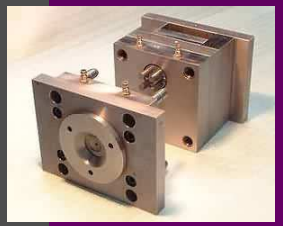
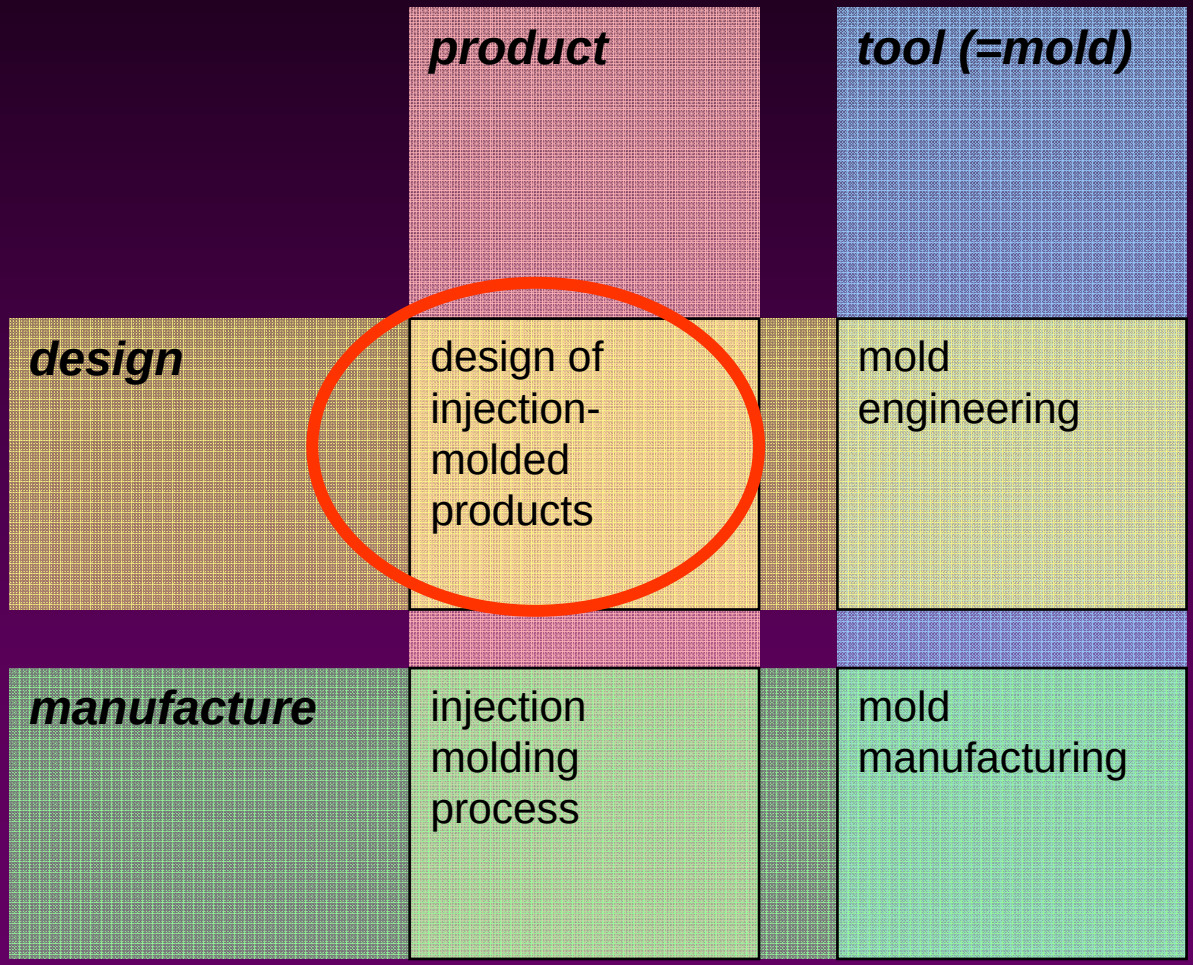
plastic injection molding

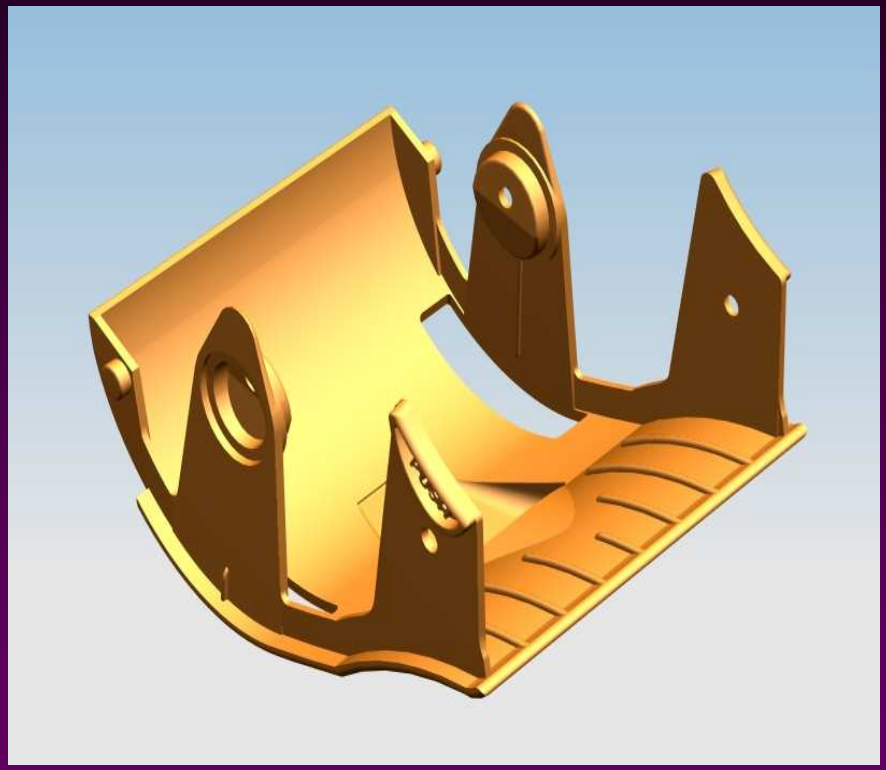
part 2

design of plastic parts and products

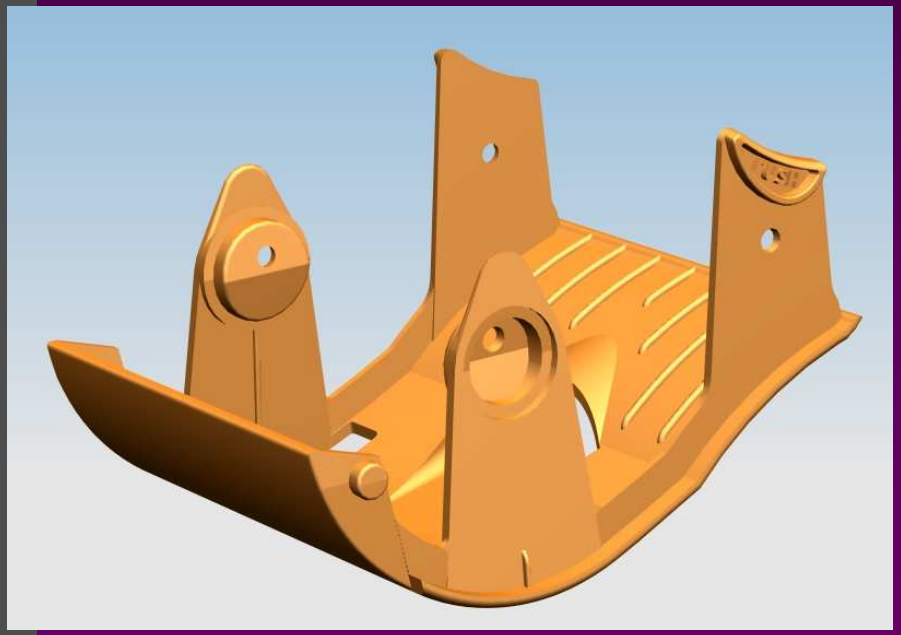
erik de lange




product
tool (=mold)
design
design of injection-molded products
mold engineering
manufacture
injection molding process
mold manufacturing




PUSH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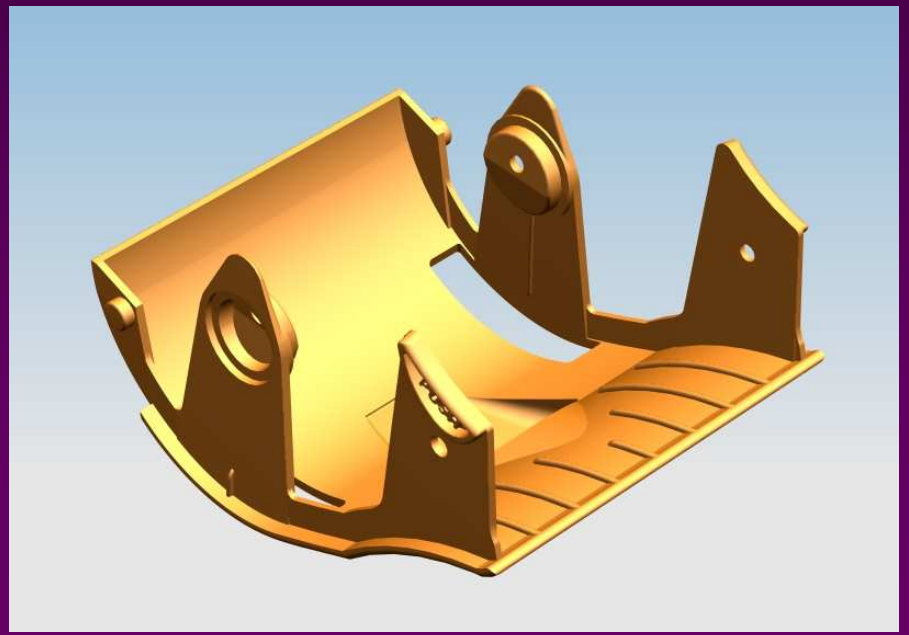
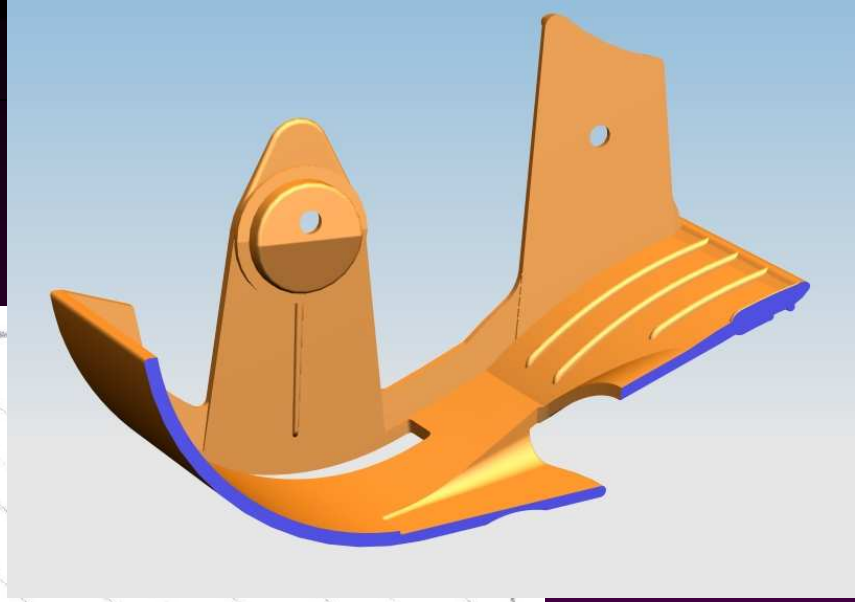
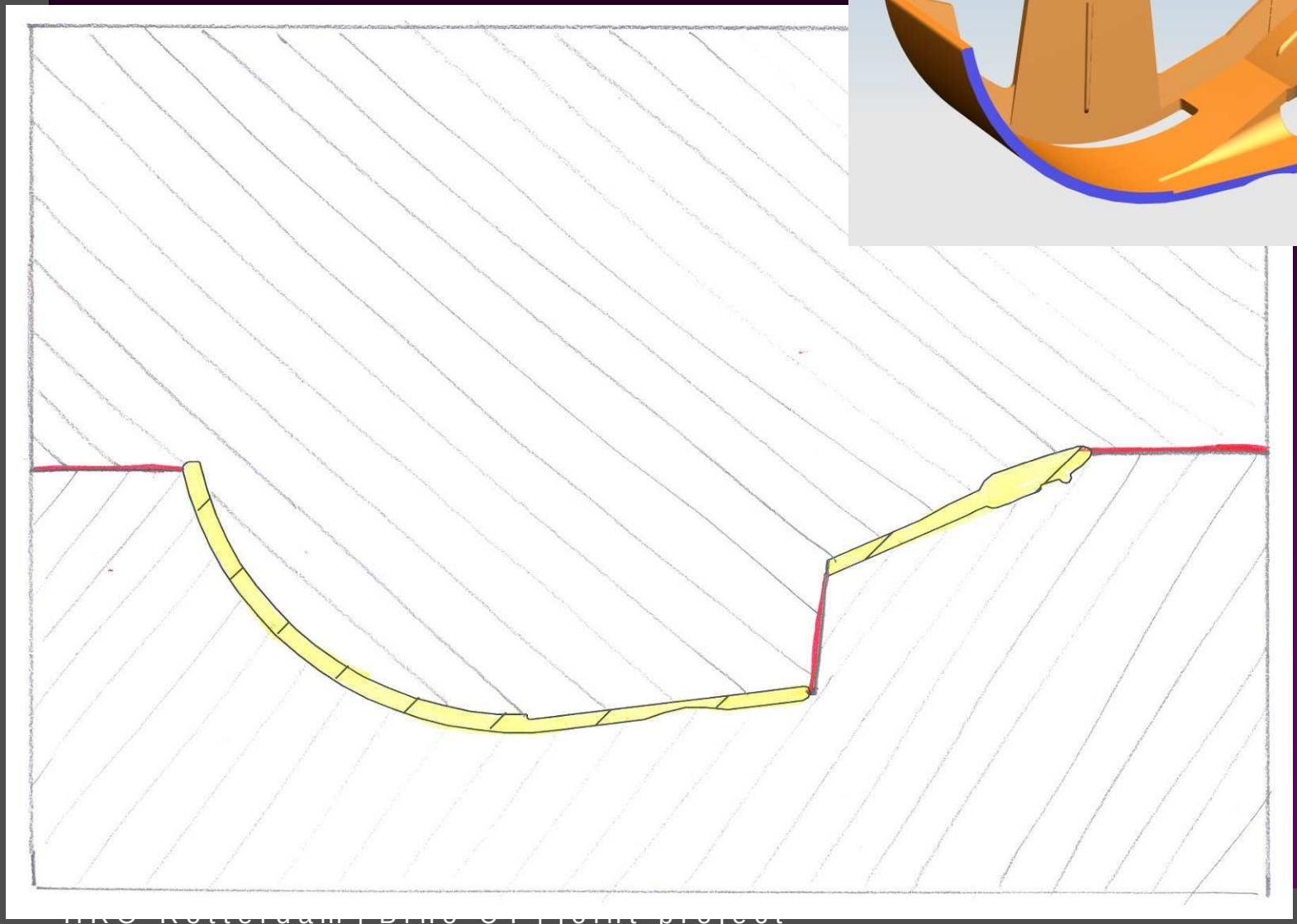
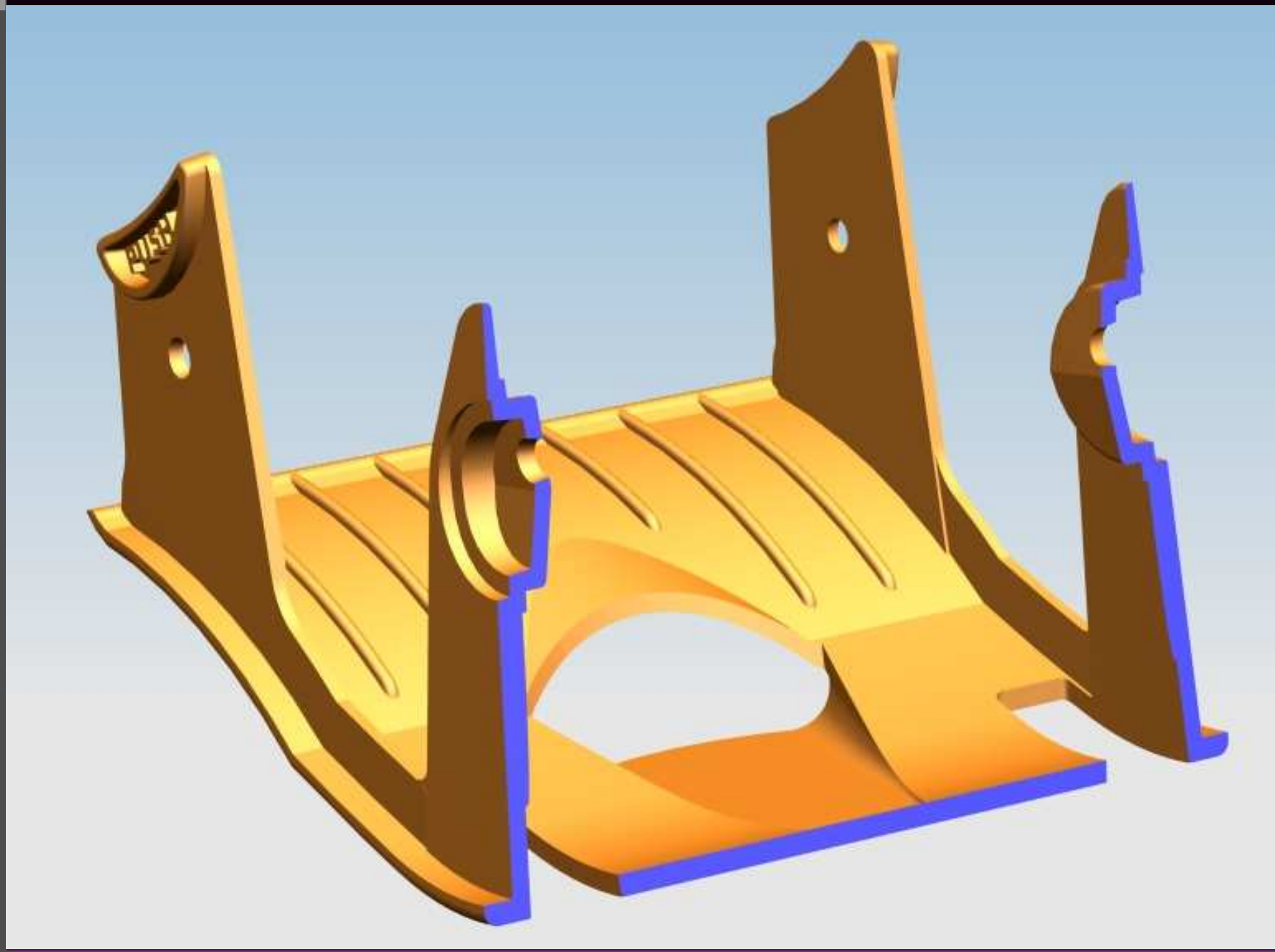
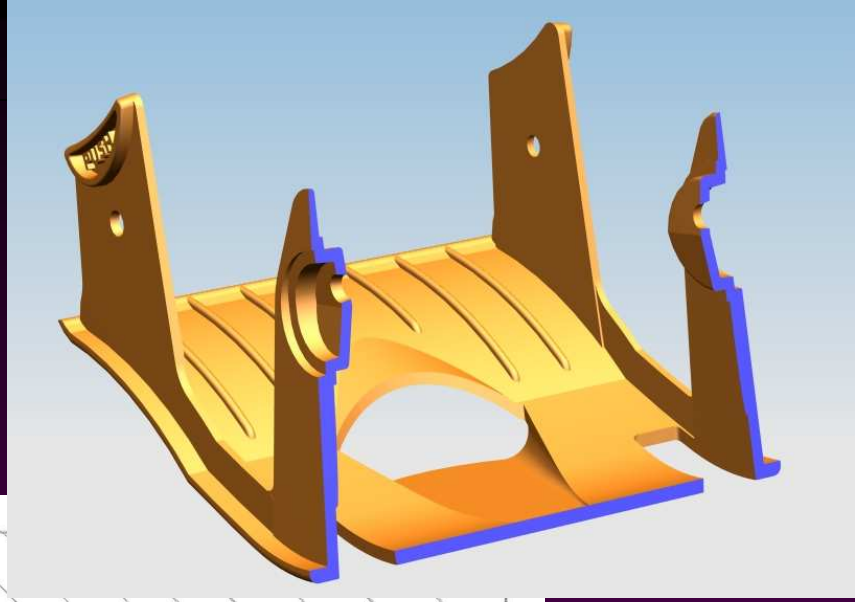
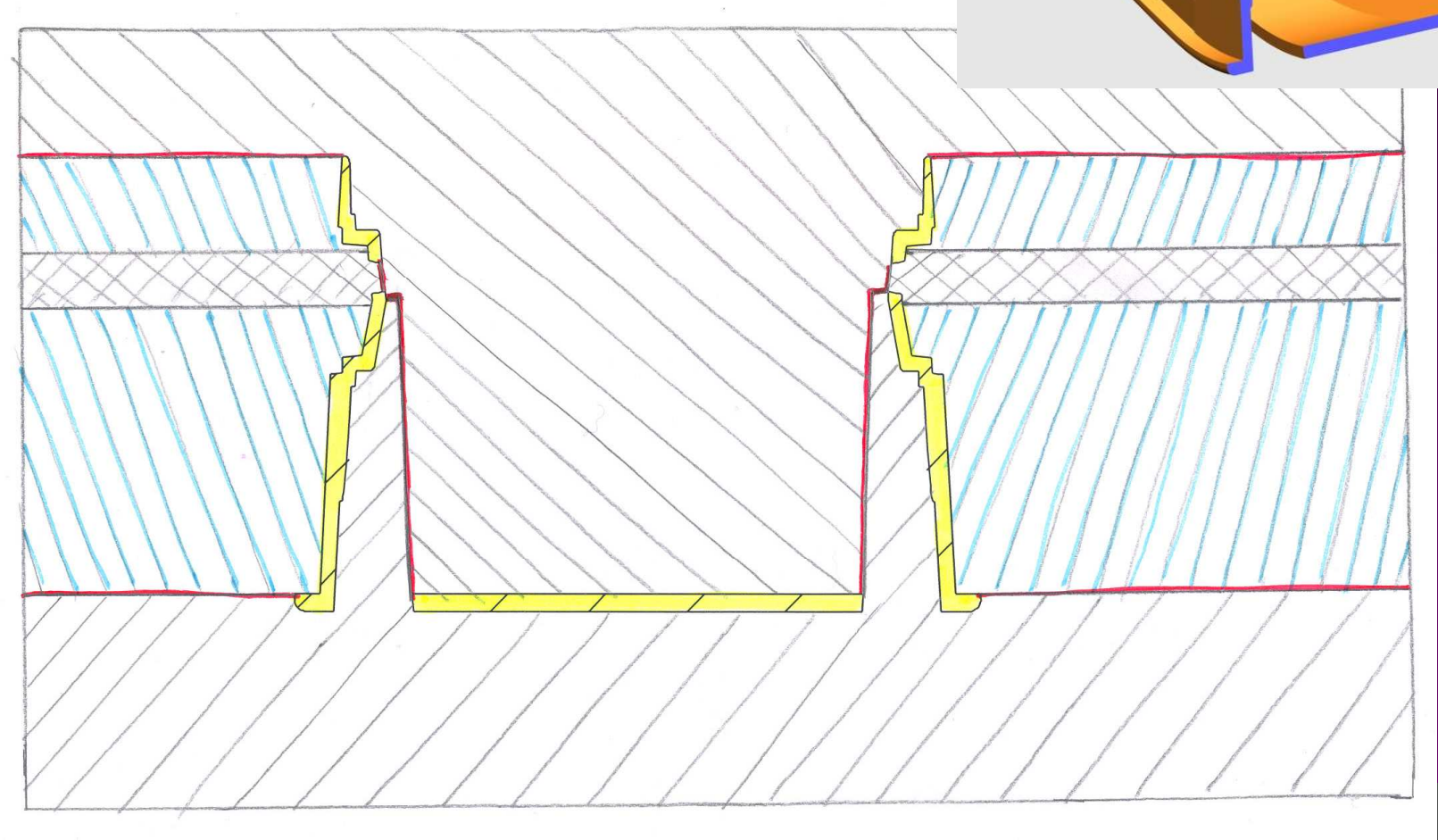


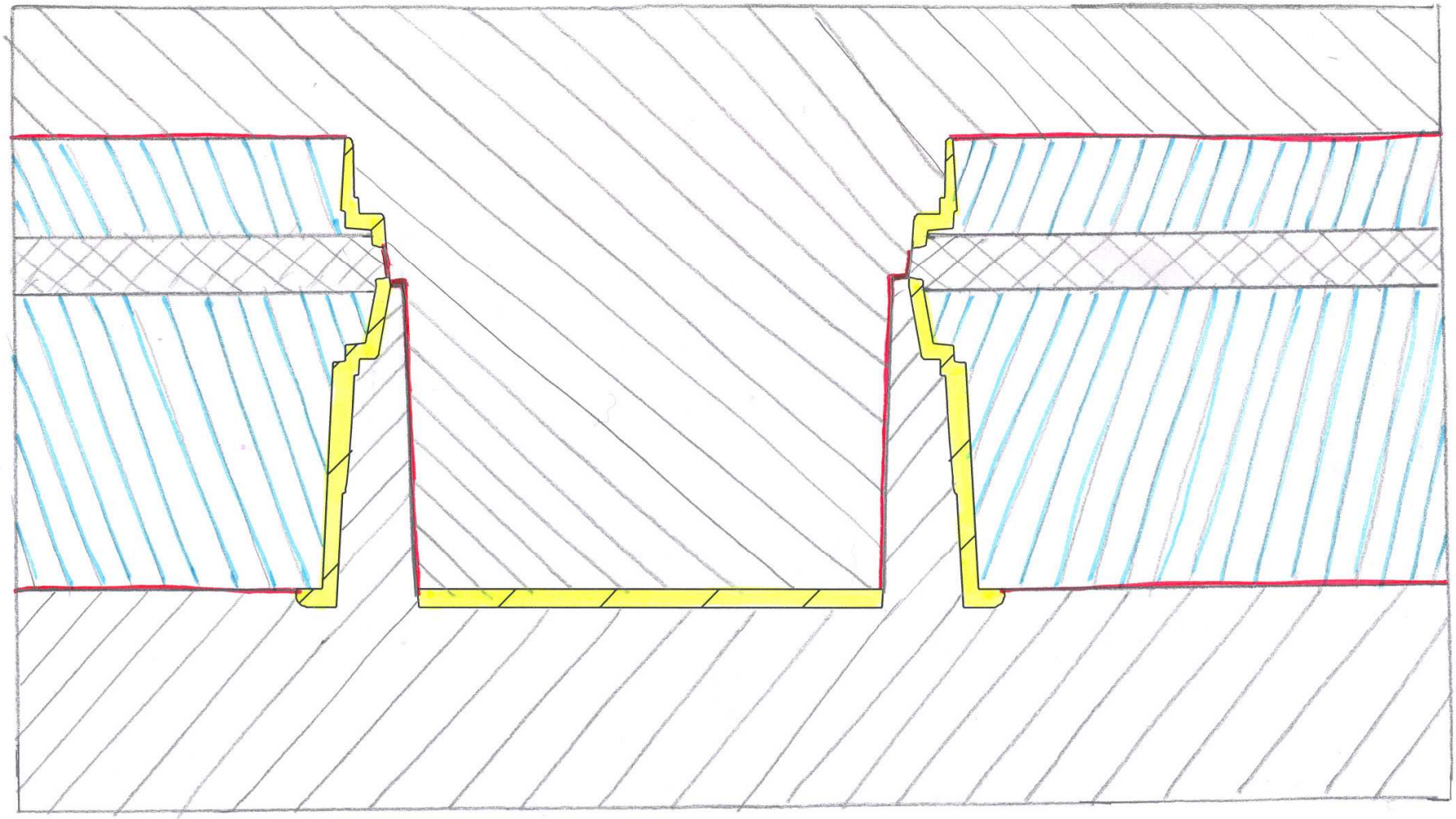


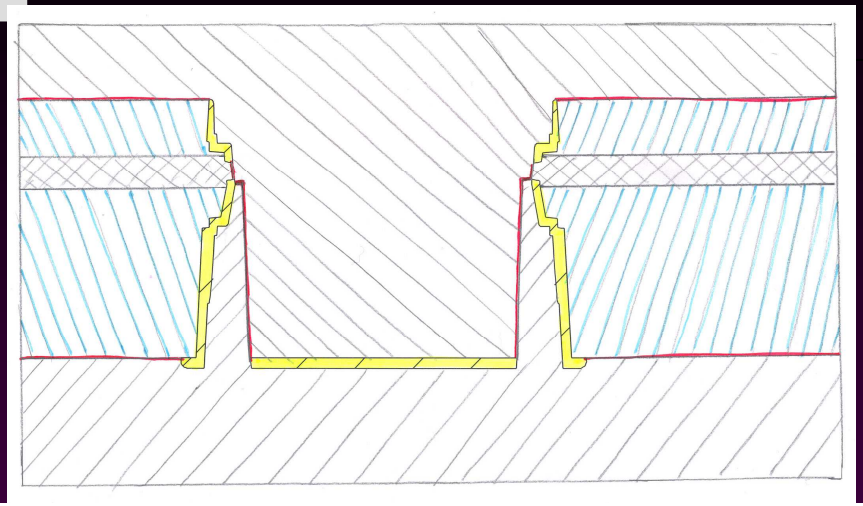


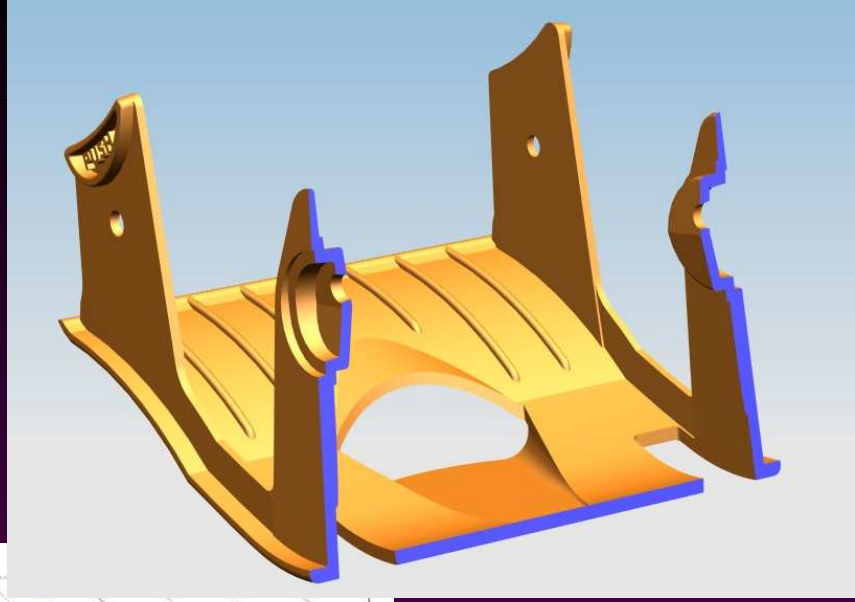


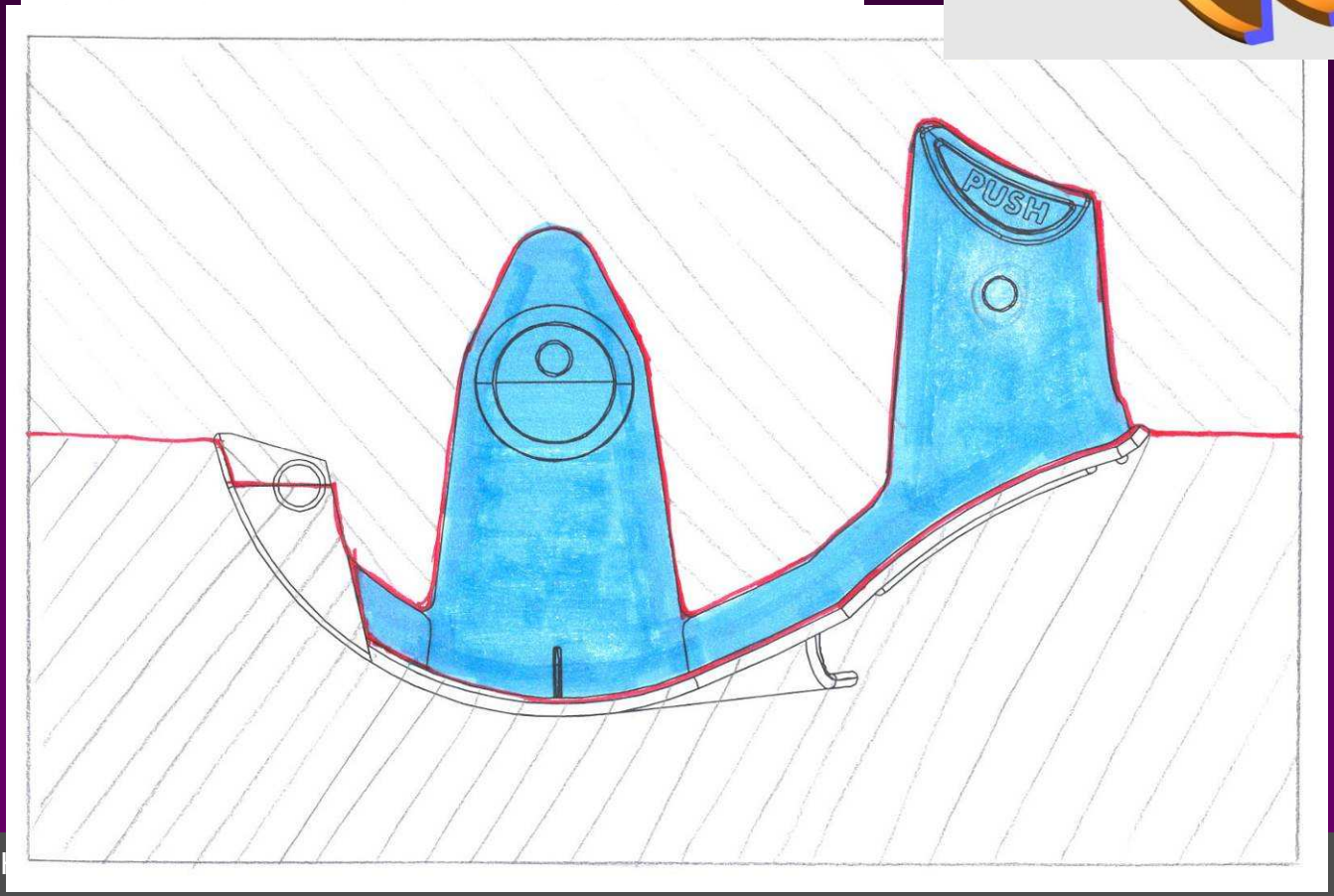











PUSH

concept

assembly level

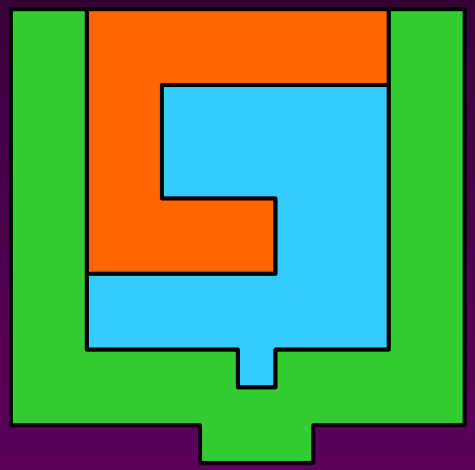
decomposition into set of parts

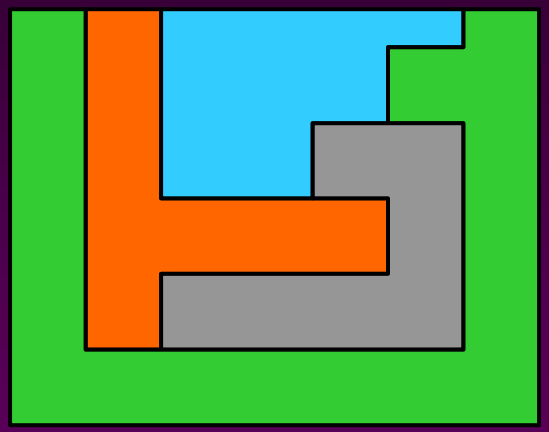
part level

detailed part design

- no undercuts ☺
  or at least
  a feasible slide arrangement 😐 *$*
- all parts fitting and reachable
- cost-effective!

Reachable: a possible assembly order must exist





Cost-effectiveness of the assembly

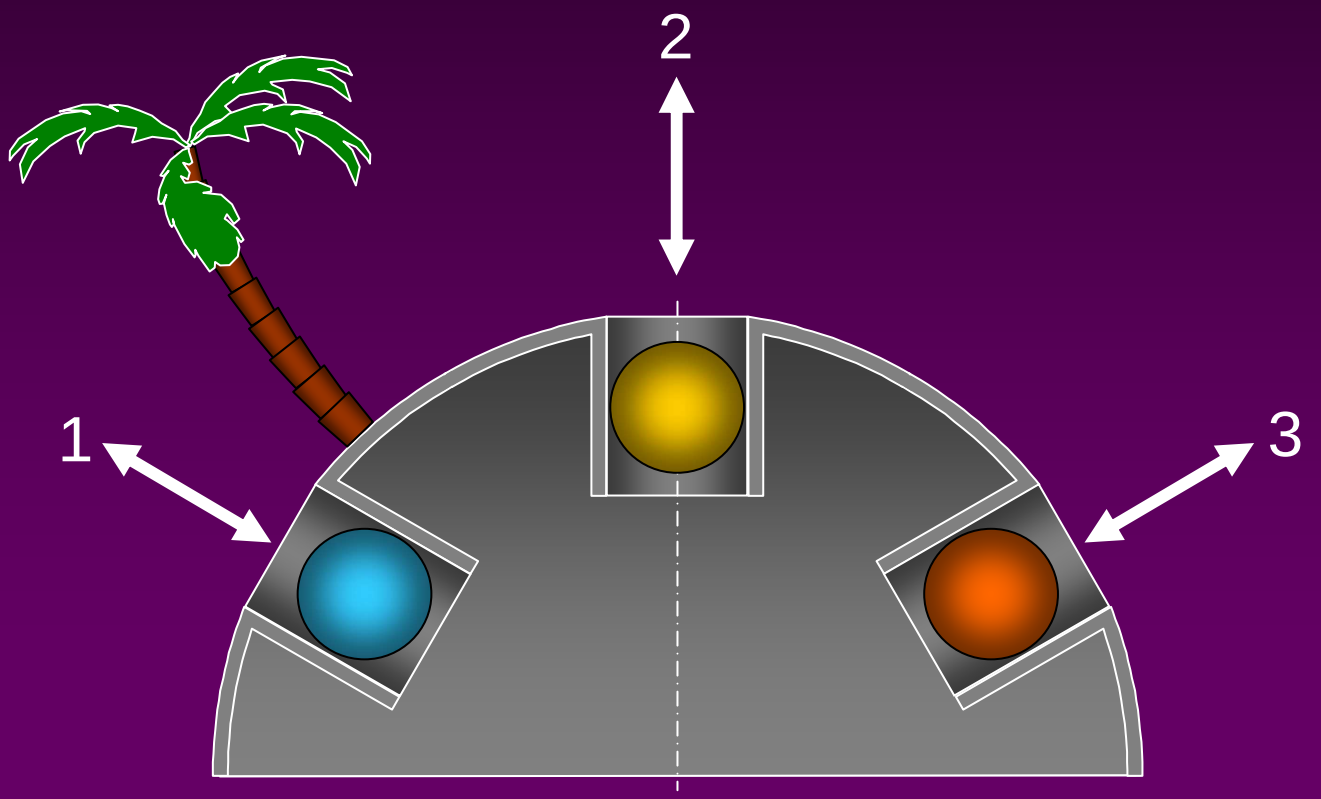
Three golden rules:

- try to decompose you concept design in the smallest number of parts you can think of
- try to use the same part more than once
- try to eliminate separate hinges and fasteners
    - hinge function→ living hinge
    - fastening → snap rims, snap hooks

Example:

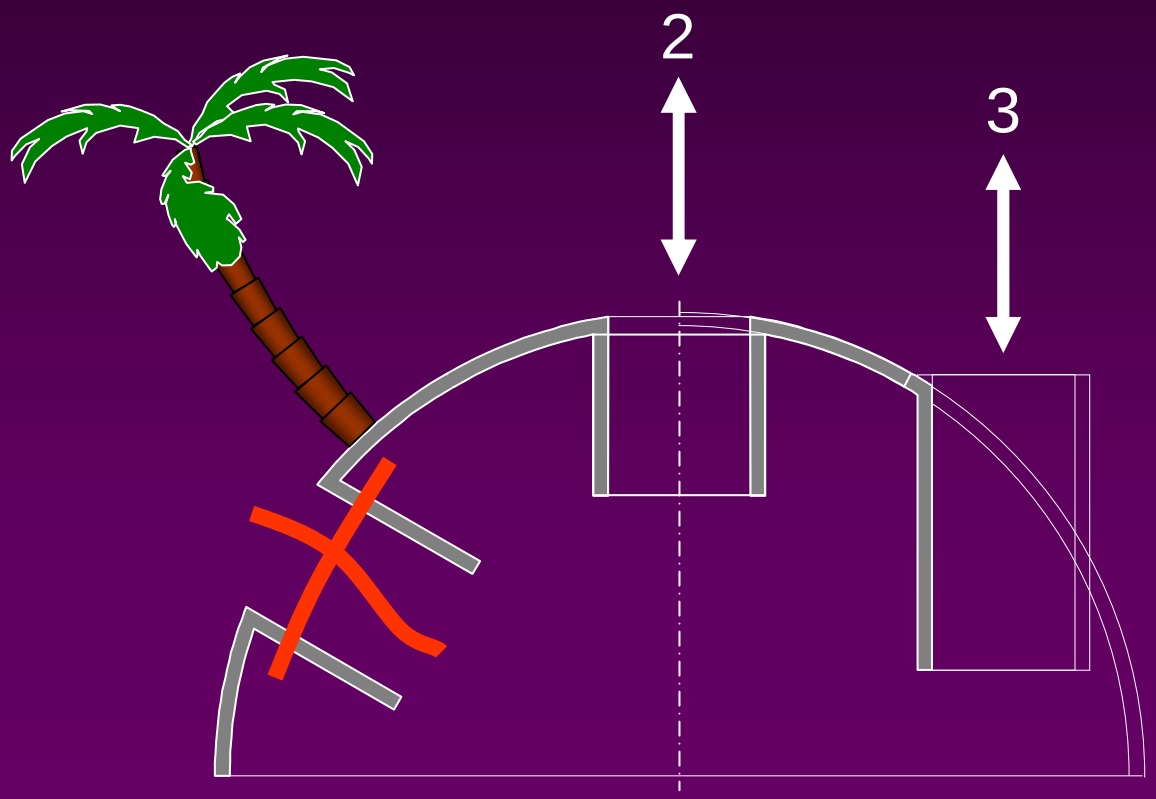
This part has three *conflicting* lines of draw.

You cannot make this part in a mold, not even with slides.



Solution #1:

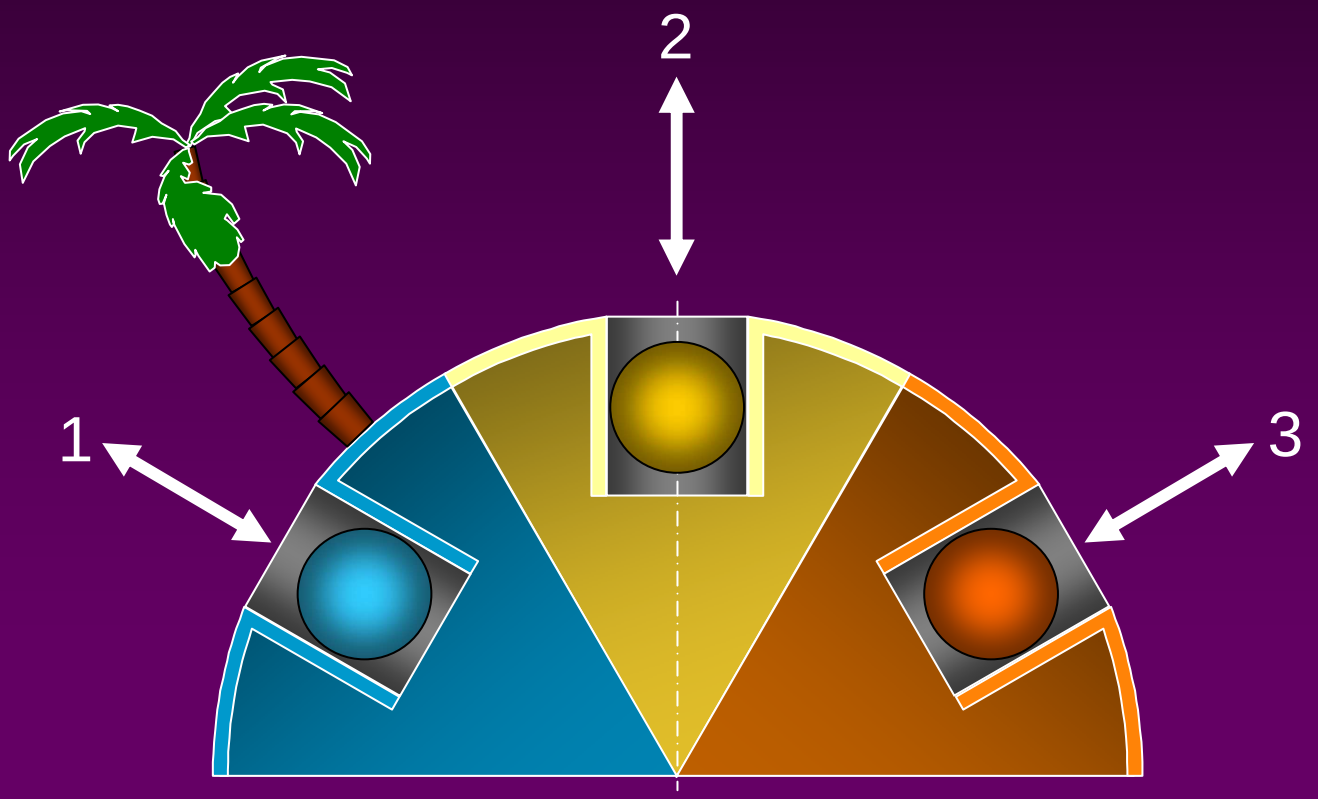
You might reorient the holes. This solves the drawing problem, but it’s probably not what you had in mind.



Solution #2:

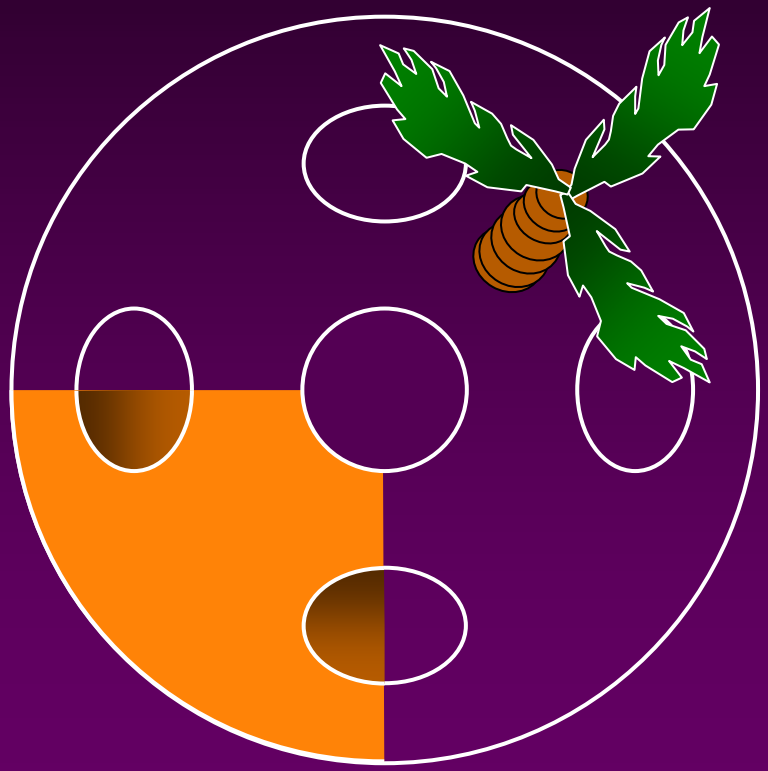
Decomposition along lines of draw.

There might be a problem in the fitting or the fastening.



Solution #4:

Changing your viewpoint might give new ideas for decomposing yor concept.



Assembly design and parts design have conflicting design guidelines.

Assembly design guidelines

- small number of parts
- integrating functions (hinges, fastening means)

Part design guidelines

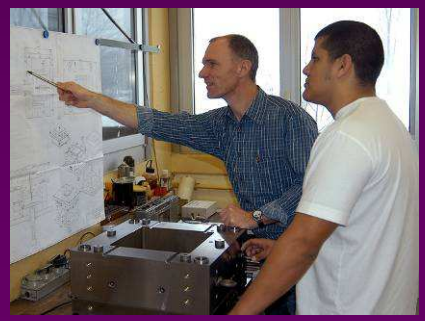
- injection-moldable shape
- single draw
- no slides

Conflict!

Try to find a good balance.

Advice

- Discuss the parts decomposition with your mold manufacturer
- Treat your subcontractors as co-makers, rather than only subcontractors
- Have them involved in the early stages of the project

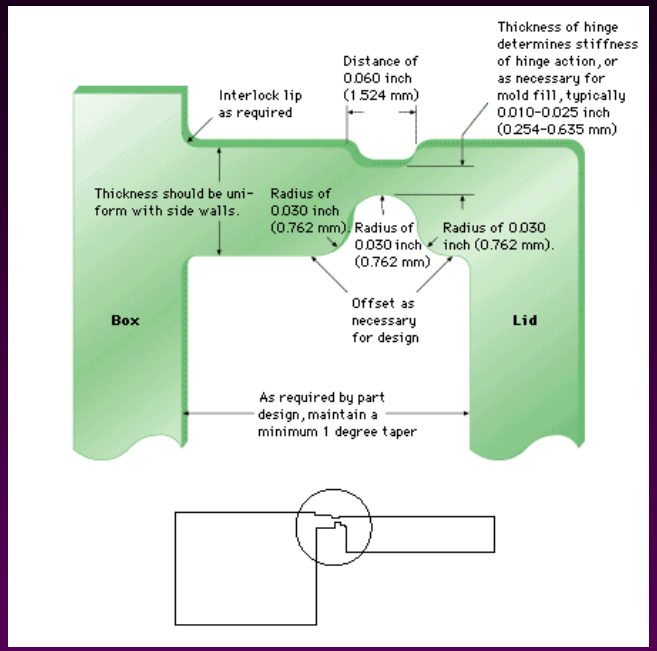


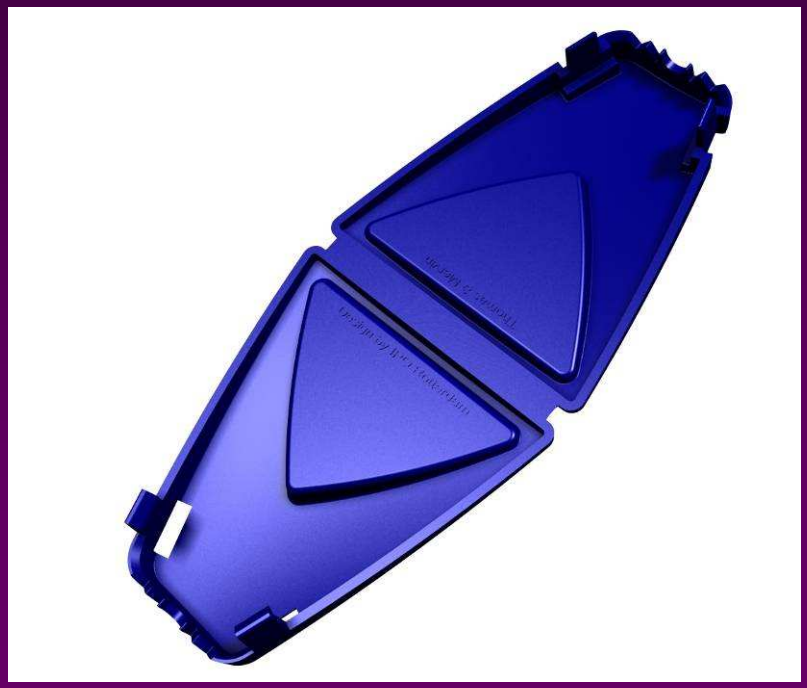
Function integration reduces the number of parts.

Examples:

- Hinge function
- Fastening function
- Closure fastening
- Spring function

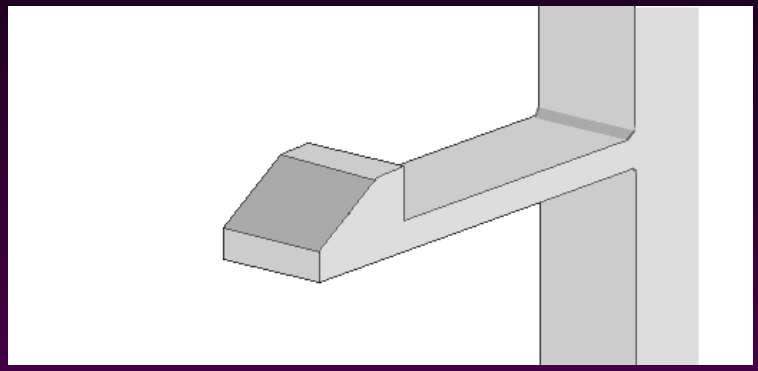
- PP-hinges can survive many thousands of open/close movements
- Right after the molding (when it is still hot) the hinge should be opened end closed once to arrange (orient) the molecules.
- Sources for instance: www.efunda.com

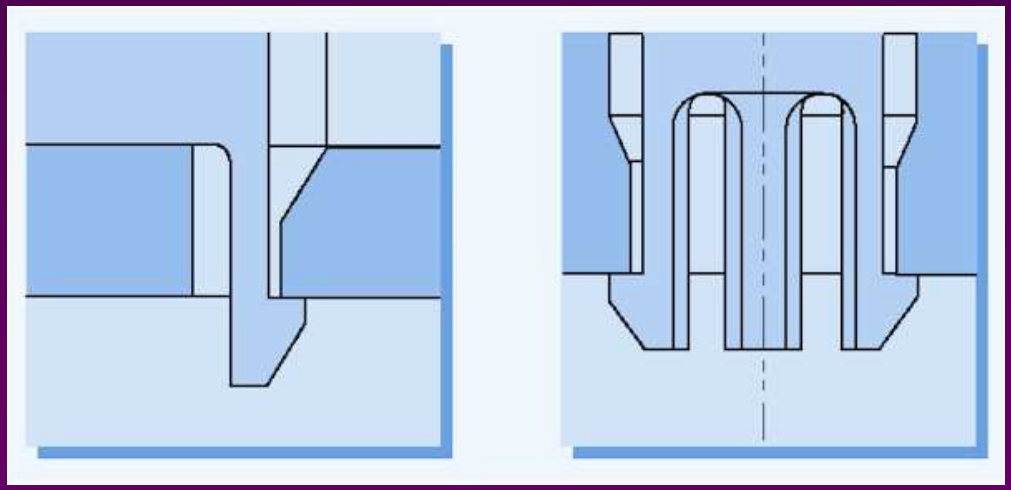




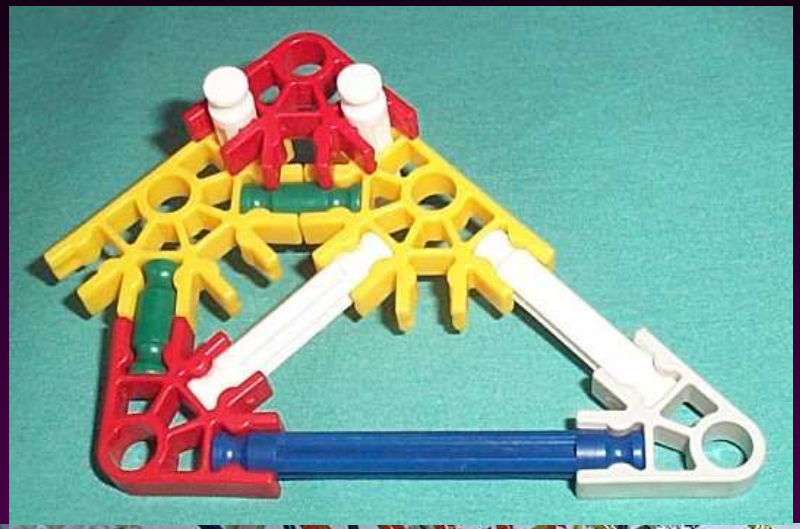
herring clip

Snap hooks that are too
short will overstrain or break.





design of snappers



BREAK!

After the break: part design

concept

assembly level

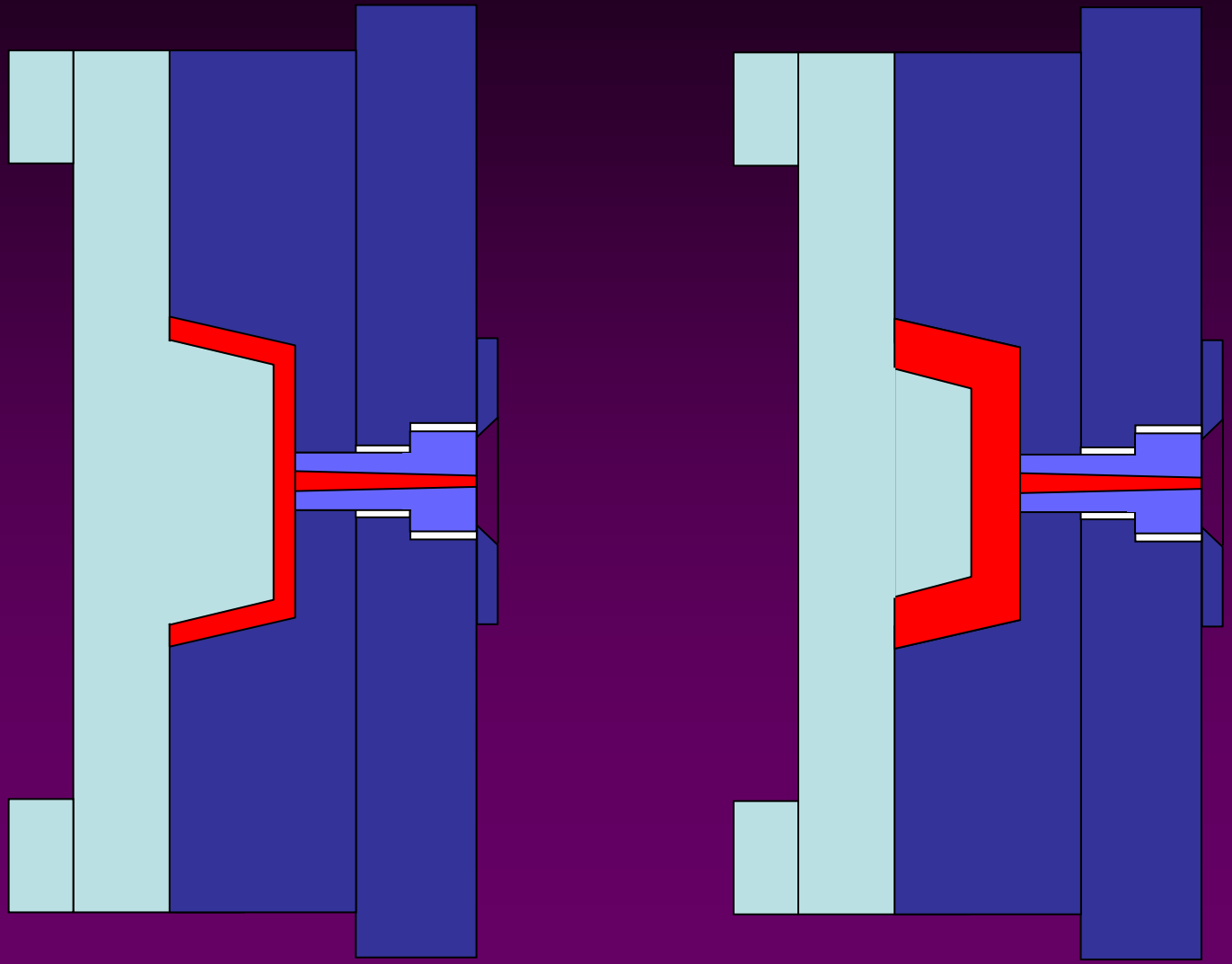
decomposition into set of parts

part level

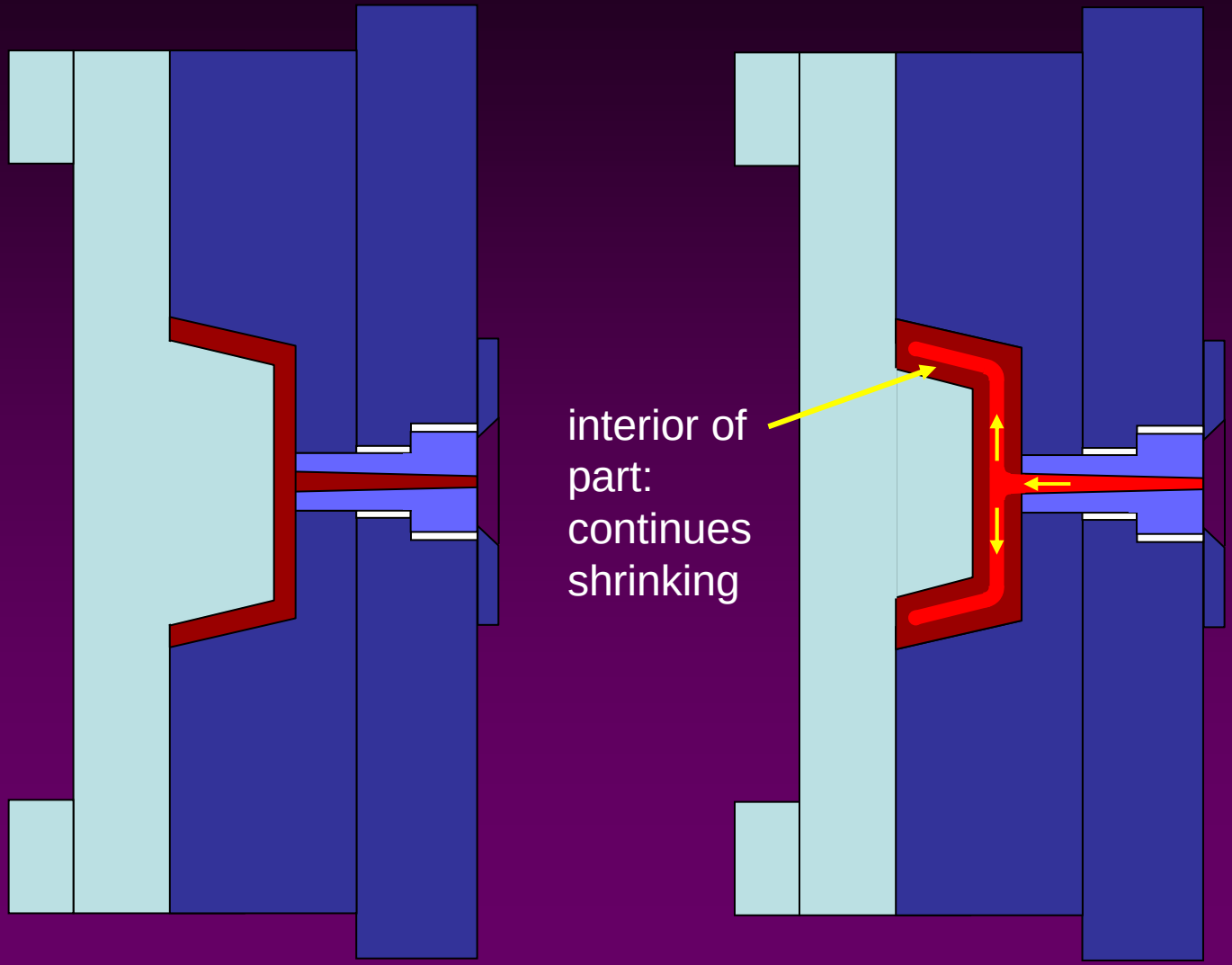
detailed part design

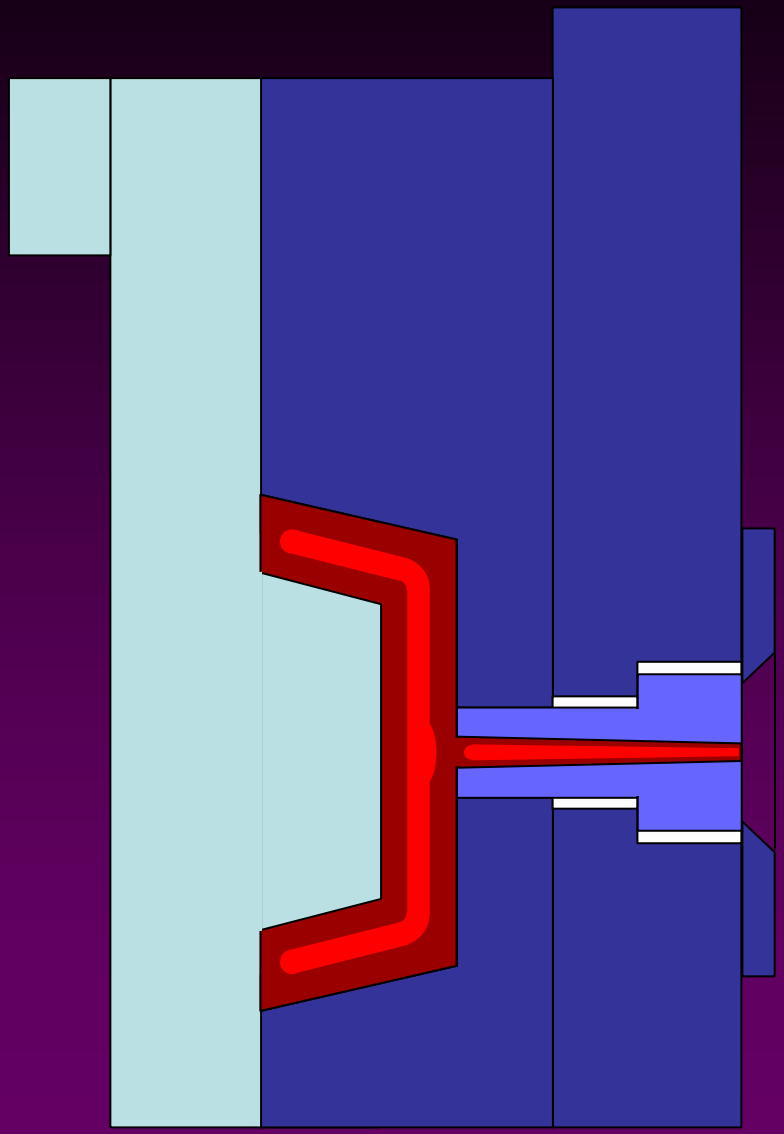
- thin walled $ 😐
  - yet strong and stiff
- equal wall thickness
- free of error

Shortly after injection: both products are still fully plastic (not solidified)



A couple of seconds later: the left product has soldified completely, the right one not yet.





Spuitneus komt rechtstreeks in de holte uit

If the gate “freezes” (solidifies) too soon, no further injection of material is possible.

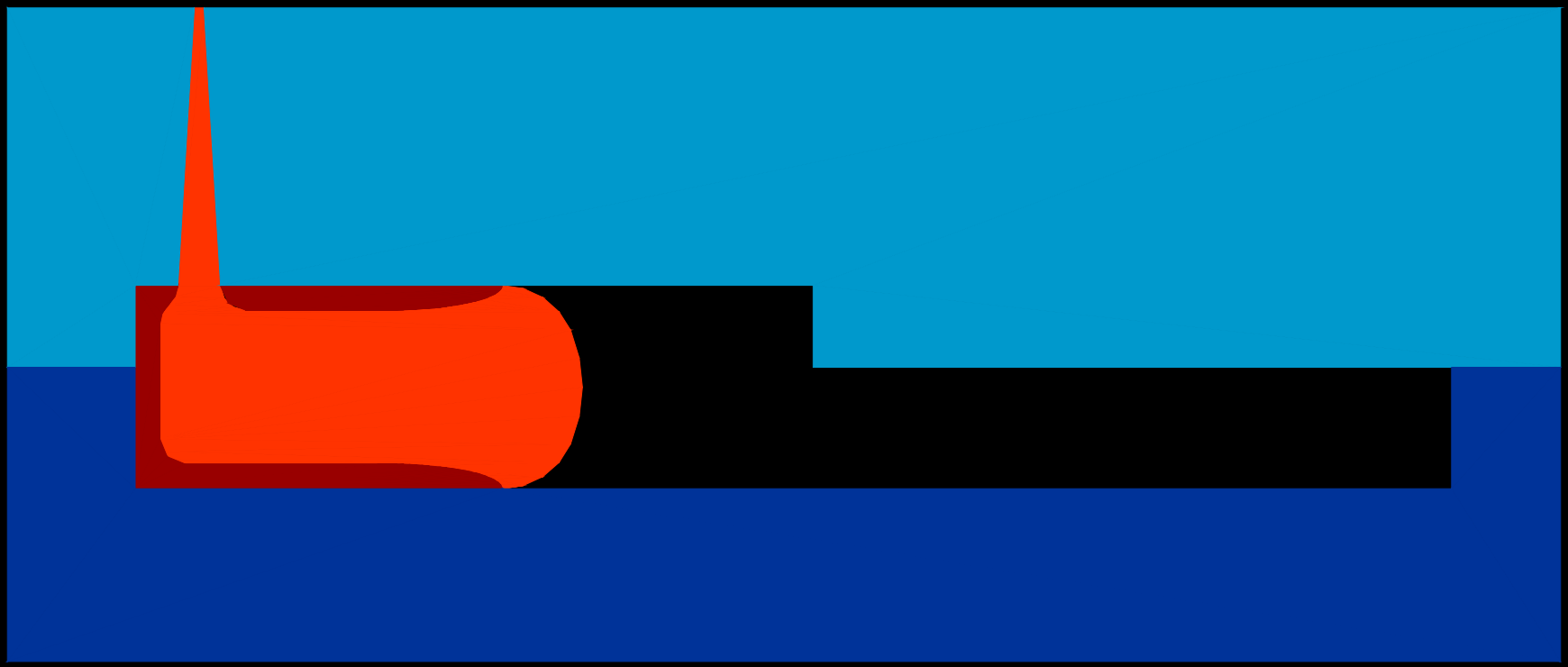
However: the product will continue to shrink.

This will result in a faulty product, having not the correct shape and dimensions.

	When the	goes
	wall thickness	↑
then:	cooling time	↑
	products per hour	↓
	part cost	↑
	profit	↓

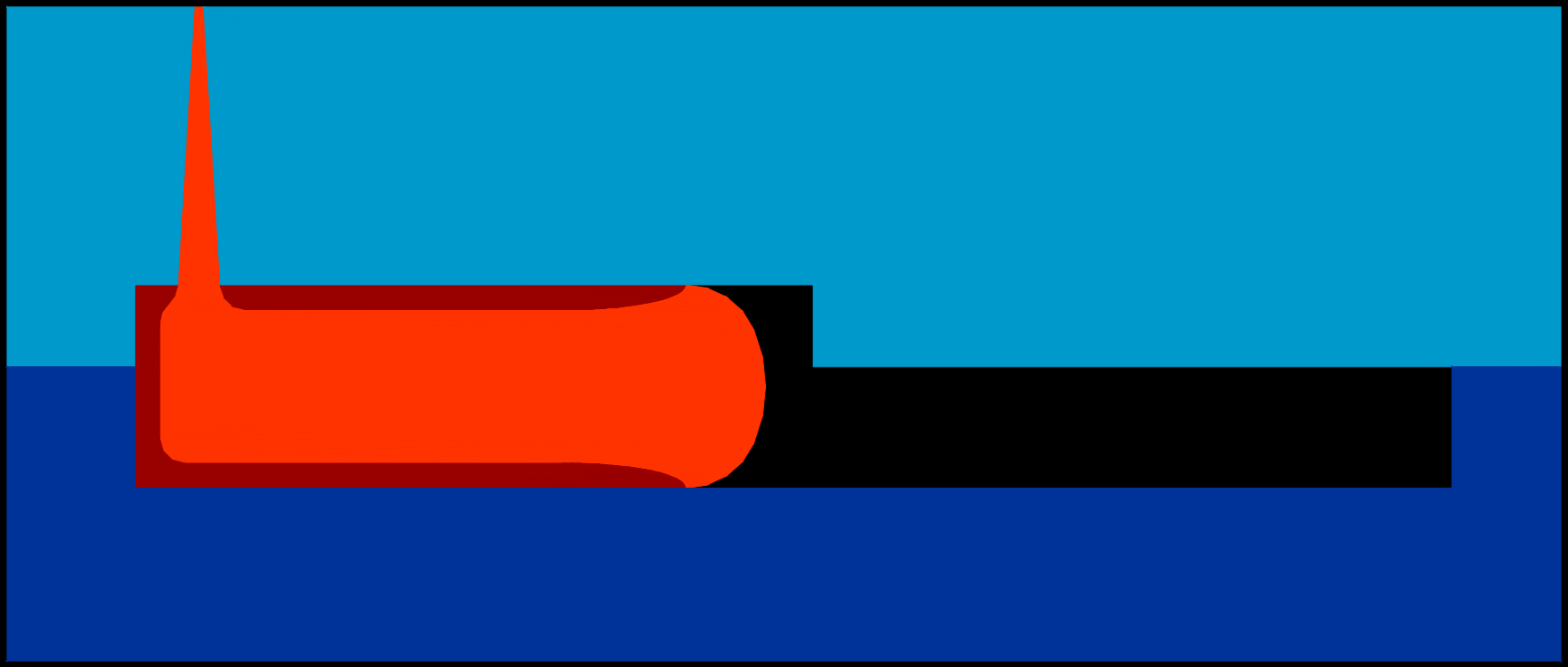
Example: Nokia mobile phone top part

consequence of uneven wall thickness



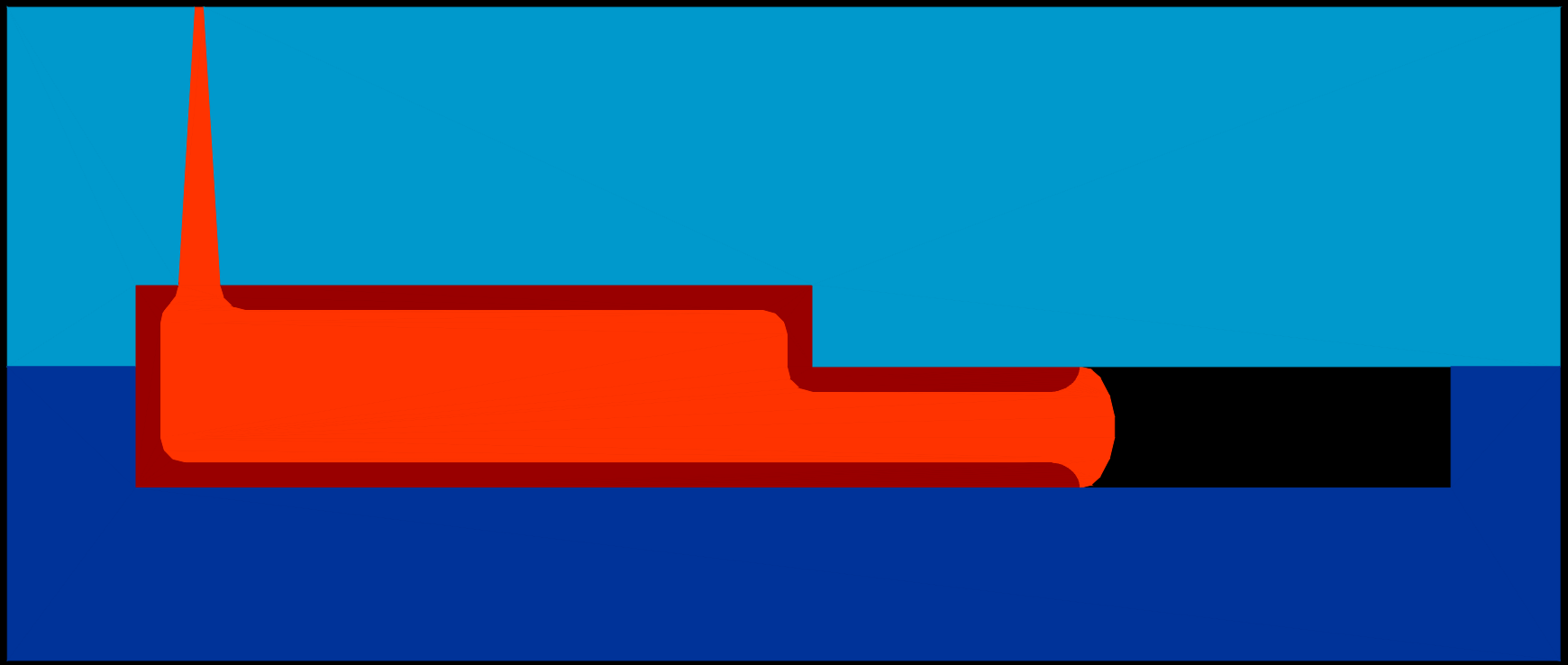
consequence of uneven wall thickness

Spuitneus komt rechtstreeks in de



consequence of uneven wall thickness

Spuitneus komt rechtstreeks in de



consequence of uneven wall thickness

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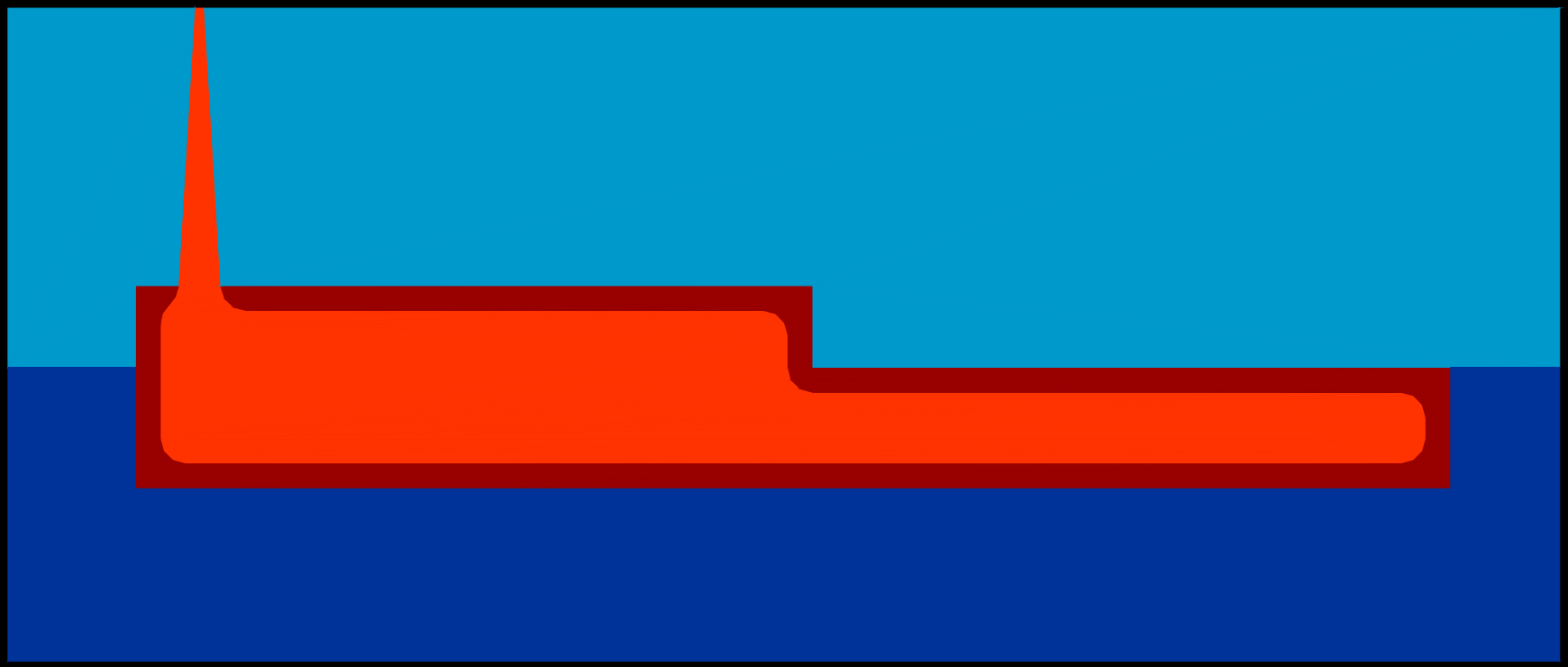

consequence of uneven wall thickness

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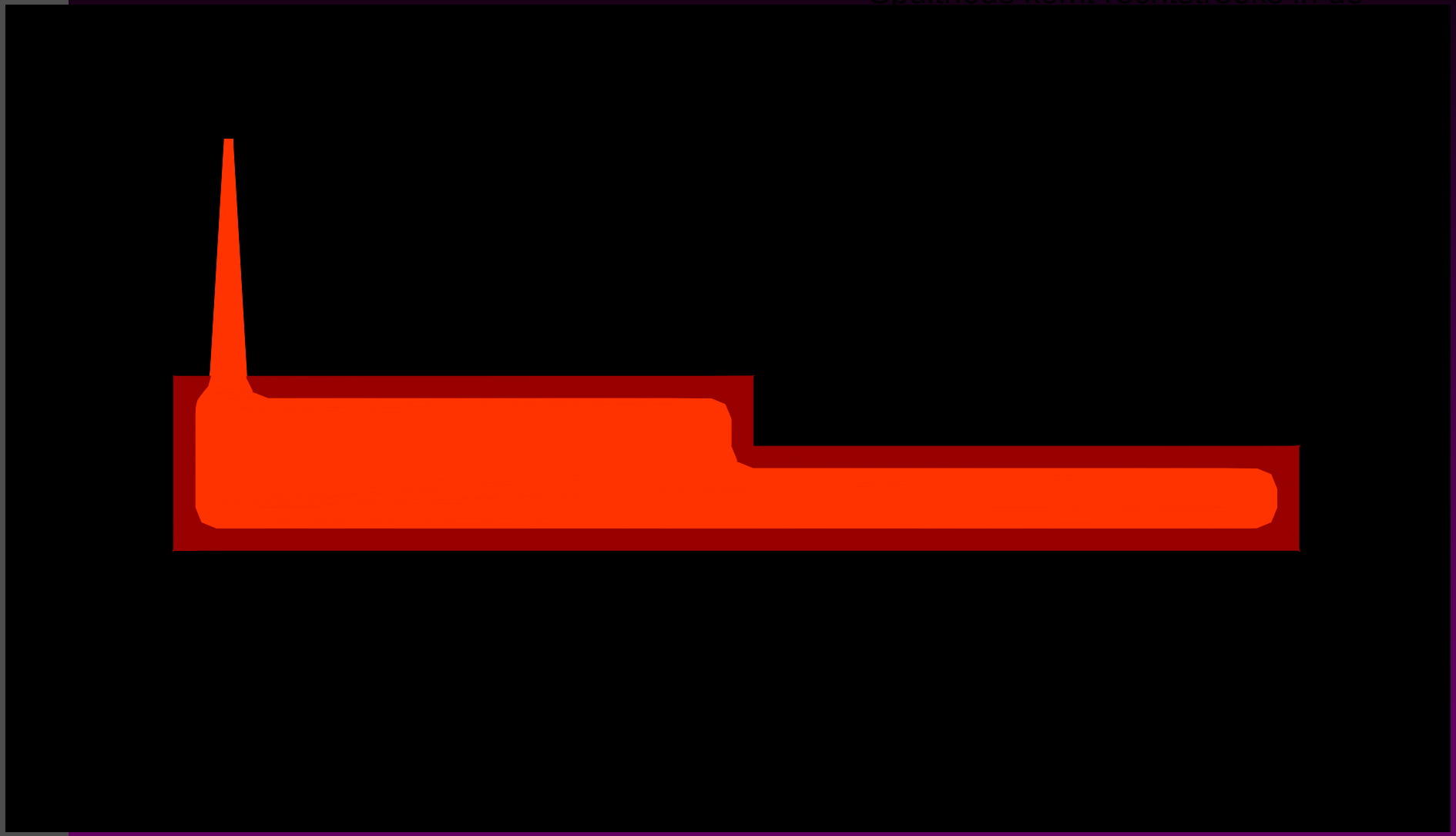

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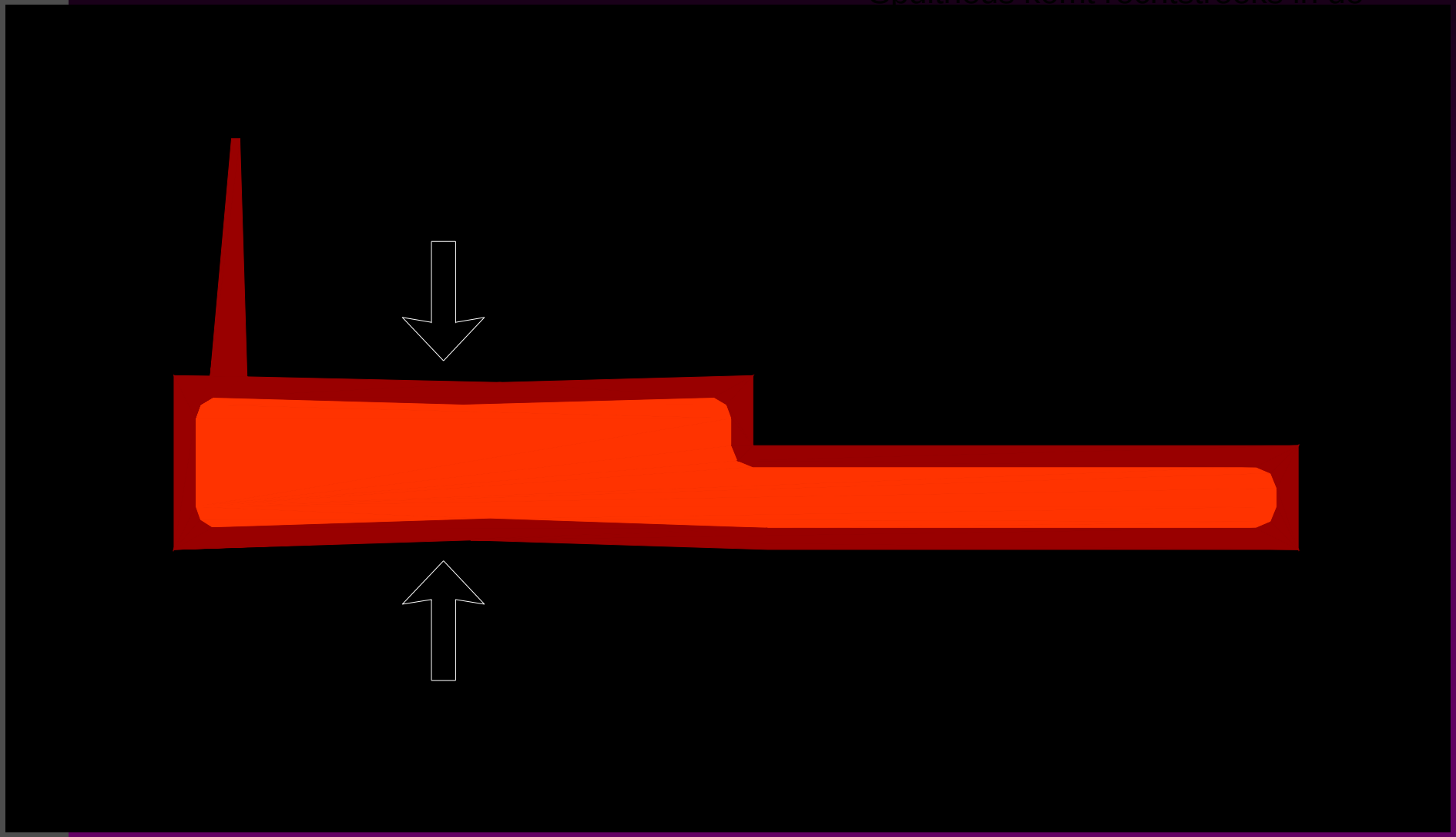

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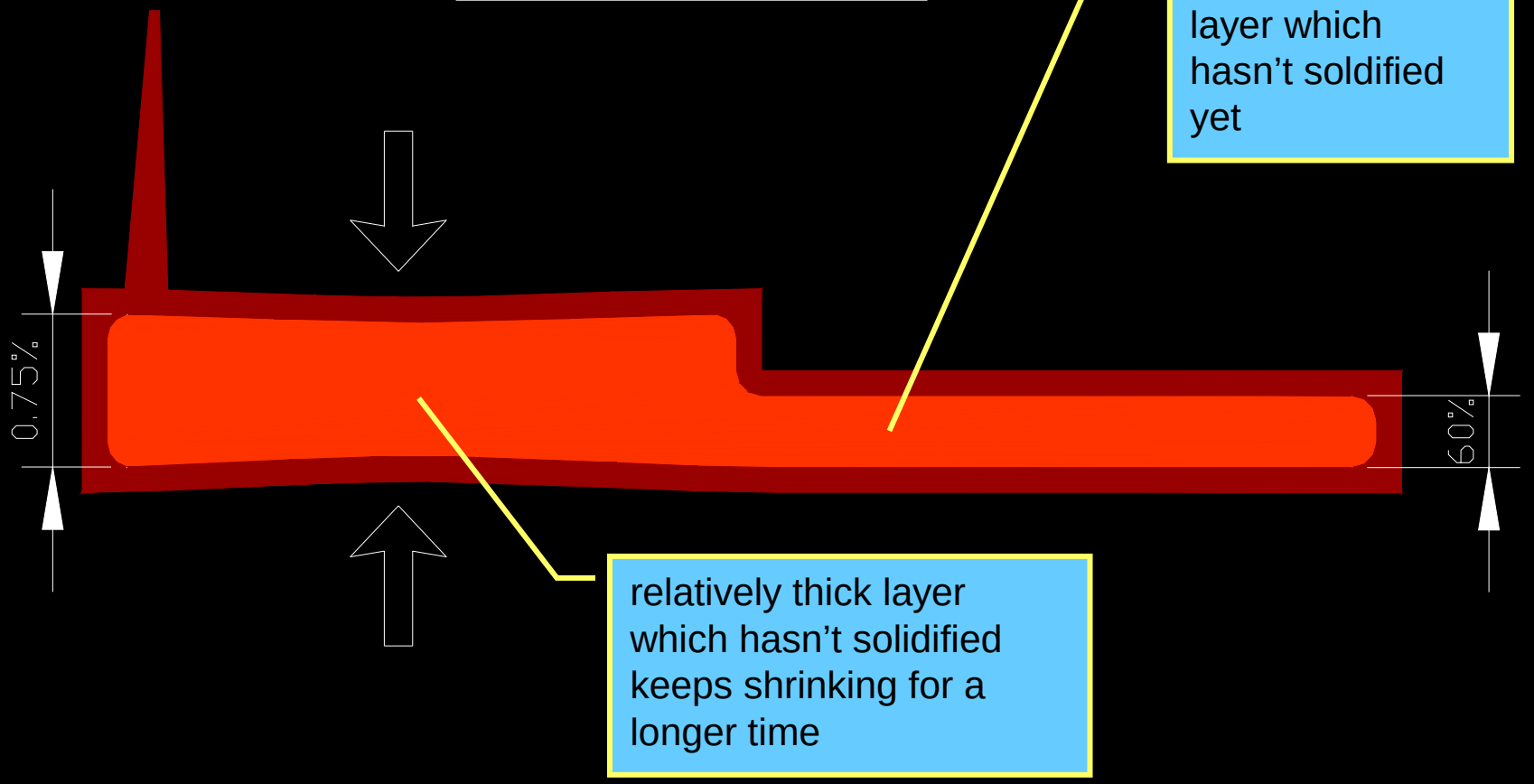
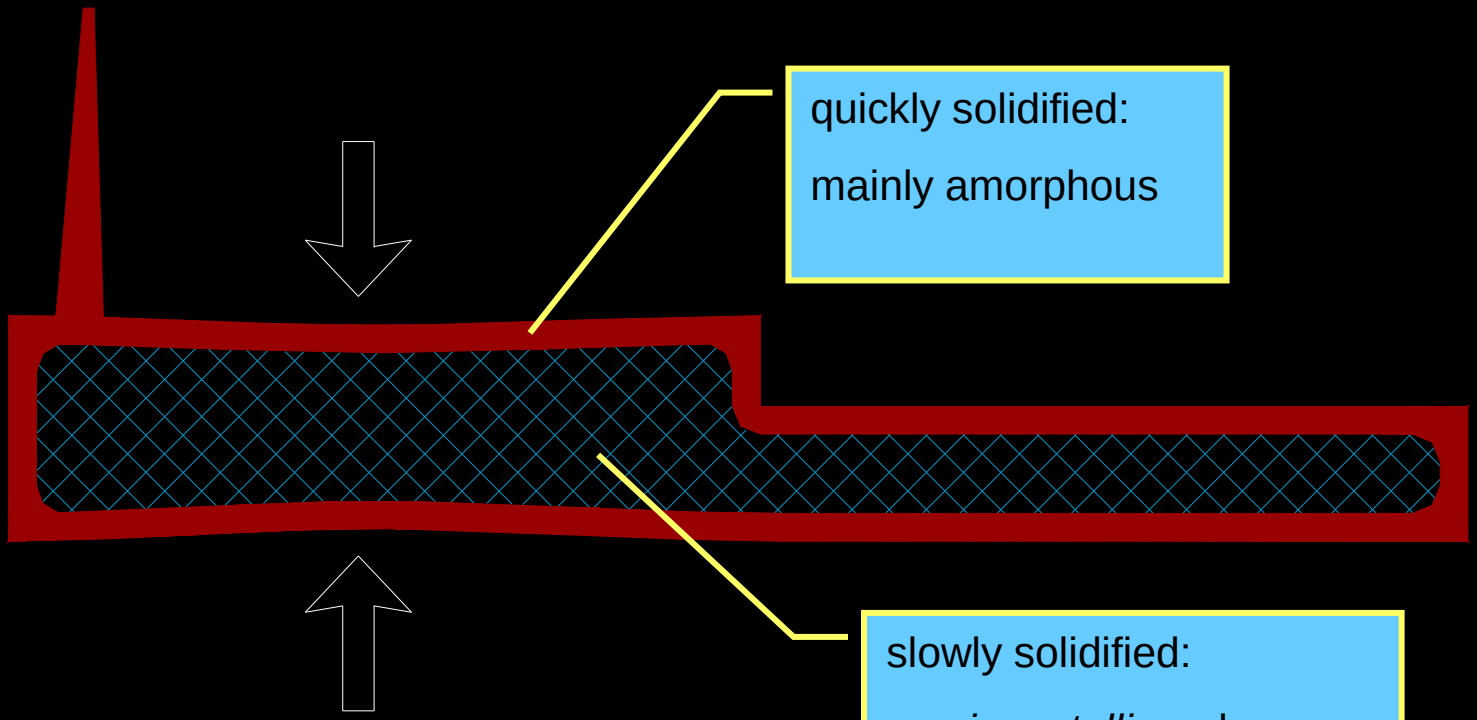


Spuitneus komt rechtstreeks in de

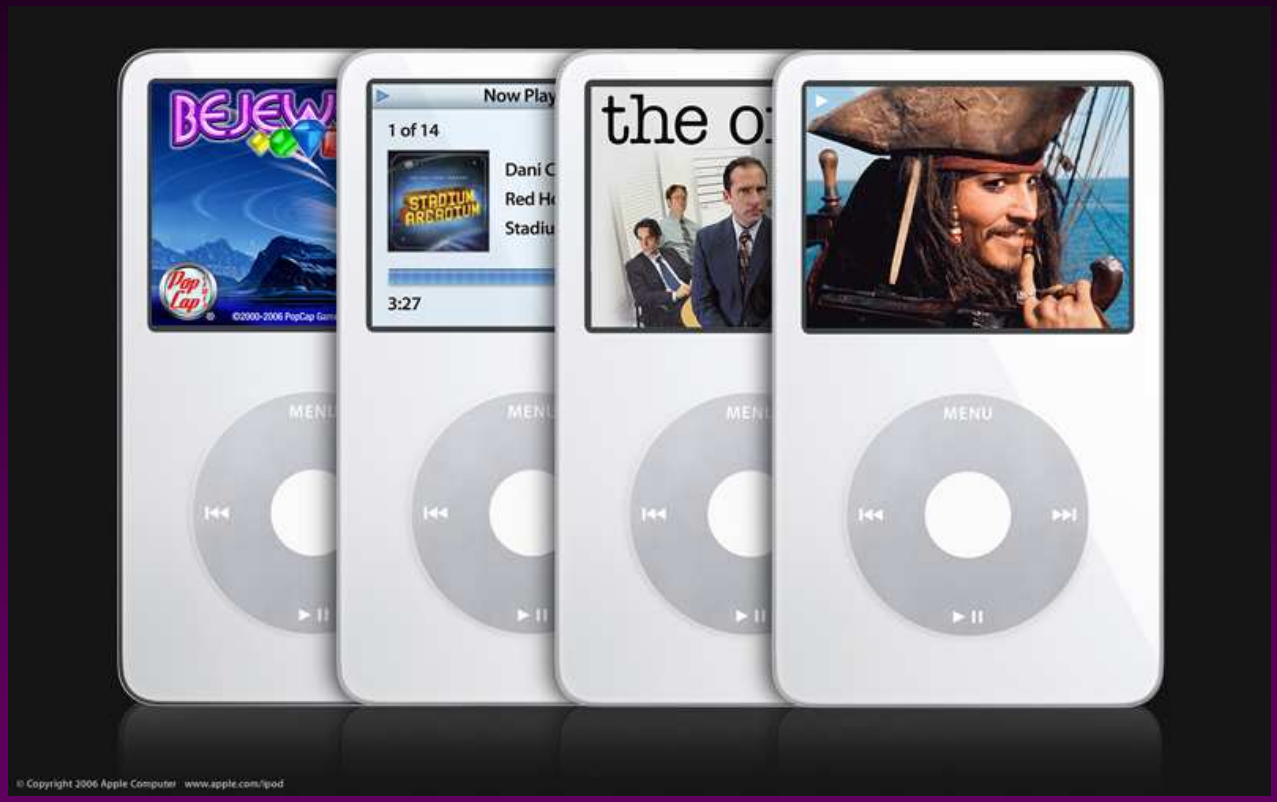
Cause #2



Spuitneus komt rechtstreeks in de

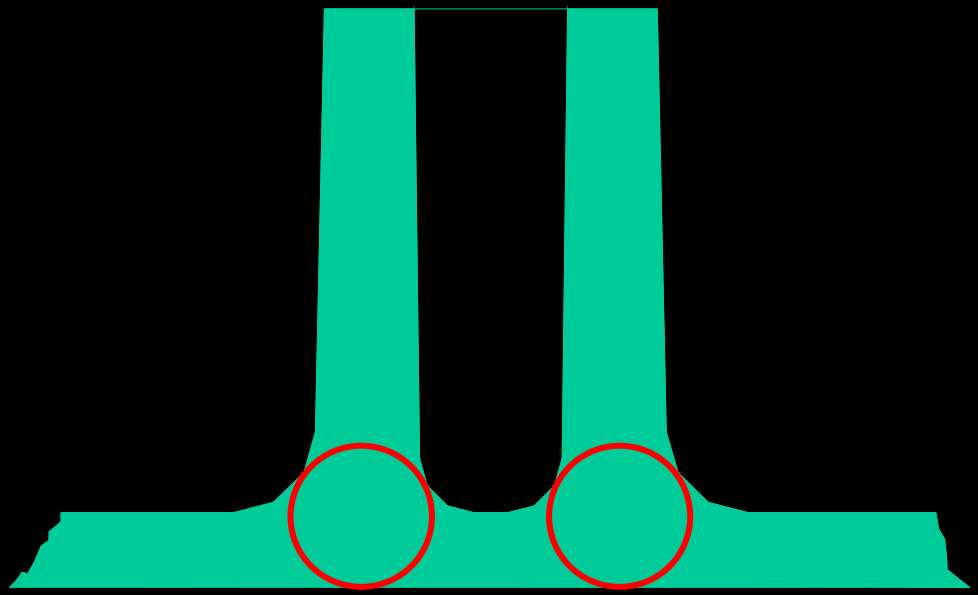
Sinkmarks are localized depressions in the product's surface.
They make the product looking "low quality" and "cheap".

Spuitneus komt rechtstreeks in de holte uit



IPod: absence of sinkmarks give the sensation of a quality product.

Sink marks typically occur in locations where there is a “lump” of material:



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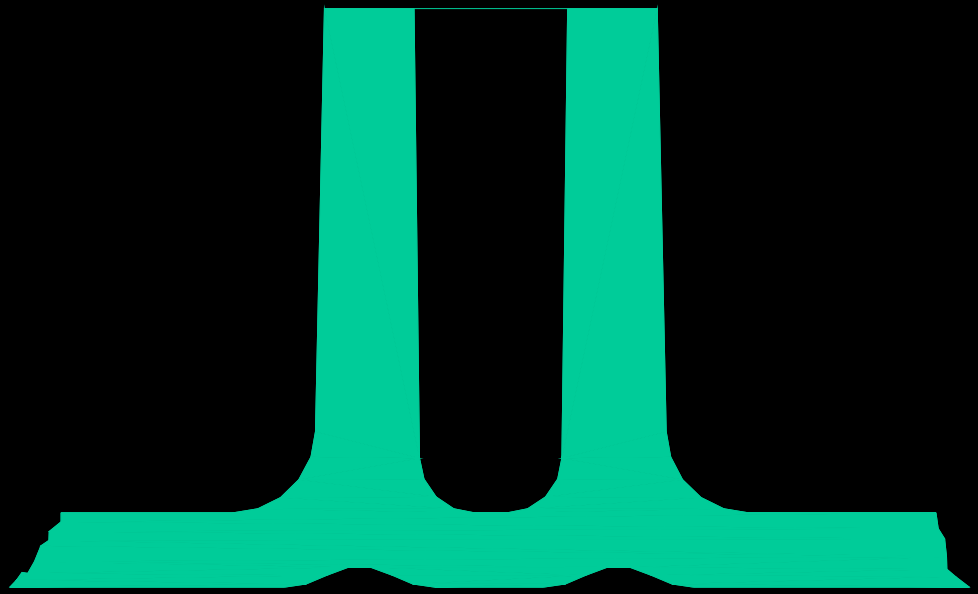
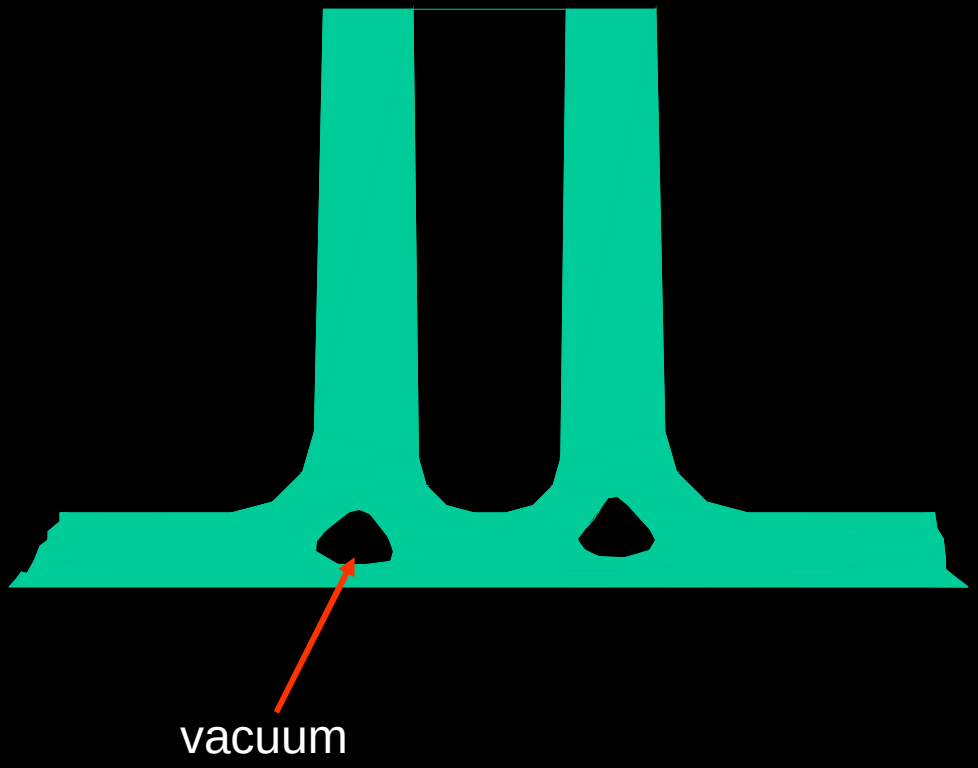


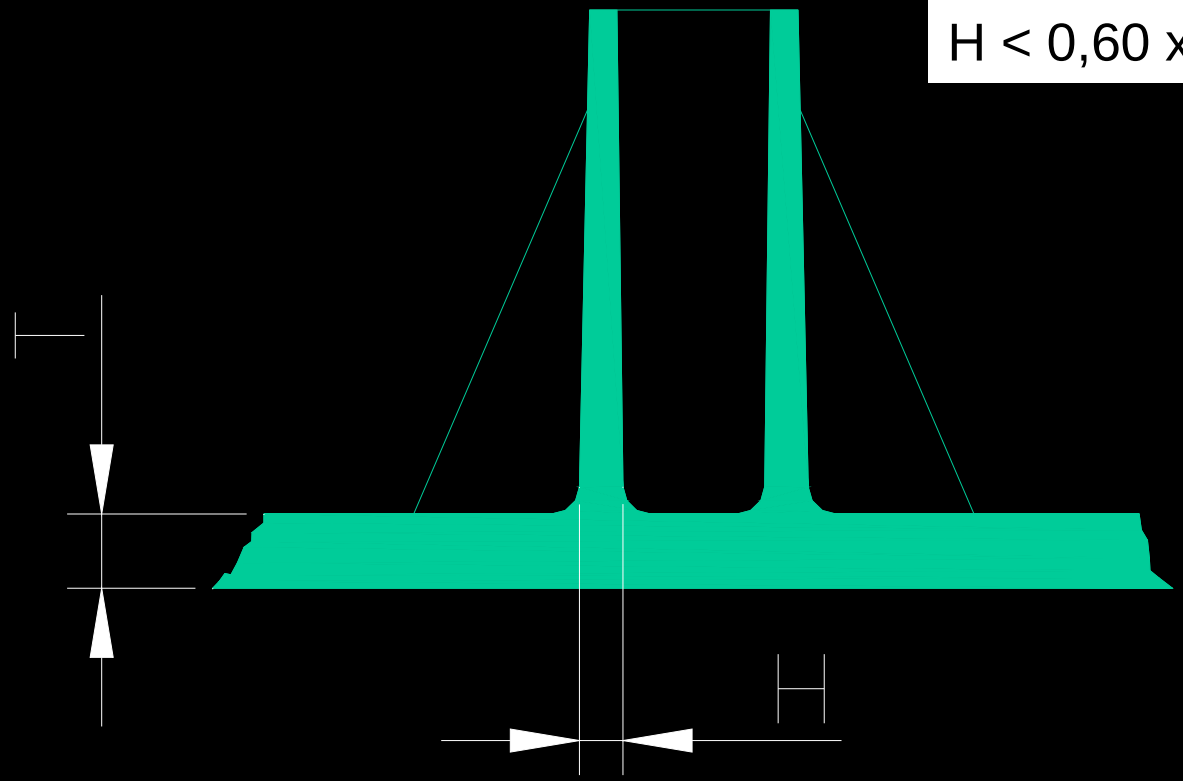
Excessive shrinkage in the lump might even cause voids, compromising the strength of the product.



Design rule:

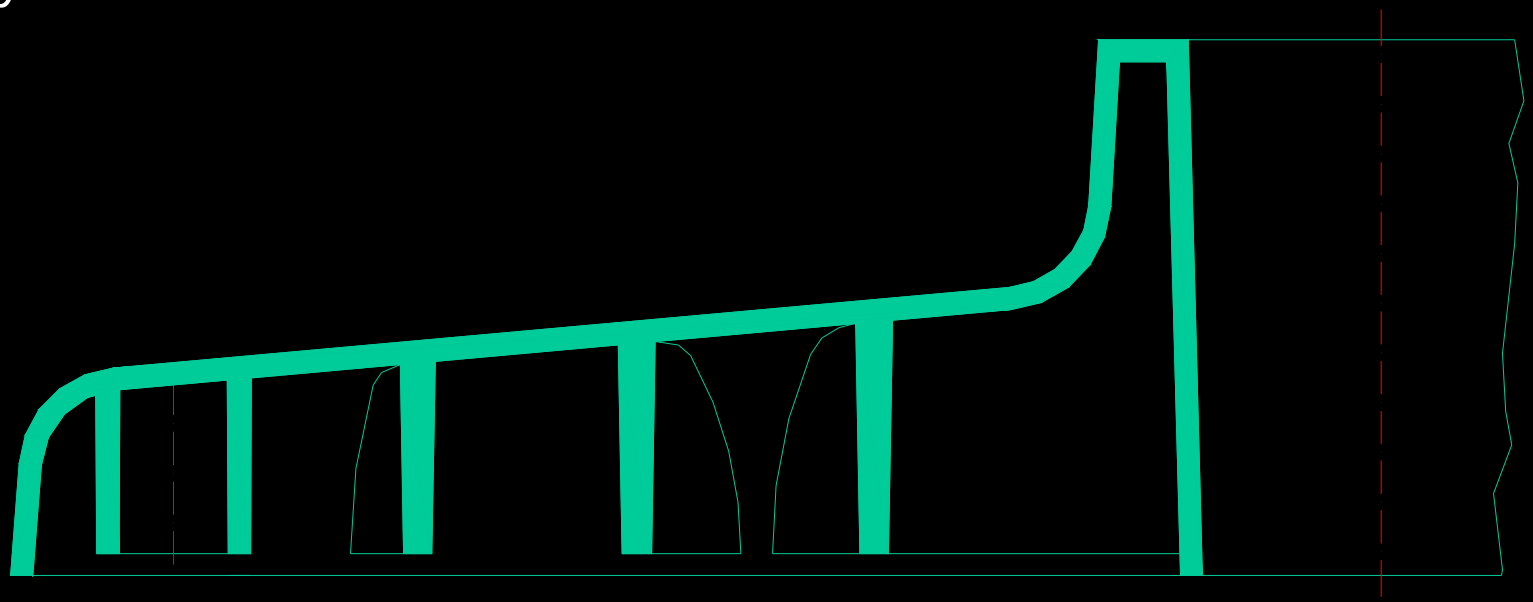
no sink marks when

H < 0,60 x T

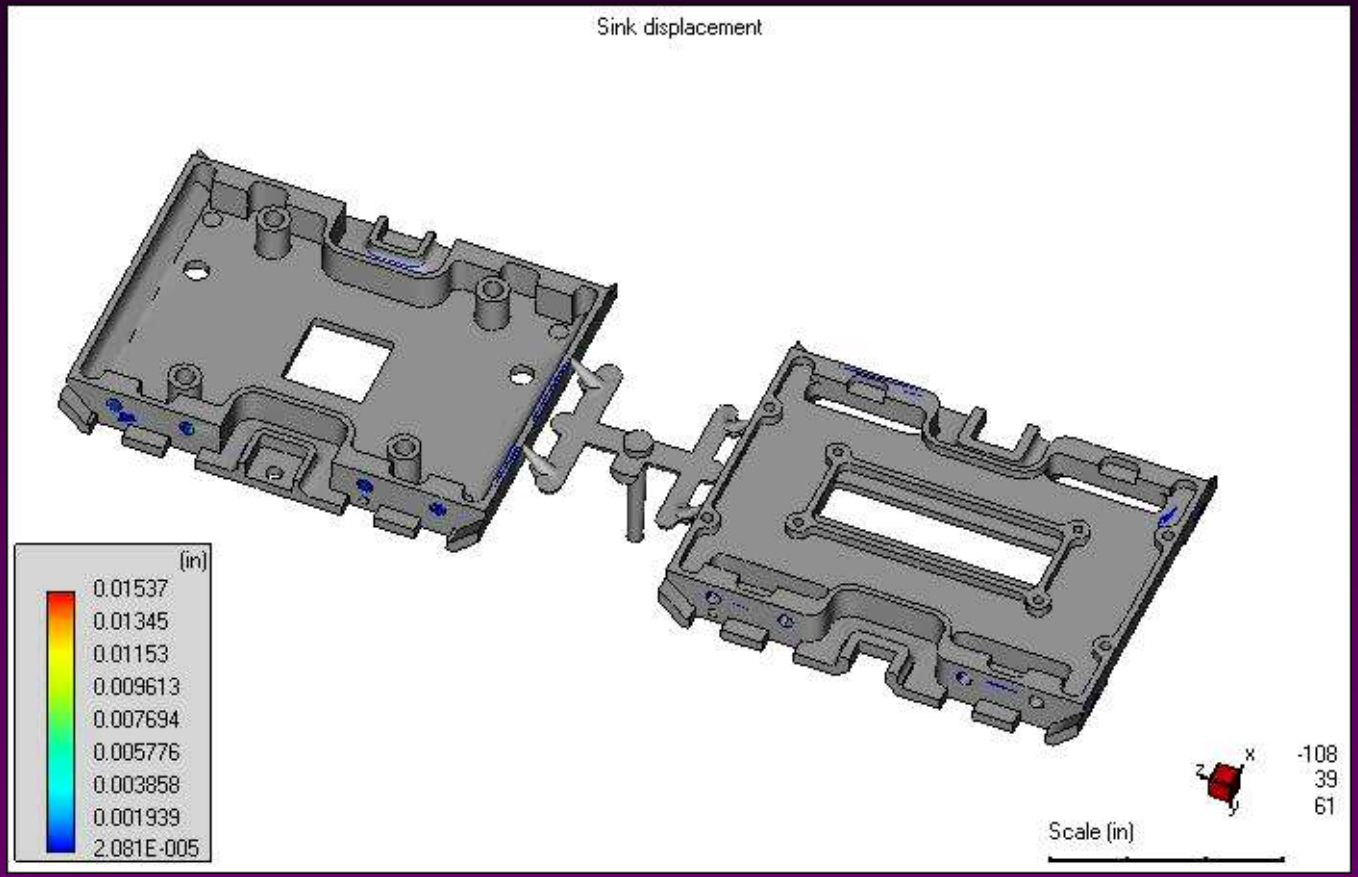


- excessive amount of material
- cycletime > 10 min

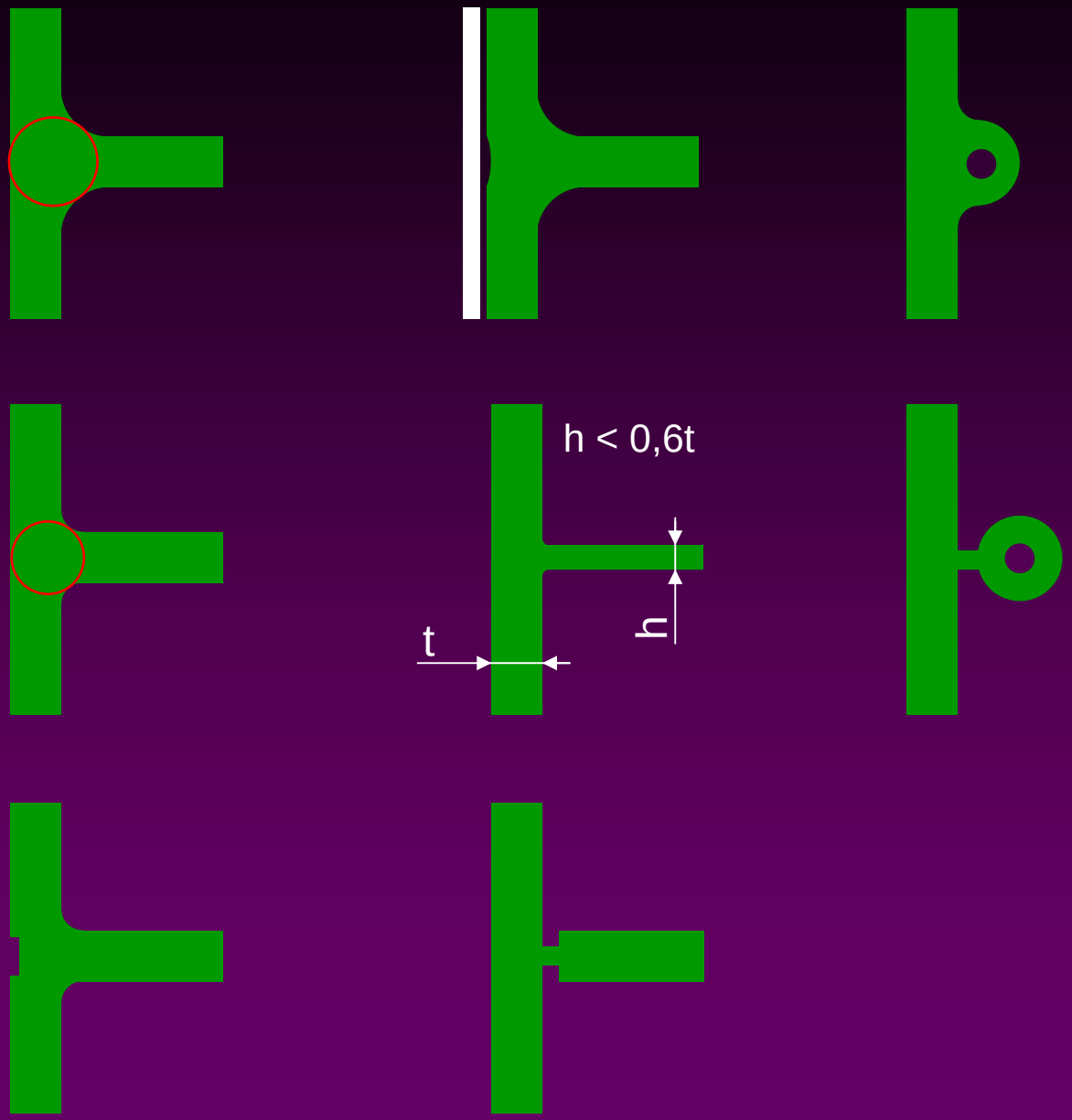
- thin walled product with ribs
- cycle time 35 secs



Shrinkage prediction using Moldflow software

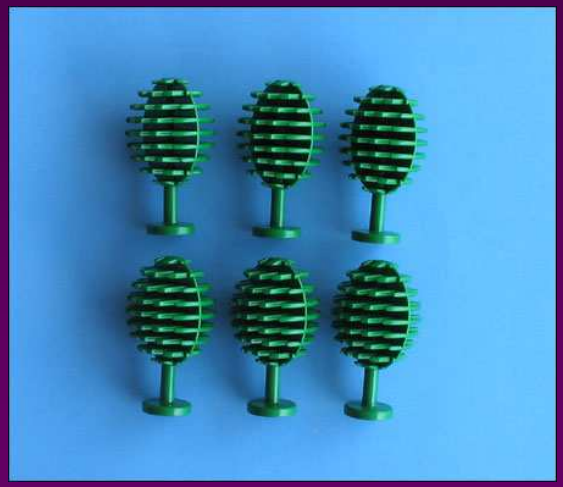


avoiding sink marks



Ribs are being used:

- to increase the product's stiffness
- to fix other parts onto
- to make a thick "solid looking" part for instance a handle, or Lego trees



Approximate Young's Moduli of Various Solids

Material	Young's modulus (E) in GPa
Rubber (small strain)	0.01-0.1
Low density polyethylene	0.2
Polypropylene	1.5-2
Polyethylene terephthalate	2-2.5
Polystyrene	3-3.5
Nylon	3-7
Oak wood (along grain)	11
High-strength concrete (under compression)	30
Magnesium metal (Mg)	45
Aluminium alloy	69
Glass (all types)	72
Brass and bronze	103-124
Titanium (Ti)	105-120
Carbon fiber reinforced plastic (unidirectional, along grain)	150
Wrought iron and steel	190-210
Tungsten (W)	400-410
Silicon carbide (SiC)	450
Tungsten carbide (WC)	450-650

- balance the cost of the parts against the cost of the assembly
- co-operate with mold engineers: use their experience!

Thank you for your attention, and see you in Rotterdam!