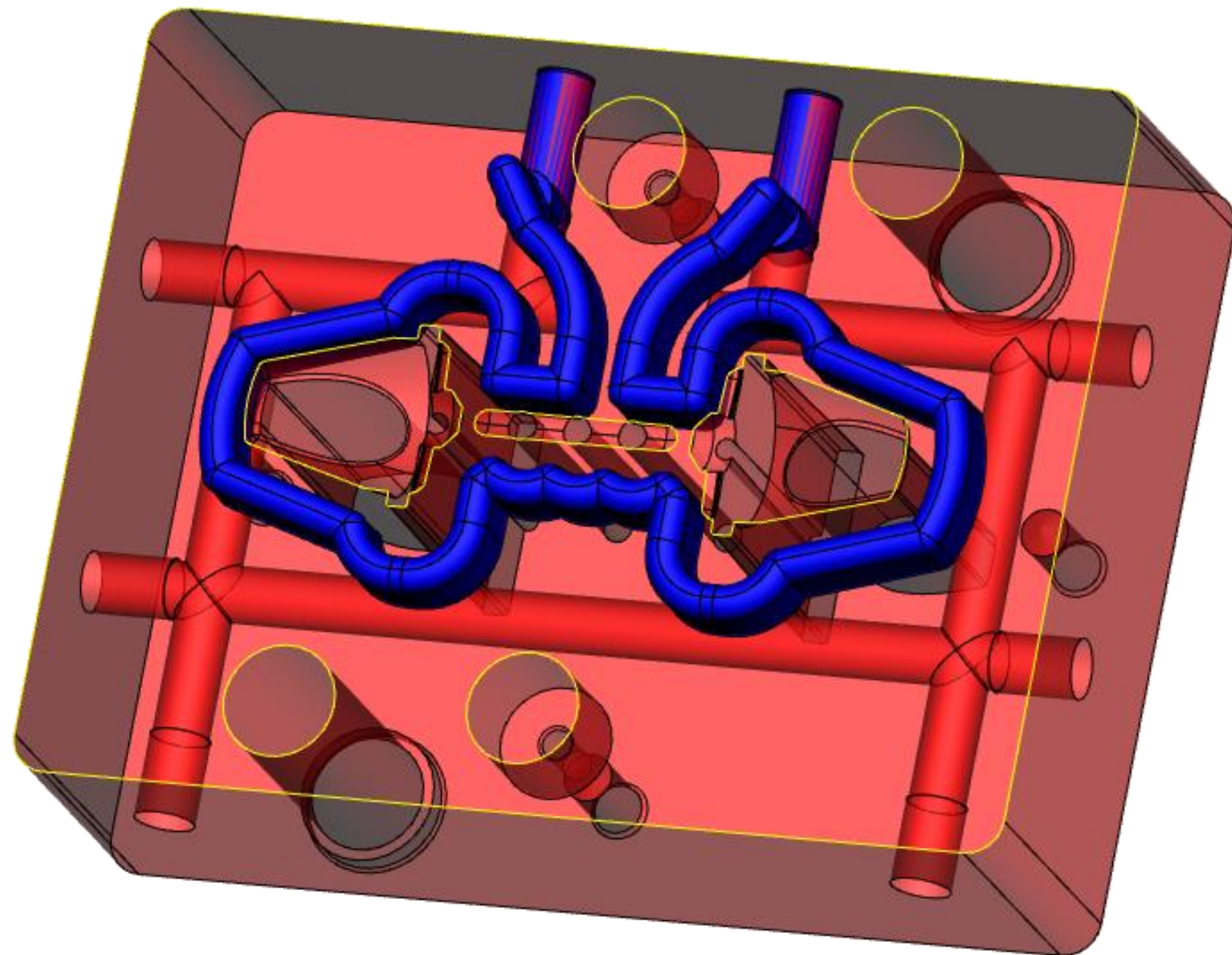
257
8
146

APPLICATION EXAMPLE

Cycle Time optimization
of a thick wall part

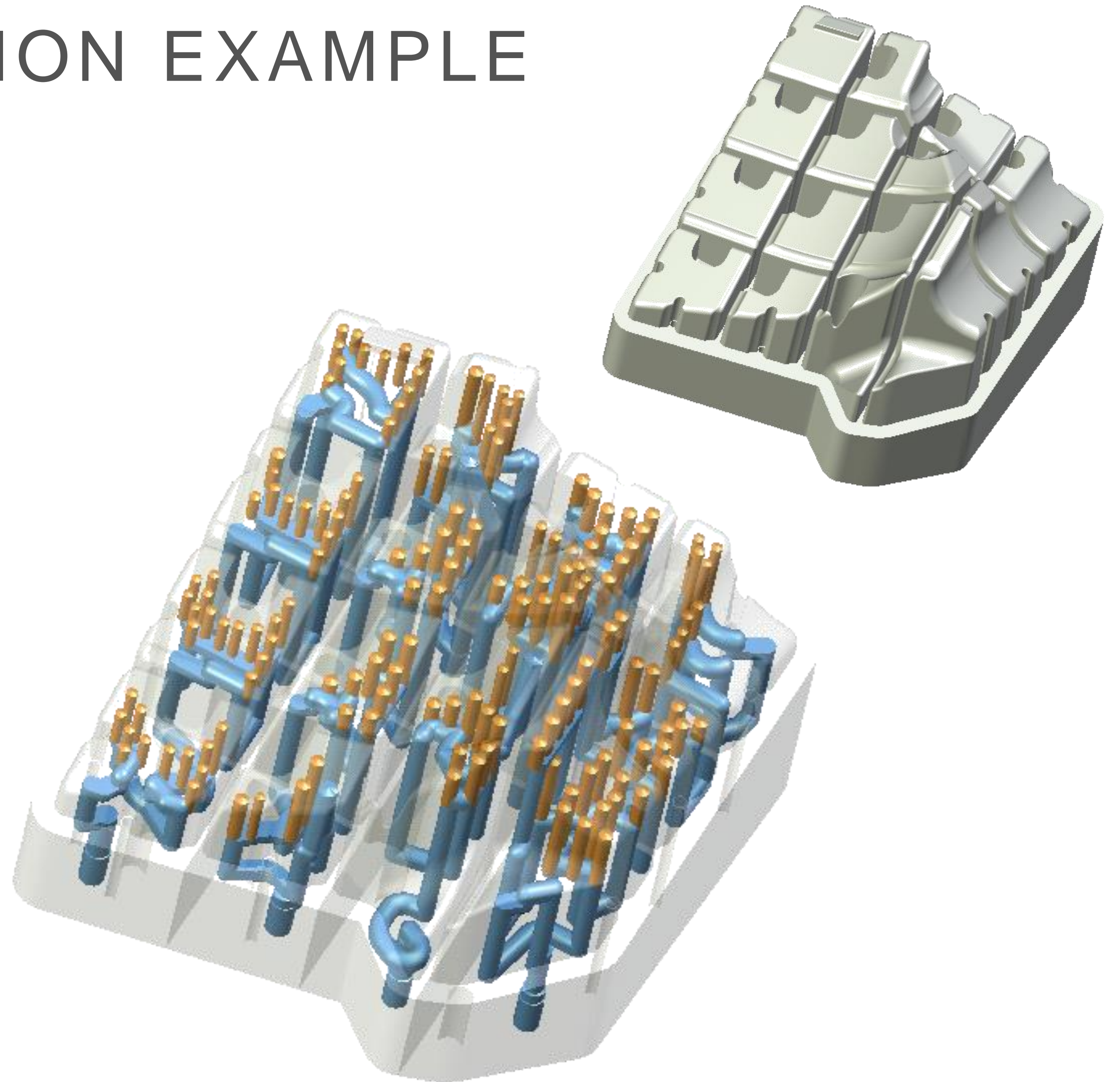
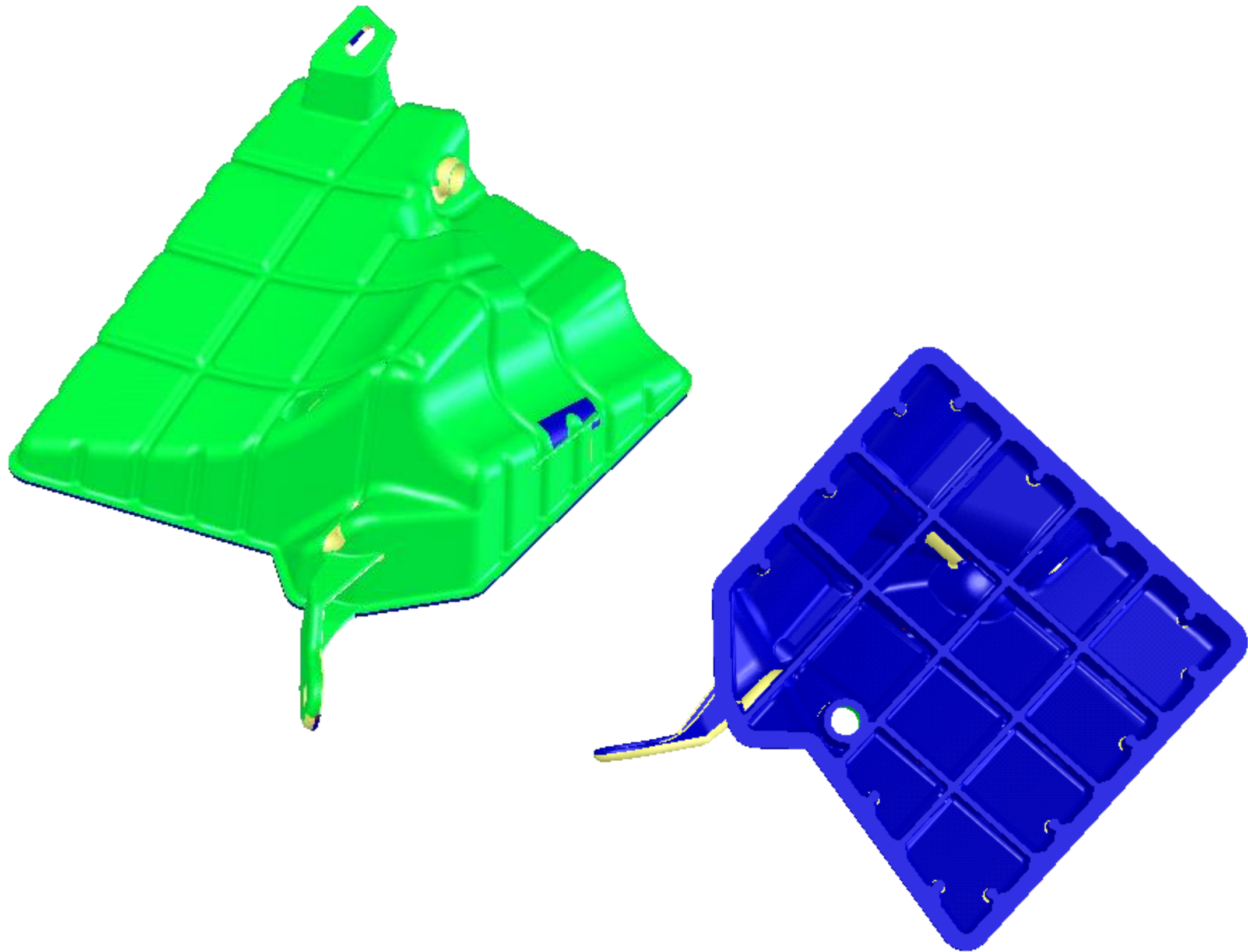
33%

Saving



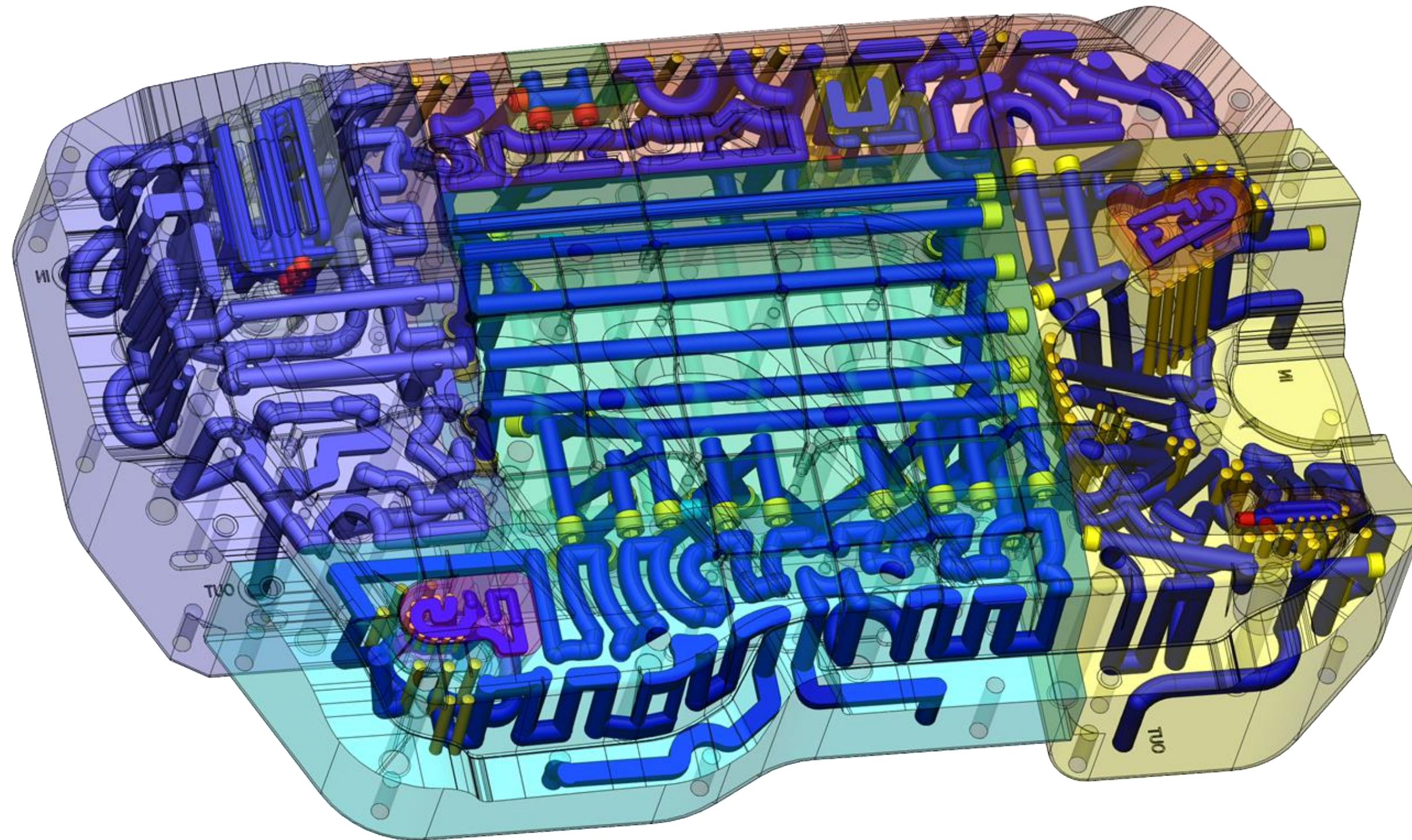
APPLICATION EXAMPLE

Cycle Time optimization
of a Automotive Water Tank



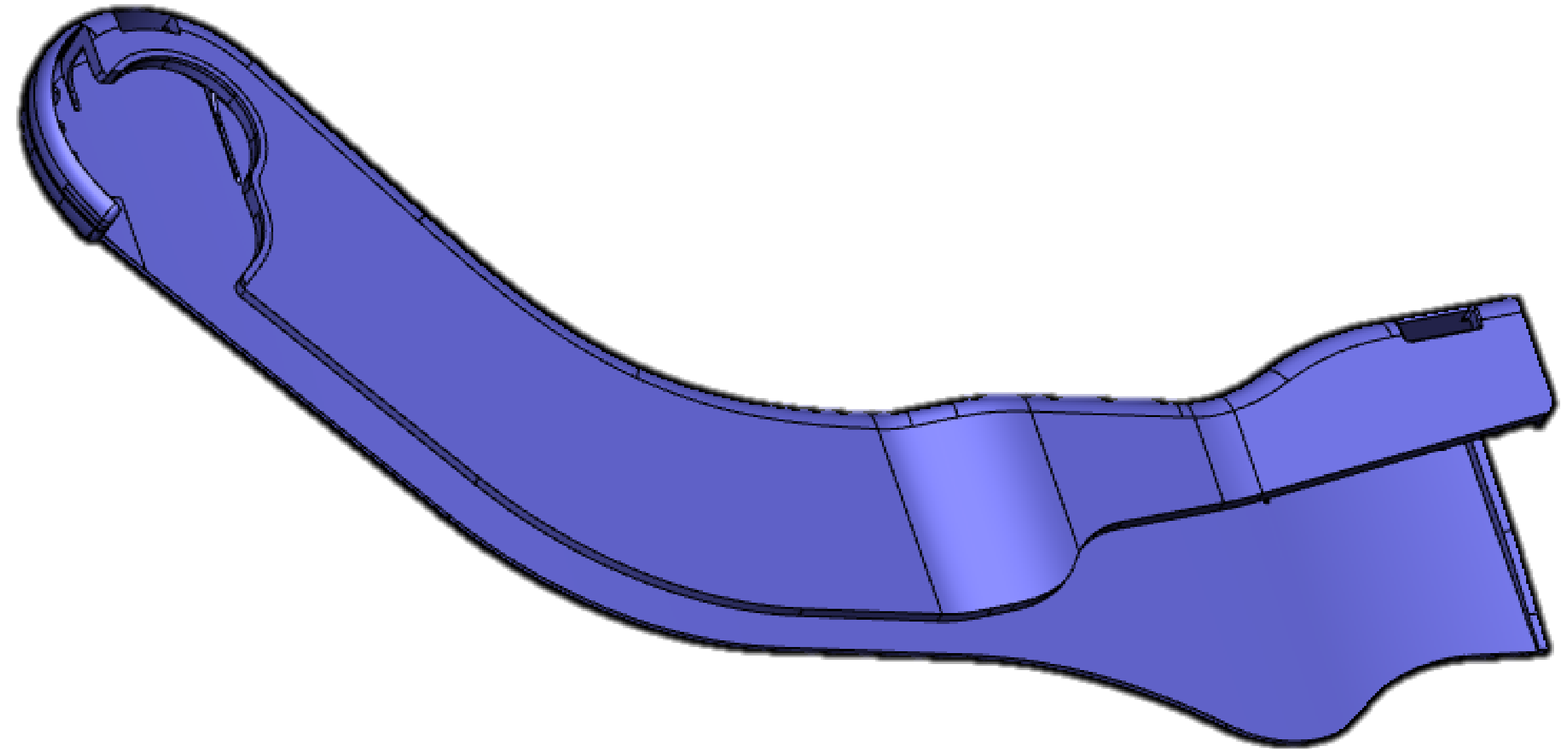
APPLICATION EXAMPLE

Cycle Time optimization
of an Automotive Engine Cover



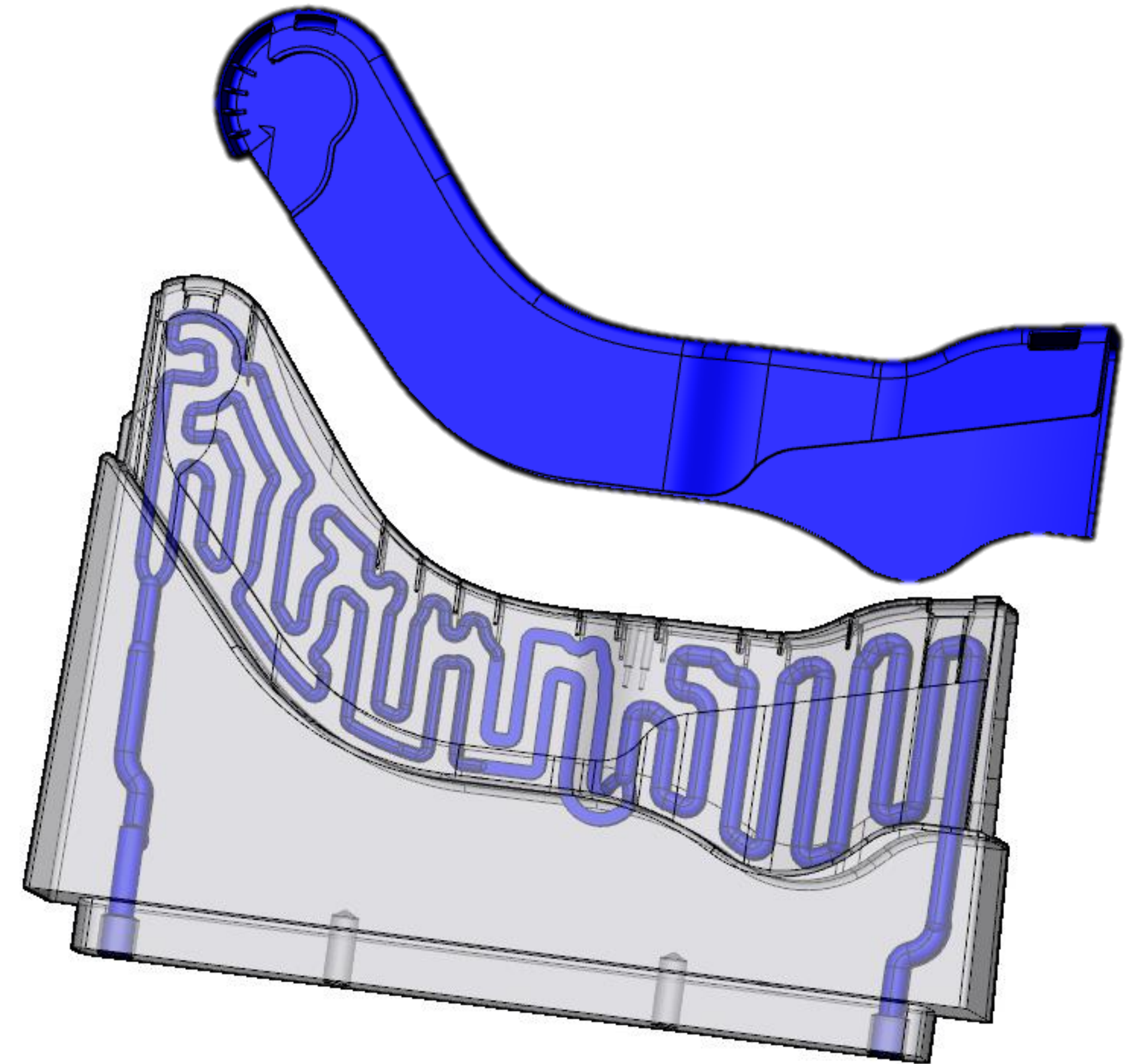
APPLICATION EXAMPLE

Warping & Cycle time optimization
of a Seat Cover



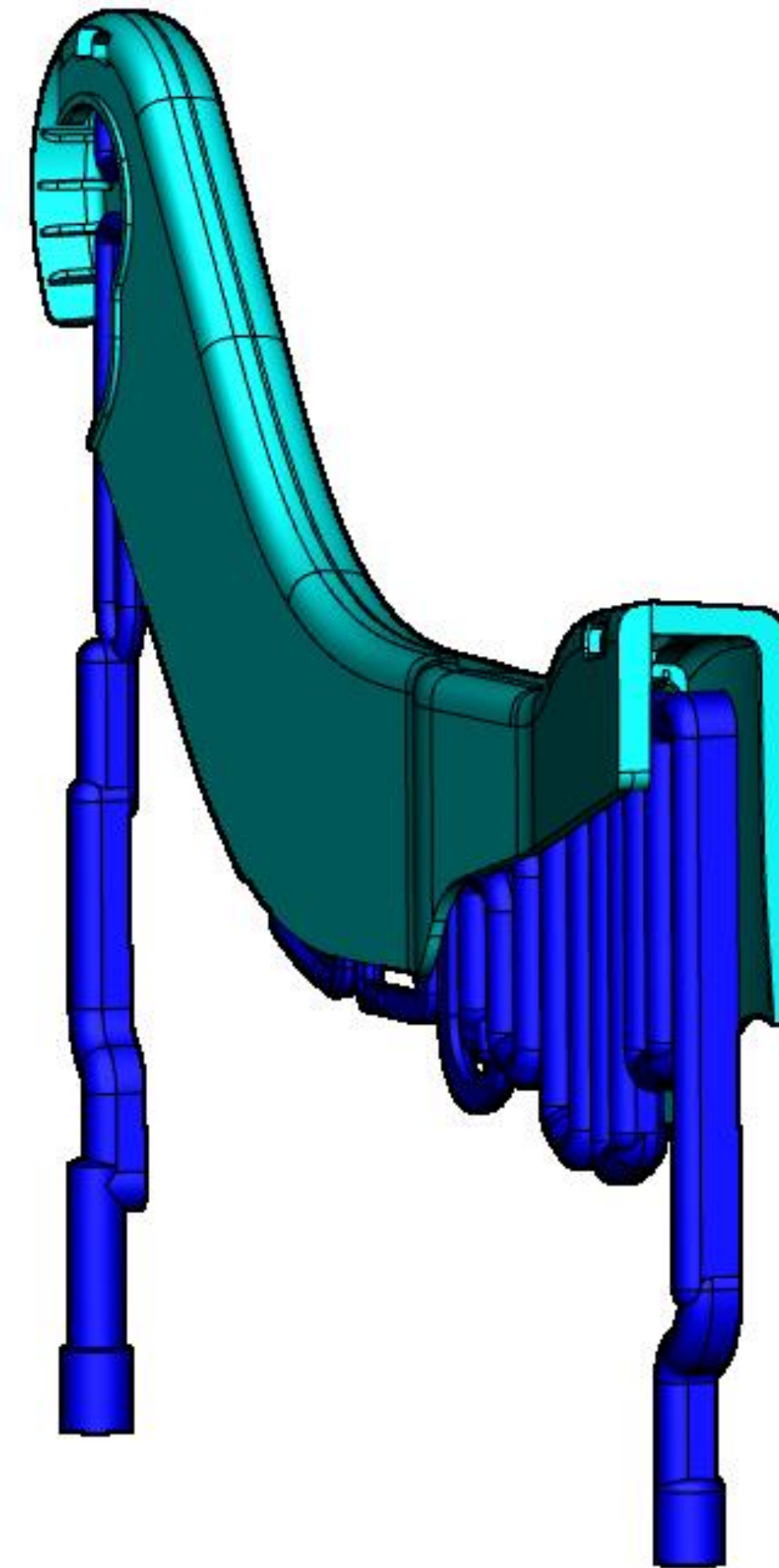
APPLICATION EXAMPLE

Warping & Cycle time optimization
of a Seat Cover



APPLICATION EXAMPLE

Warping & Cycle time optimization
of a Seat Cover



ROI calculation tool (Input / Eingabe)

General information / Allg. Informationen

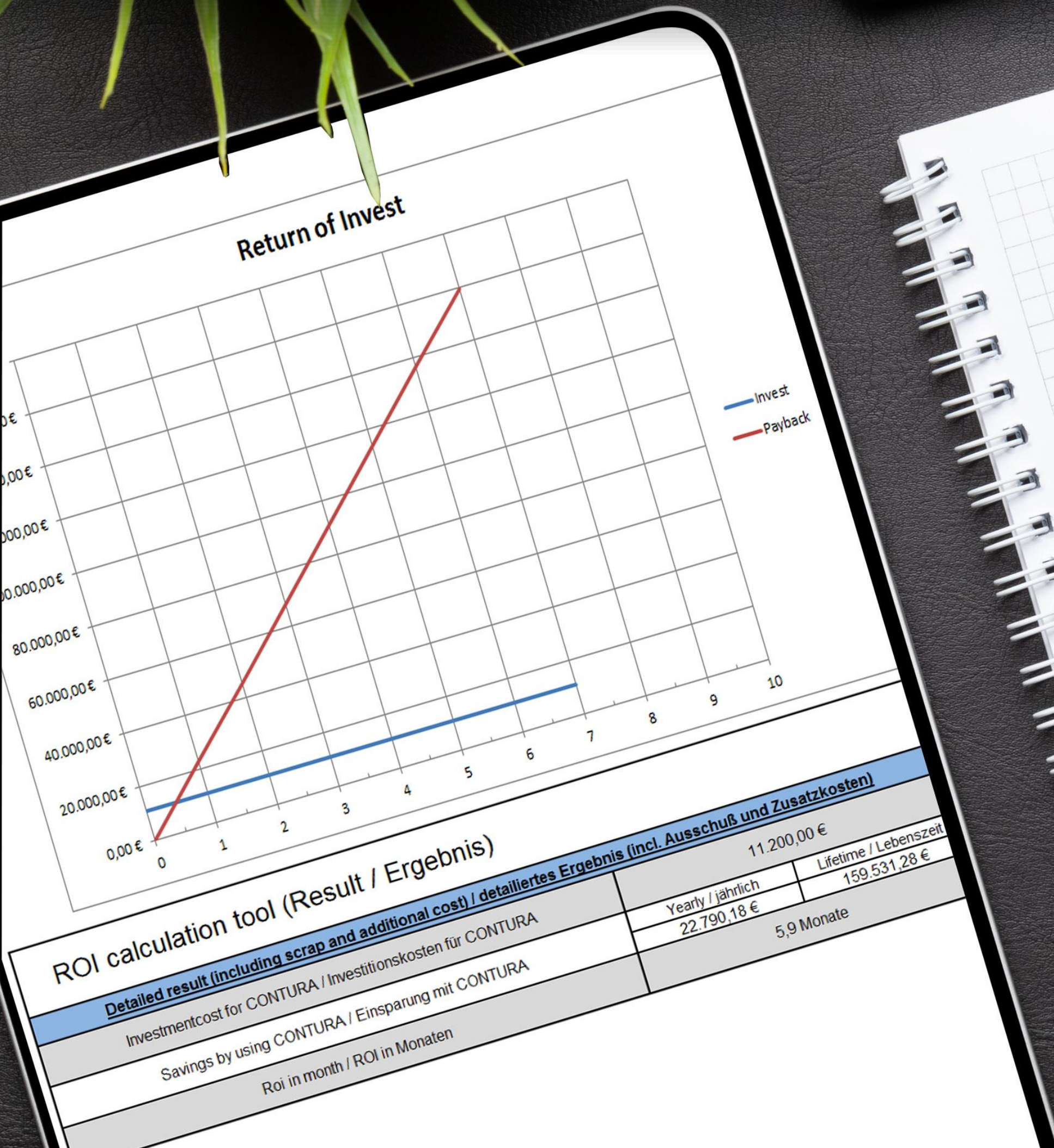
Yearly production volume / Jahresstückzahl	300.000
Machine hourly rate / Maschinenstundensatz	65,00 €
Additional process cost/ Zusatzausrüstung Maschine	0,00 €
Additional cost for CONTURA / Zusatzkosten für CONTURA	11.200,00 €
Savings for Toolmaker / Einsparung Werkzeugmacher	0,00 €
Cost for finishing (for Modification) / Fertigbearbeitungskosten (bei Umrüstung)	7
Tool lifetime / Laufzeit in Jahren	4
Numbers of cavities / Anzahl Kavitäten	8,00%
Actual scrap rate / aktuelle Ausschußrate	3,00%
Expected scrap rate / erwartete Ausschußrate	0,00 €
actual finishing cost per part / aktuelle Veredelungskosten pro Teil	0,00 €
Expected finishing cost per part / erwartete Veredelungskosten pro Teil	43 g
Shot weight per part in g / Schussgewicht pro Teil in g	0,80 €
Material price per Kg / Materialpreis pro Kg	

Process information / Prozessinformationen

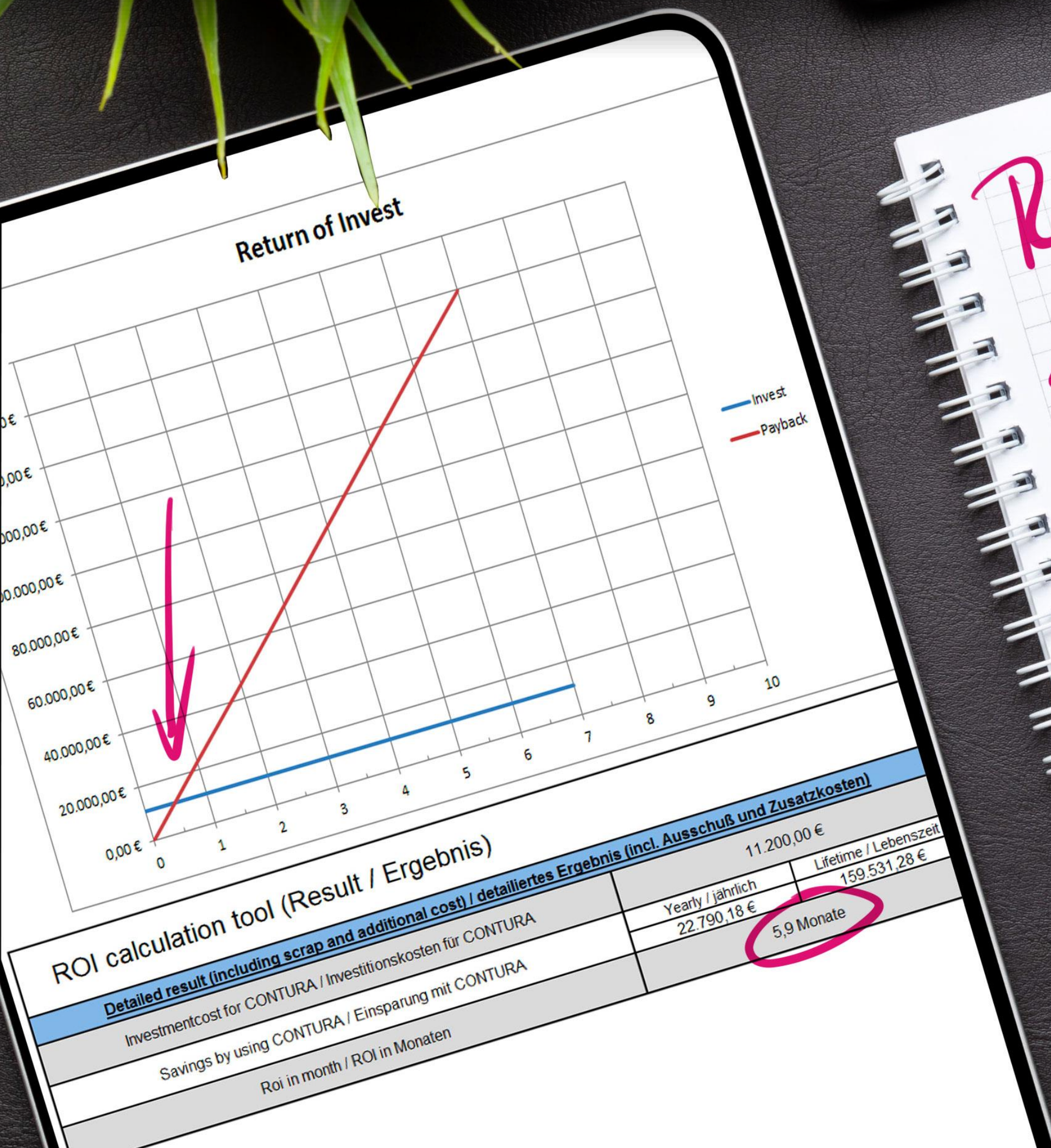
Actual total cooling time / aktuelle Gesamtkühlzeit	27,00 s
Expected total cooling time / erwartete Gesamtkühlzeit	13,00 s
Auxiliary time / Nebenzeit	9,00 s

Cooling Time -14 sec.
(-48%)

PROFITABILITY OF CONFORMAL COOLING



PROFITABILITY OF CONFORMAL COOLING



Return of Invest
< 6 months
 Savings over lifetime:
~160.000 €



THE VARIOOTHERMAL PROCESS

THE VARIOOTHERMAL PROCESS

- **Before Injection**

→ *Heating up the cavity*

- **After volumetric filling**

→ *Switch to cooling*

- **After freeze off**

→ *eject the part and heat up the cavity again*

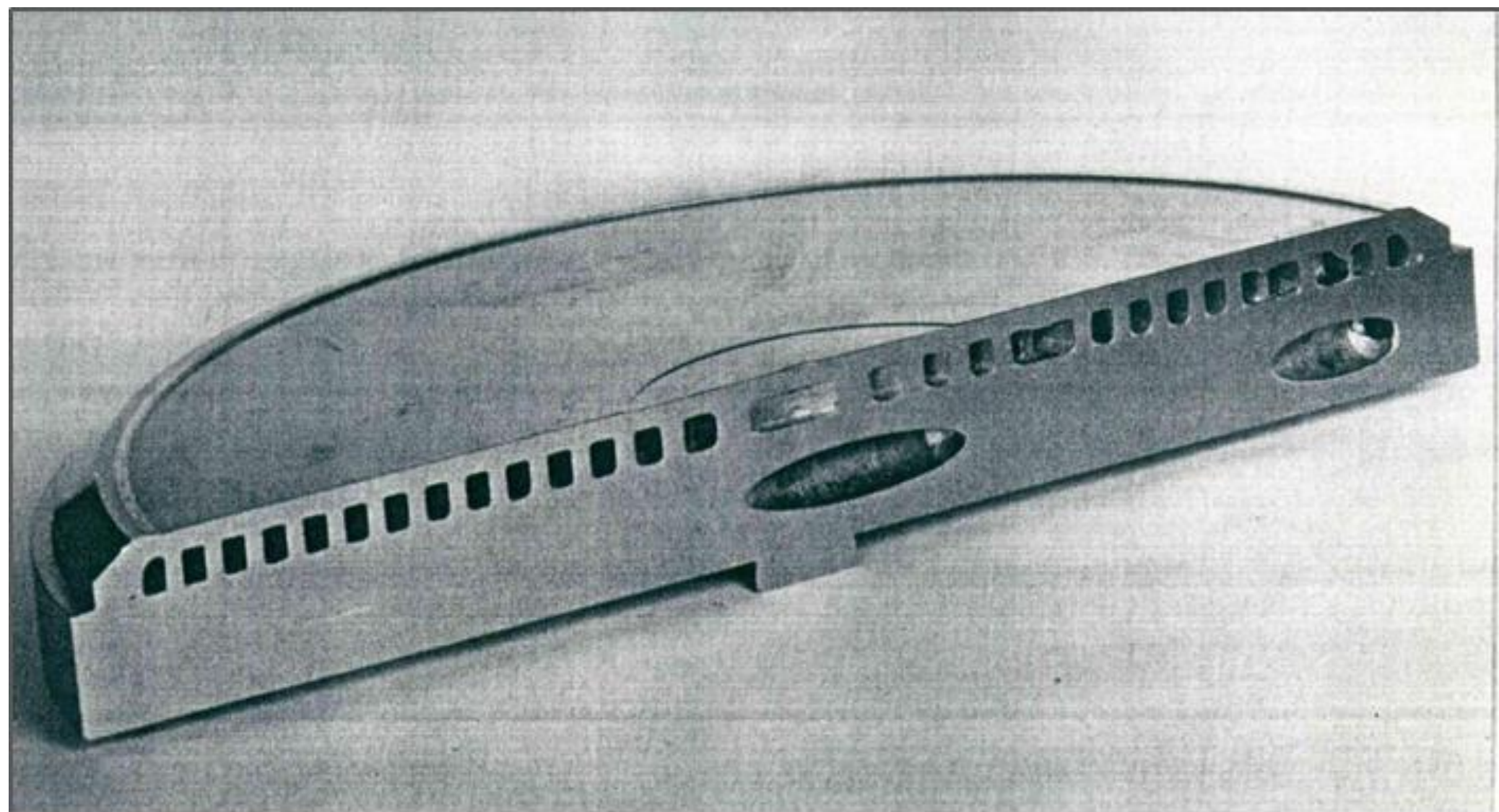
REASONS FOR VARIOOTHERMAL PROCESSING

A higher mold surface temperature ends in:

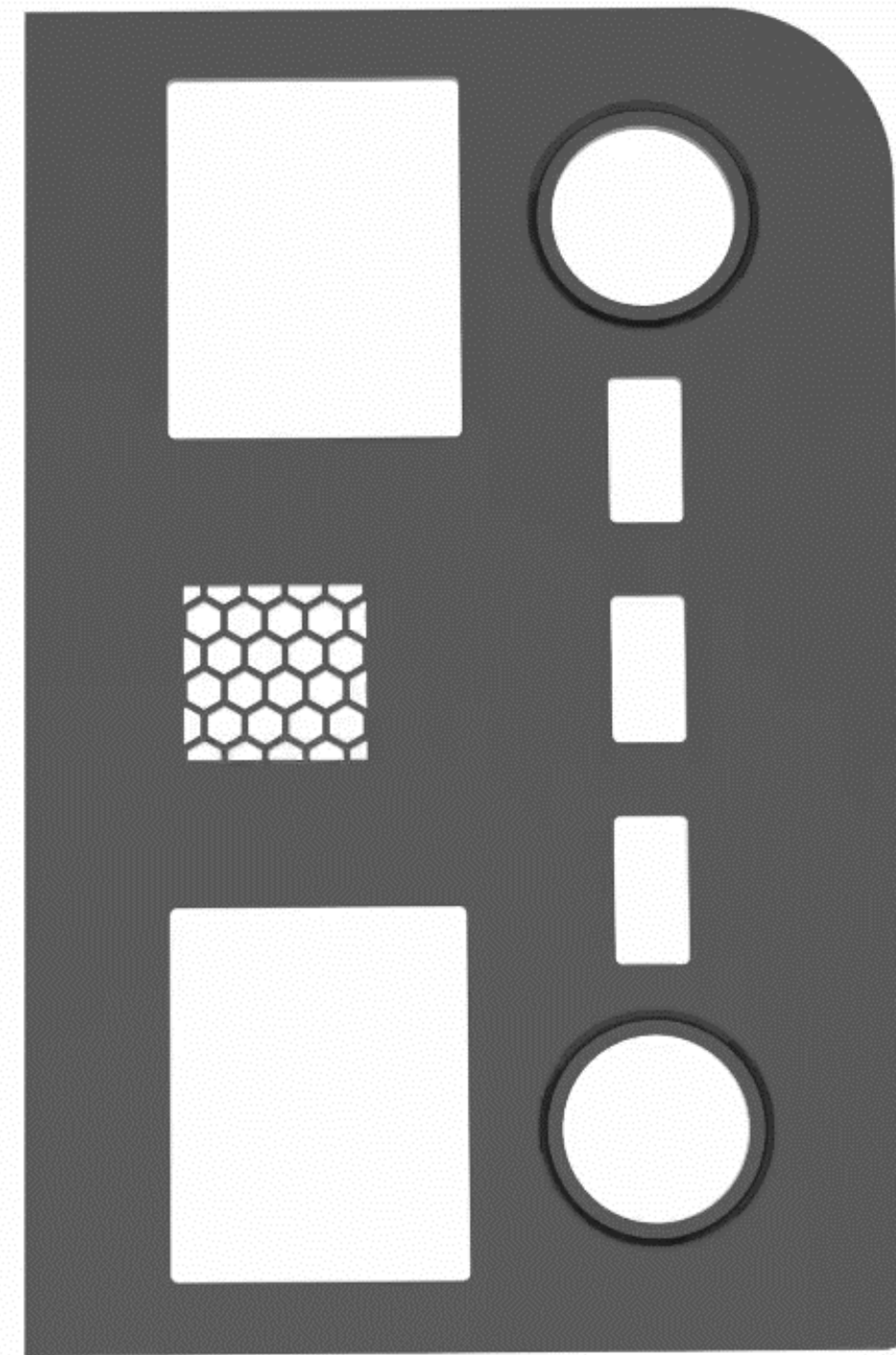
- Less visible flowlines and silver streak
- More homogeneity of the distribution of glass fibers
- Less visible weldlines
- Less risk of warpage caused by shrinkage
- Better stability
- Better mechanical properties
- Less sinkmarks

History of Variotherm Technology:

Already in 1969 Peter Schmetz started to build PVC record press molds with conformal cooling. These were run variotherm with a steam heating and cold water cooling ! Cycle time was 15 seconds. 5000 cycles/day!

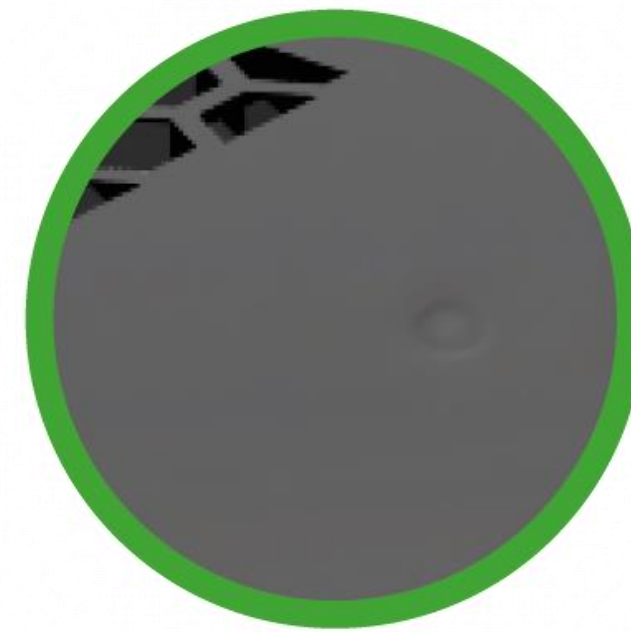


APPLICATION EXAMPLE



APPLICATION EXAMPLE

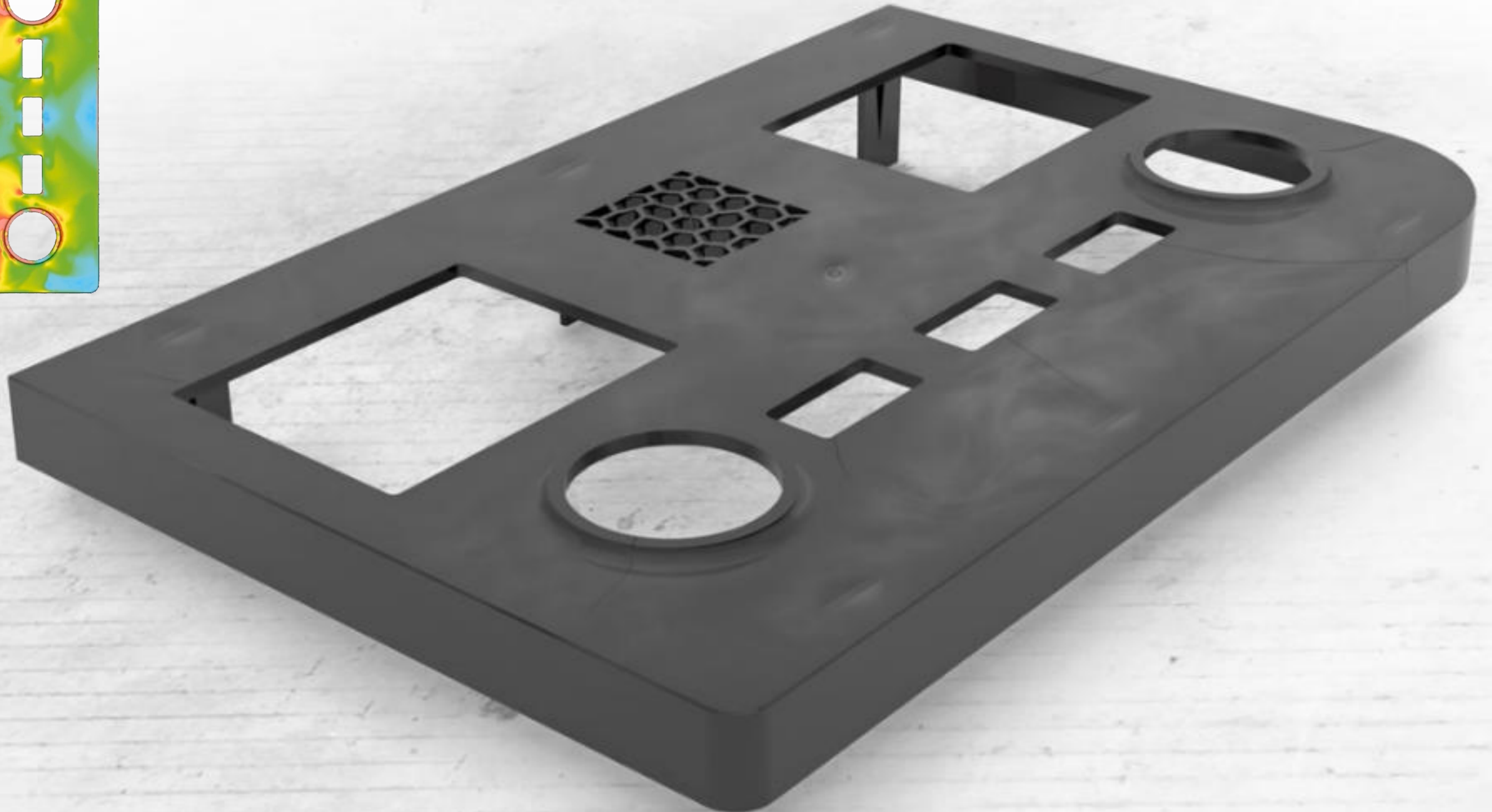
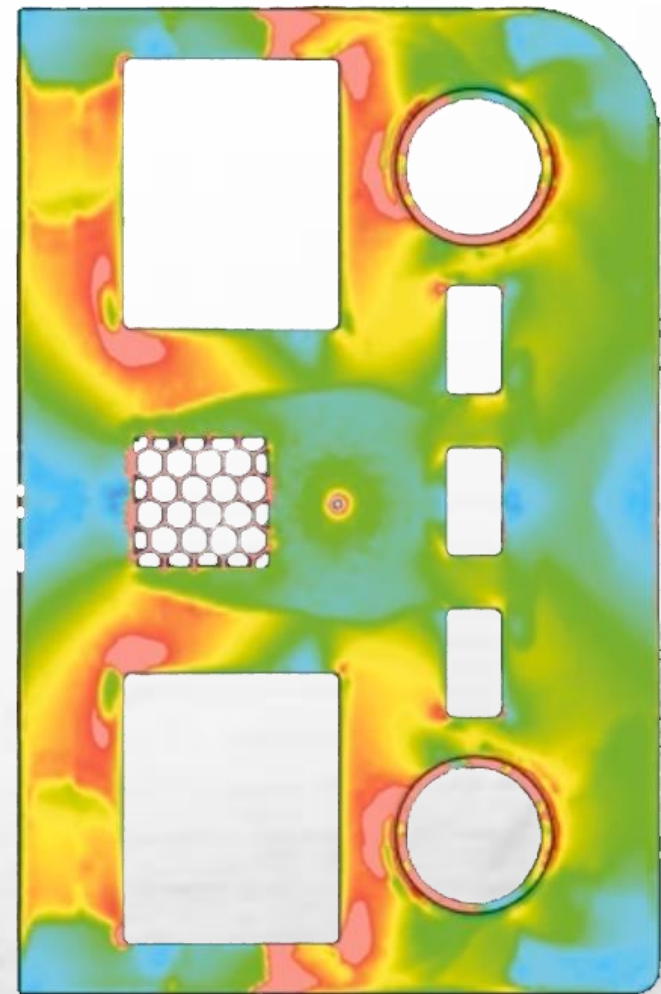
Influence of variothermal molding



Clean Gate
Point

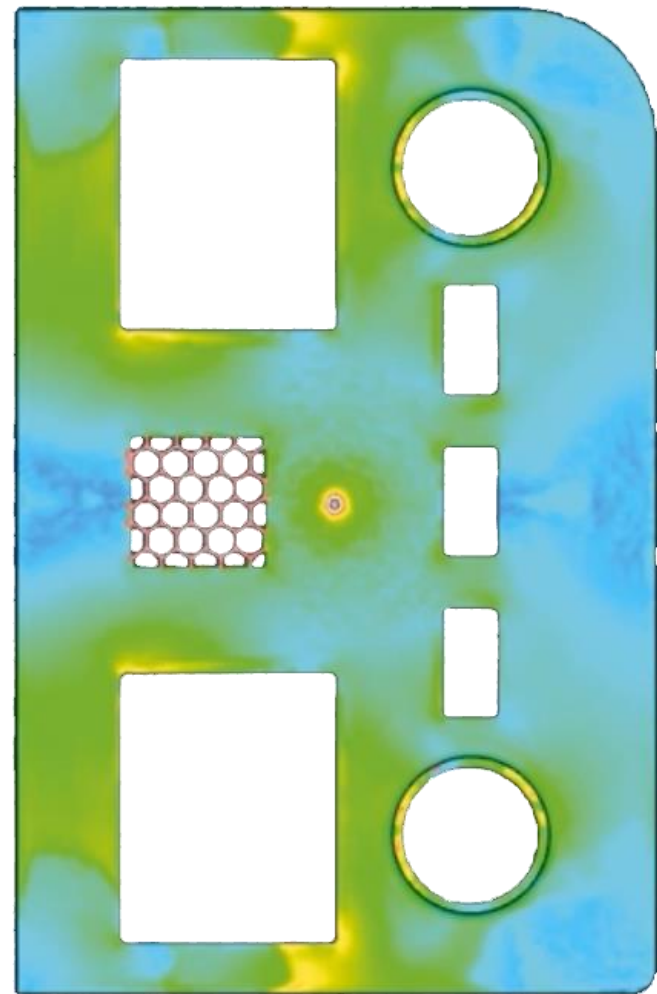
APPLICATION EXAMPLE

Influence of variothermal molding



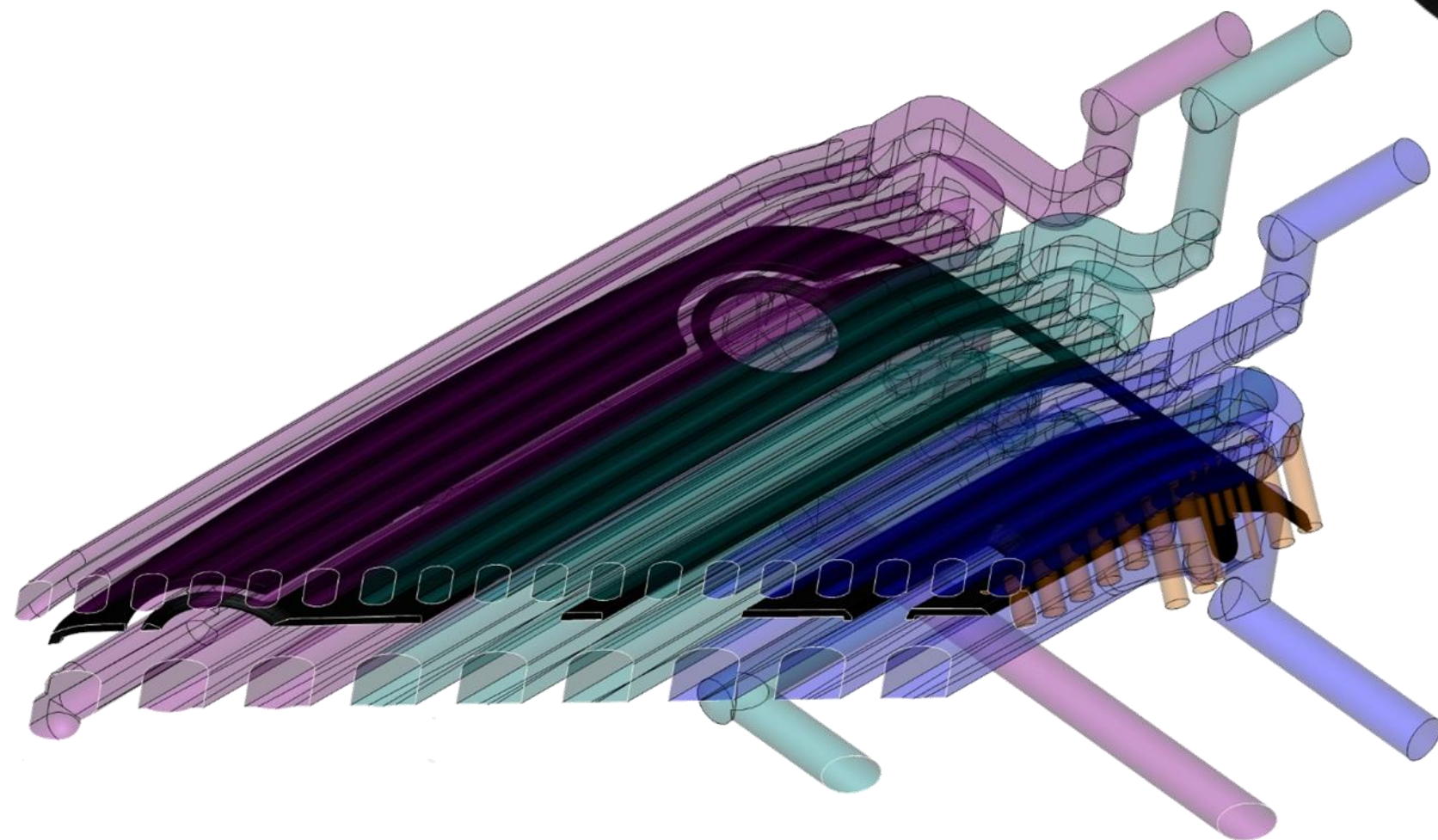
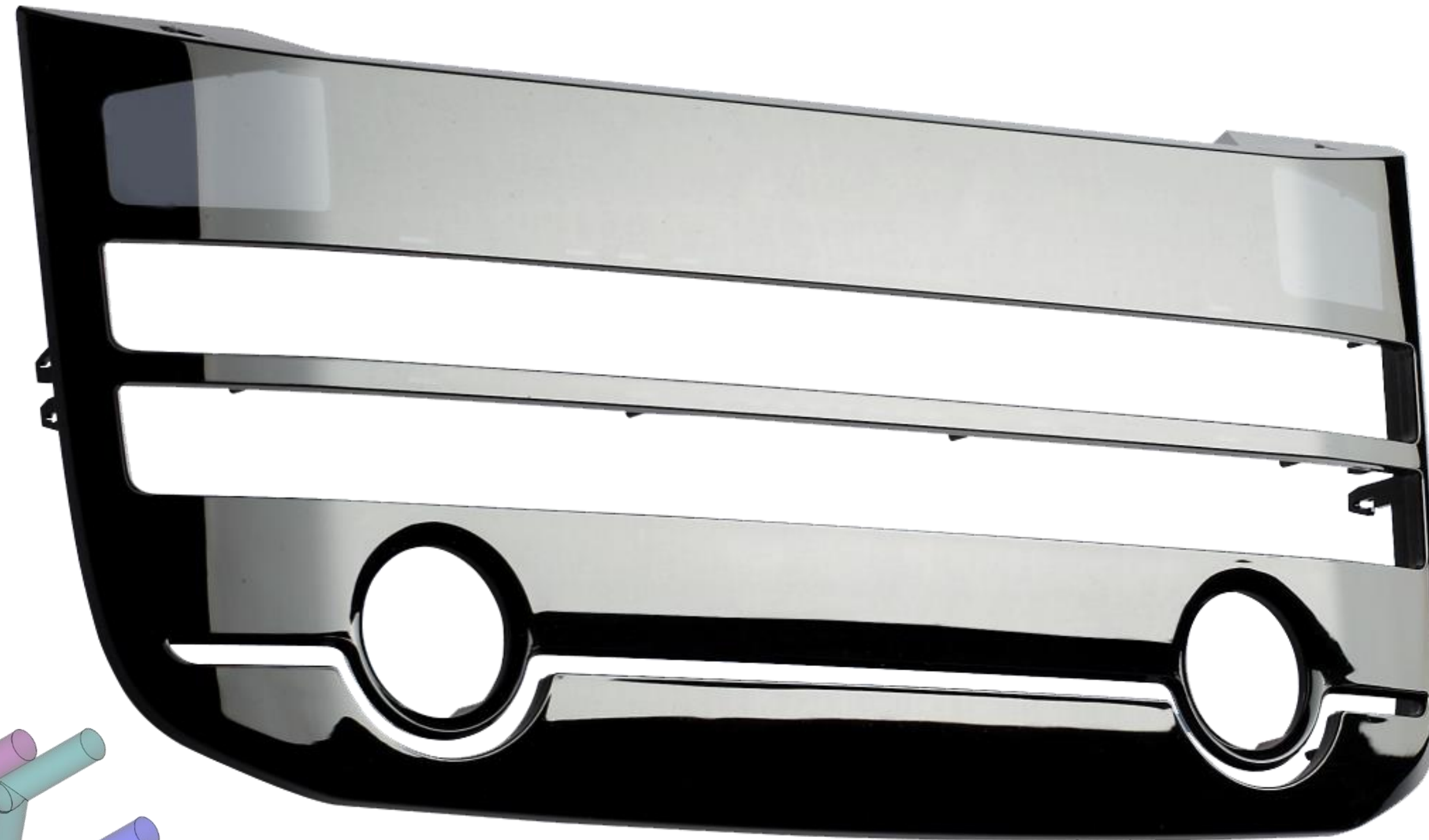
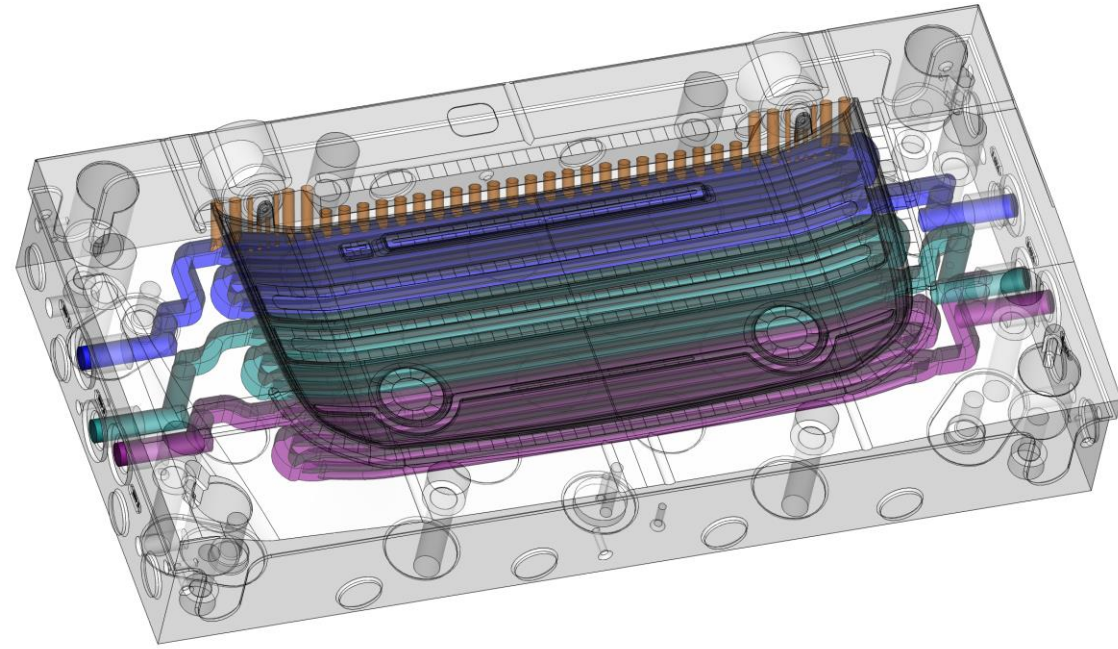
APPLICATION EXAMPLE

Influence of variothermal molding



MORE APPLICATION EXAMPLE

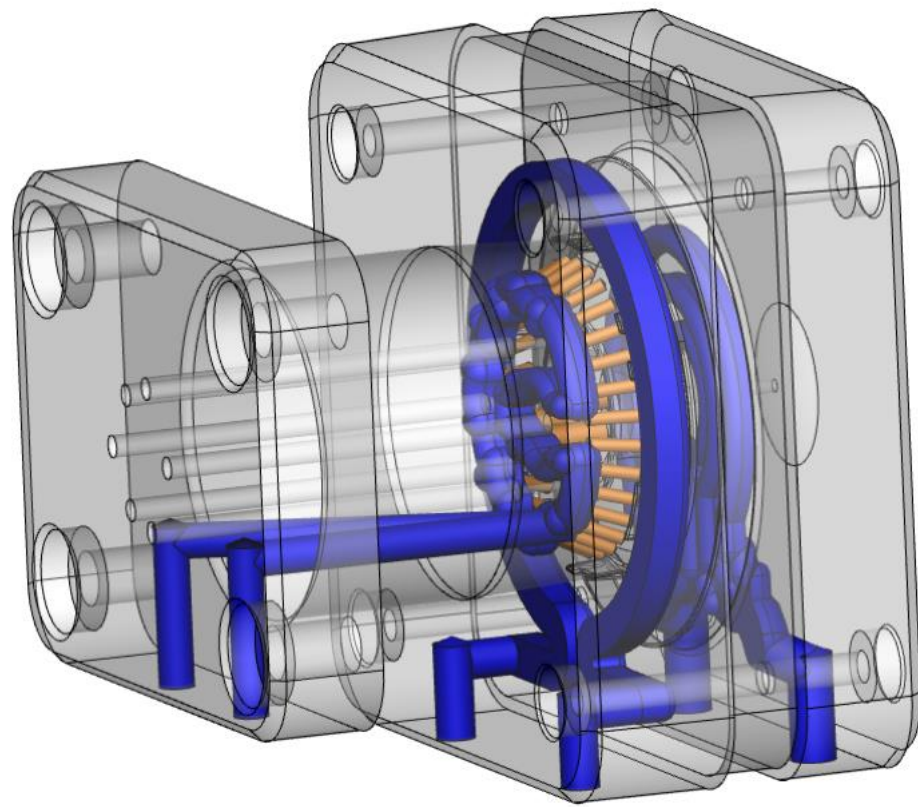
APPLICATION EXAMPLE



RESULT:

- Reduction of cycle time by 23%
- Weldline free plastic part
- Less Warp

APPLICATION EXAMPLE



RESULTS:

- Reduction of cycle time by 49%
- Cycletime from 186 sec to 95 sec
- Reduction of the scrap rate by 11%

**BOOST
YOUR
PROCESS!**



 **CONTURA**

www.contura-mtc.de



THANK YOU FOR YOUR
ATTENTION!