INNOVATION PLASTURGIE COMPOSITES

TRANSLATION CASE: OPTIMAL COOLING SYSTEM DESIGN FOR INJECTION MOLDING PROCESS

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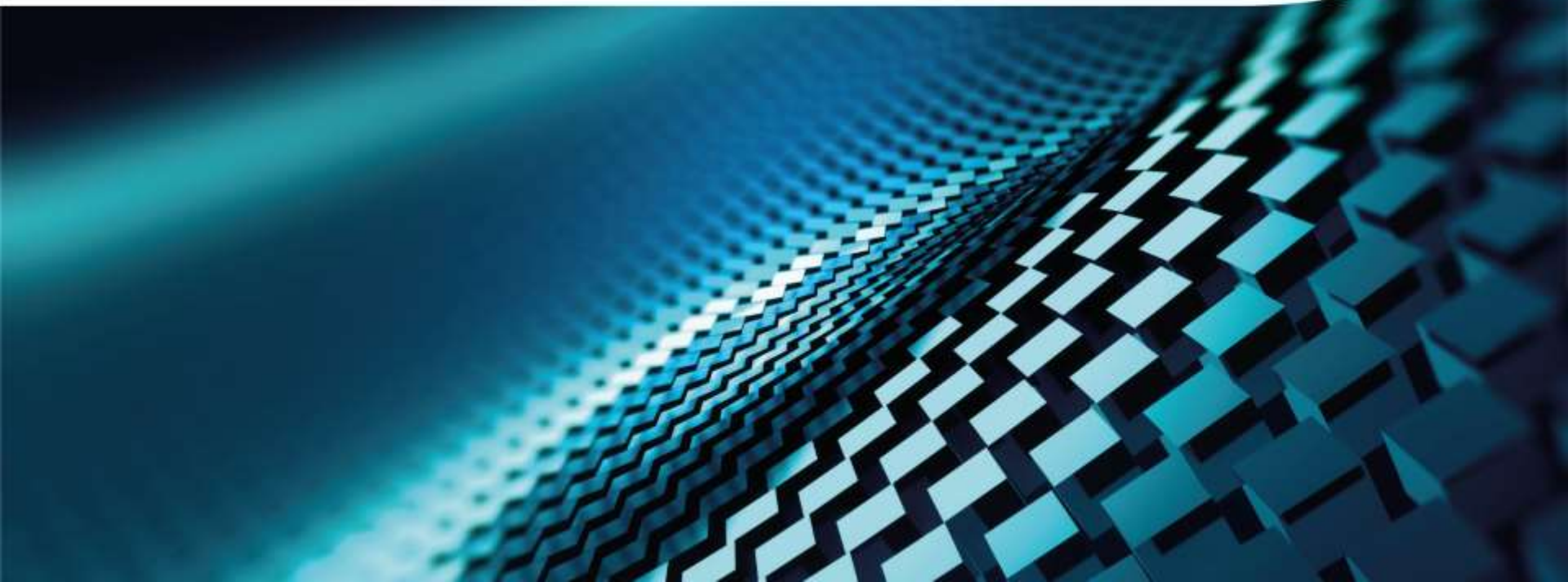
IPC AT A GLANCE



INNOVATION PLASTURGIE COMPOSITES

IPC is an Industrial Technical Centre whose expertise is dedicated to innovation in plastics and composites in France. Since 2016, the profession has new means to support all companies, especially micro-enterprises and SME, regardless of the process used, thanks to a contribution established to finance R&D, innovation, technology transfer and skills.

OUR GOAL :

To improve the **competitiveness of our national industry** through **innovation** and the supply of **technological means** for **participating** industrial beneficiaries.

EXPERTISE RESEARCH & DEVELOPMENT

Our activities

- R&D
- Services
- Collective actions
- Training

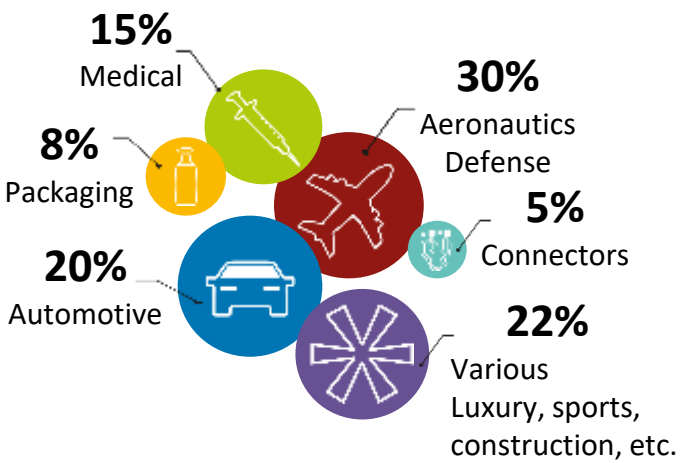
Our competencies

- Materials
- Design & simulation
- Processes & tools
- Smart Hybrids
- Recycling

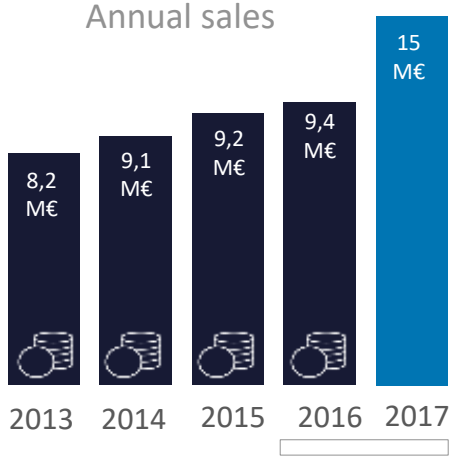
INNOVATION PLASTURGIE COMPOSITES

130 employees (researchers, engineers, technicians): multi-competencies teams

Market share



Annual sales



Services for companies / Private R&D

40 %

Research & Development
(R&D : collectives actions & collaborative projects)

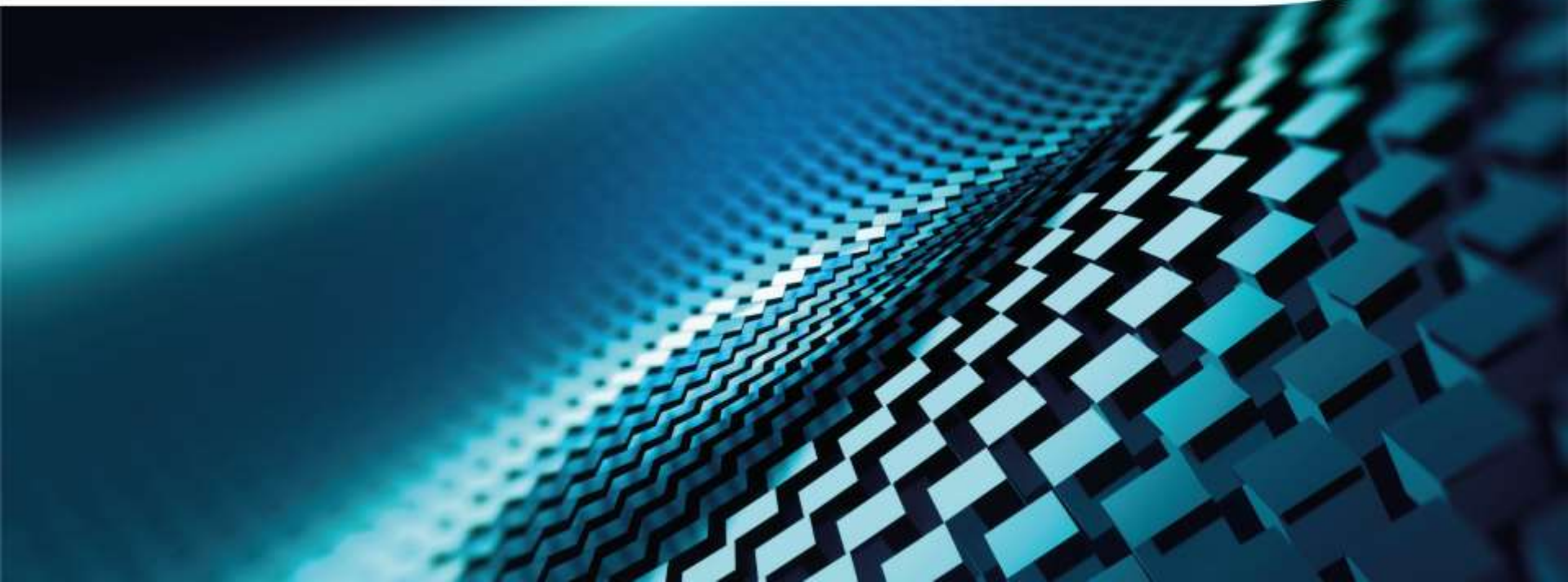
60 %

CIR
Approved Credit research tax (CIR)

SGS
Certified ISO 9001

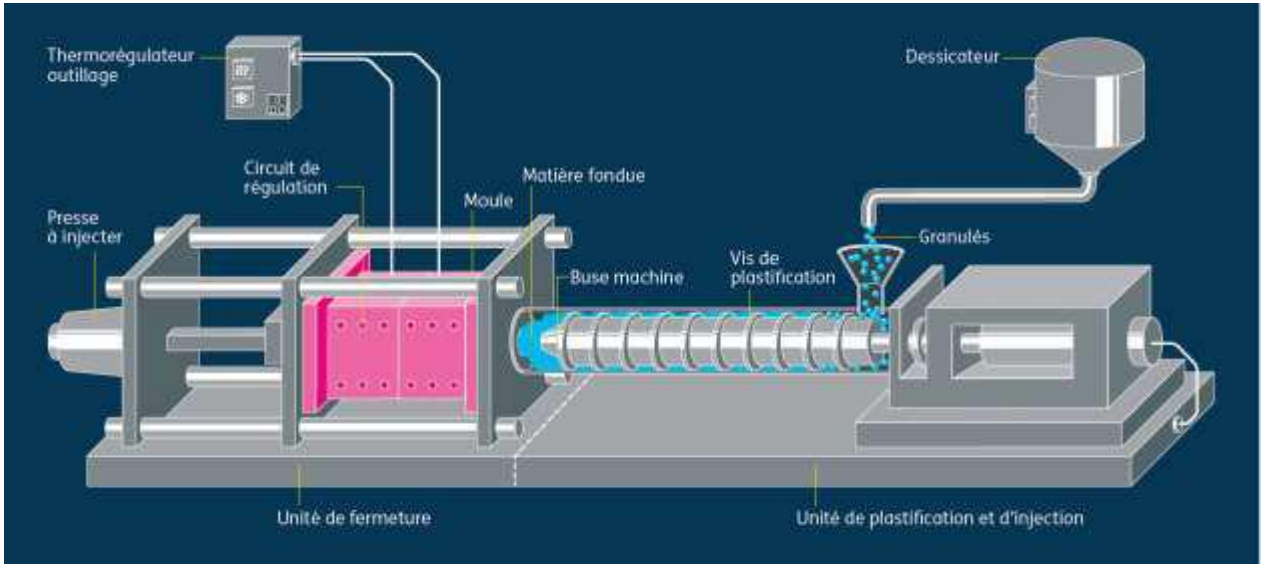
IPC is labeled Institut Carnot, a guarantee of excellence in partnership research

TRANSLATION CASE
CONTEXT



Injection Mold

- Injection molding



- Bottlenecks
  - Business : Mold delay and cost
  - Technical :
    - Mechanical resistance due to injection pressure
    - Part quality mostly due plastic cooling conditions and fiber orientation
    - Cycle time is related to solidification time

Translation Steps

1) Good understanding of the business case

2) Good understanding of the industrial case

3) Analysis of the experimental (and modelling) data available within the client:

PART 1
Business and Technical understandings

4) Translation to (preferably more than one) modelling workflows

PART 2
Modelling Strategy

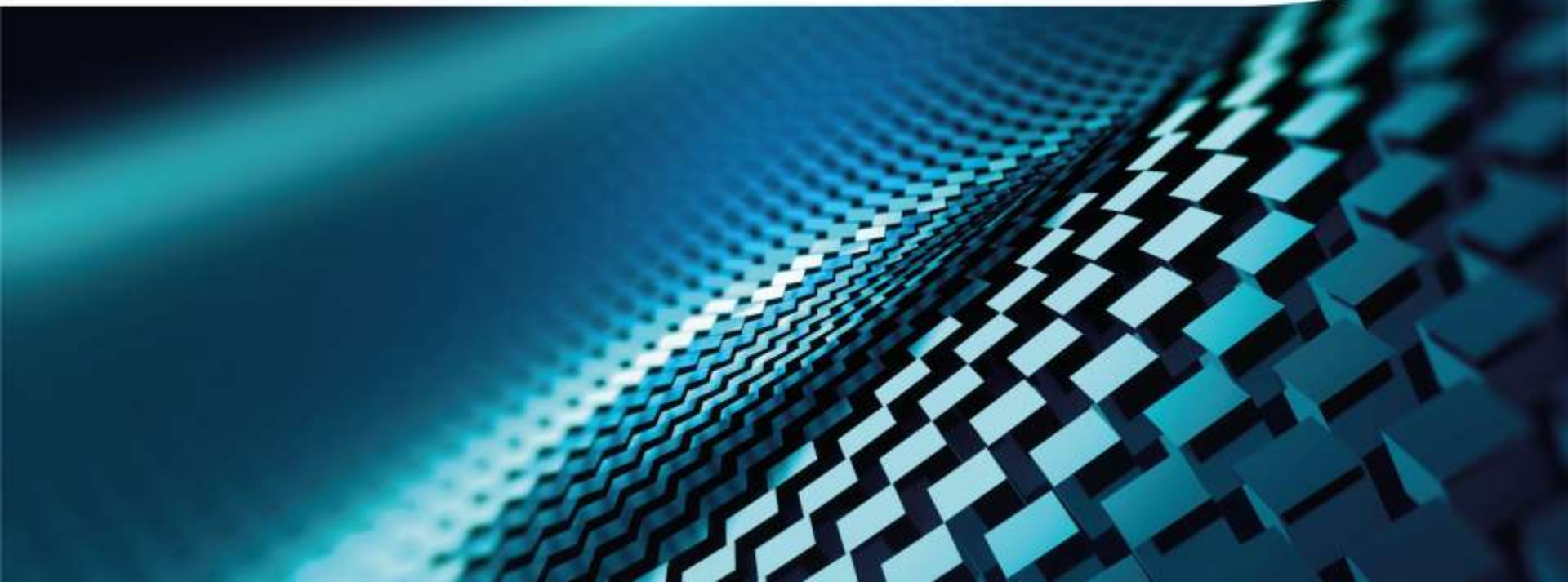
5) Propose to the client modelling executor(s) and strategy for model validation

6) Translation of the modelling results to information that is understandable, reliable and usable by the client

PART 3
Validation and restitution

+ Final ROI

PART 1
BUSINESS AND TECHNICAL UNDERSTANDINGS



Manufacturing Tool for a body actuator

Industrial Needs

- MOPLA is a mold maker and a plastic converter
- Need to design a new version of a body actuator mold.
  - The product is made by injection
  - The actual mold lifetime is over

Body actuator

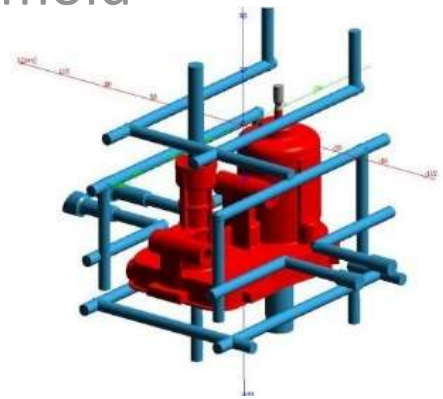
- Want to improve the manufacturing performance of production :
  - by improving quality
  - by increasing productivity

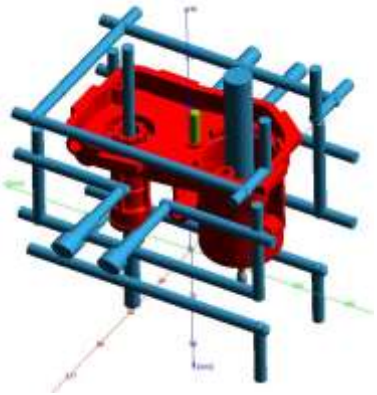
MOPLA came to see IPC for our additive manufacturing facilities and our simulation skills. We proposed to use advanced modelling to optimize the design

Manufacturing Tool for a body actuator

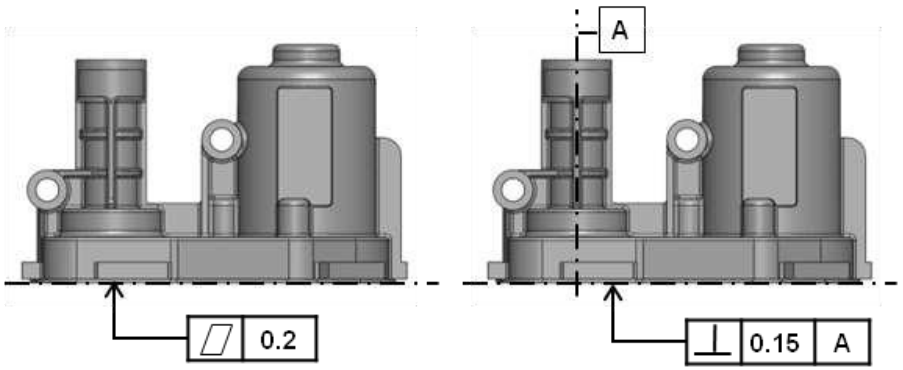
The former mold

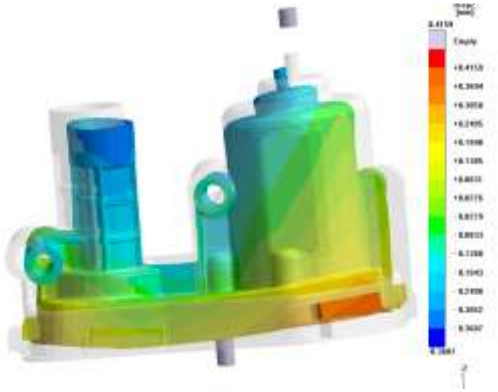
- Design





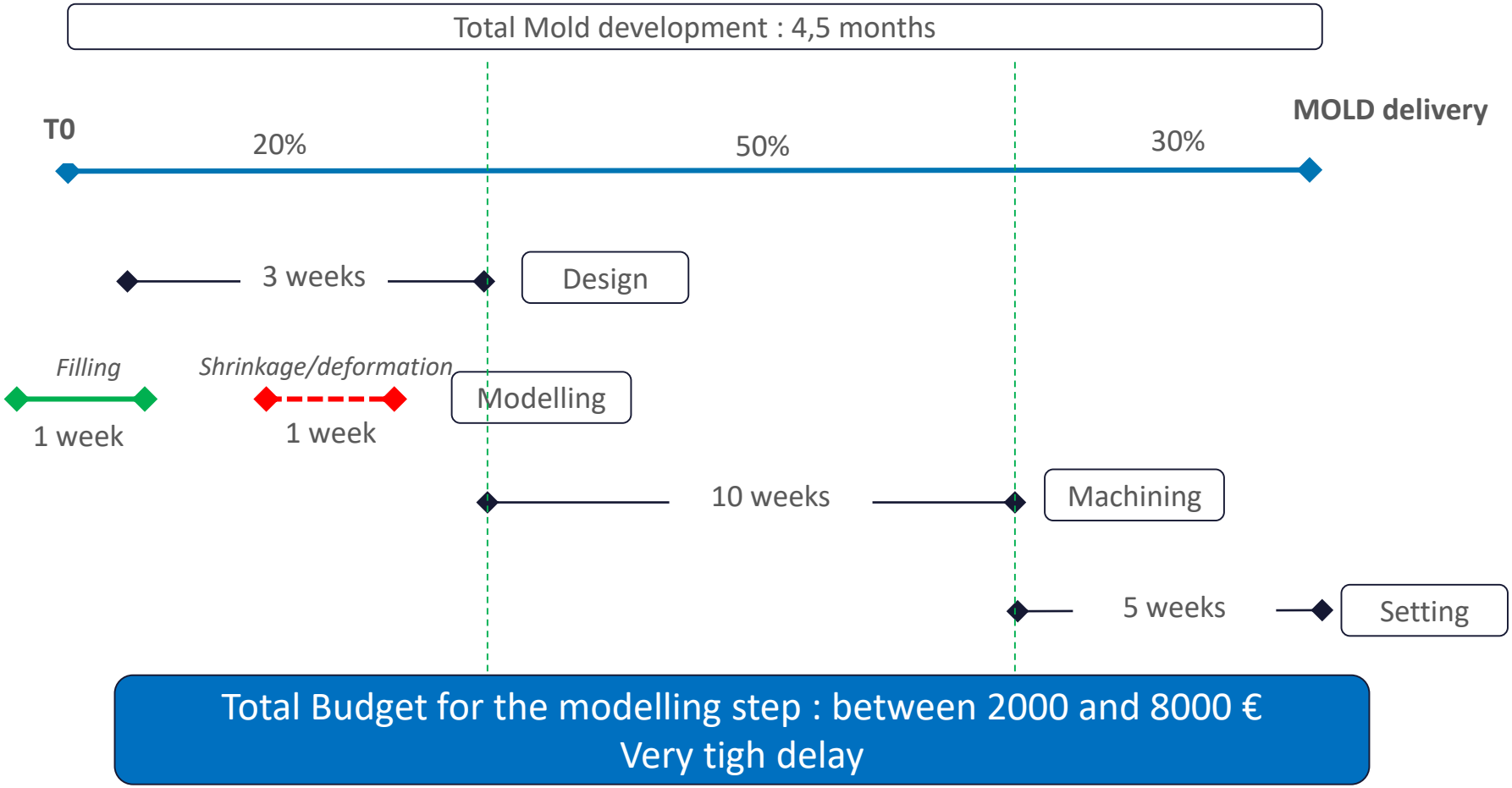
- Difficulty to respect quality specification





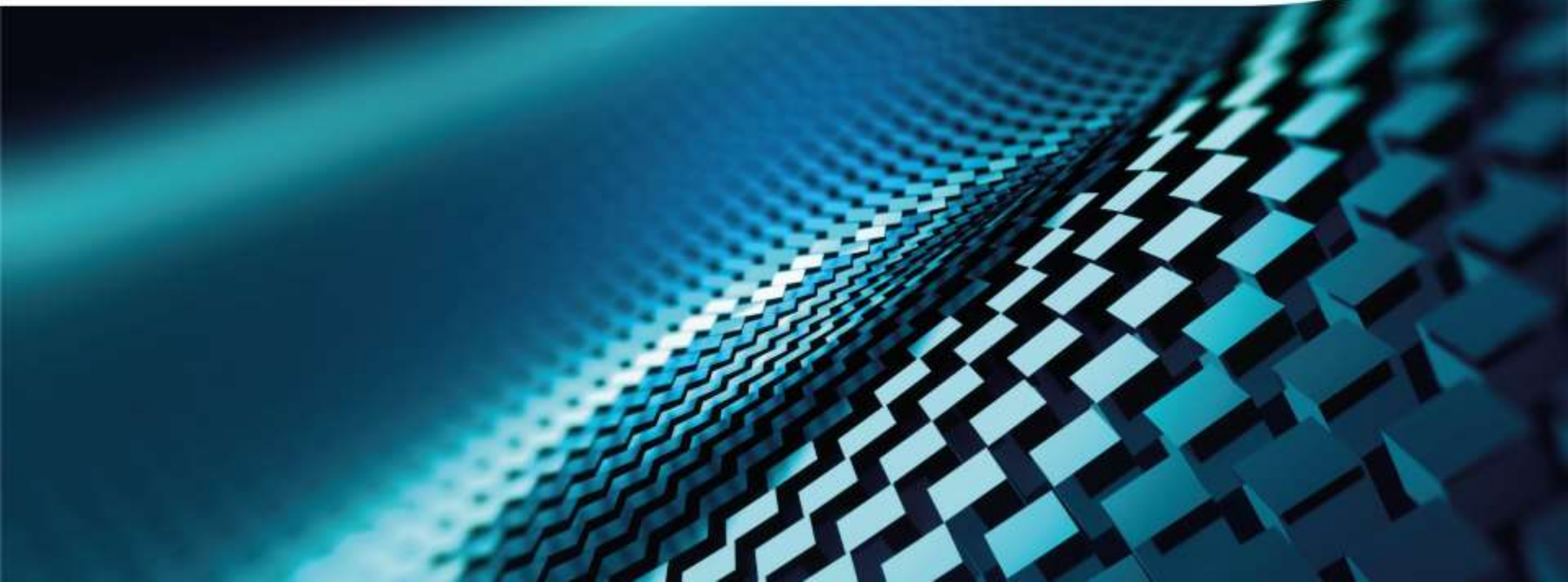
The Time Line

Generic Mold Development workflow

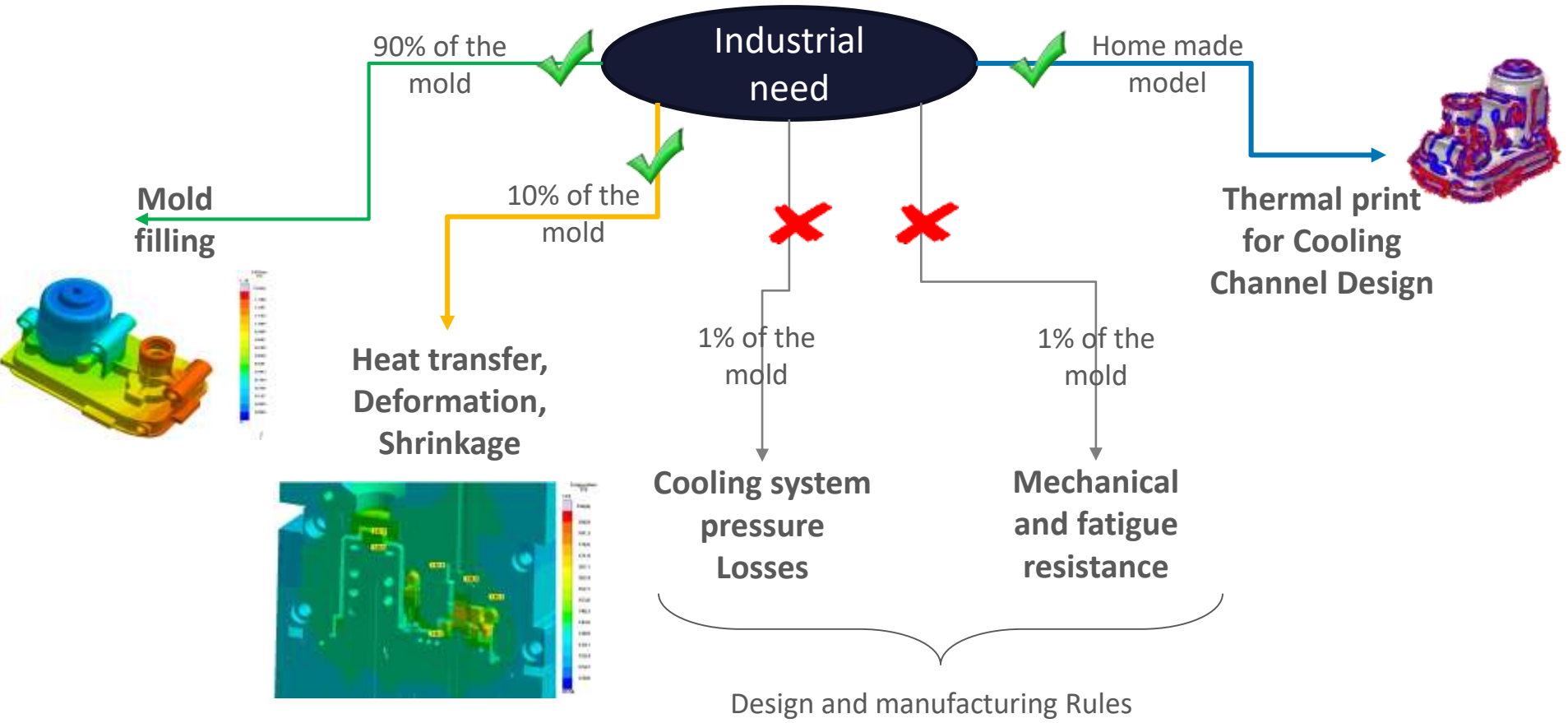


PART 2

MODELLING STRATEGY REGARDING ECONOMICAL BALANCE



Choice of the modelling strategy



Integration into the time line

Actuator Mold Development workflow

Total Mold development : 4,5 months

T0

20%

50%

30%

MOLD delivery

3 weeks — Design

1 week — 2 weeks — Modelling

10 weeks — Machining

3 weeks — Setting

Reduction expected

Budget for the modelling step *(including mold overcost)* : 10 000 € without delay for the design phase

Modelling Workflow

What about Material Characterization ?

- Sometimes material characterization could be a issue (to anticipate in the quotation phase)
- Characterization cost for injection process model : 5000 €

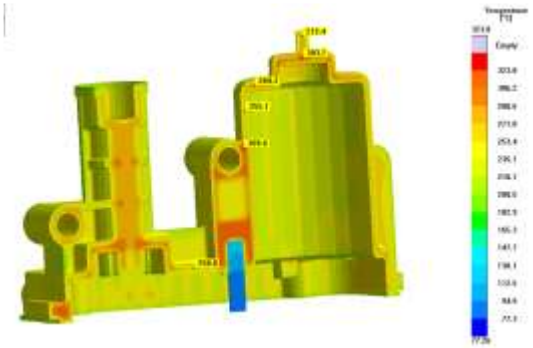
- Our Approach :
  - 1. Check existing databases
  - 2. Check quality of the data (temperature dependant data)
  - 3. Try to include characterization into quotation
  - 4. In last choice : Try to find a an equivalent material

Modelling Workflow

Step 1 : Mold filling

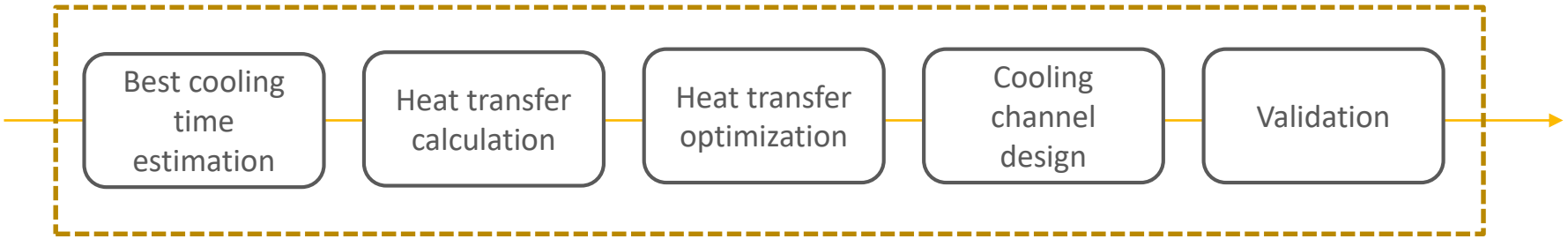
- Very Standard Simulation
- Different Competitors on the market with their own specifies

Thermal and Packing issues : Frozen area prevents a good packing of the polymer



Geometry modification

Step 2 : Cooling system Design

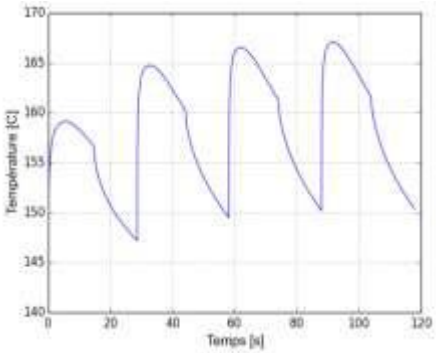


Cooling circuit mold design

Step 2 : Cooling system Design

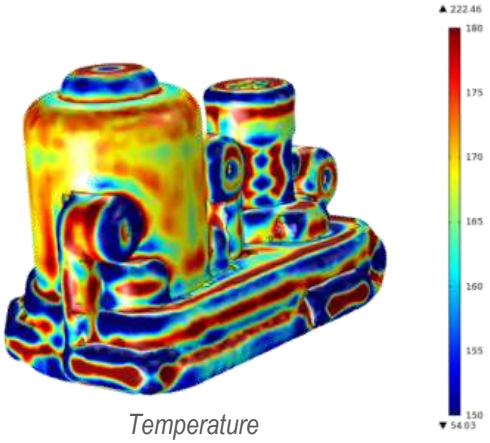
- Model 1 : 1D energy equation

Heat transfer calculation App for cooling time estimation in injection molding



- Model 2 : 3D heat transfer + optimization engine

Heat and mass transfer modeling

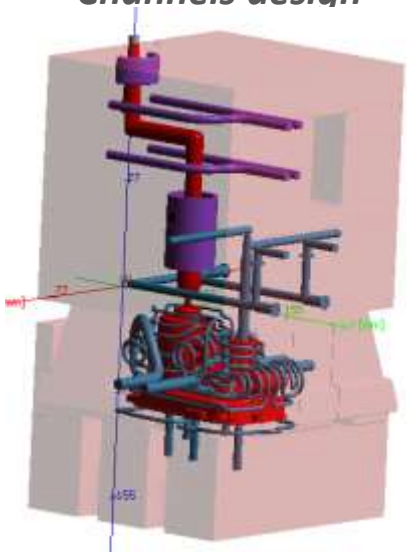


Temperature distribution on cooling surface

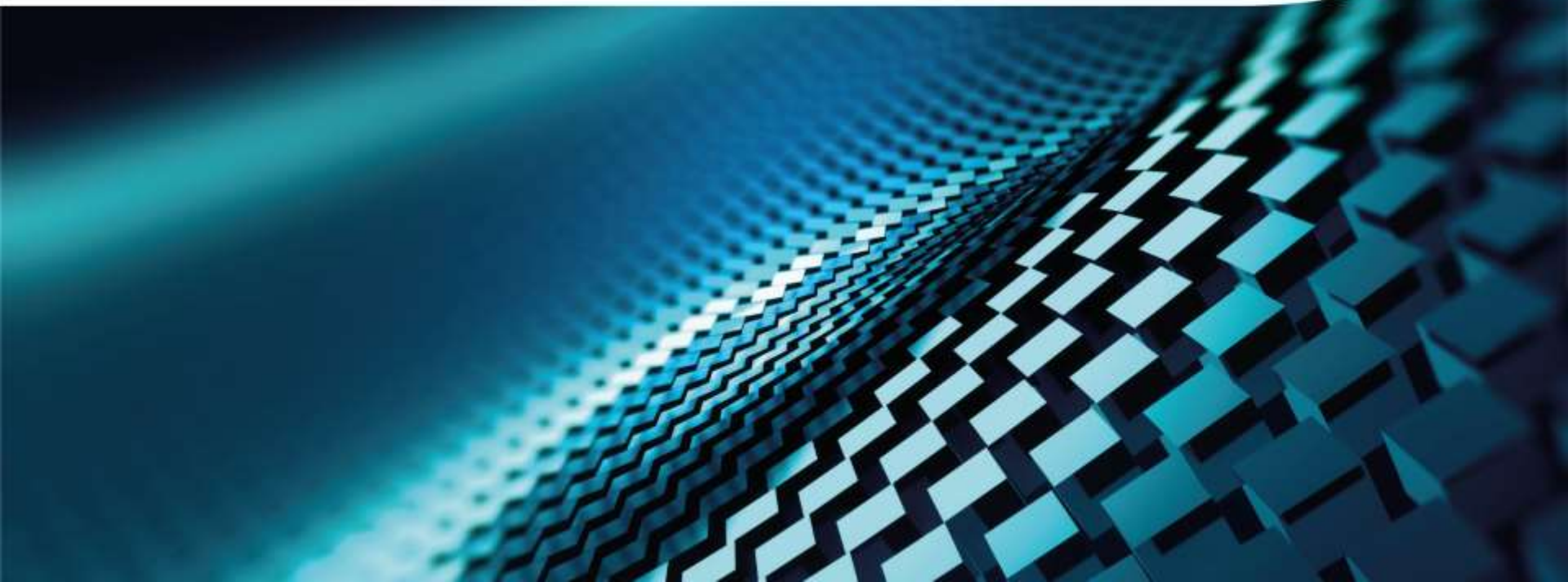
Isotherms for cooling channel design

Isotherm and heat flux

Conformal Cooling Channels design

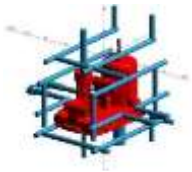


PART 3
VALIDATION AND RESTITUTION



Validation

- Numerical comparison between drilled cooling and conformal cooling channel
- Comparison with production data



		Drilled cooling channels		Conformal cooling channels		Outcome
		Production	Numerical	Production	Numerical	Production
Productivity	Cycle time[s]	66	64	42	42	-36%
	Cooling time [s] (Packing included)	50	50	32	32	-35%
Quality	⏥ [mm]	0.48	0.13	0.25	0.13	- 48%
	⊥ [mm]	0.30	0.32	0.18	0.29	- 40%

Restitution

- Reporting on modelling
  - Detailled reporting focused on the result (less on the physical equations and solver) in the “client’s language”
  - Some keys to understand modelling specificities and assumptions

- Molding tool

Validation of the Economical balance

Direct Benefit

Annual product quantity to be produced	400 000
Life time of the mold	4 year
Gain on the product cost	0.03 €
Direct Benefit	**48 000** €

Indirect Benefit

Cost of a set up	3 000 €
reduction of number of set up	3
Indirect Benefit	**9 000 €**

ROI

Direct benefit	57 000 €
Investment	10 000 €
ROI	**4,7**

THANKS FOR YOUR ATTENTION !