FRED

Fabrication Rapide & Éco-Design

Additive Manufacturing + Ecoconcept = High Added Value

PROGRAMME D'INNOVATION POUR LA COMPÉTITIVITÉ DES PME DE LA MÉCANIQUE, DE LA MACHINE SPÉCIALE, DE LA DÉFORMATION ET DES MATÉRIAUX DANS LES RÉGIONS WALLONIE-LORRAINE-LUXEMBOURG (WLL)

Denis Gravet

Le 30-09-2014

UNION EUROPÉENNE

Interreg IV-A

Wallonie

Département Moselle Conseil Général

PRÉFECTURE DE LA RÉGION LORRAINE

sirris driving industry by technology

Additive Manufacturing

=

- No chips
- Freeforms
- Complex shapes
- Internal shapes
- Customization
- Materials range
- Graded materials

Good opportunity to change the World by

Accelerate innovation
Redesign
New **Eco** concepts

- Lightweight
- Internal geometries
- Multi-functional
- Porosities

High Added Value

Why reduce weight ?

- less buiding time
- less waste during production (no chips)
- less energy during production
- less energy during transport
- less energy during component using
- reduce cost
- Carbon footprint ? (Interreg FRED)

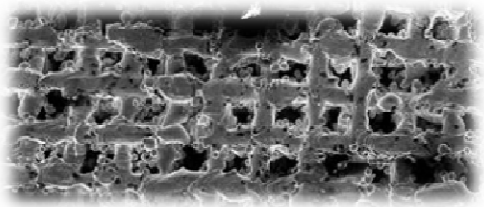
Vanguardist sectors

- Aeronautic
- Spatial
- Automotive
- …

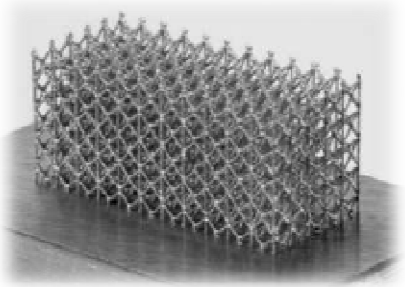
How reduce weight ?

Functionalities

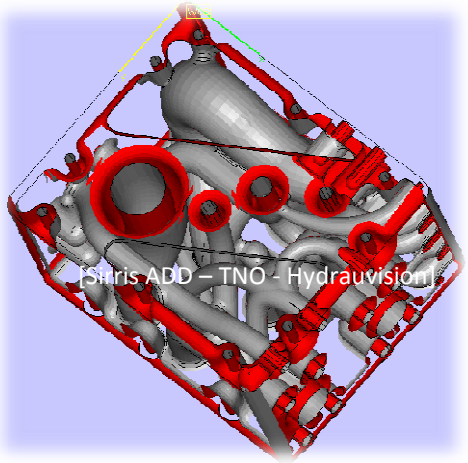
Porosities



3D lattice structures

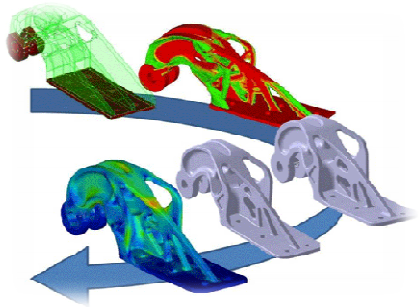


Internal freeforms



Multi - functionality

Topology optimization



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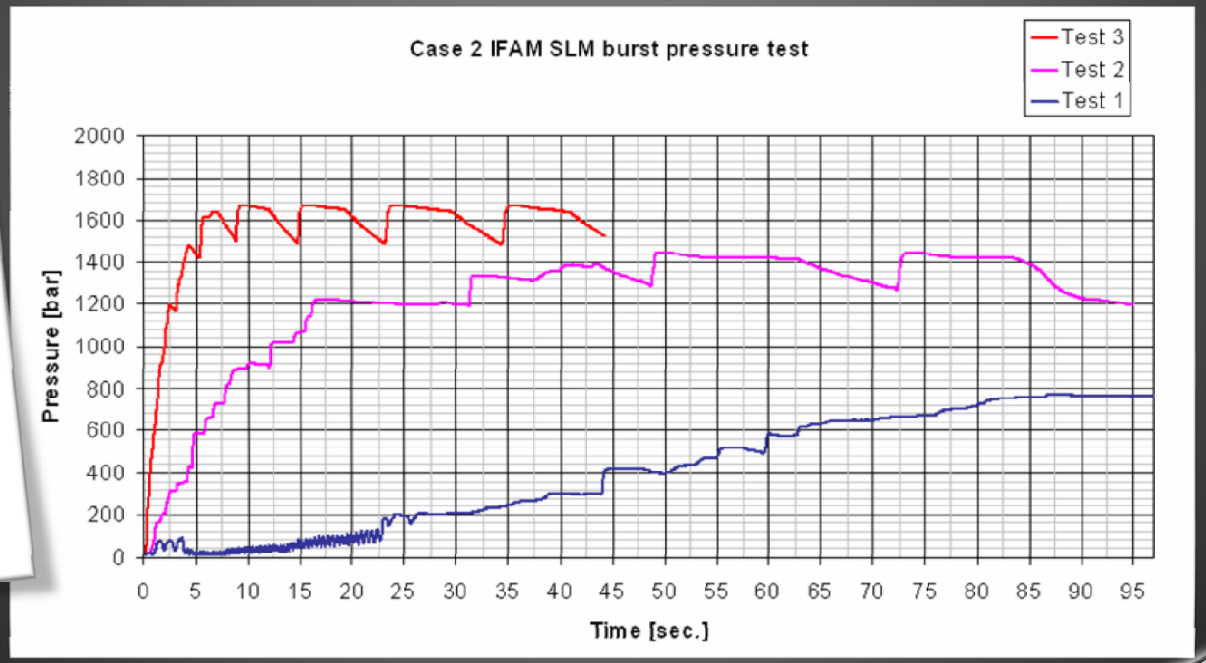
Fabrication Rapide & Éco-Design

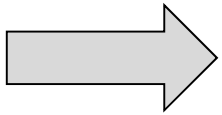
Pressure resistance

- p using: 400b
- p test: 600b
- p rupture PM: 1.535b

Functionalities

Results of pressure test IFAM SLM



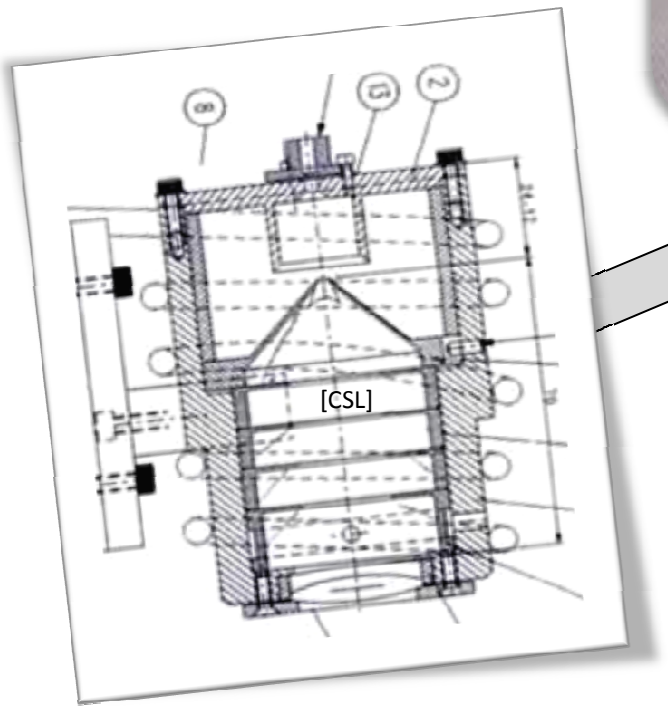


- Mass: 1.33kg at 0.8kg ➔ Reduction of **38%**
- Volume: 171 cm³ at 91 cm³ ➔ Reduction of **47%**
- External size: **similar**
- Pressure resistance **OK**
- Cost 1 unit PM: 450€ (**similar** conventional)
- Cost 150 units PM: 43€/unit

Multi - functionality

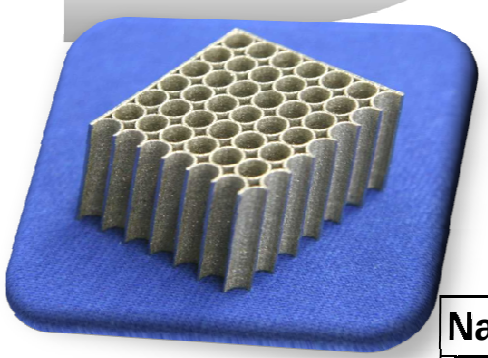

[Sirris ADD - CSL]


[Sirris ADD - CSL]

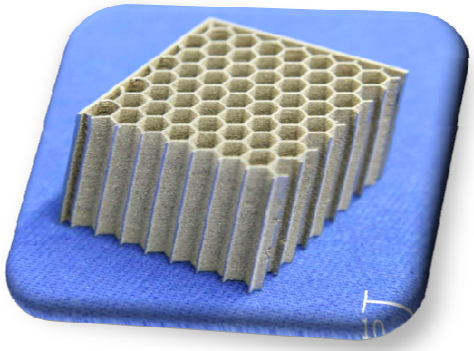

[CSL]

- Simplification
- Cooling tube removed and integrated
- Support integrated
- Rings and braces removed
- 12 components ➔ 1 part

3D lattice structures

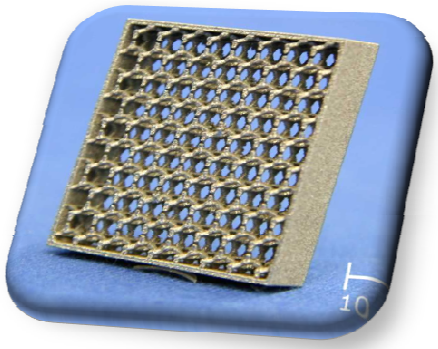


Circular profil



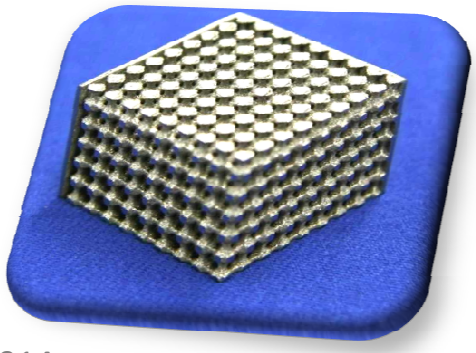
Honeycomb

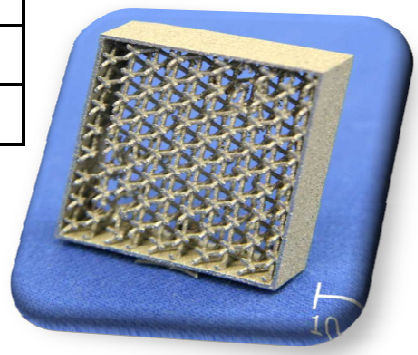
Name/Description	Part volume	Relative
Full cube	27.00 cm³	100 %
Circular profile	4.37 cm³	16 %
Spherical	2.75 cm³	10 %
Honeycomb	3.74 cm³	14 %
Double honeycomb	3.25 cm³	12 %
Reduced honeycomb	1.93 cm³	7 %



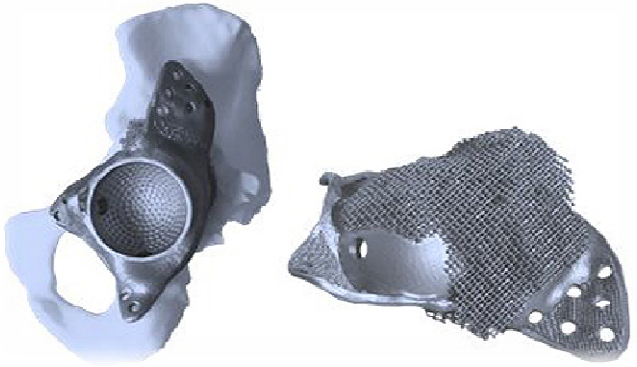
Double honeycomb

Spherical

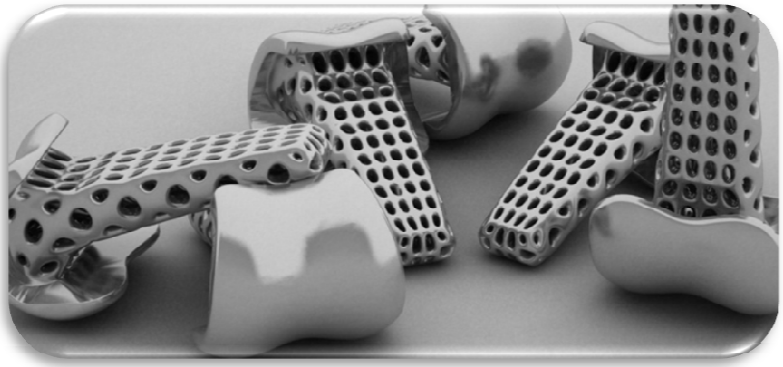


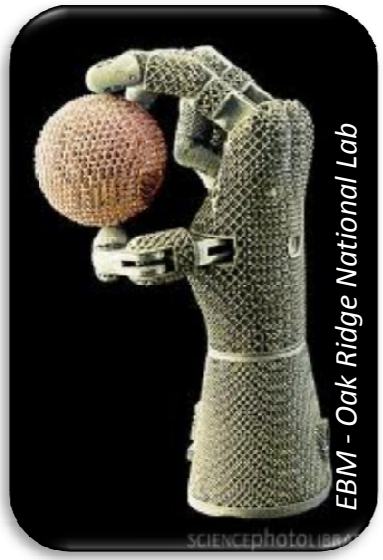


Reduced honeycomb

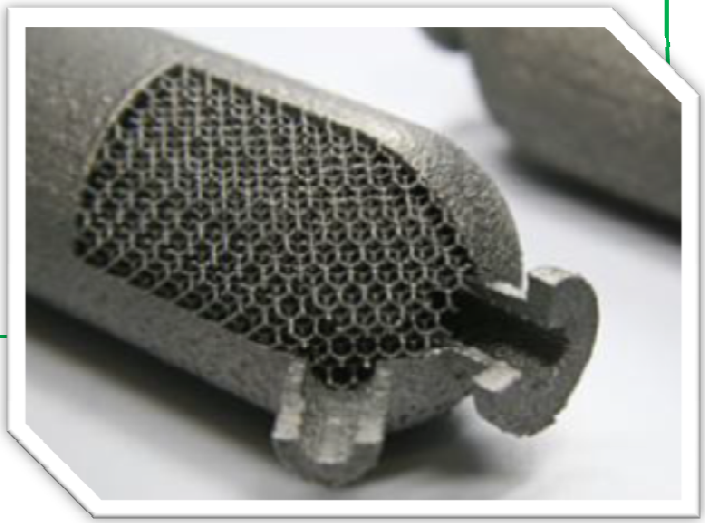


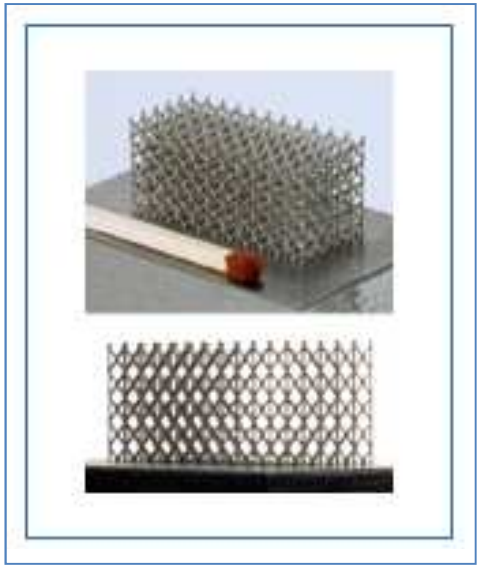
3D lattice structures

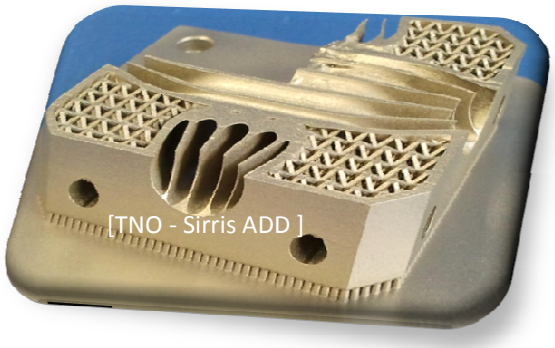




- Weight reduction with minimal strength reduction
- Biomedical implants: bone regeneration
- Graded structures
- Shock damping
- Vibration reduction
- Filtration





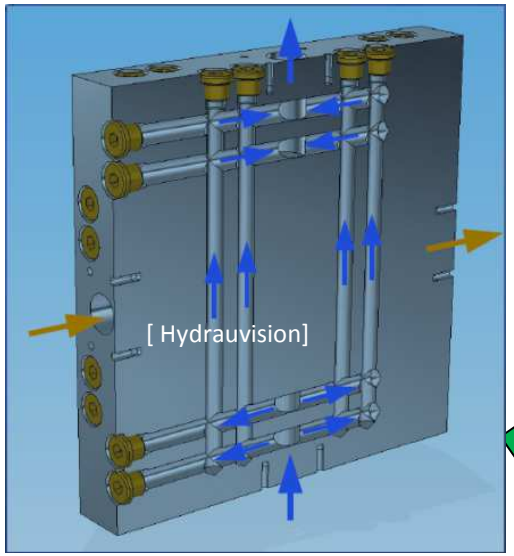


Functionalities

Internal freeforms

- Weight
- Volume
- Pressure drops
- Cost
- Pressure resistance

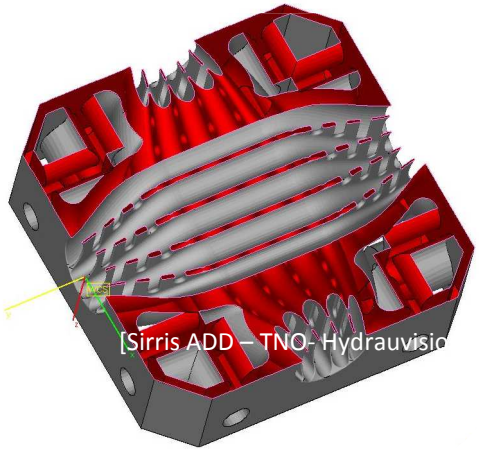
Manifolds (Hydrauvision)

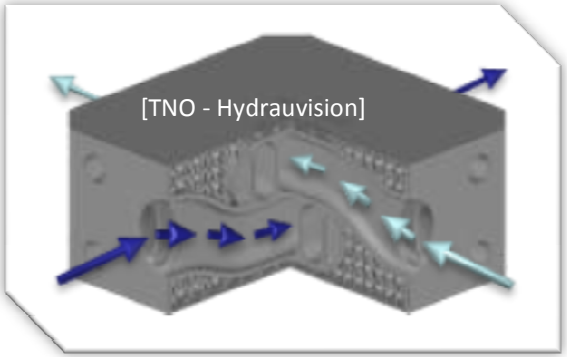


Volume: 2.900 cm³

Mass: 19.2 kg

External size: 210 x 210 x 70mm





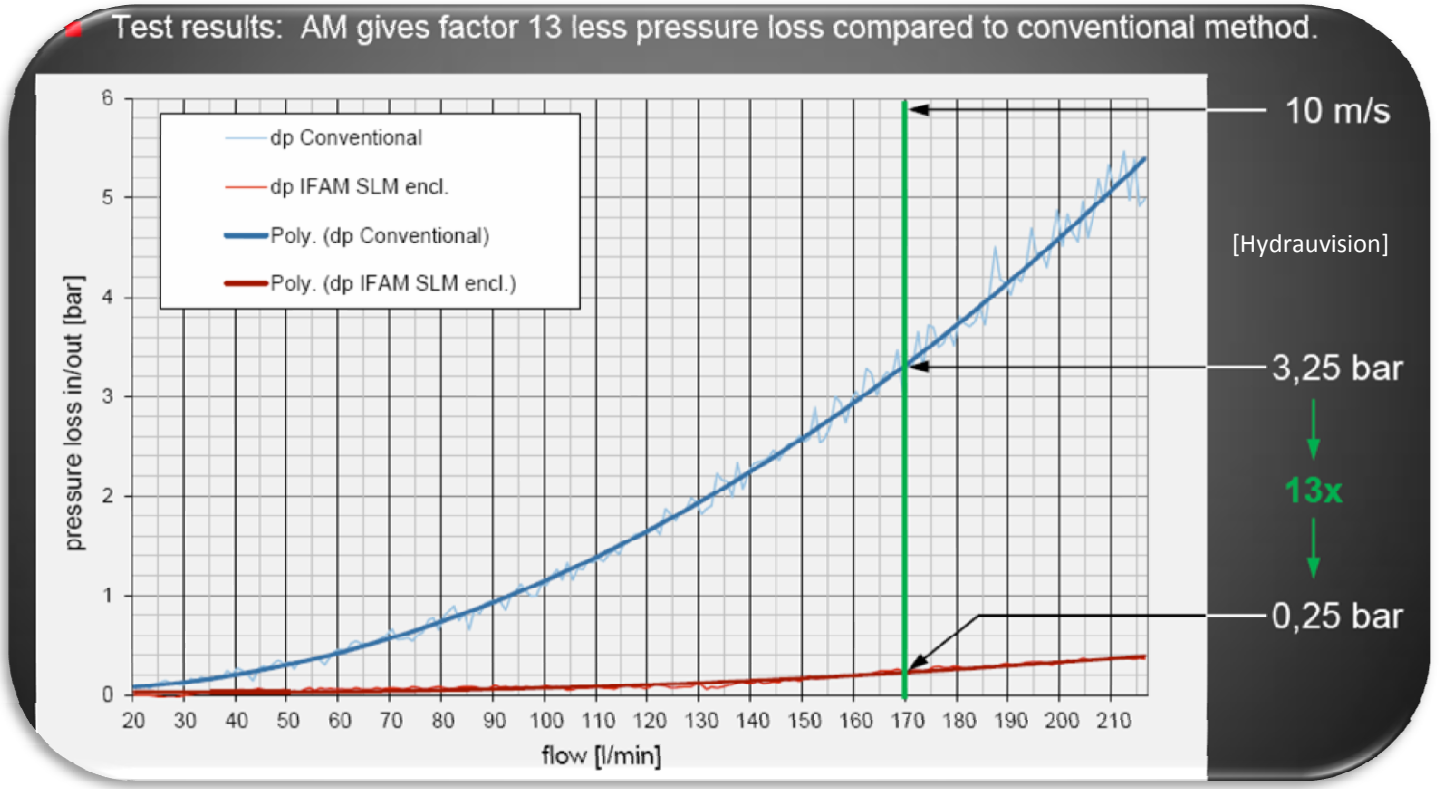
Volume: 244 cm³

Mass: 1.2 kg

External size:

85 x 85 x 38mm

Pressure drops:



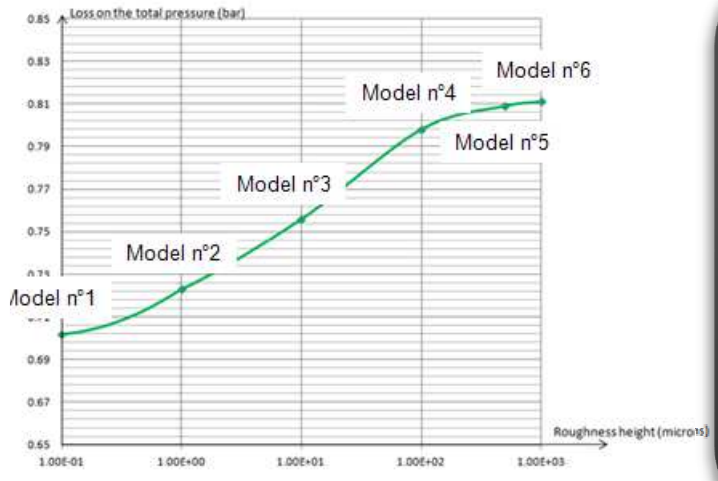
3,25b

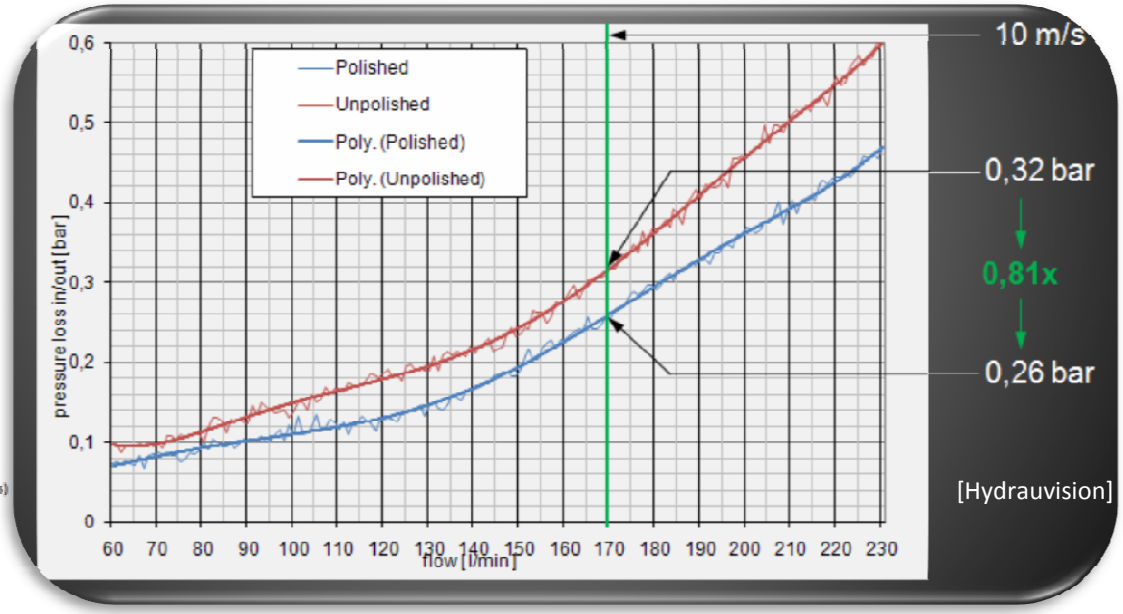
13x

0,25b

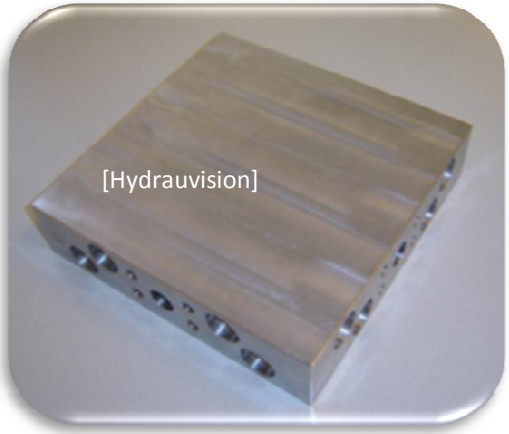
Very important reduction of pressure drops and also good pressure resistance

Influence of **roughness** on pressure drops:





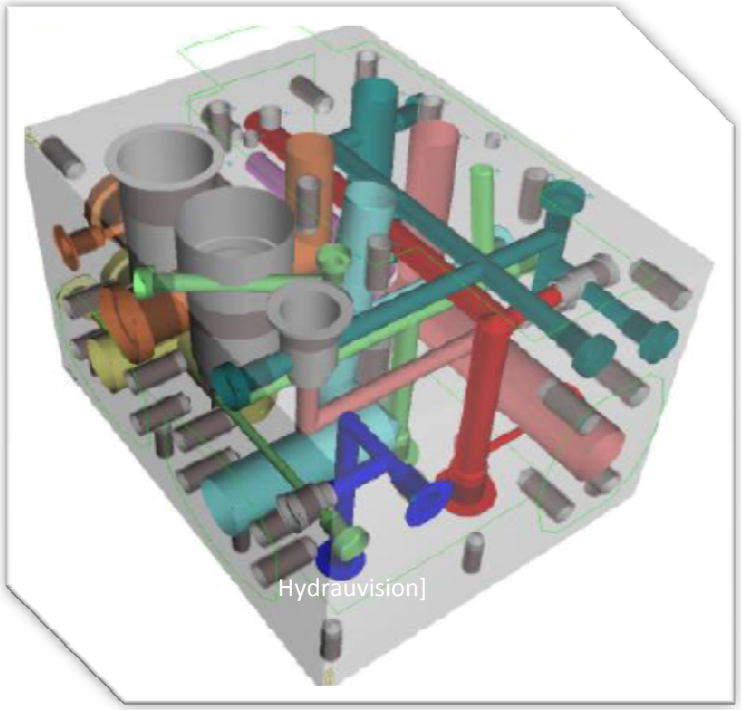
Negligeable regarding previous result and cost of polishing

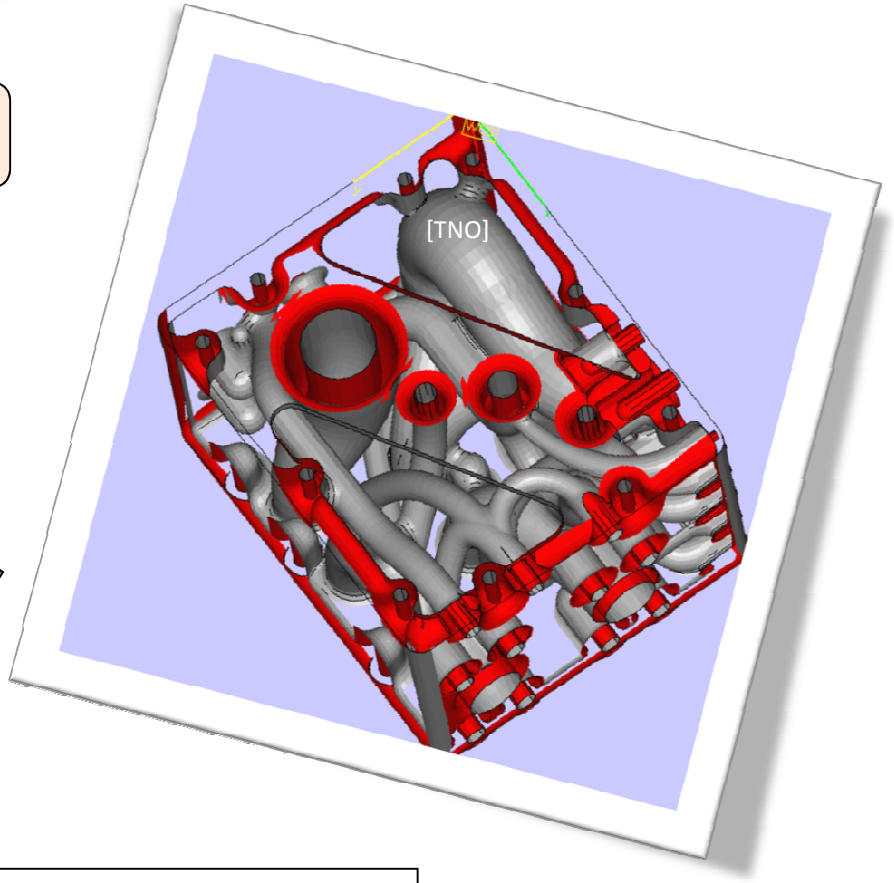


- Mass: 19.2kg at 1.2kg ➔ Reduction of 94%
- Volume: 2900 cm^3 at 244 cm^3 ➔ Reduction of **92%**
- External size: **much less** (210mm => 85mm)
- Pressure resistance: **OK**
- Pressure drops: 3,25 at 0,32b ➔ Reduction of **90%**
- Cost 1 unit PM: 750€ at 538€ ➔ Reduction of **28%**
- Cost 112 units PM: 78€/unit + milling

Functionalities

Internal freeforms

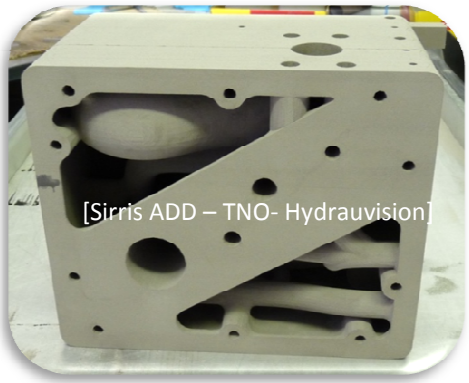


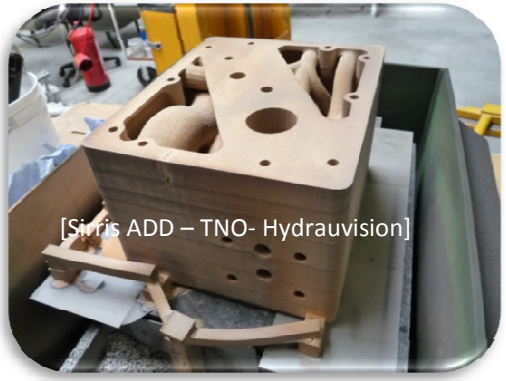


Rounded channels

Changing diameters

Same functionalities

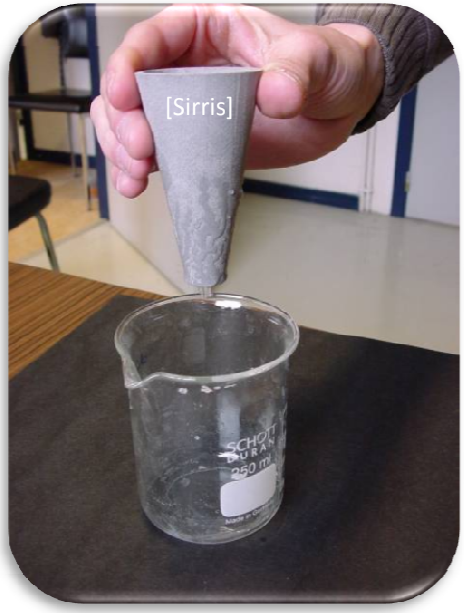


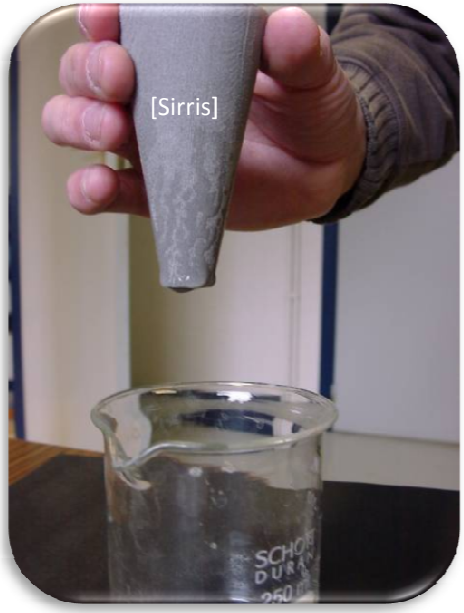


- Mass: 55kg at 20kg ➔ Reduction of 63,6%
- Volume: 2334 cm^3
- External size: 265 x 200 x 165mm => 240 x 200 x 150 mm
- Pressure resistance: **OK**
- Pressure drops: 1,68 at 0,37b ➔ Reduction of **78%**
- Cost 1 unit PM: 2500€ at 3122€ + milling ➔ increase of >**25%**
- Cost 6 units PM: 2500€/unit at 2376€ + milling **(similar)**

Investigation ways to manage the porosity

- Sintering parameters
- Composition of the powder mixture
- Addition of organic charges





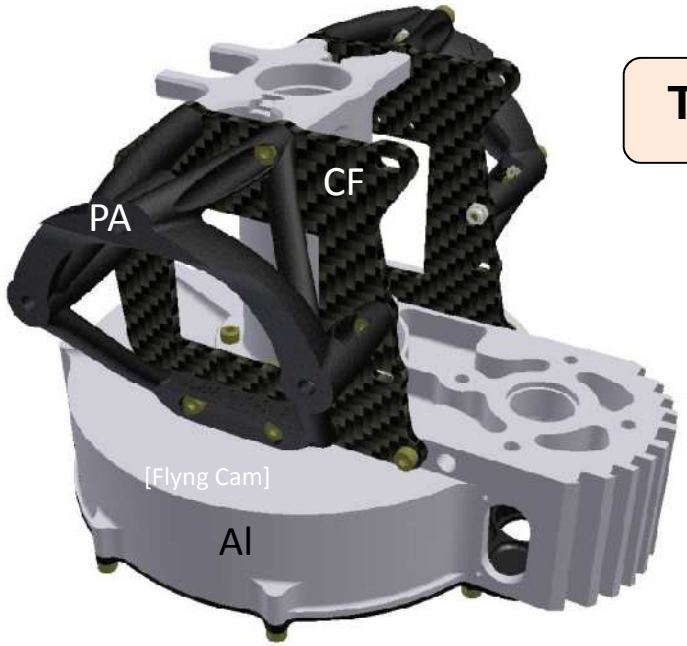
	Densité (%)	porosité ouverte	porosité fermée	R0,2 (MPa)	Rm (MPa)	A (%)
I66 1425°C	92,7	1,3	6,0	152	416	37
I66 1420°C	92,6	1,3	6,1	137	400	35
31 1420°C#1	92,4	1,0	6,5	154	457	42
31 1420°C#2	**97,1**	**1,0**	**1,9**	**158**	**512**	**62**

Porous applications

- Fluid controls, filters,

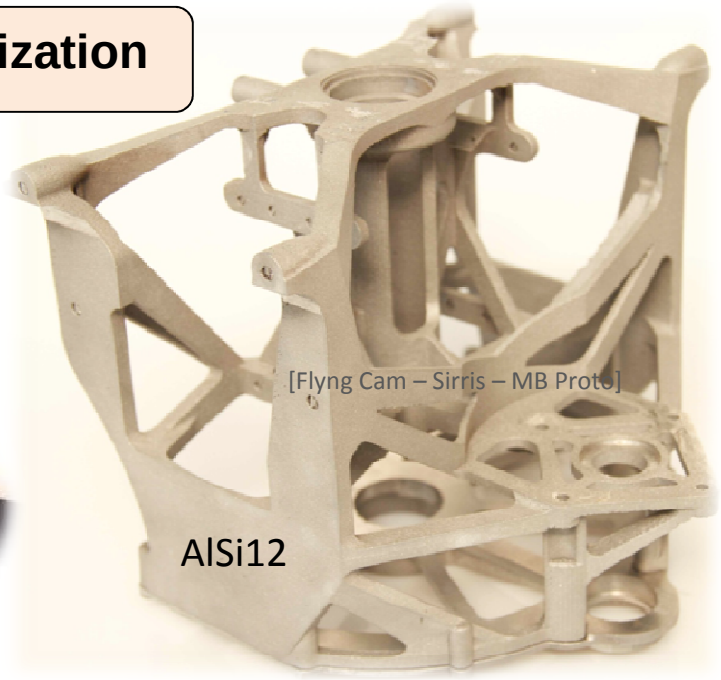
- Material: SS316L
- Density: 50-95%
- Open porosity: 0-50%
- Pore diameters: 5-35µm
- Permeability (Darcy law): 10^{-16} up to $10^{-12}m^2$

- Weight reduction: 530g ➔ 392g (–26%)
- 7 components ➔ 2 components
- 3 materials ➔ 1 material (1 technology)
- Carbon foot print



Topological optimization

[FP7 Compolight Project]



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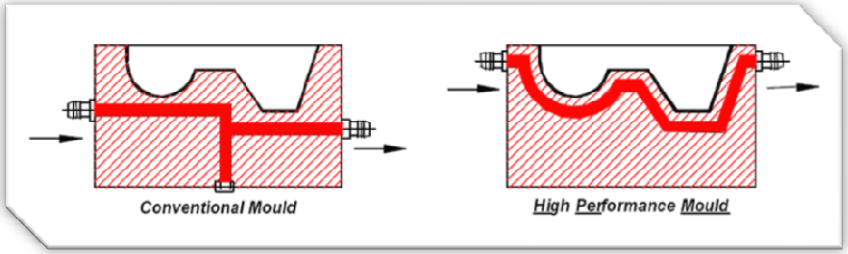
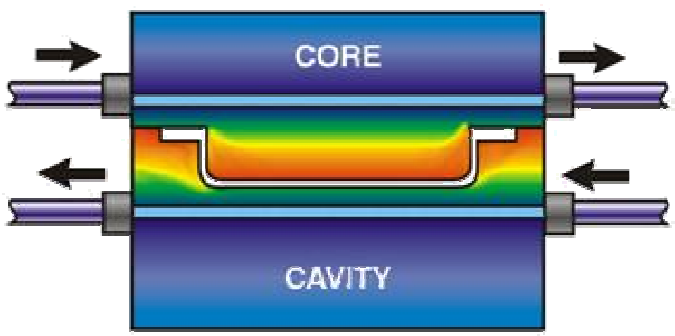
Thermal management

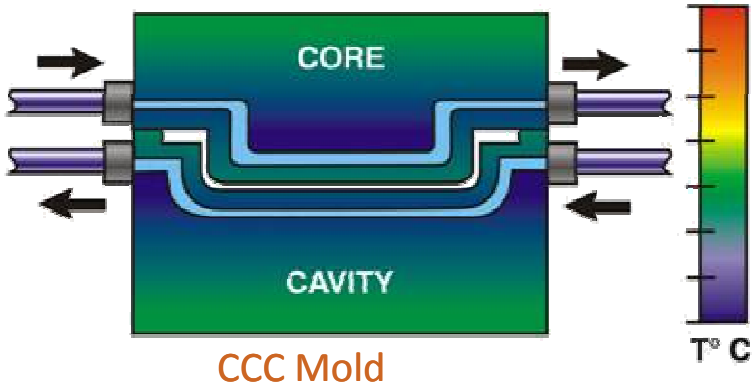
by

Conformal Cooling Channels





Conventional Mold

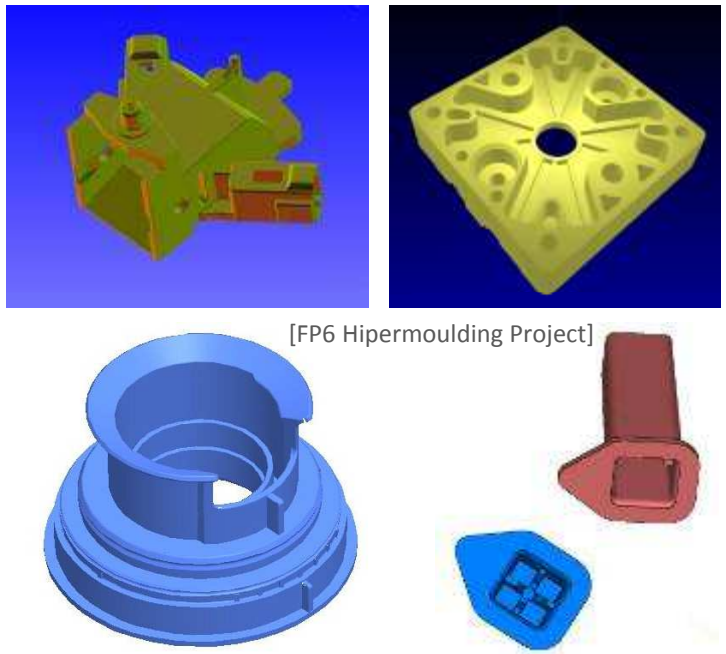


CCC Mold

High performance molds using Conformal Cooling Channels in an optimal way near the surface of the cavity

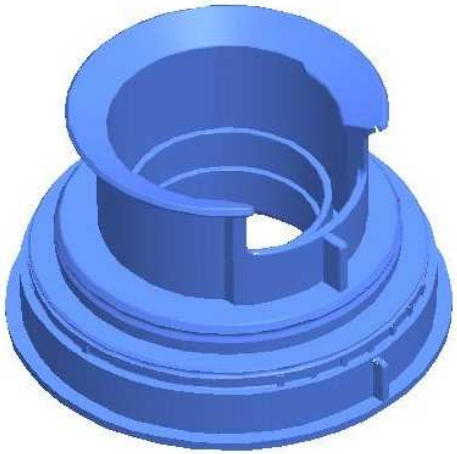
Industrial cases: (in production)

- Tool conception
- Building of inserts by additive manufacturing
- Milling and assembly of inserts in the cavities
- Comparison conventional and CCC molds

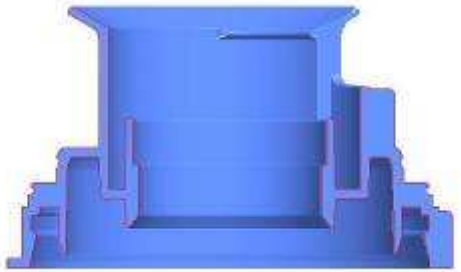


[FP6 Hipermoulding Project]

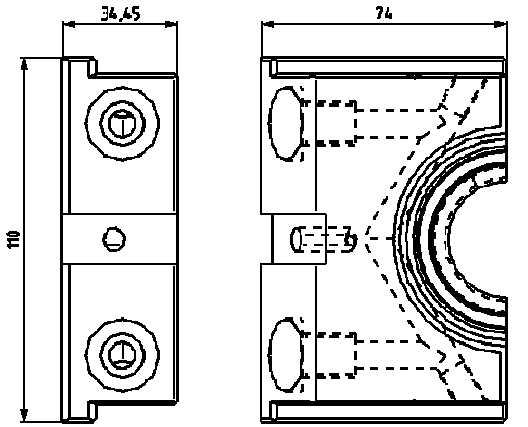
Spanish case: Gestap (Food sector)

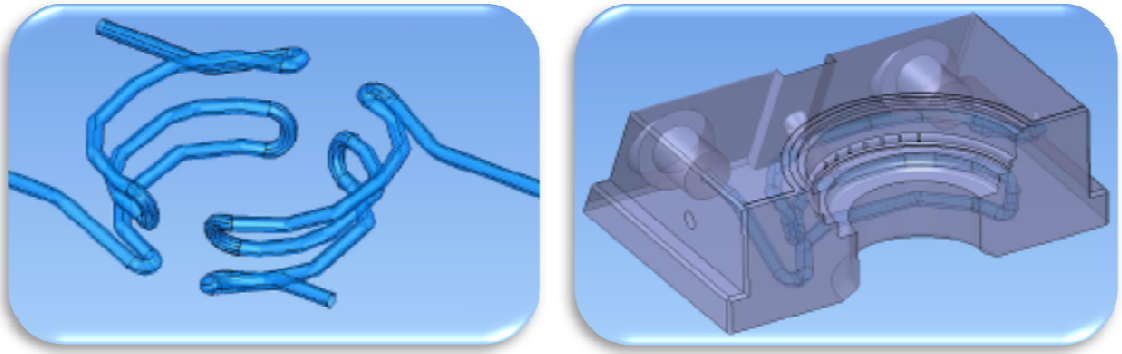


- Material: HDPE
- Size: Dia 60 x 35 mm
- Thicknesses: 1.2 / 1.7 mm
- Production: 6.000.000 units/year
- t_{cycle}: 38 s (Too long)



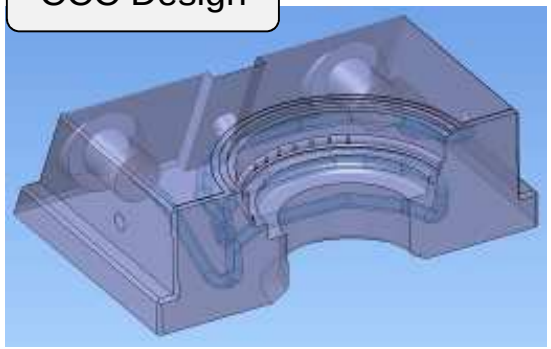
[FP6 Hipermoulding Project]





Dia 60 x 35 mm

CCC Design



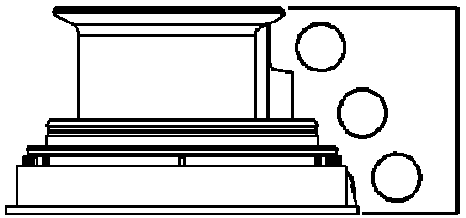
[FP6 Hipermoulding Project]

LBM manufacturing

- Concept Laser CL50 (steel 1.2344)

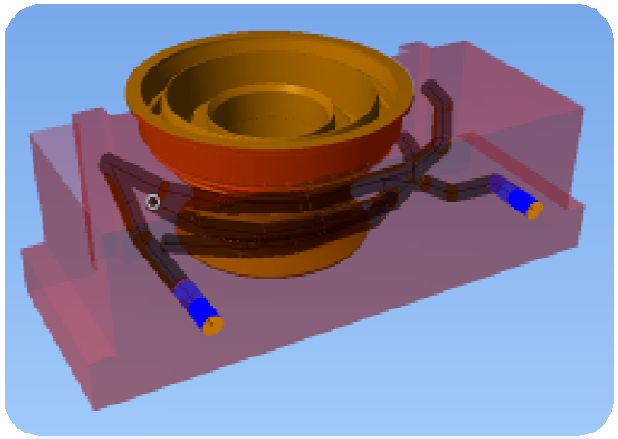
Finishing and mould integration

Injection

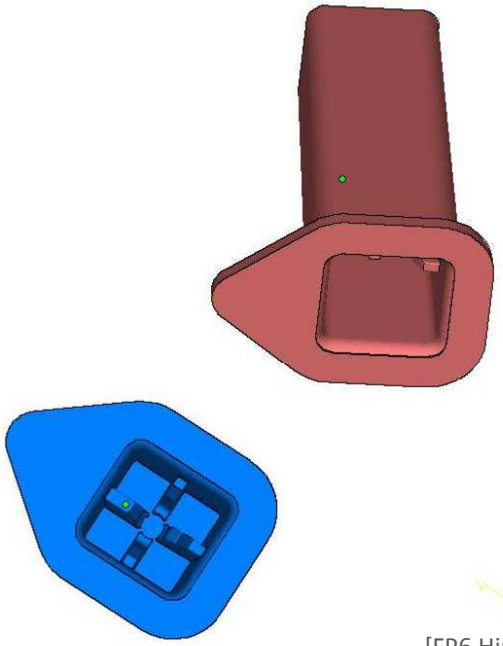


- Conventional cycle time: 38s
- CCC cycle time: 32s
- Reducing cycle time: 16%
- Profit as the 1° year: 222.000 € (6.000.000 units/year)

[FP6 Hipermoulding Project]

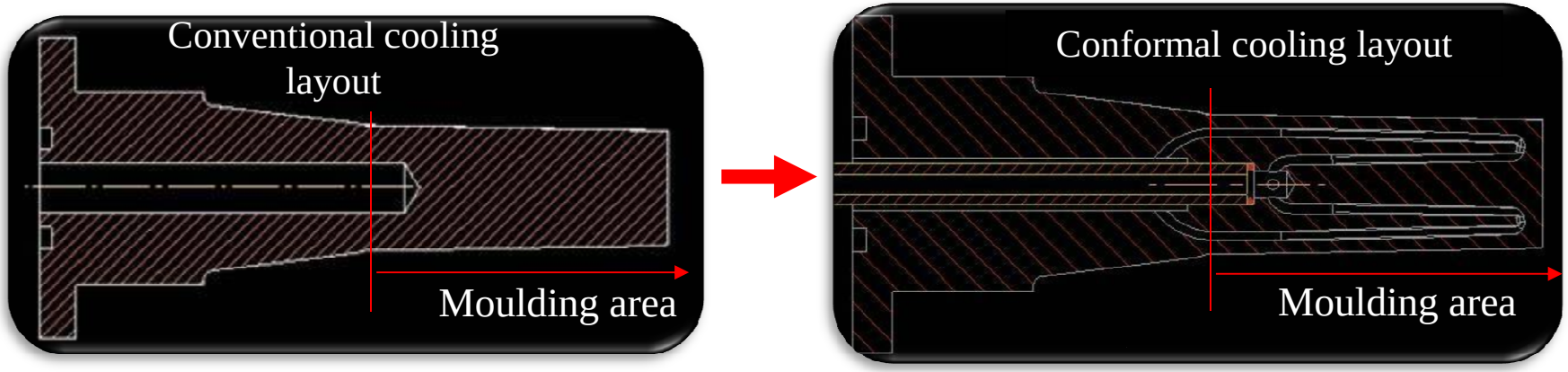


Belgian case: Container (Medical sector)



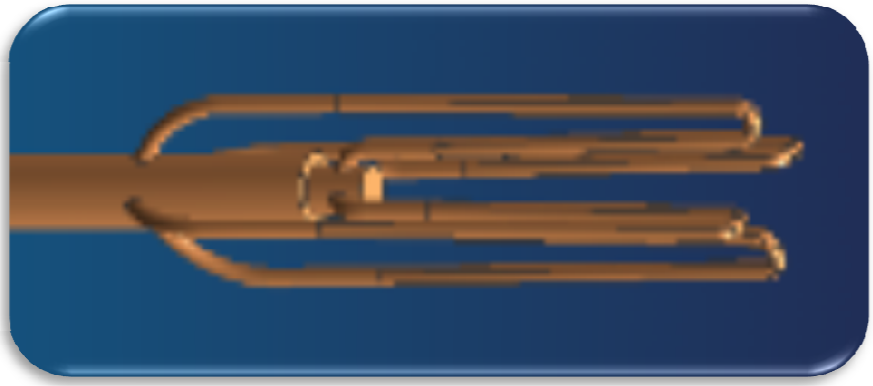
- Material: PP
- Size: 26 x 36 x 53 mm
- Thicknesses: 2 mm
- Production: 100.000 units/year
- t_{cycle}: 27.2 s (Too long)
- Very small parts: very closed volume available to manage a good cooling
- Ejection problems

[FP6 Hipermoulding Project]



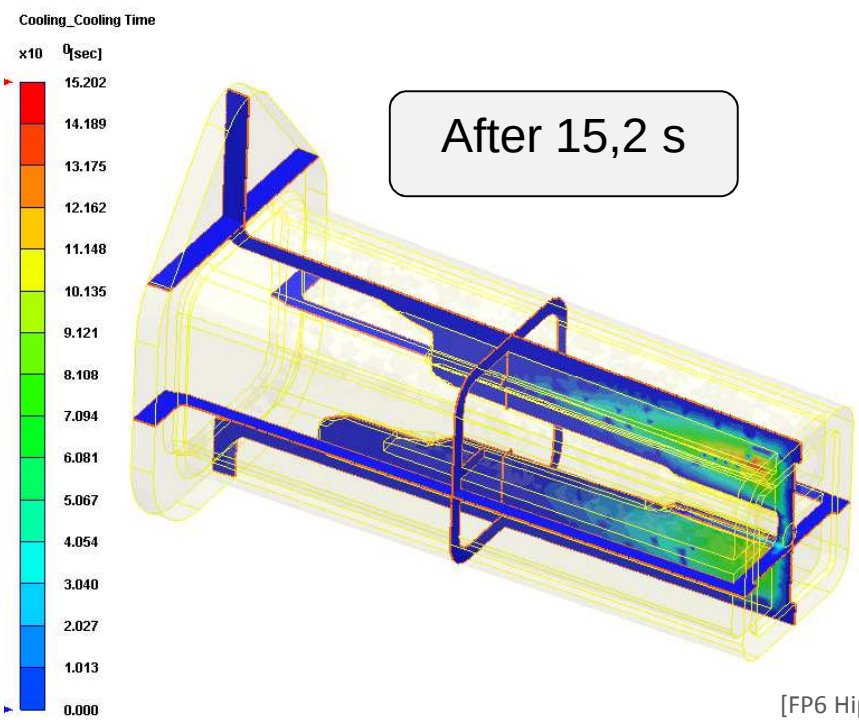
[FP6 Hipermoulding Project]

New core concept to increase the thermal exchanges: 4 cooling channels (Dia 1.5mm)

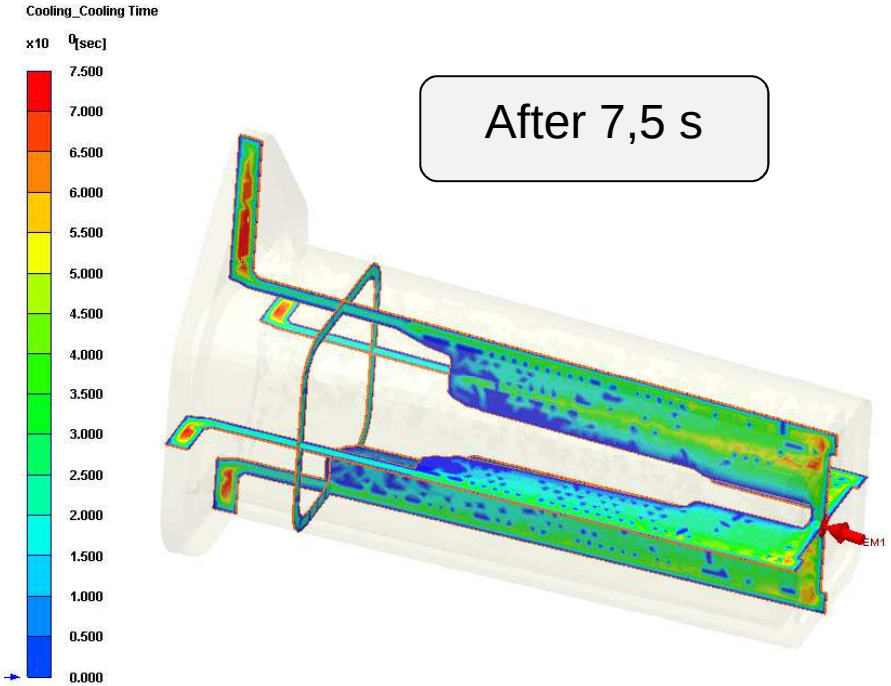


PROGRAMME D'INNOVATION POUR LA COMPÉTITIVITÉ DES PME DE LA MÉCANIQUE, DE LA MACHINE SPÉCIALE, DE LA DÉFORMATION ET DES MATÉRIAUX DANS LES RÉGIONS WALLONIE-LORRAINE-LUXEMBOURG (WLL)

Cycle time



After 15,2 s

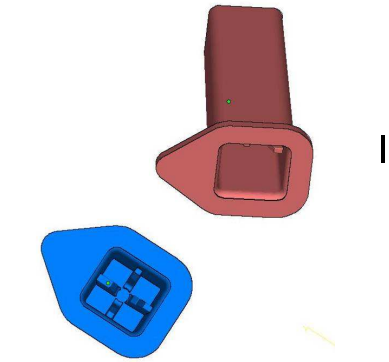


After 7,5 s

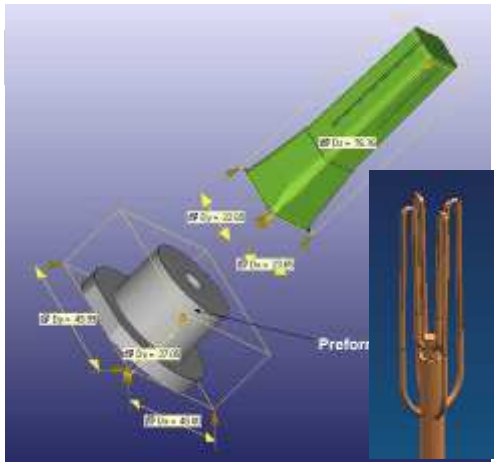
[FP6 Hipermoulding Project]

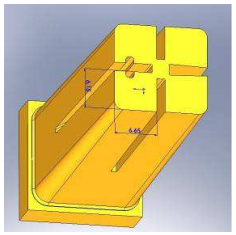
Conventional concept

CCC concept



26 x 36 x 53 mm



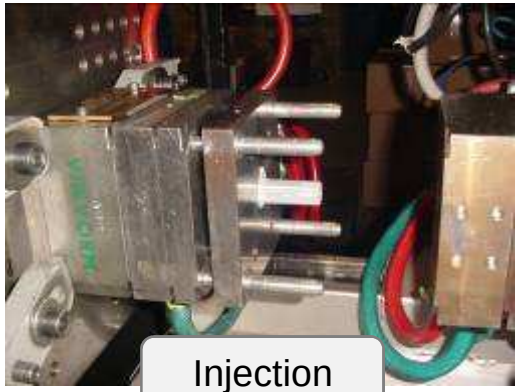


LBM Manufacturing

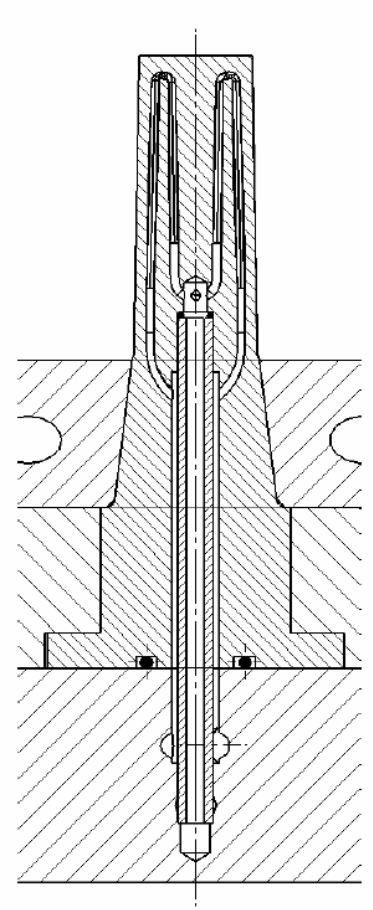
- Concept Laser CL50 (steel 1.2344) [FP6 Hipermoulding Project]

Finishing

Mould integration



Injection



- Conventional cycle time: 27.2 s
- CCC cycle time: 17.9 s
- Reducing cycle time: 34%
- Profit as the 1° year: 8600 € (100.000 units /year)
- Reducing thickness
- Better ejection and quality part

[FP6 Hipermoulding Project]

➔ Reducing cycle time: 10 - 35%

➔ Reducing energy consumption (cycle time, less material, less warping, good filling and less rejects)

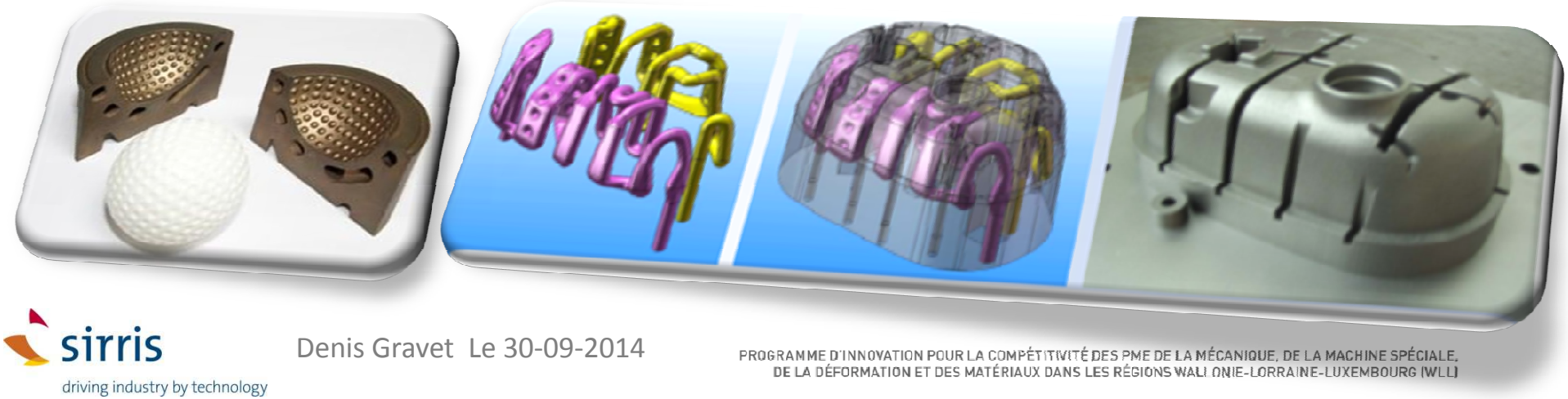
➔ Improvement of the durability of mould (Uniformity of T°and pressure – Reducing Max T°and pressure)

➔ Reducing unit cost (Reducing time, rejects, material volume)

➔ Improving quality injected parts (Hot spots management, Mould T° uniformity, reducing rejects)

➔Possibility to local cooling by local insert integration

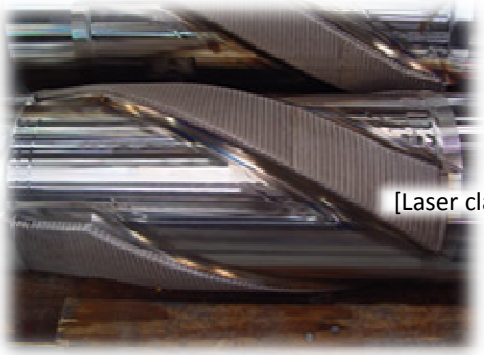
➔ Carbon foot print



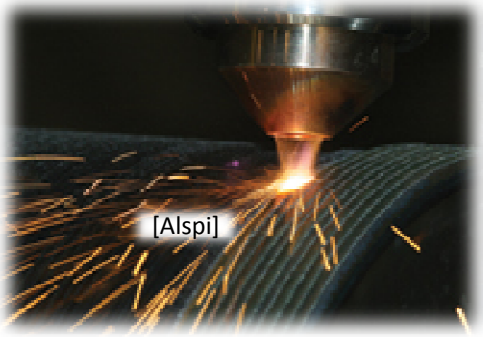
Laser Metal Deposition (Cladding)

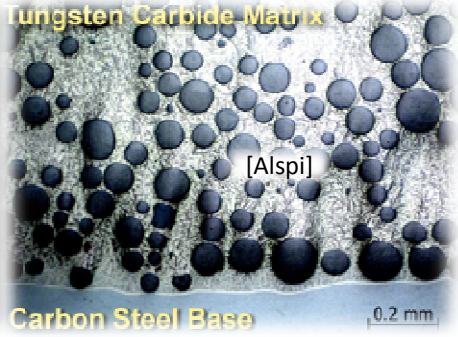
→ **Coating :**

- Easy way to coat any piece from its CAD file in order to improve properties such as :
  - Wear resistance
  - Corrosion resistance
  - hardness



- 3-D parts for glass manufacturing
- Wear protection
- Powder-based cladding process

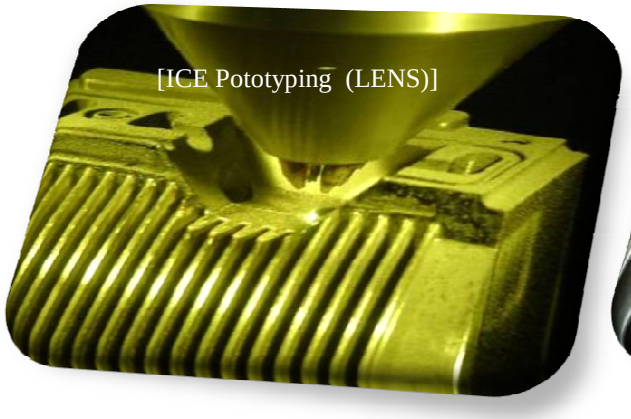




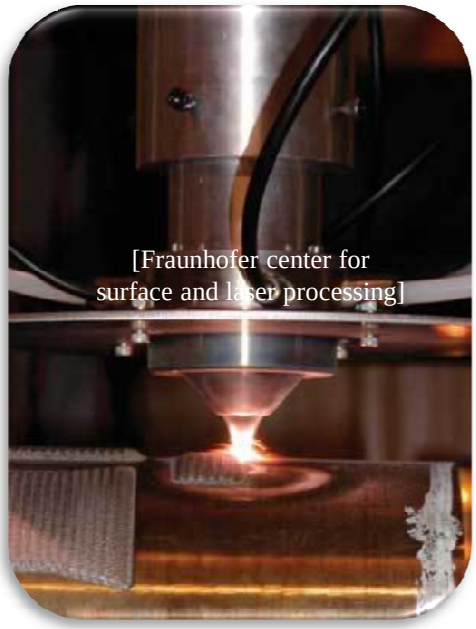
→ **Repairing :**

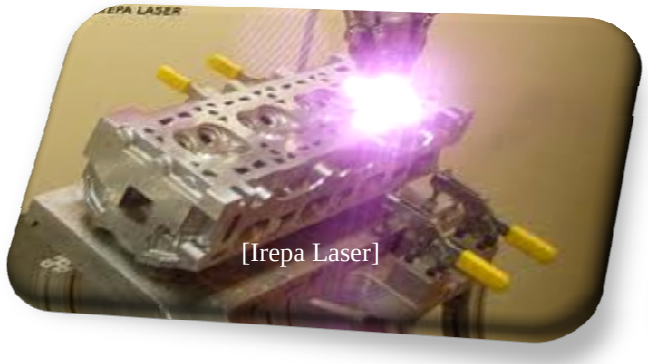
- Parts with high added value


[IWS fraunhofer]


[ICE Pototyping (LENS)]


[ICE Pototyping (LENS)]

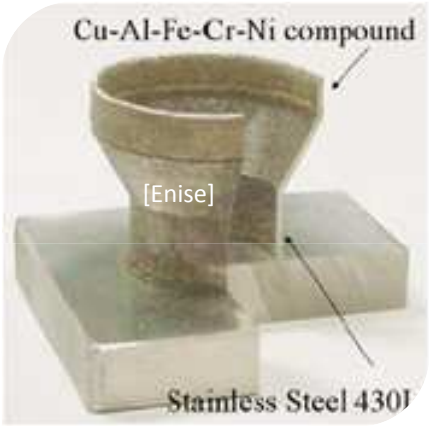

[Fraunhofer center for surface and laser processing]

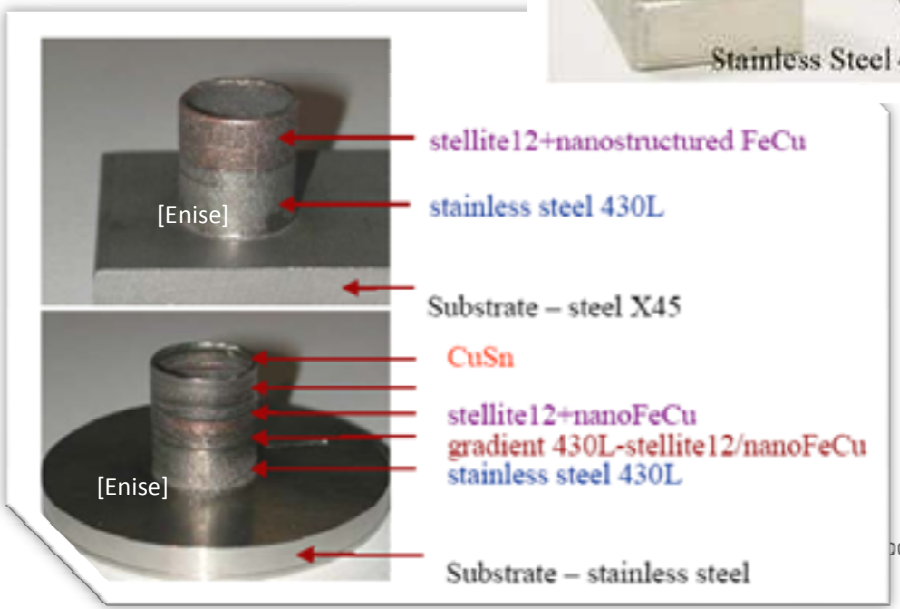

[Irepa Laser]

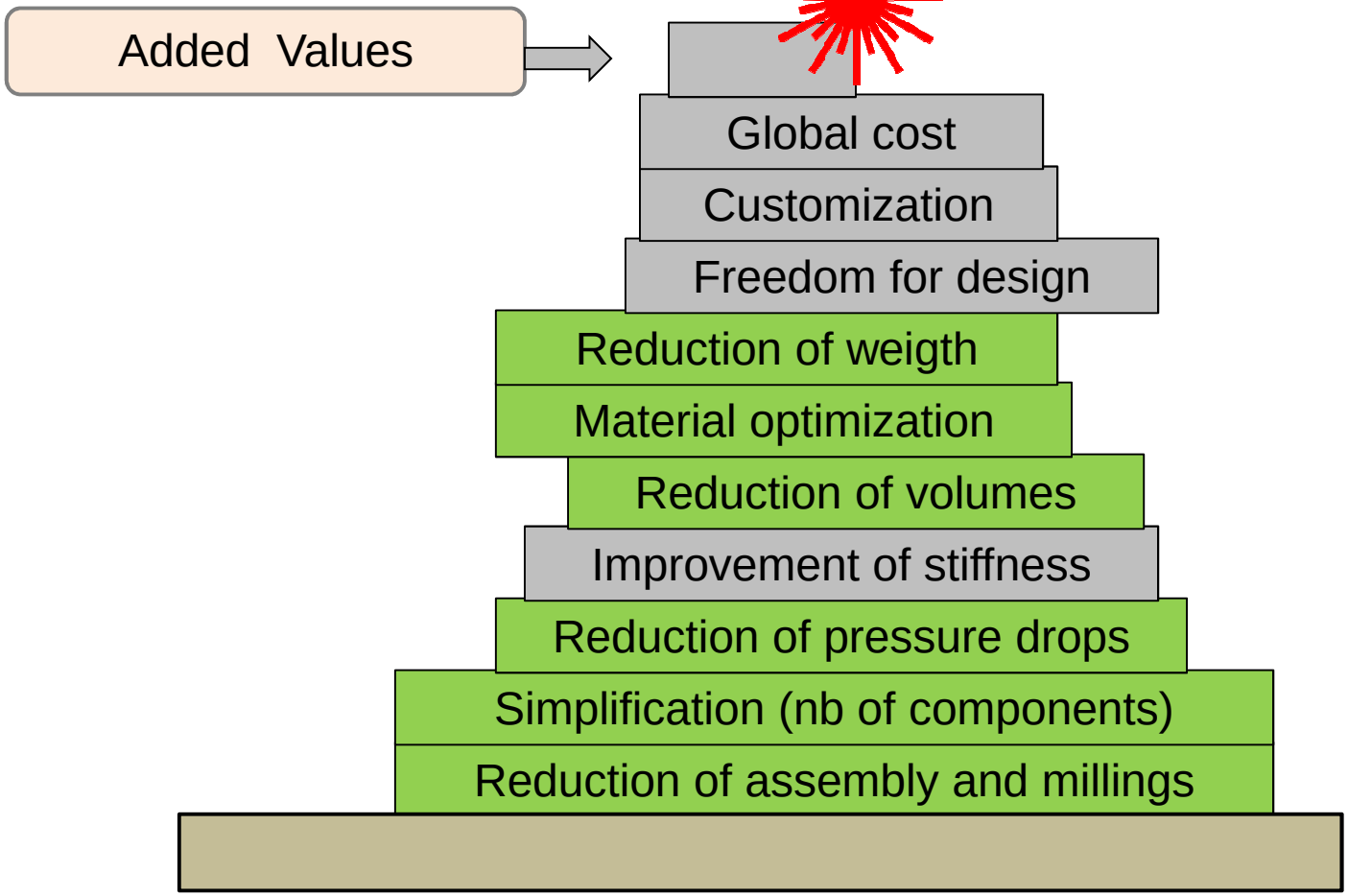

[IWS fraunhofer]

→ Functionnaly Graded Materials :

- Same material (lattices, porosities)
- Different materials







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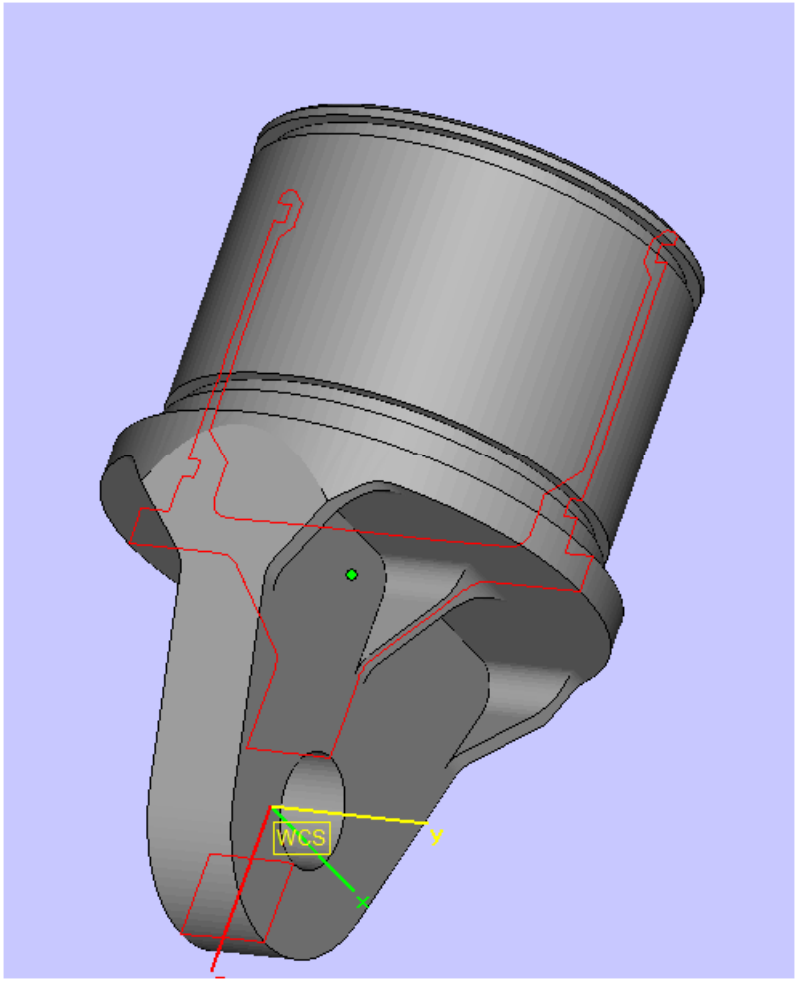
ECO Bilan

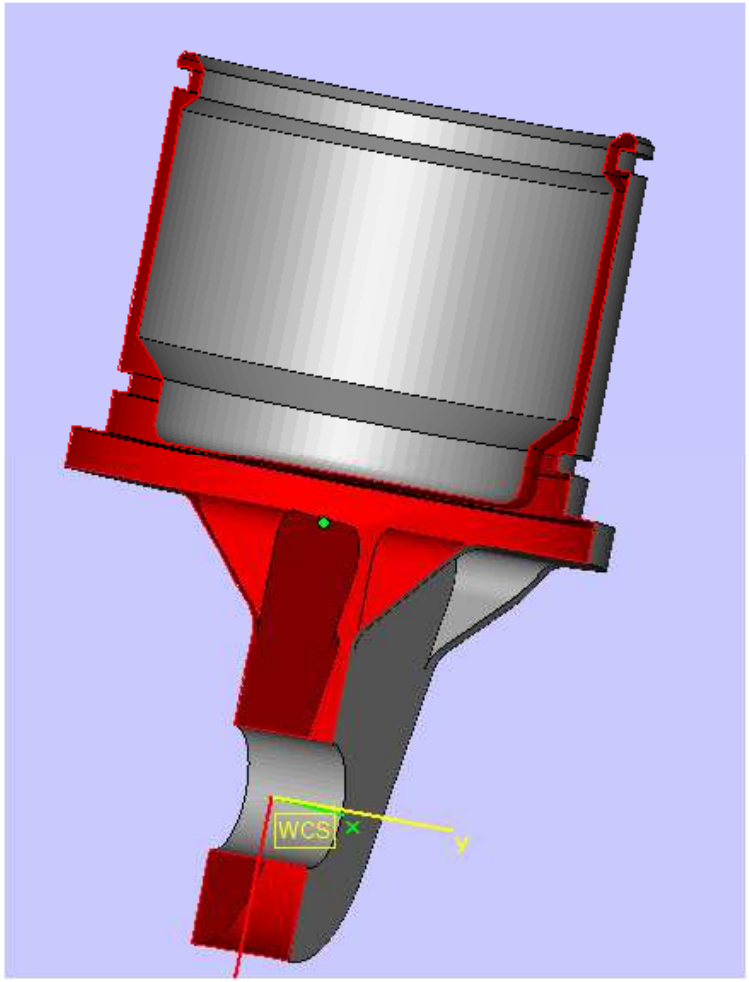
- → Réduction de matériaux de base
  - Usinage parfois rapport 20/1
- → Réduction de frais de transport et logistique:
  - Production locale et décentralisée (pas de moule)
- → Réduction de la consommation d'énergie produite

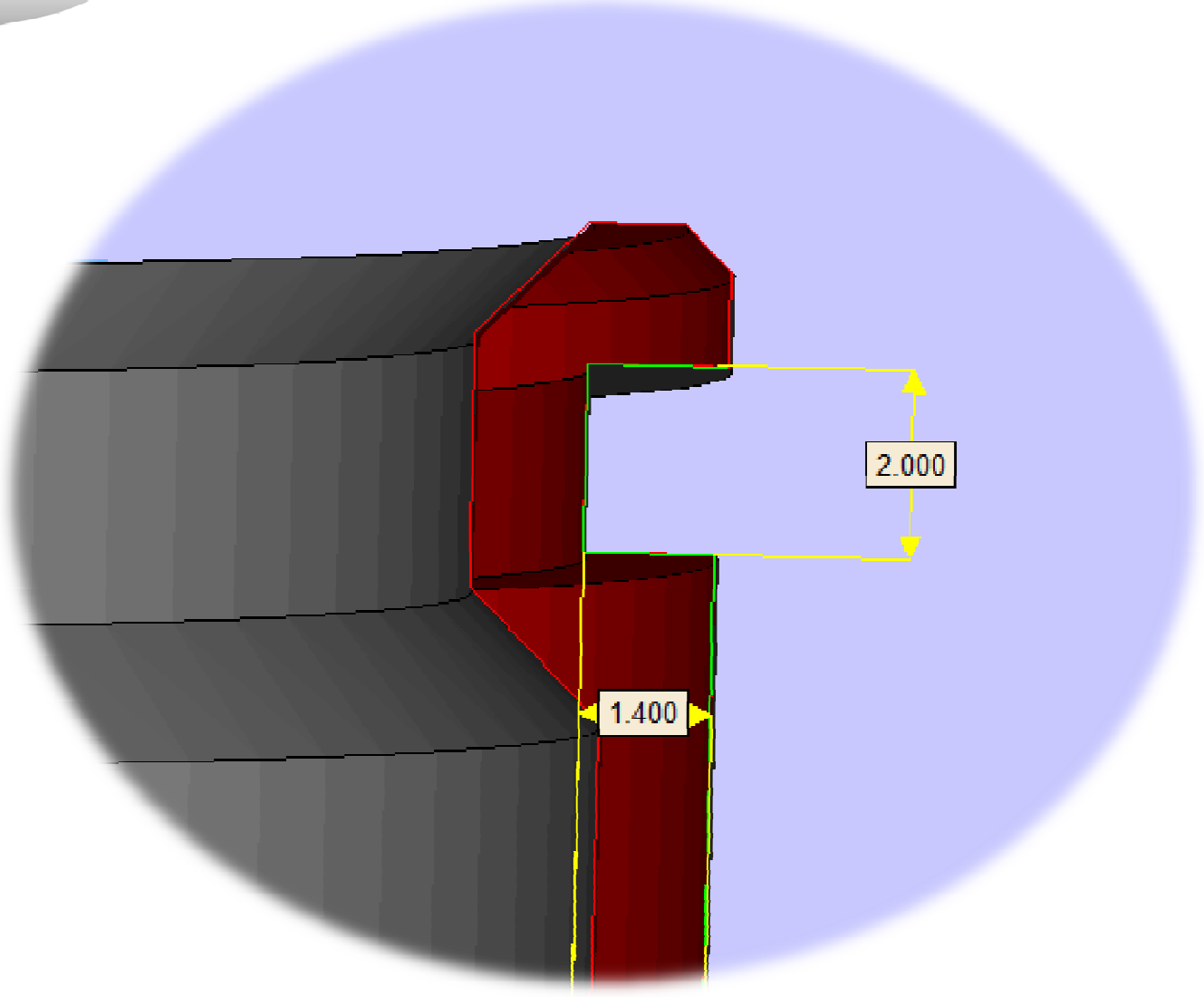
➔Empreinte globale CO2 réduite

- ATKINS project (EU)

Cas pratique







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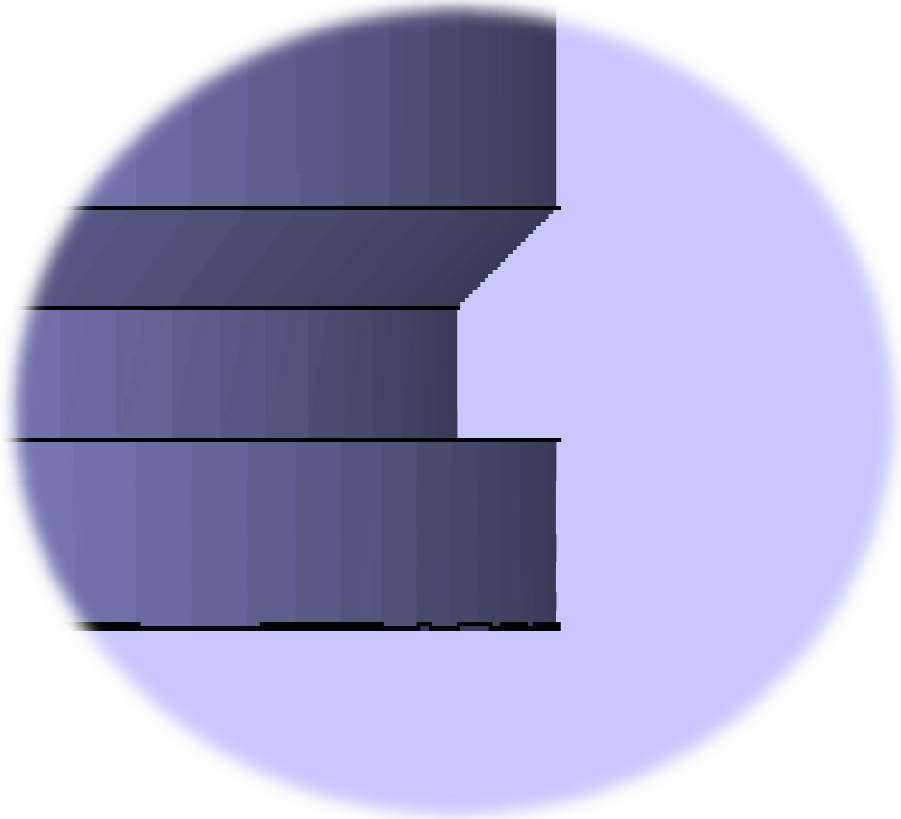
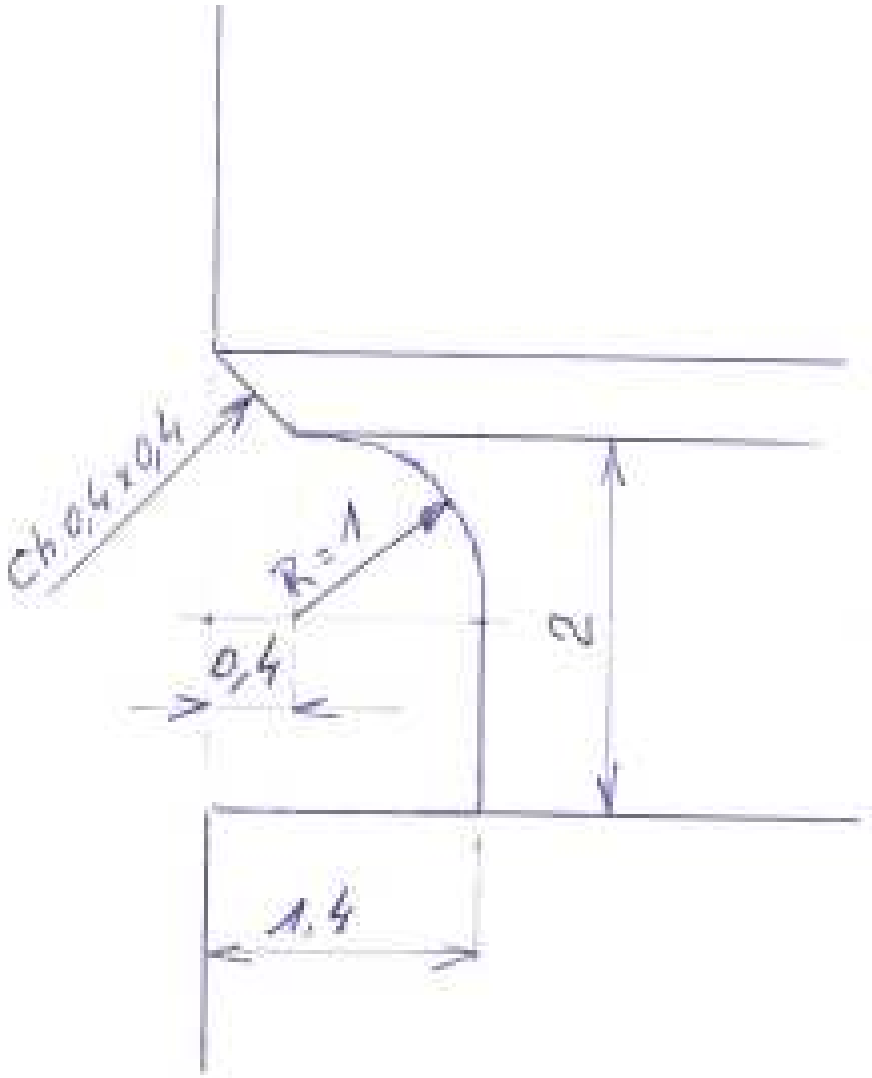
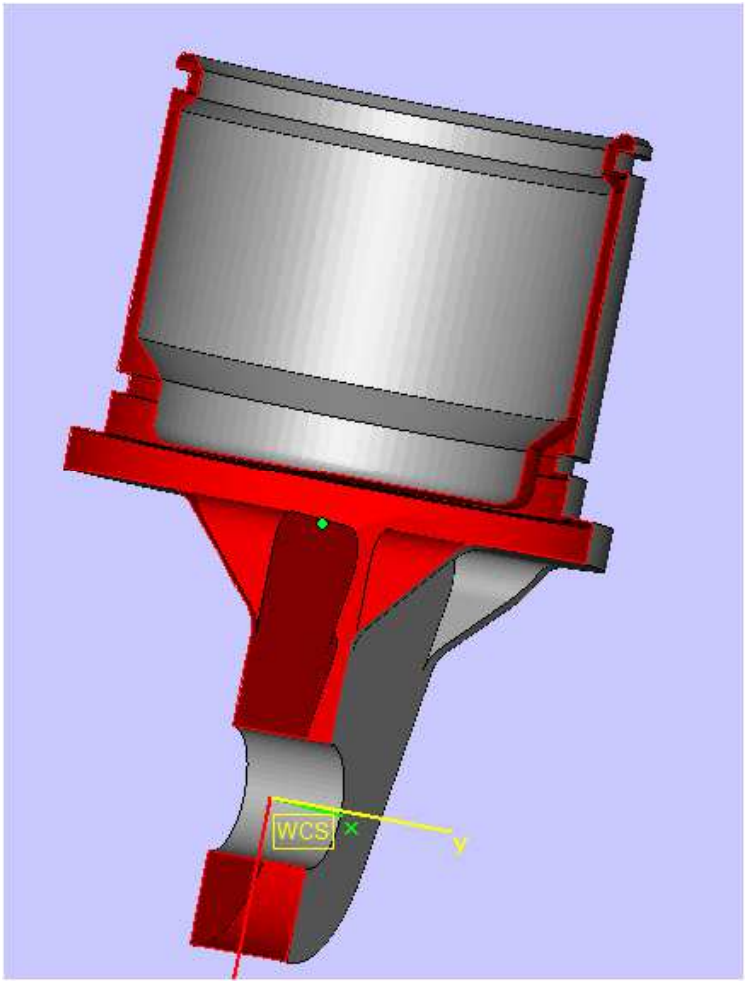
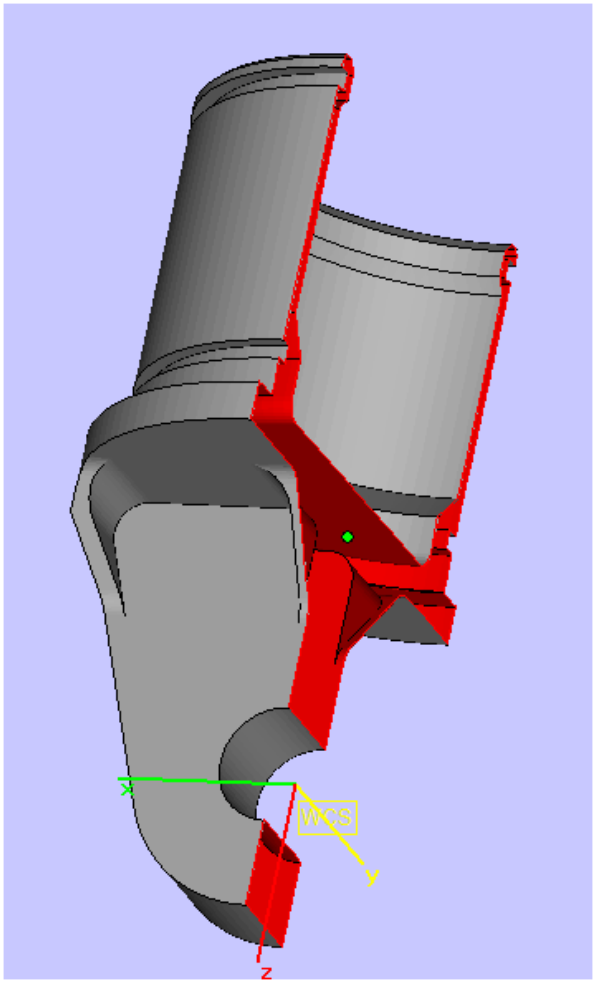


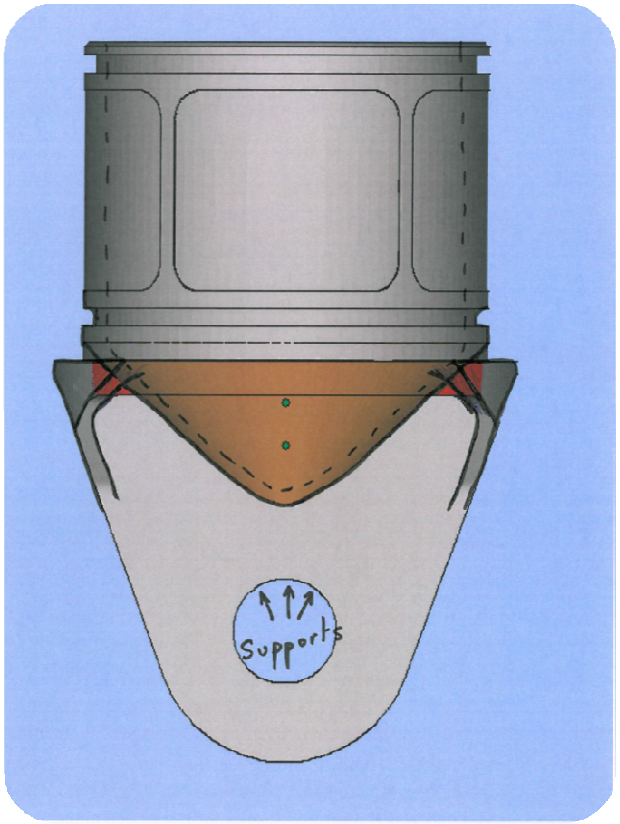
PROGRAMME D'INNOVATION POUR LA COMPÉTITIVITÉ DES PME DE LA MÉCANIQUE, DE LA MACHINE SPÉCIALE, DE LA DÉFORMATION ET DES MATÉRIAUX DANS LES RÉGIONS WALLONIE-LORRAINE-LUXEMBOURG (WLL)

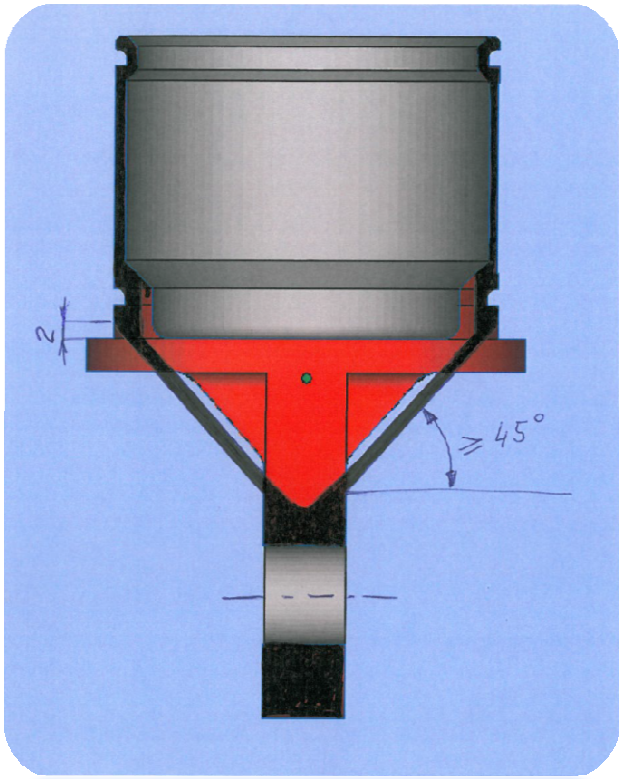


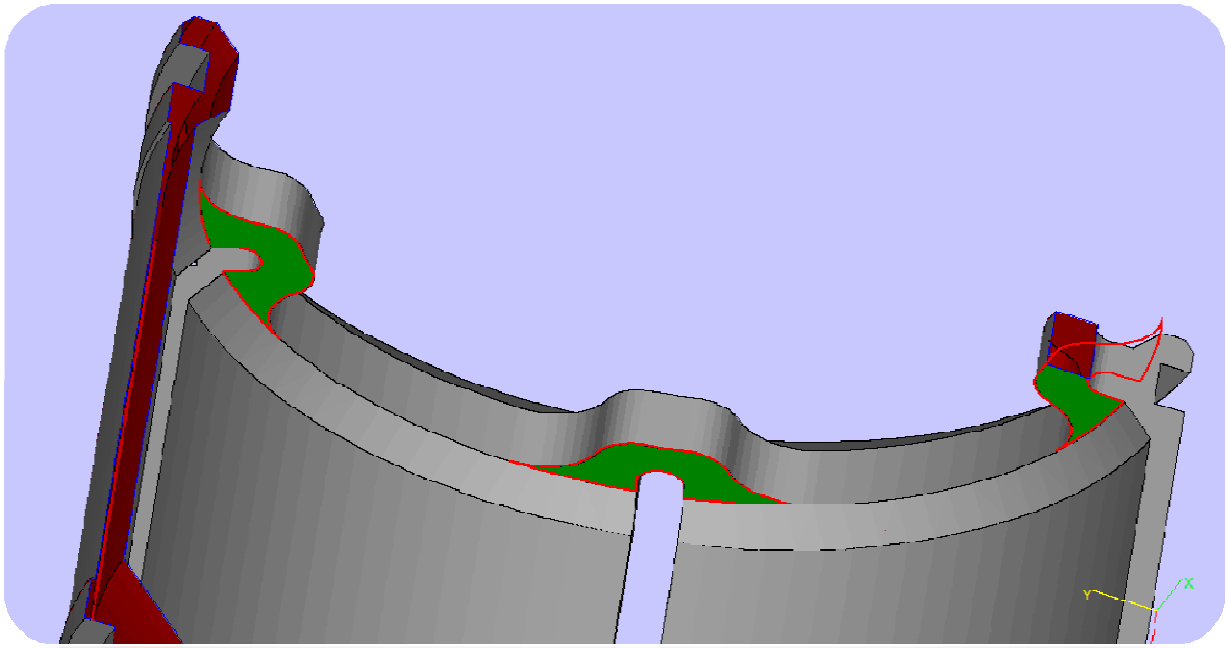
PROGRAMME D'INNOVATION POUR LA COMPÉTITIVITÉ DES PME DE LA MÉCANIQUE, DE LA MACHINE SPÉCIALE, DE LA DÉFORMATION ET DES MATÉRIAUX DANS LES RÉGIONS WALLONIE-LORRAINE-LUXEMBOURG (WLL)

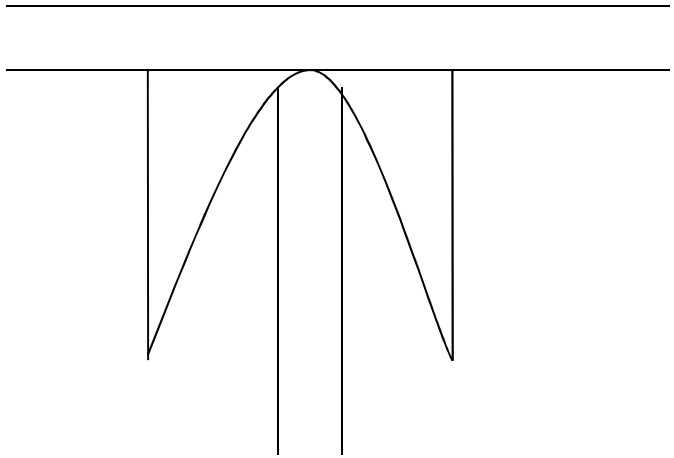

WCS
x
y


x
WCS
y
z


Supports


2
≥ 45°





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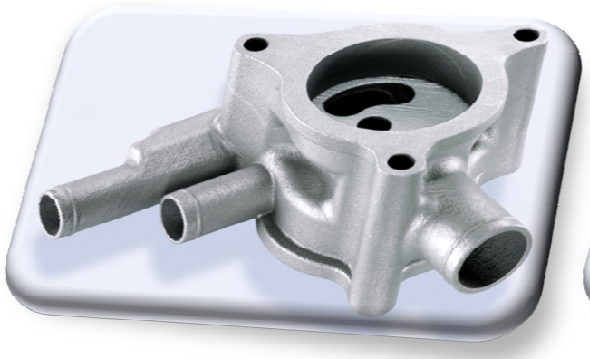
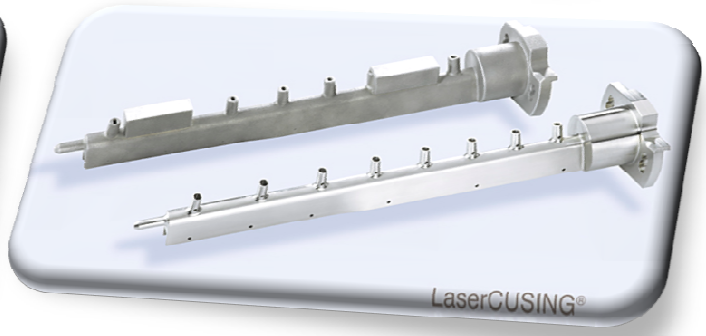
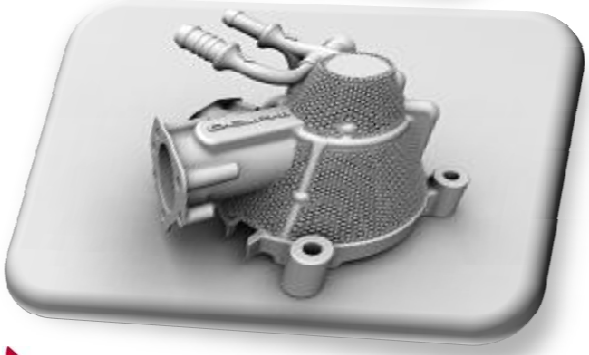
FRED
Fabrication Rapide & Éco-Design

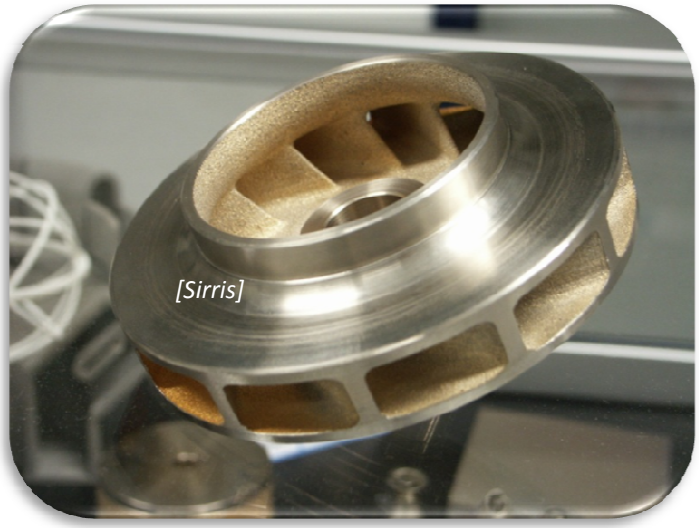
Technical

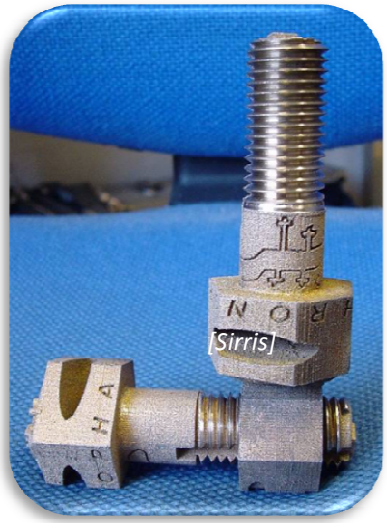




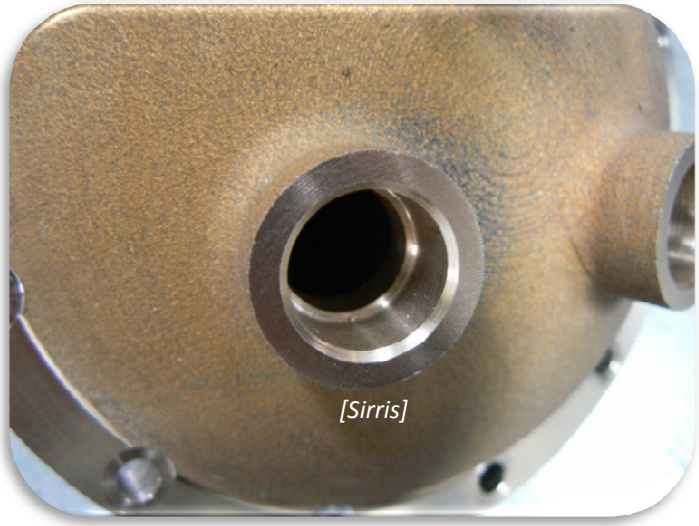


Technical





Steel part (Concept Laser)



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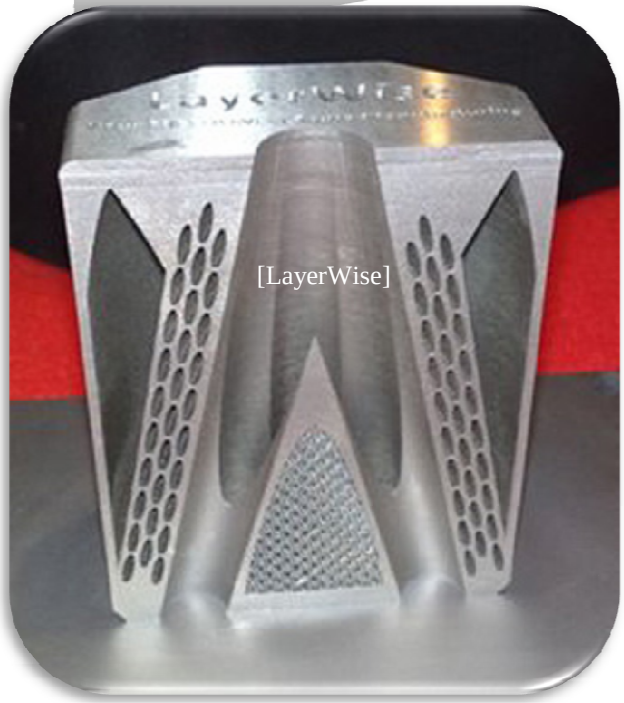
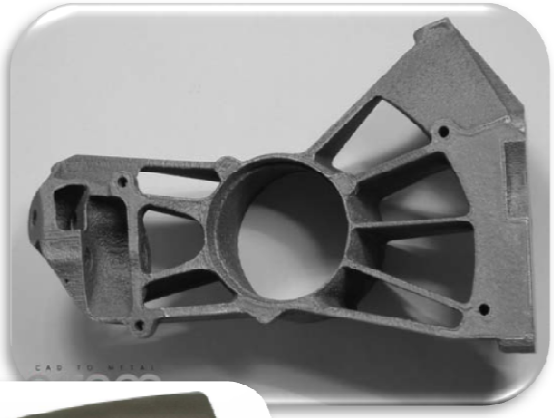
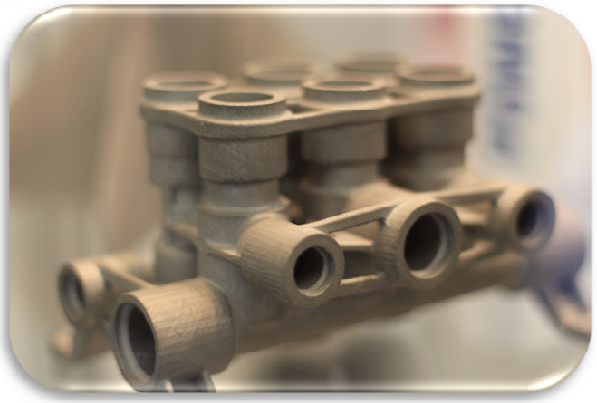
Fabrication Rapide & Éco-Design

Technical







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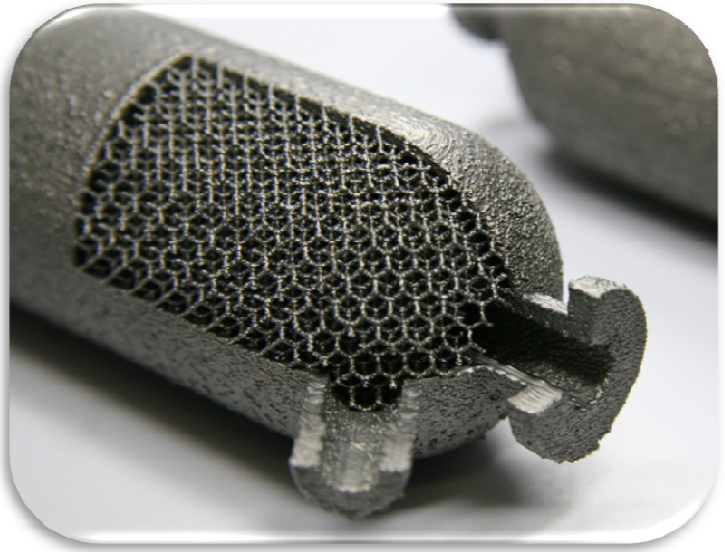
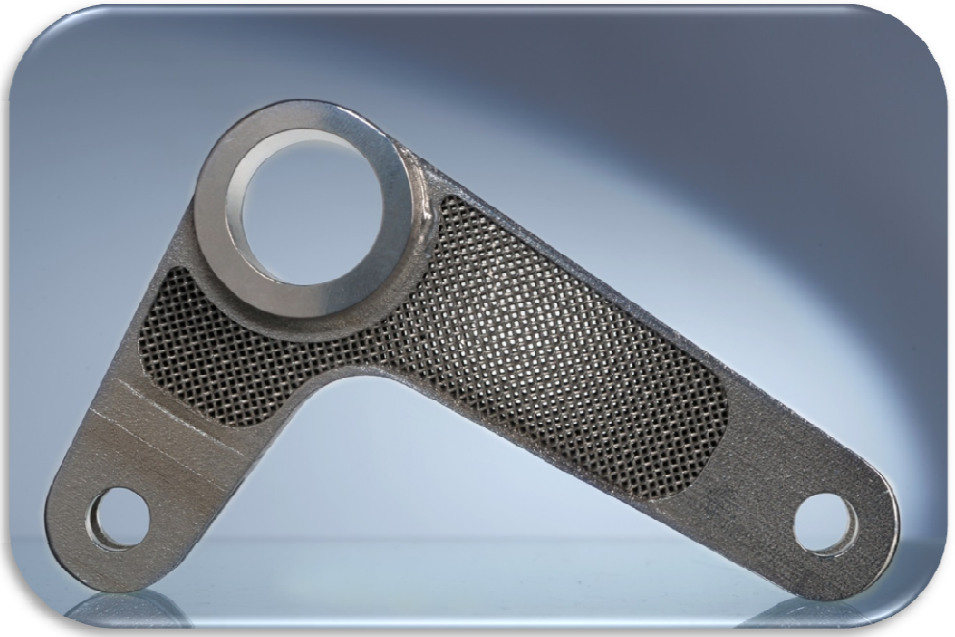
Technical





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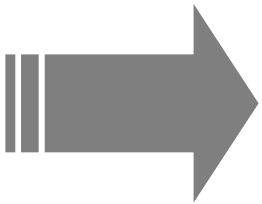
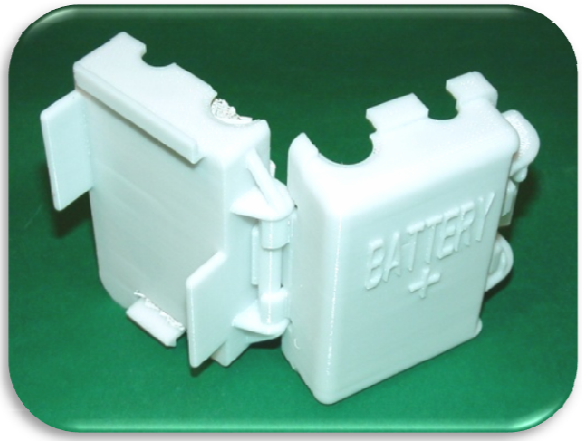
Technical

Assemblage de 20 pièces



1 pièce en PA fritté +
1 bande élastomérique

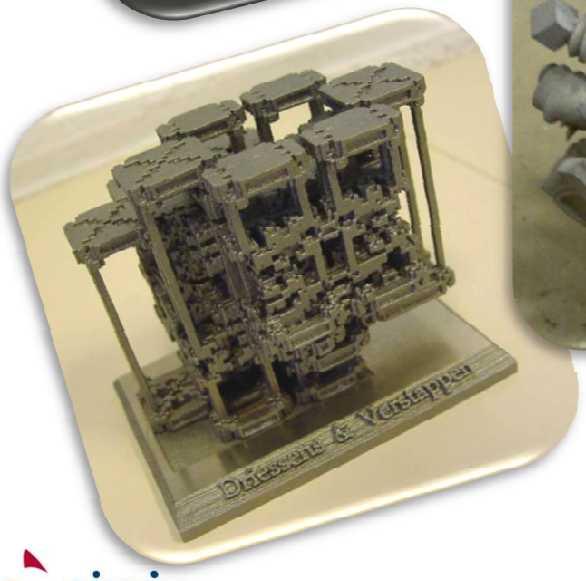


Artistic

[Wim Delvoye]
[3DP metal Sirris]

[Wim Delvoye][
3DP metal Sirris]

[Gil Bruvel]
[Ex One]



Batsheba Grossman

[Batsheba Grossman]
[Sirris 3DP]

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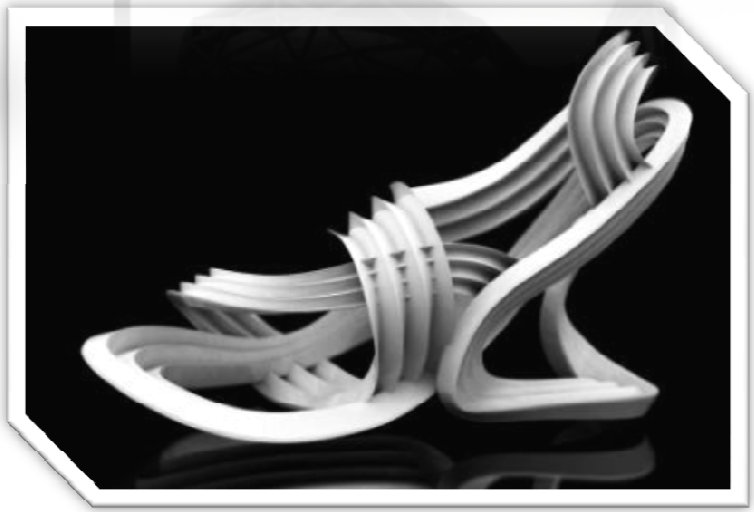
Fabrication Rapide & Éco-Design

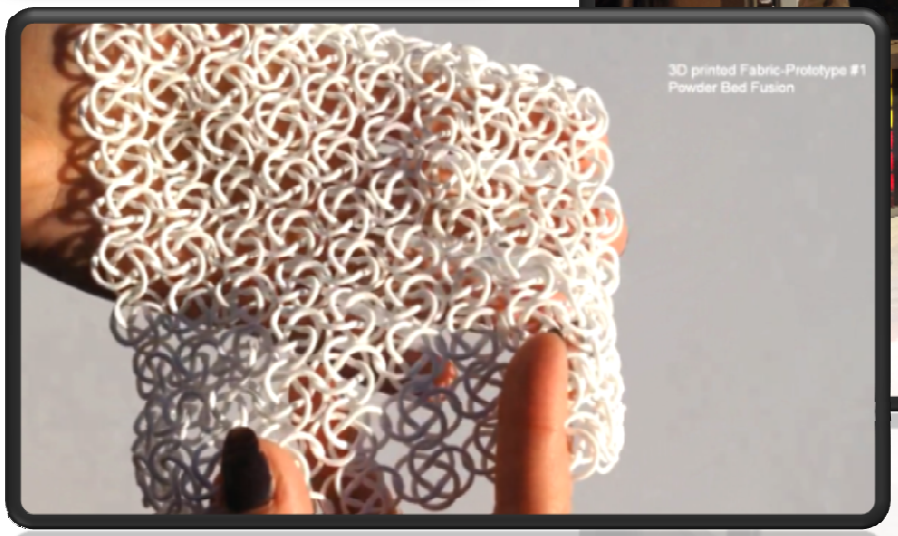
Jewelry

Fashion



Fashion


THE
VERLAN
DRESS
MADE FROM
PRINTED ON


3D printed Fabric-Prototype #1
Powder Bed Fusion

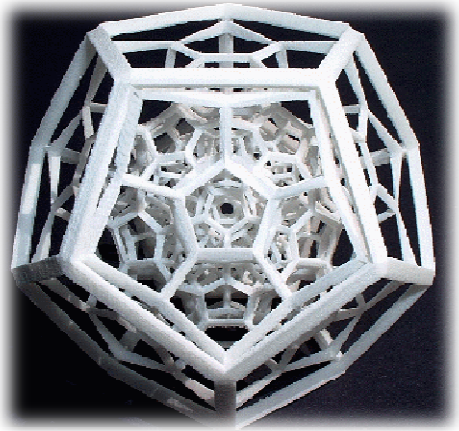
Prototypes d'aspect


[SPA monopole]
[Sirris]


[Sirris]
[Before finishing]

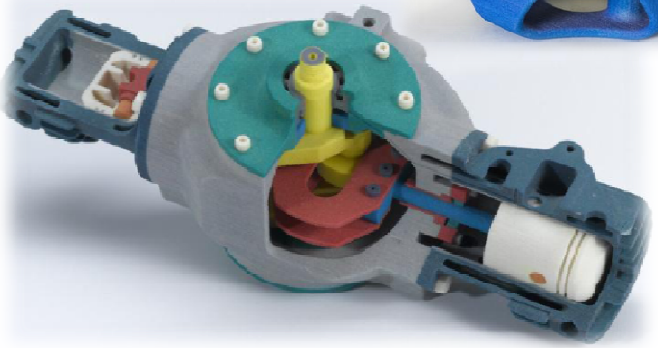

[Sirris]
[After finishing]

Design - Customization

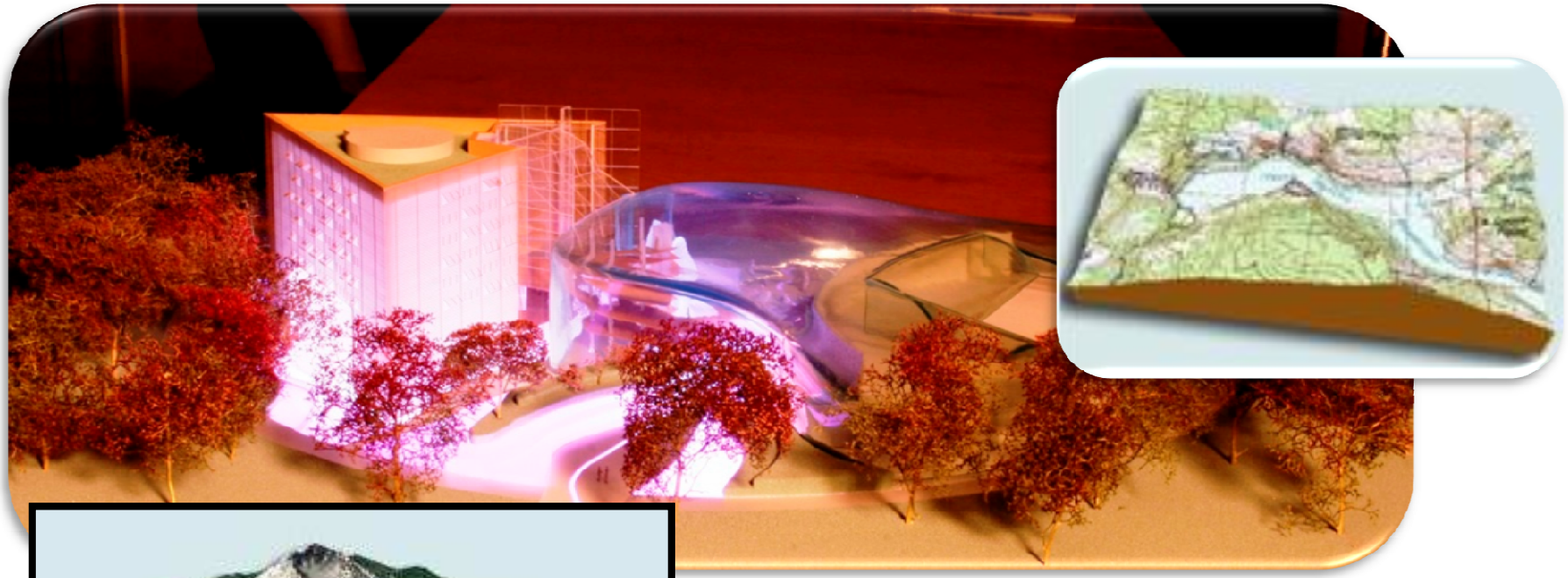


Customization

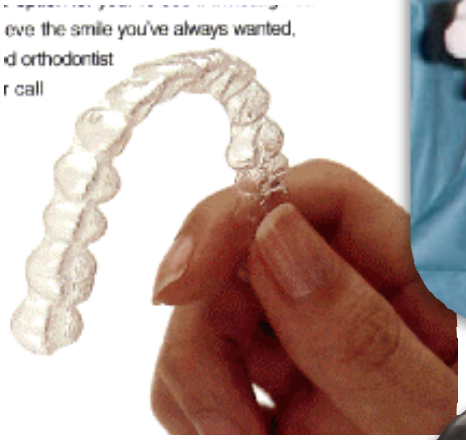
Marketing – Training - Bimatière

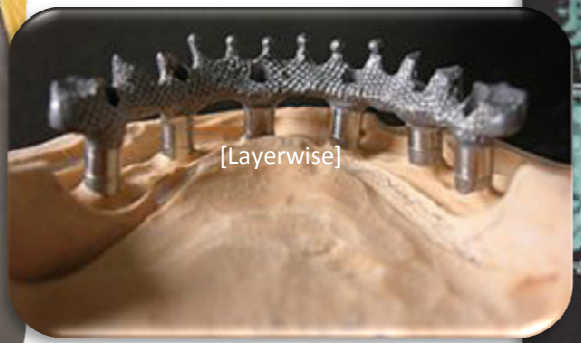


Topography - Architecture



Medical


eve the smile you've always wanted,
d orthodontist
r call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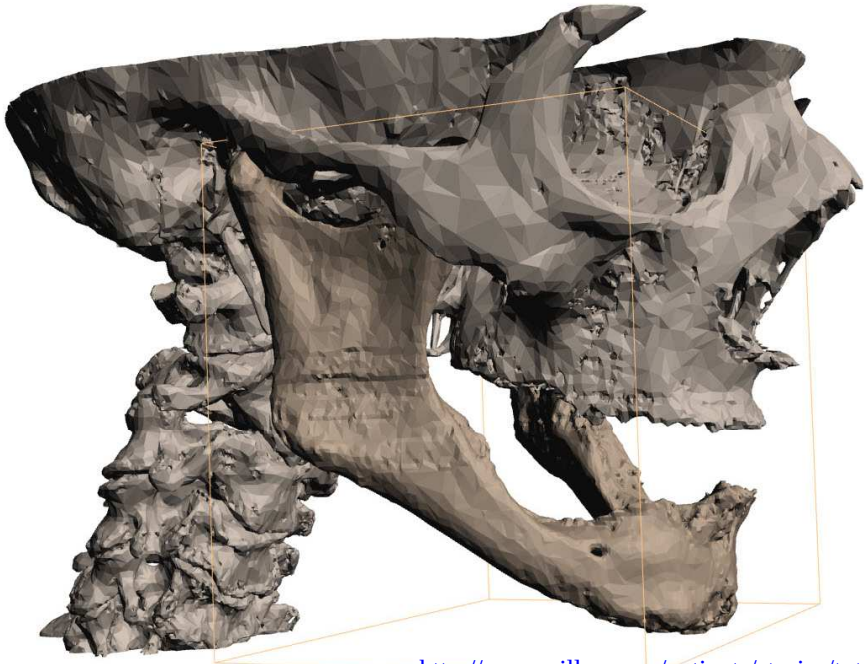
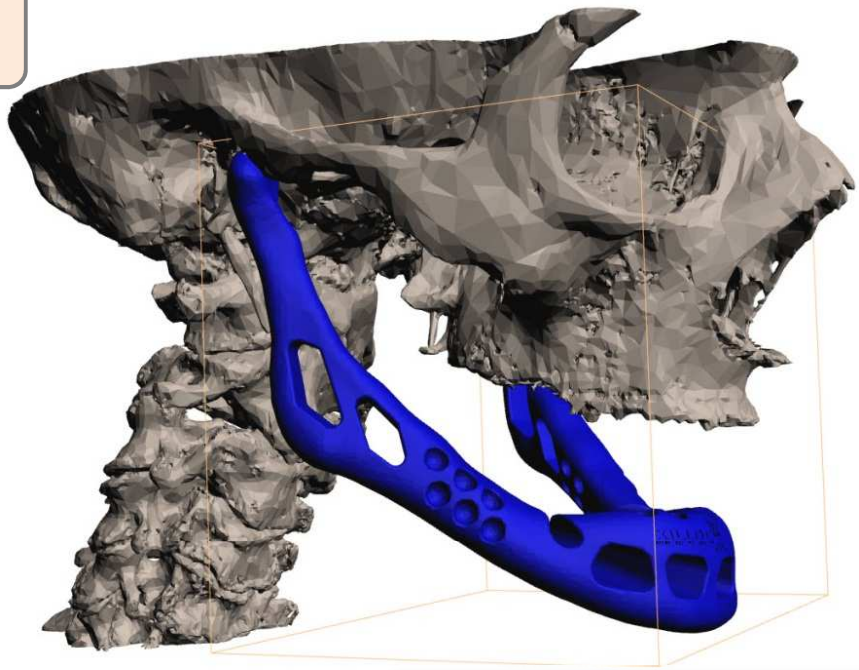
Medical



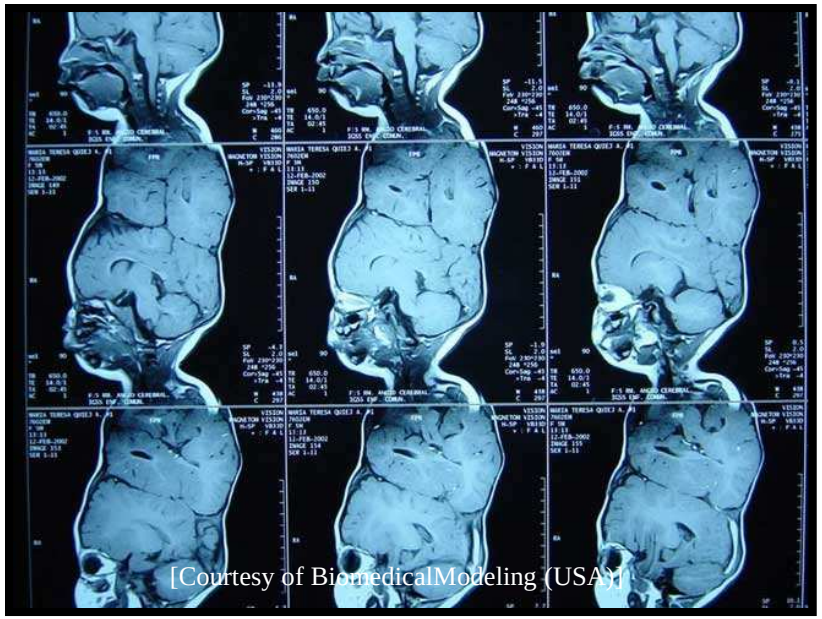


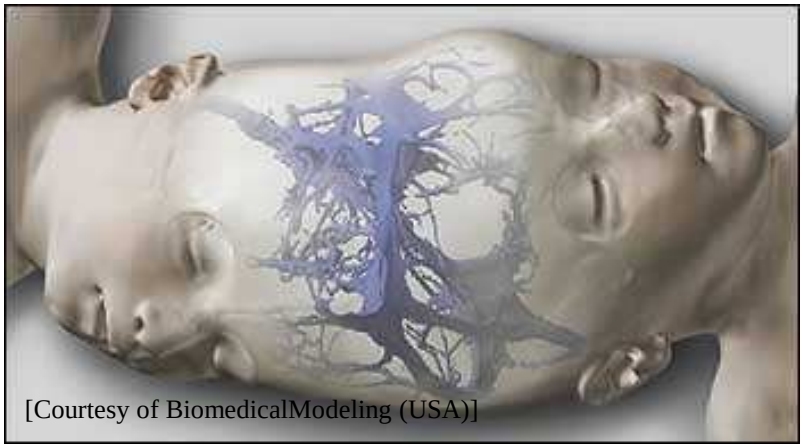
http://www.xilloc.com/patients/stories/total-mandibular-implant/

Medical


The Cortex Exoskeletal cast shown fitted snuggly on the patient's arm giving lightweight but super strong support exactly where needed for this particular wrist fracture. No more heavy weight, malodorous bulk for this lucky patient.


[Courtesy of BiomedicalModeling (USA)]


[Courtesy of BiomedicalModeling (USA)]


[Courtesy of BiomedicalModeling (USA)]

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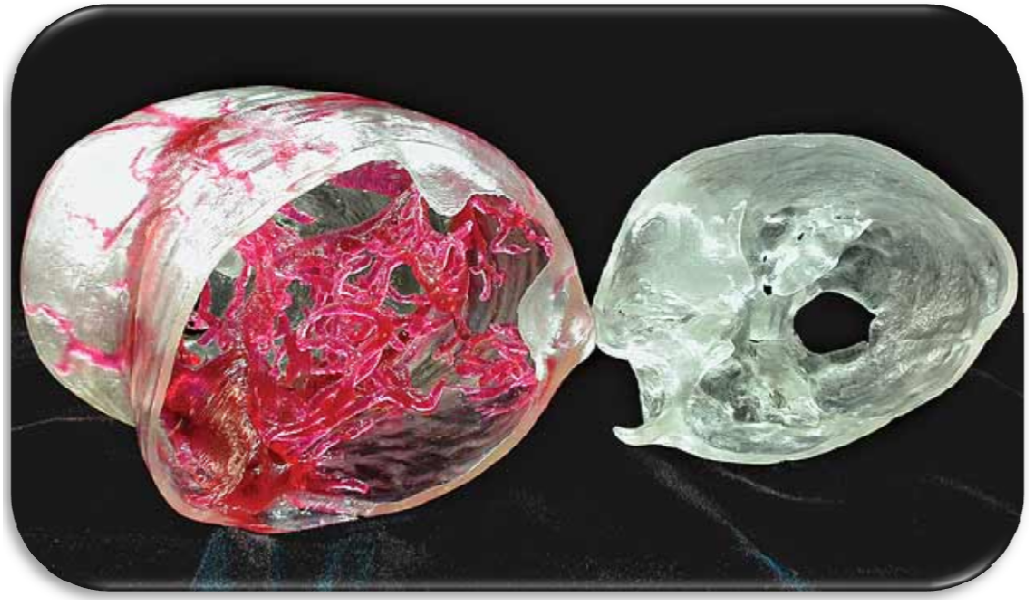

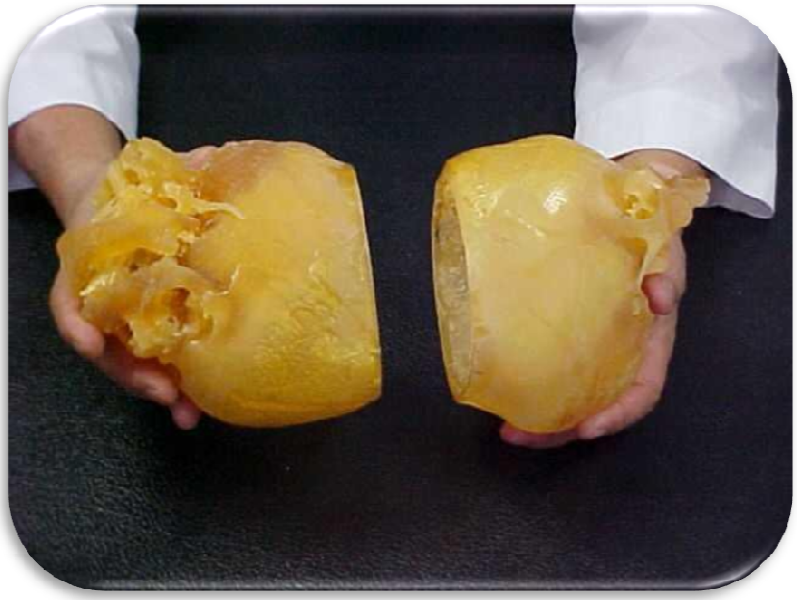

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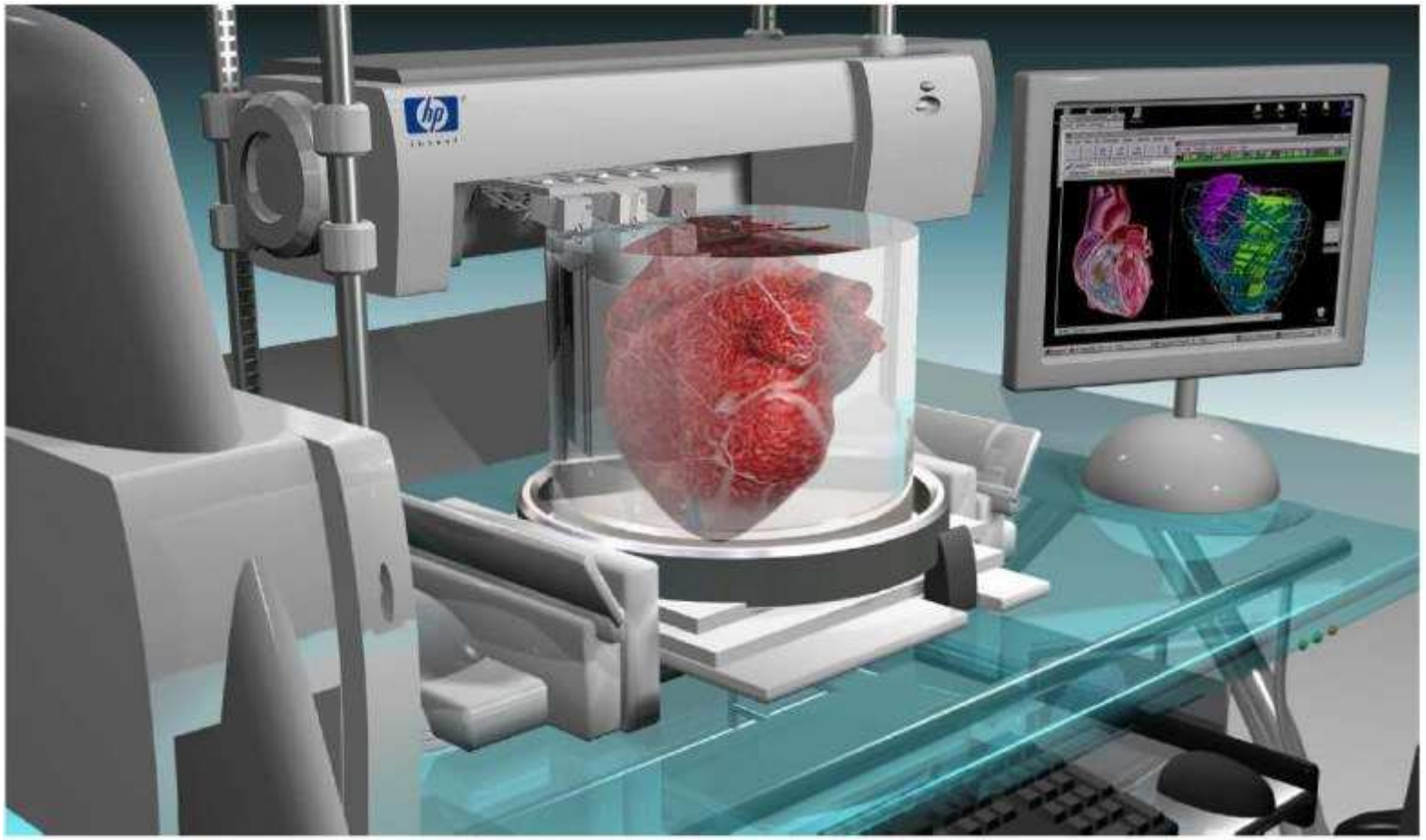
driving industry by technology

Denis Gravet Le 30-09-2014

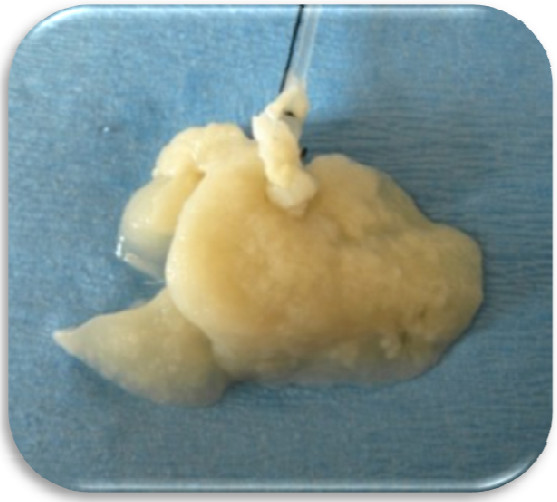
PROGRAMME D'INNOVATION POUR LA COMPÉTITIVITÉ DES PME DE LA MÉCANIQUE, DE LA MACHINE SPÉCIALE, DE LA DÉFORMATION ET DES MATÉRIAUX DANS LES RÉGIONS WALLONIE-LORRAINE-LUXEMBOURG (WLL)

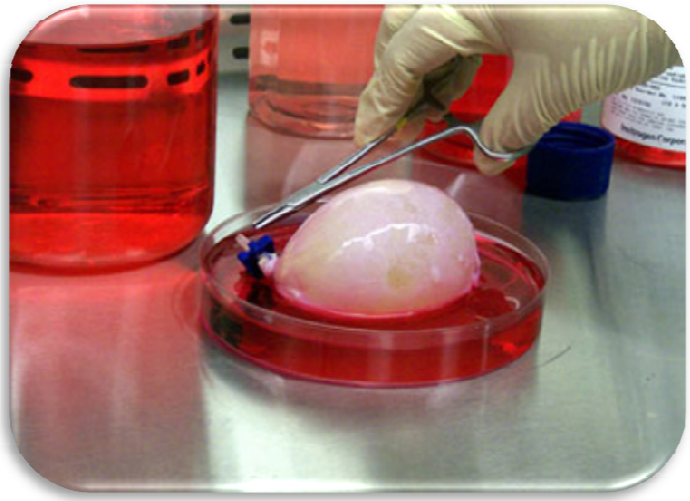
Future ?

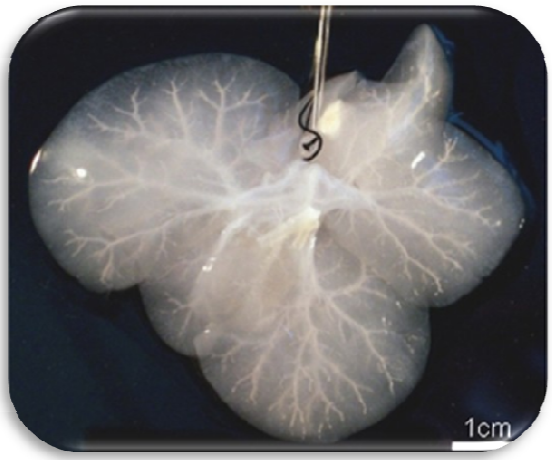
Future

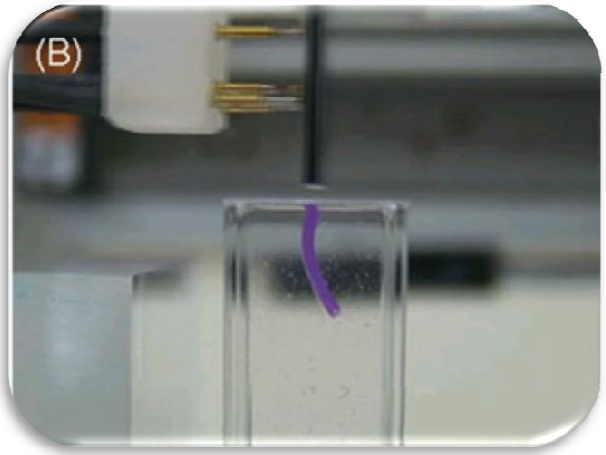


Now

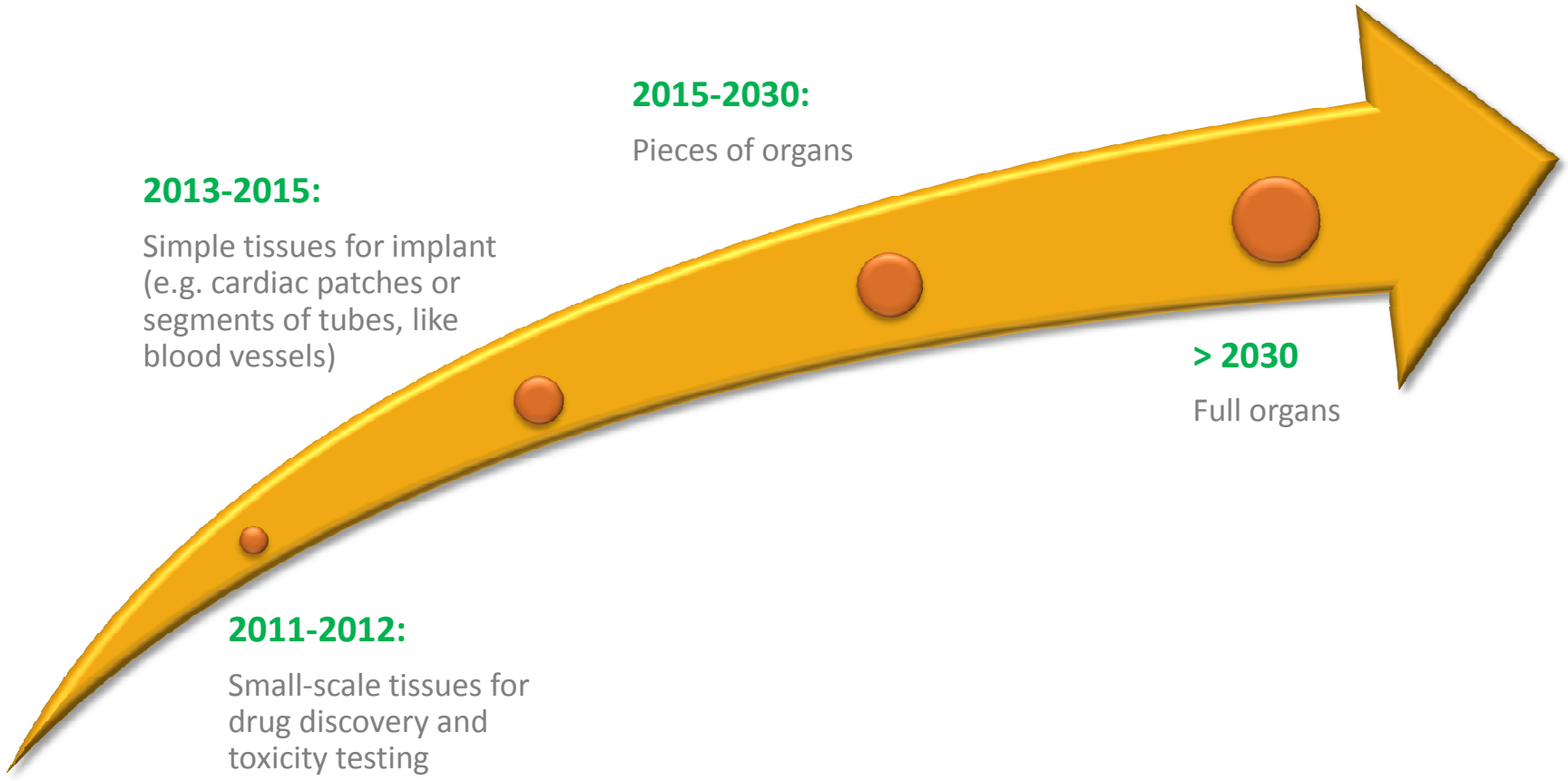








Evolution


2015-2030:
Pieces of organs
2013-2015:
Simple tissues for implant (e.g. cardiac patches or segments of tubes, like blood vessels)
> 2030
Full organs
2011-2012:
Small-scale tissues for drug discovery and toxicity testing

Thanks for your attention

FRED

Fabrication Rapide & Éco-Design

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WWW.INTERREG-FRED.EU

POUR TOUTE AUTRE QUESTION,
VOUS POUVEZ CONTACTEZ INFO@INTERREG-FRED.EU

LES PARTENAIRES DU PROJET

LORRAINE

CIRTES recherche & développement

Tec3i Bureau d'études

Arts et Métiers LCFC ARTS

InSIC GIP

INNO8

WALLONIE

Université de Liège

INNOVATECH

hénallux

sirris driving industry by technology

TECHNIFUTUR

[Sirris ADD]

GRAND-DUCHÉ DU LUXEMBOURG

tudor

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