



# EOS Design Rules

## Design study: living hinge sintering

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e-Manufacturing Solutions

# EOS Design Rules

## laser-sintering a living hinge

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— What is a living hinge

— Conventional living hinge design

- Two layer hinges

— Starting from scratch

- Regular laser-sinter living hinge
- Snap living hinge

— Examples of integrated living hinge

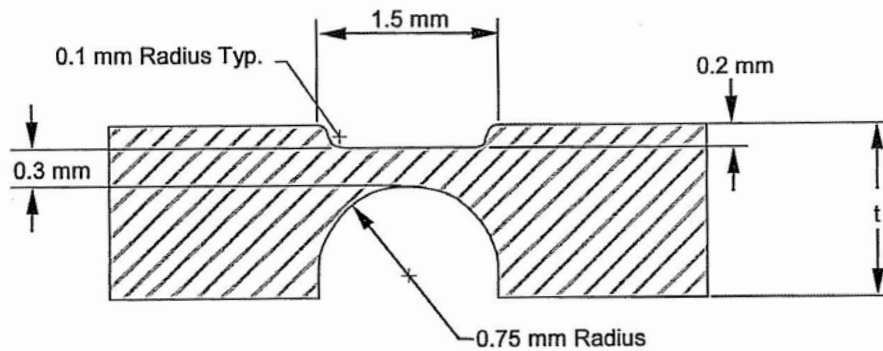
- Anyflip
- Formiga
- Shampoo cap



# What is a living hinge

A living hinge is the type of flexing hinge that can flex from thousands to million times.

Conventional geometry



It is a process conditioned geometry.



# Designing our own living hinge with the conventional formula

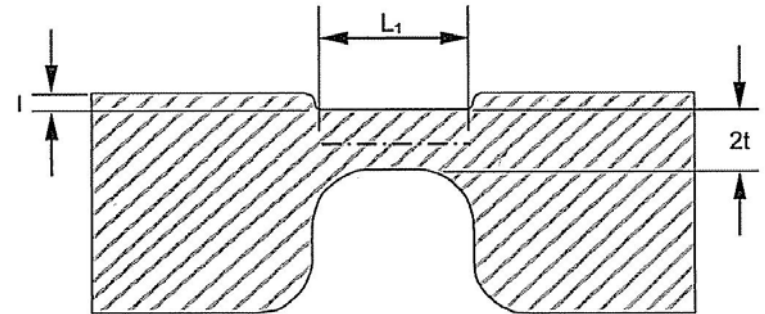
Formulas found to design our own living hinge, in any plastic material:

$$\sigma_{\text{yield}} = \pi t E / L_1$$

$$L_1 = \pi R$$

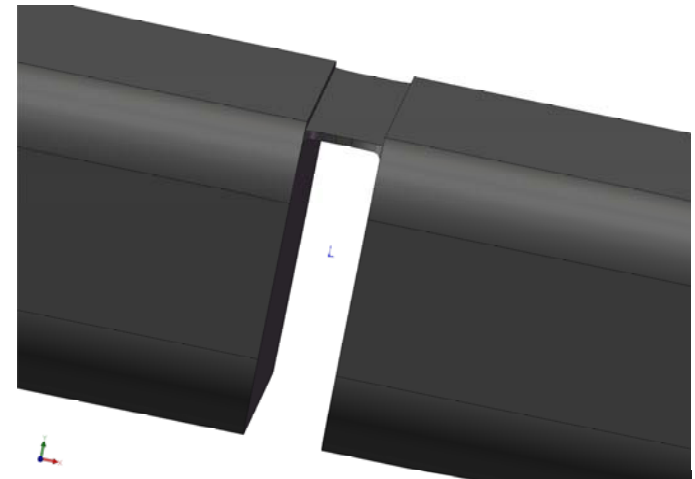
No optimised geometry, so we adapted it.

We minimised the size.



# Living hinges with two Layers

- The geometry works till some extent
- Smaller sizes are critical
- very thin film thickness
- **→ flexing hinge but no living hinge**



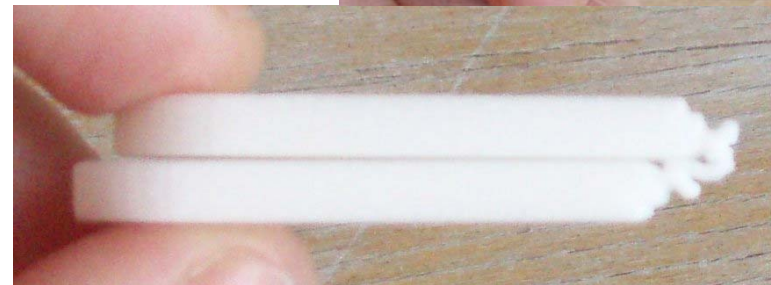
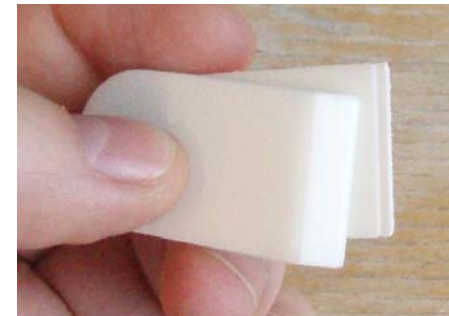
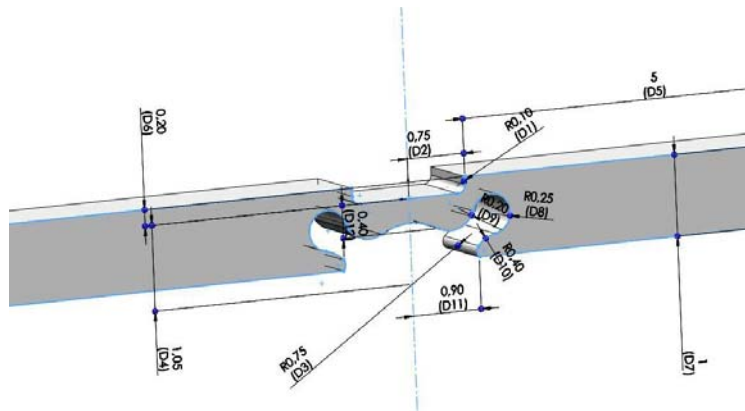
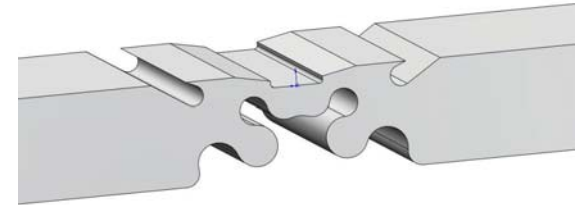
machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	horizontal
spring force	low
size	2x1 mm



# Adapting the conventional geometry

The geometry was changed

Tiny details – not properly adapted to our technology



# Starting from scratch

## Reflection and analysis

- 1. What functions does really a living hinge fulfil?
- 2. What do we really expect from it?
- 3. What features could we add to it?

# Starting from scratch

## Reflection and analysis

— A living hinge is basically a union between two parts that allows us to build them in one step and afterwards to clap them together.

additional features:

— A concrete bending angle

— An appropriate size

— Self opening

— Self closing

— One or two rest positions

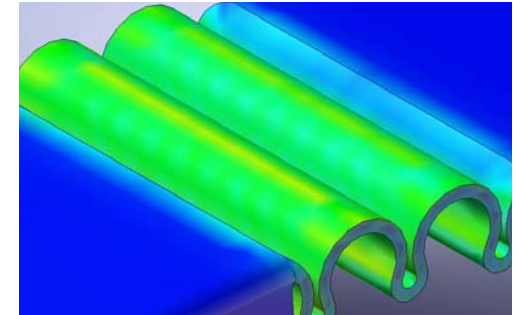
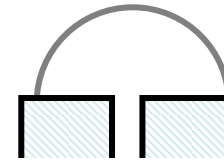
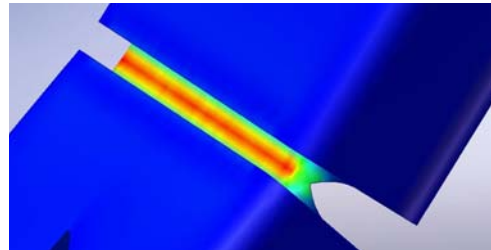
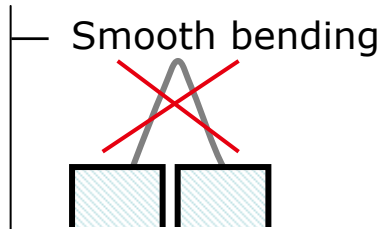


# Regular laser-sinter living hinge



# Regular laser-sinter living hinge

## Objectives



Different building directions

- upright



horizontal



Small building volume

Long lifecycle

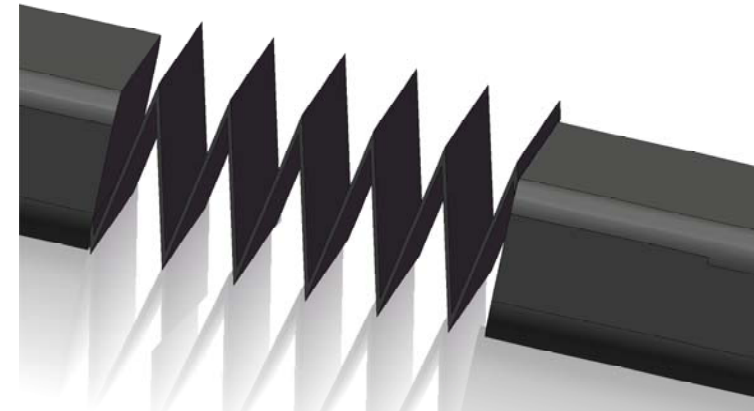
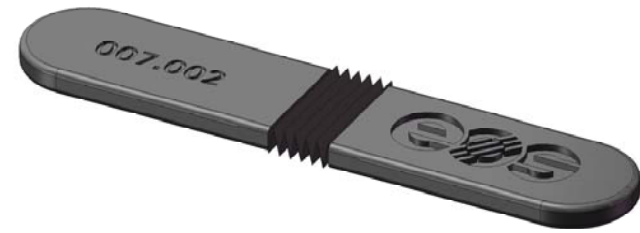
# Regular laser-sinter living hinge

## 007.002 zigzag living hinge

Simple geometry

Both directions

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	360
building direction	upright
spring force	high
size	4x10 mm



# Regular laser-sinter living hinge

## 012.004 wave living hinge

Start with 4 waves

No stress peaks

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180° (360° possible)
building direction	upright
spring force	high
size	4x10 mm

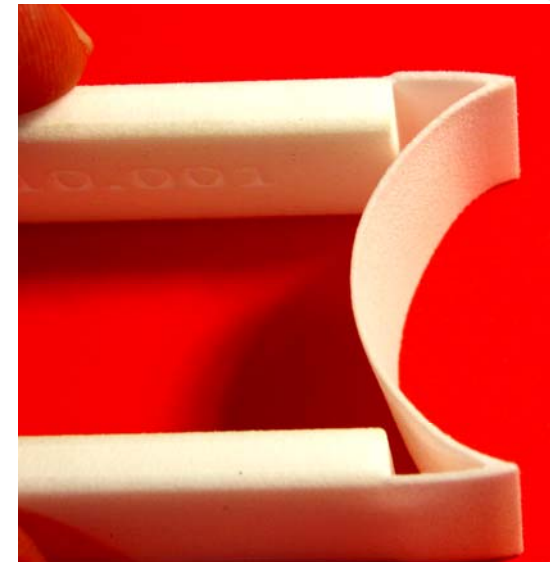
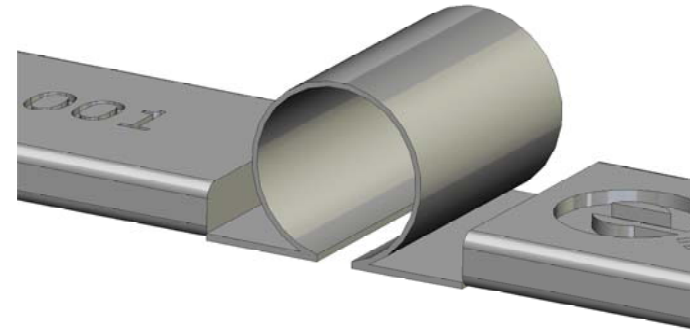
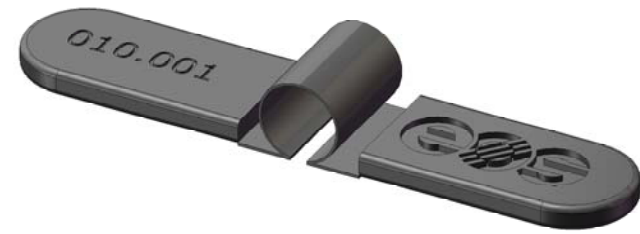


# Regular laser-sinter living hinge

## 010.001 big ring living hinge

- Easy design
- Big volume
- Change characteristics with wall thickness
- Very wide end position

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	upright
spring force	low
size	13x20 mm

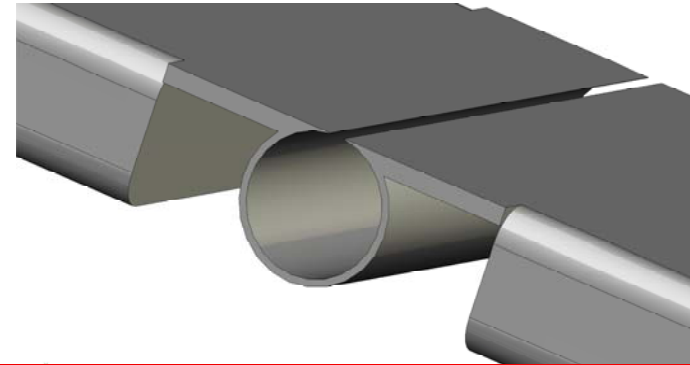
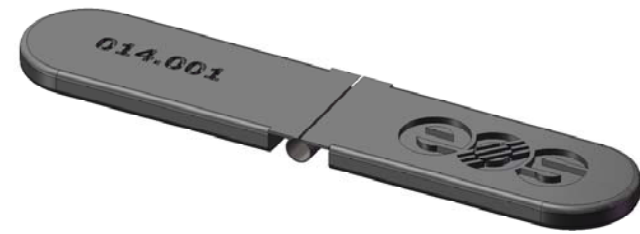


# Regular laser-sinter living hinge

## 014.001 small ring living hinge

- Basic like the big ring
- Smaller size
- Closer end position

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	upright
spring force	high
size	4x10 mm

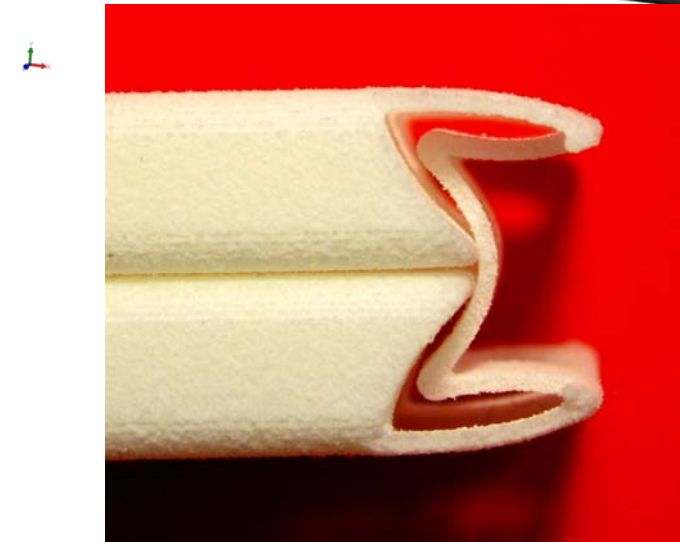
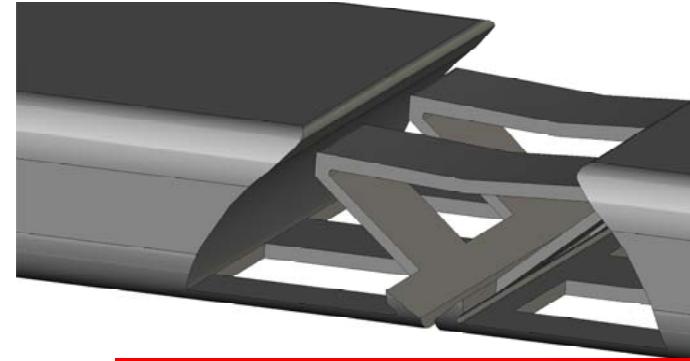
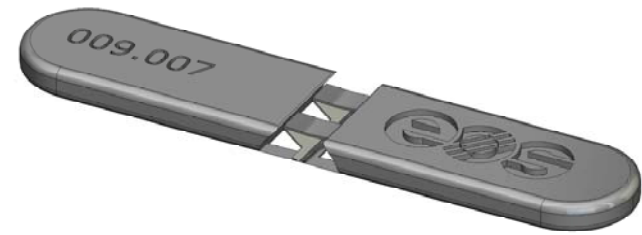


# Regular laser-sinter living hinge

## 009.007 double-z living hinge

- Very smooth bending
- Closed end position
- Same wall thickness
- Height of hinge on closed end position 10 mm

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	upright
spring force	middle
size	5x14 mm

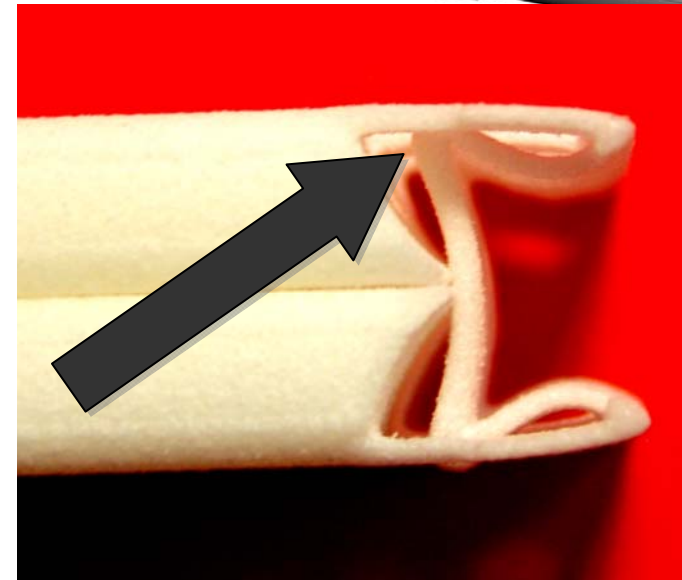
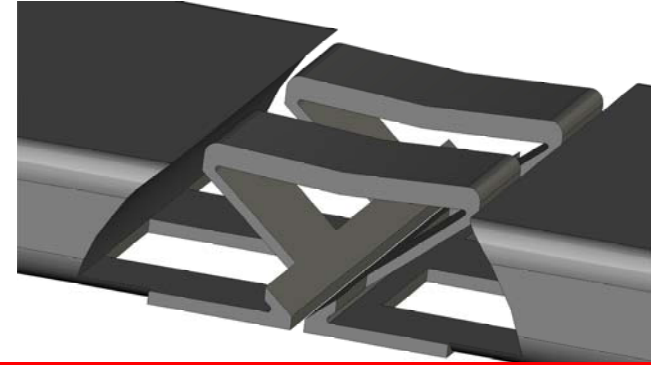
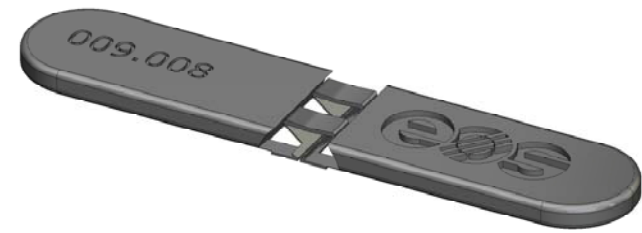


# Regular laser-sinter living hinge

## 009.008 double-z living hinge

- Same principle as 009.007 optimised
- Different wall thickness of one segment
- Height of hinge on closed end position 8 mm

machine type	P100
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	upright
spring force	middle
size	4x14 mm



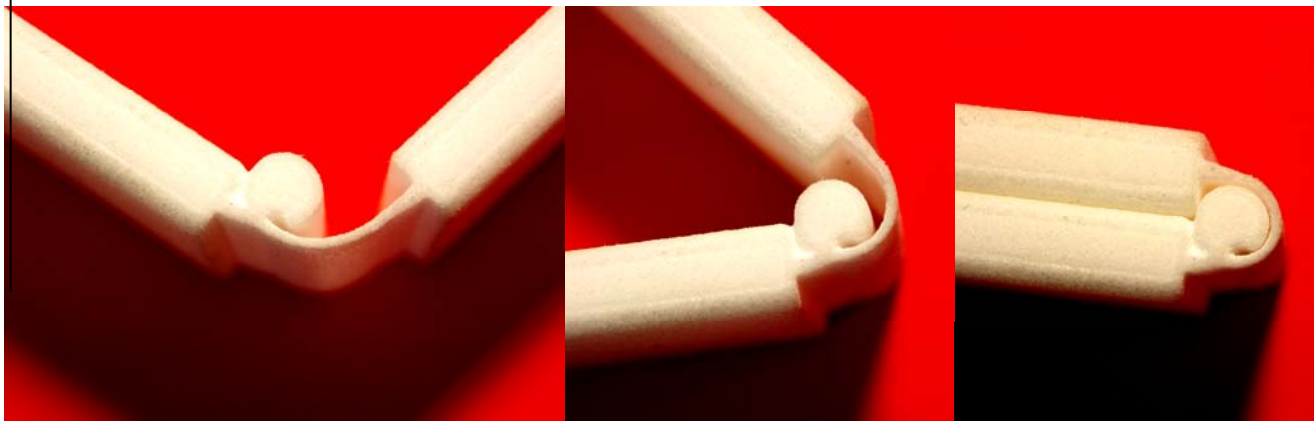
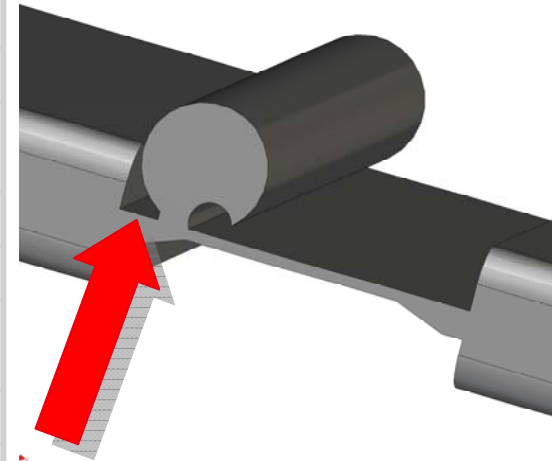


# Regular laser-sinter living hinge

## 015.001 cylinder living hinge

- Defined end position
- Gap for lower energy input
- Very smooth moving

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	upright
spring force	middle
size	6x10 mm



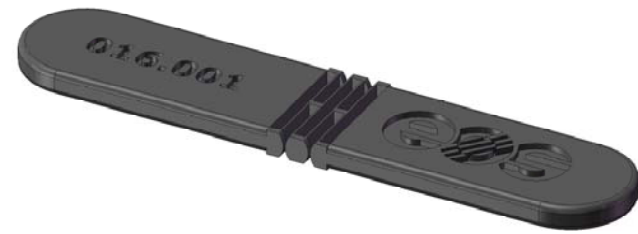
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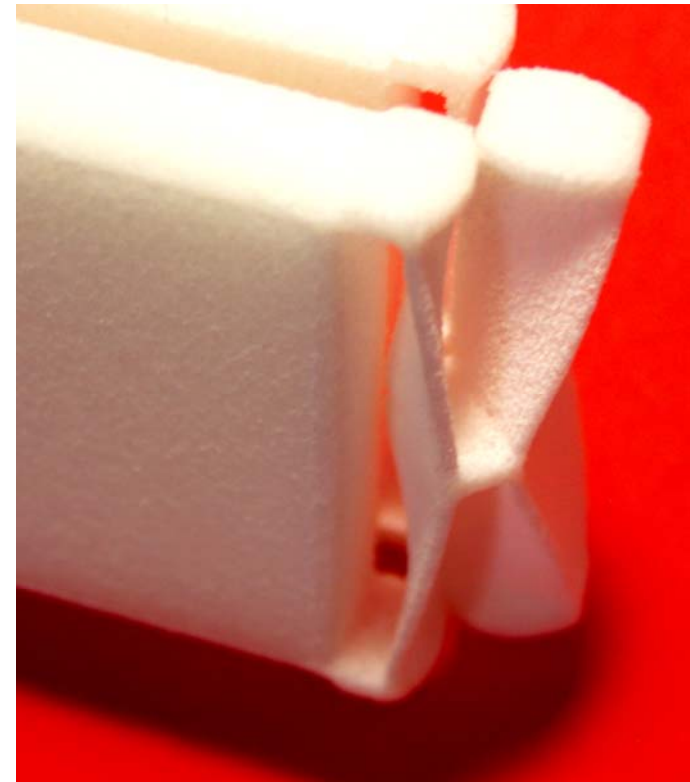
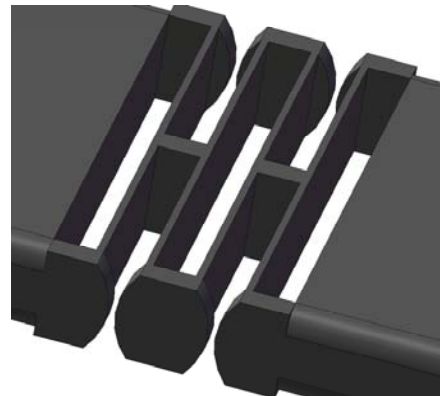
# Regular laser-sinter living hinge

## 016.001 lamella living hinge



- Bending through torsion
- Equal movement in both directions
- Torsion of every segments only up to 45°

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	360
building direction	horizontal
spring force	low
size	4x10 mm

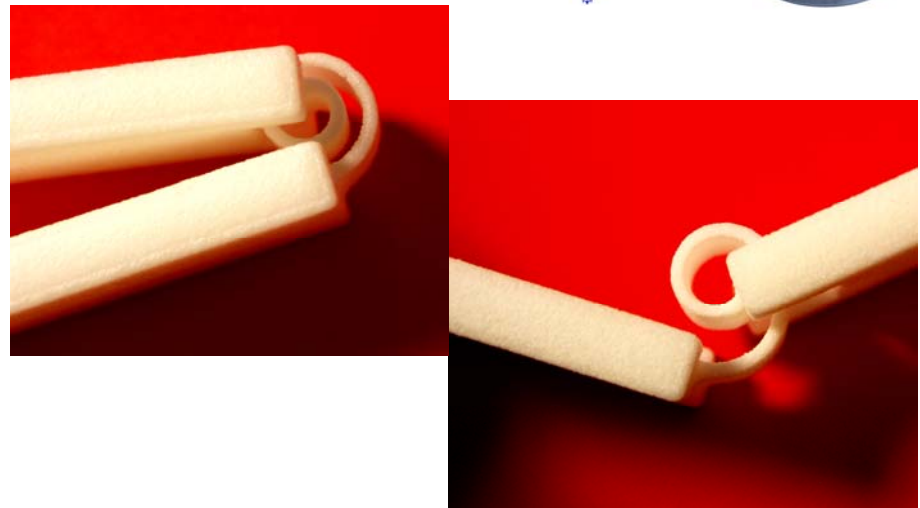


# Regular laser-sinter living hinge

## Spiral living hinge

- Smooth stress distribution
- Spring effect
- Design optimised in several loops to reach a smaller size and a good performance.

machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	upright
spring force	high
size	7x7 mm



# Regular laser-sinter living hinge

## Spring living hinge

machine type	P100/P390
parameter	mechanic
Post processing	blasting
material	PA2200
bending angle	270
building direction	upright
spring force	high
size	10x10 mm



It is a different geometry based on the same principle.

Three building positions were tested



# Snap living hinge



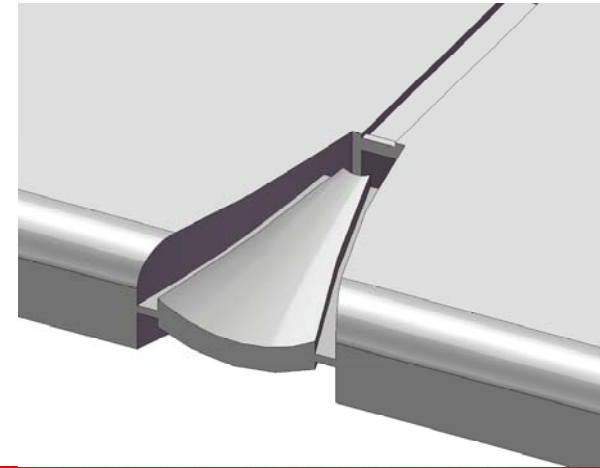
# Snap living hinge

## 025.004 straight snap living hinge

One rest Position

Horizontal building

machine type	P100
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	90
building direction	horizontal
spring force	middle
size	4x5 mm



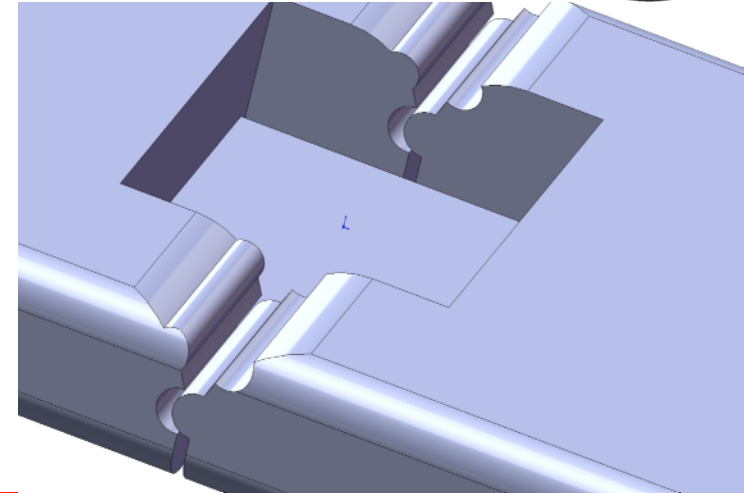
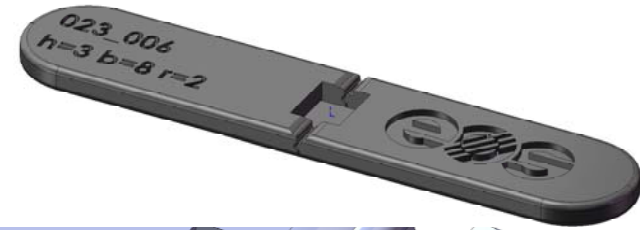
# Snap living hinge

## 023.006 double snap living hinge

Two rest positions

Upright building

machine type	P100
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	45° and 130°
building direction	upright
spring force	low
size	4x9 mm



# Application examples



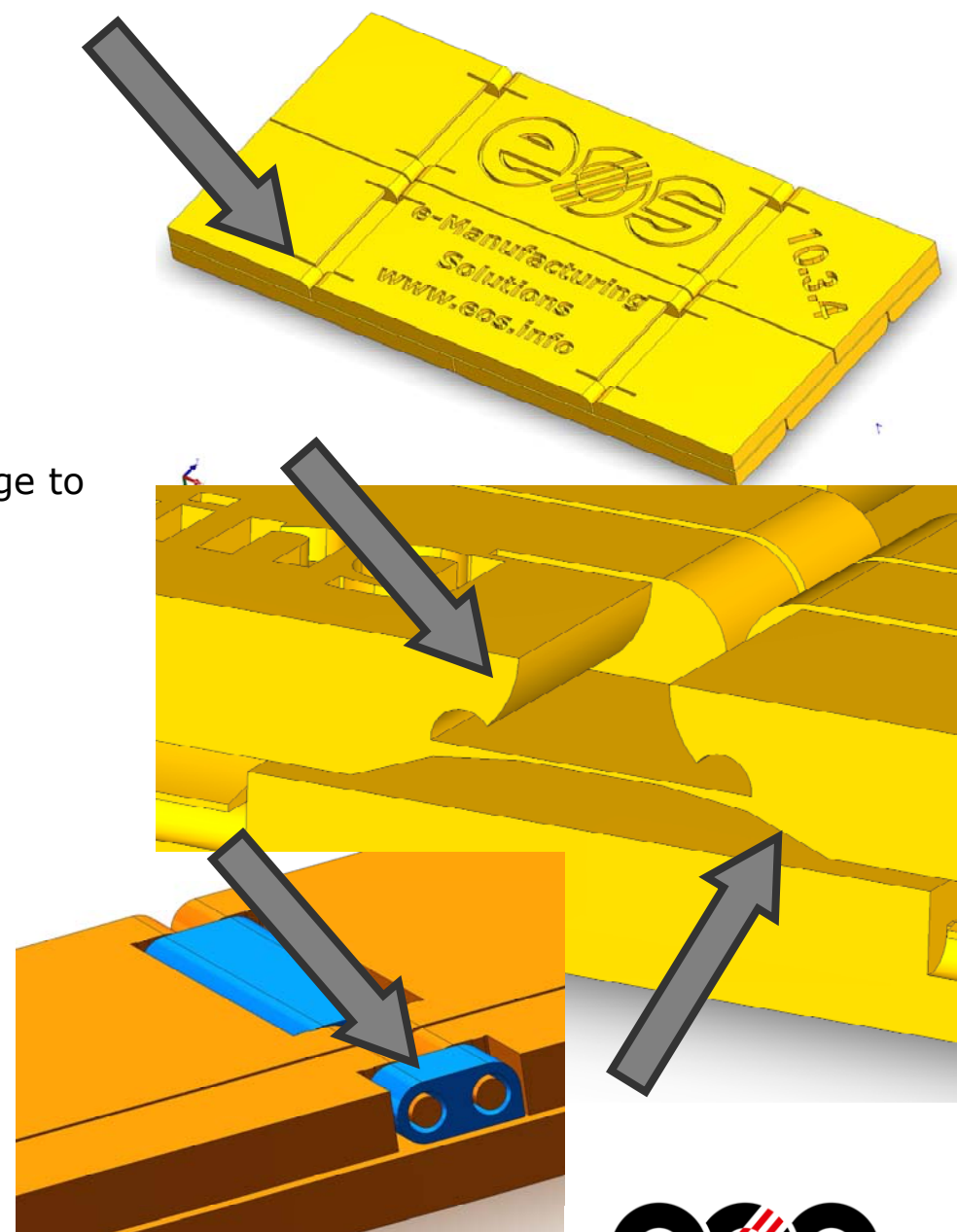


# Application examples

## Anyflip with living hinge

- Replacement of the bearing hinge
- Adapting the design of [015.001](#), change to horizontal
- Space for easy blasting
- Curves for stiffness

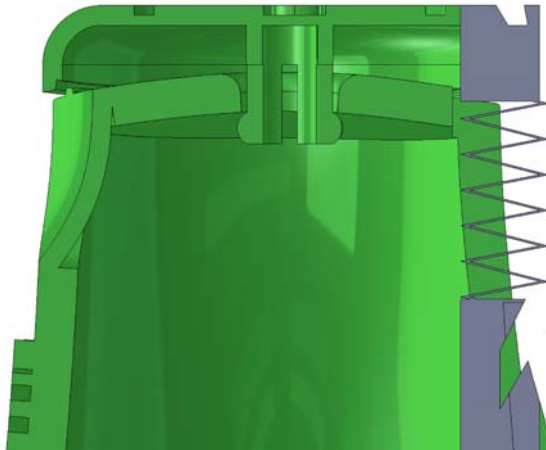
machine type	P100
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	horizontal
spring force	low
size	3x11 mm



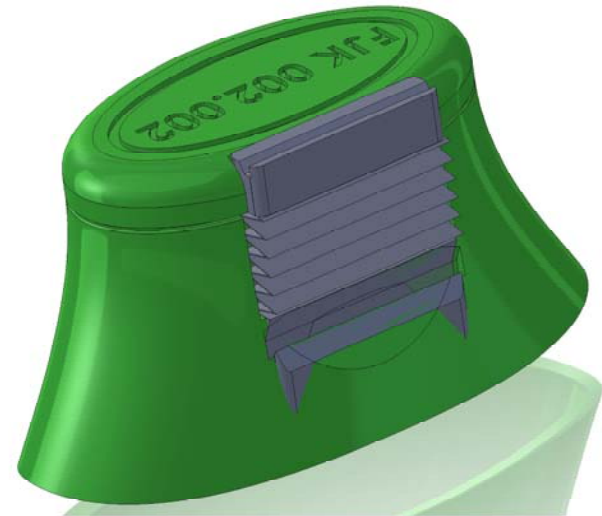
# Application examples

## Shampoo cap

- Most familiar application
- Building position: closed
- No necessary modification in living hinge geometries
- Additional rest position for zigzag living hinge
- Undercuts are no limitation!

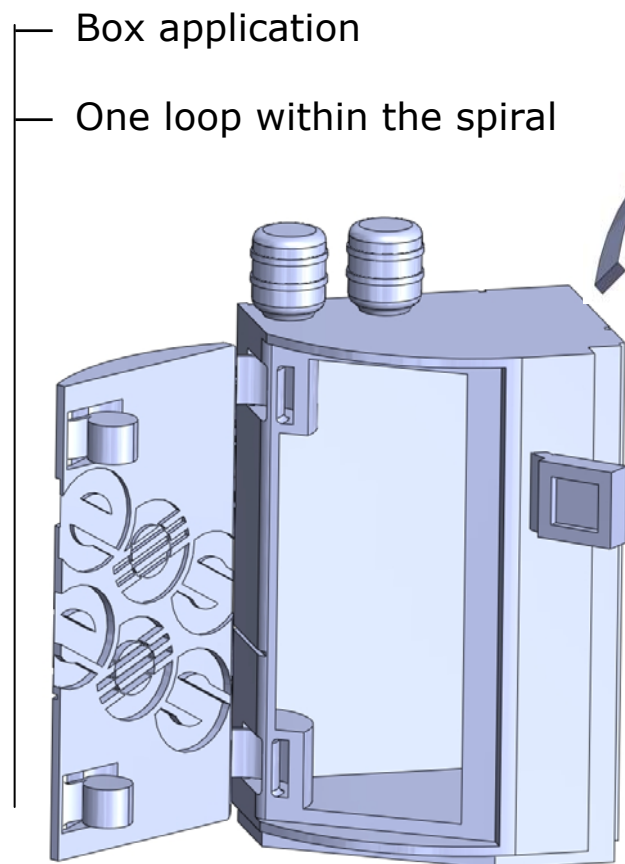


machine type	P100
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	210
building direction	upright
spring force	high
size	4x10 mm

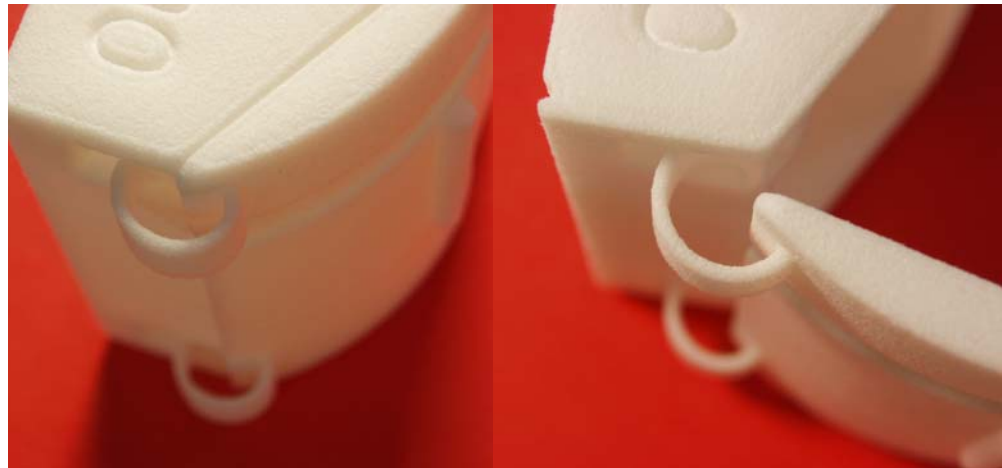


# Application examples

## Formiga with spiral living hinge



machine type	P100/P390
parameter	mechanic
post processing	blasting
material	PA2200
bending angle	180
building direction	upright
spring force	high
size	5x7 mm

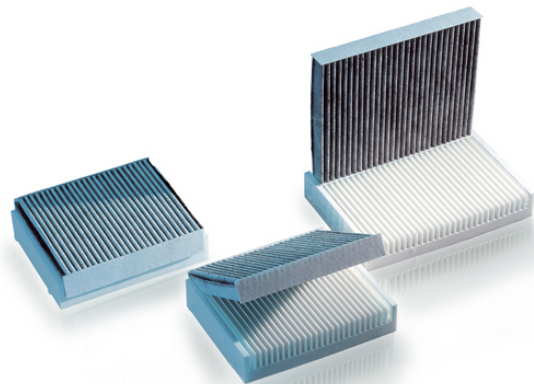


# Laser-sinter living hinge

## Summary

- We demonstrate living hinges are possible with laser-sintering
- There is no limit in design, only in your mind
- All our work will be gathered within the Design Rules structure





Any shape • Anytime • Anywhere

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