

Design Lab: Manufacturing

Corso Materiali intelligenti e Biomimetici
07/04/2020

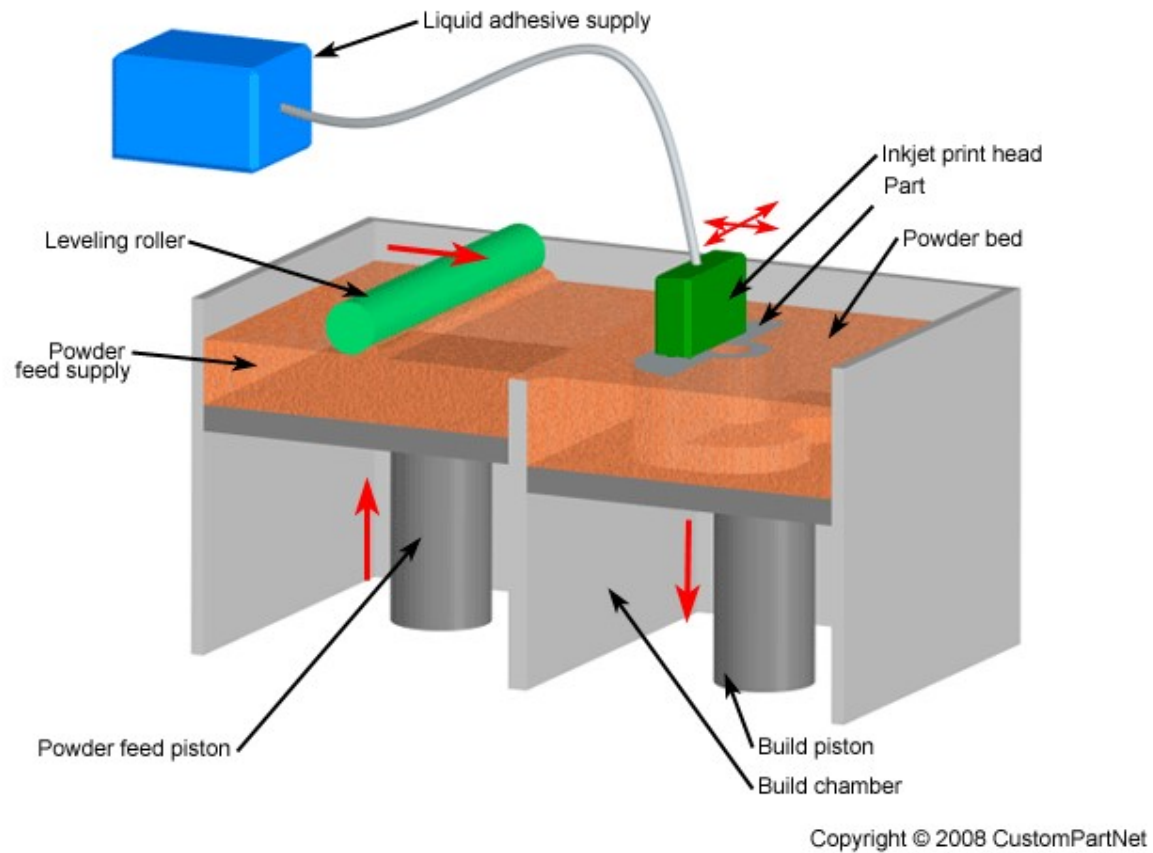
ludovica.cacopardo@ing.unipi.it

Rapid Prototyping

Rapid prototyping is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (**CAD**) data. Construction of the part or assembly is usually done using the "**additive layer manufacturing**" technology.

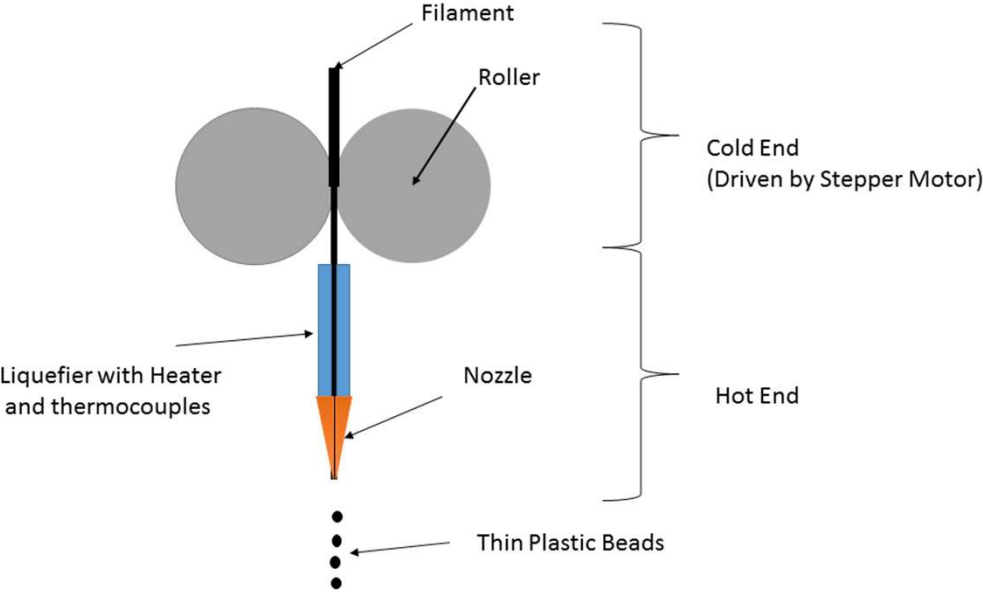
- 3D printing (3DP)
- Fused deposition modeling (FDM)
- Laminated object manufacturing (LOM)
- Stereo lithography (STL)
- Selective laser sintering (SLS)

3D printing

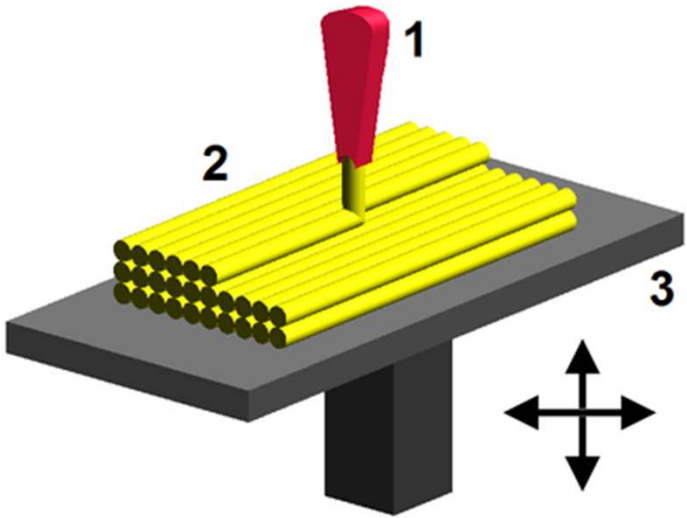


Printing of a **binder material** onto a **powder bed** with **inkjet printer** heads

FDM

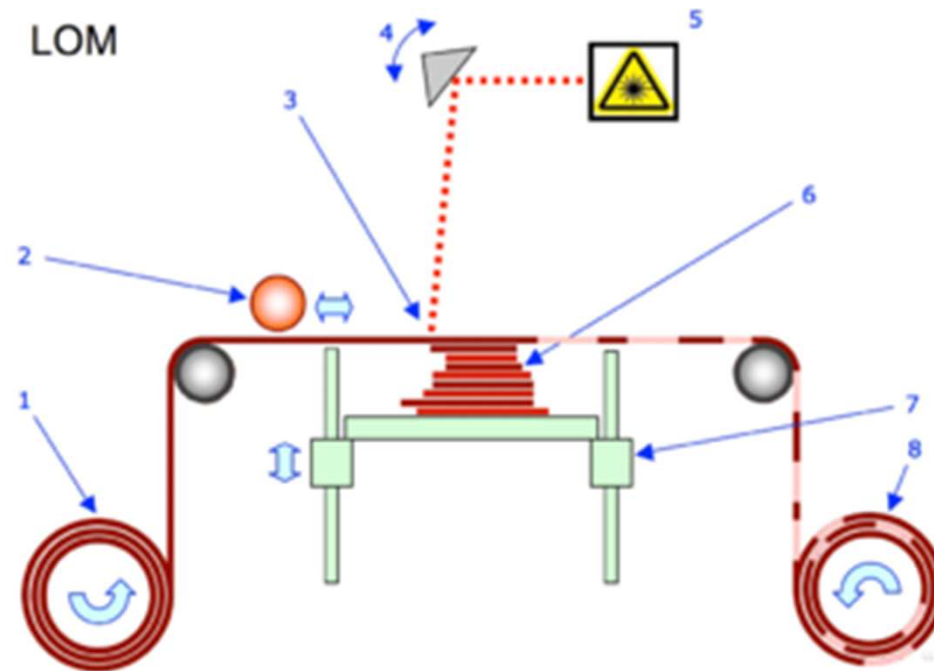


3-D Printer Extruder



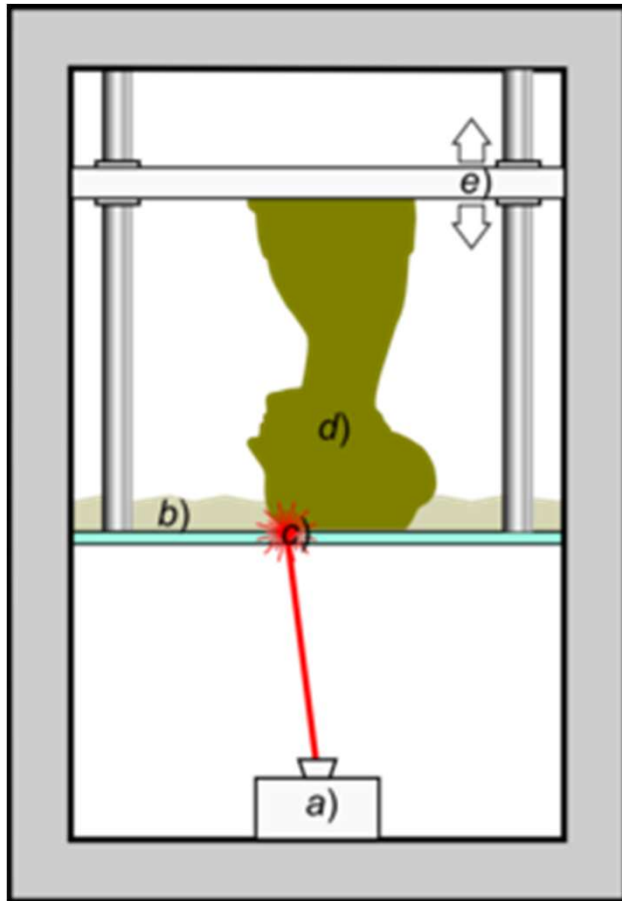
thermoplastics such as *acrylonitrile butadiene styrene* (ABS), *polylactic acid* (PLA), *high-impact polystyrene* (HIPS), *thermoplastic polyurethane* (TPU), *aliphatic polyamides* (nylon)

LOM



layers of adhesive-coated paper, plastic, or metal laminates are successively glued together and cut to shape with a knife or laser cutter

STL

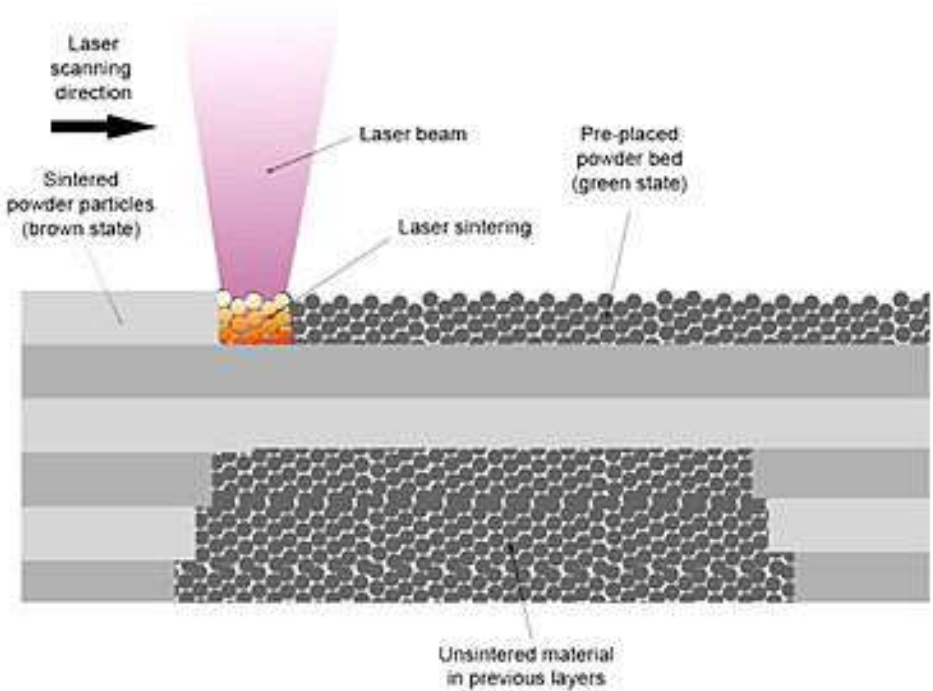
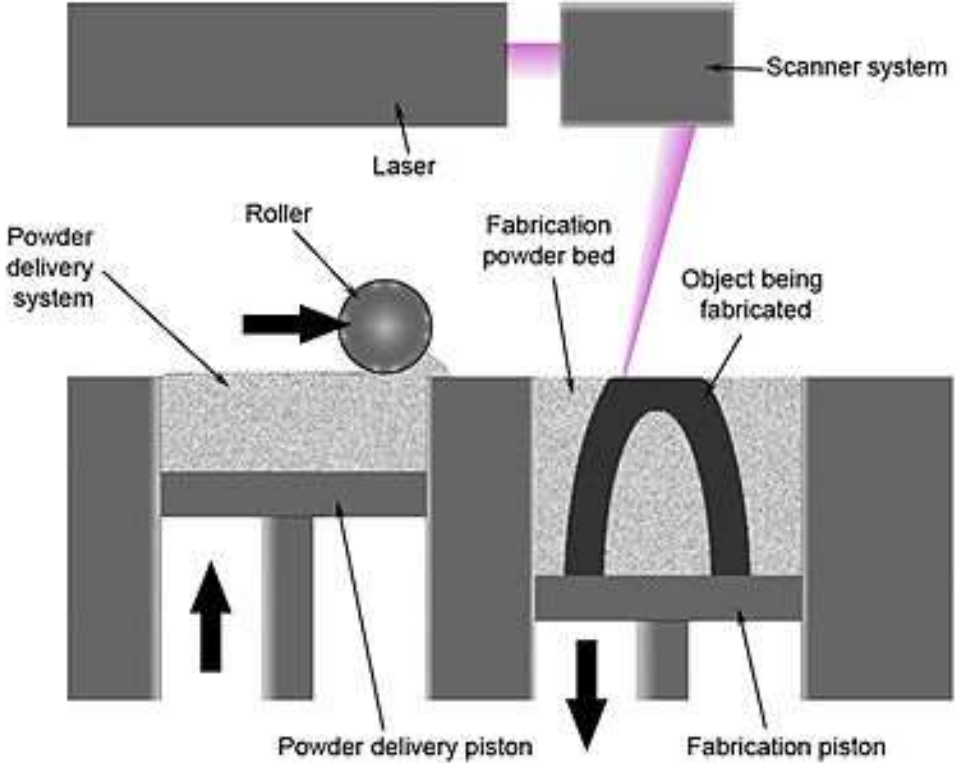


Stereolithography works by focusing an **UV laser** on to a vat of **photopolymer resin**. The UV laser is used to draw a pre-programmed design or shape on to the surface of the photopolymer vat.

Then, the build platform lowers one layer and a blade recoats the top of the tank with resin.

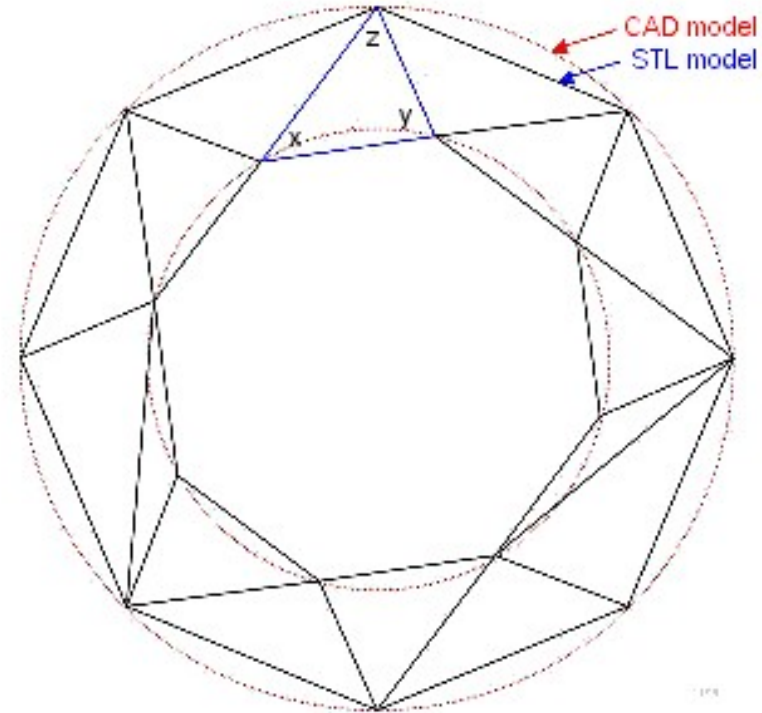
This process is repeated for each layer of the design until the 3D object is complete. Completed parts must be washed with a solvent to clean wet resin off their surfaces.

SLS



Work Flow

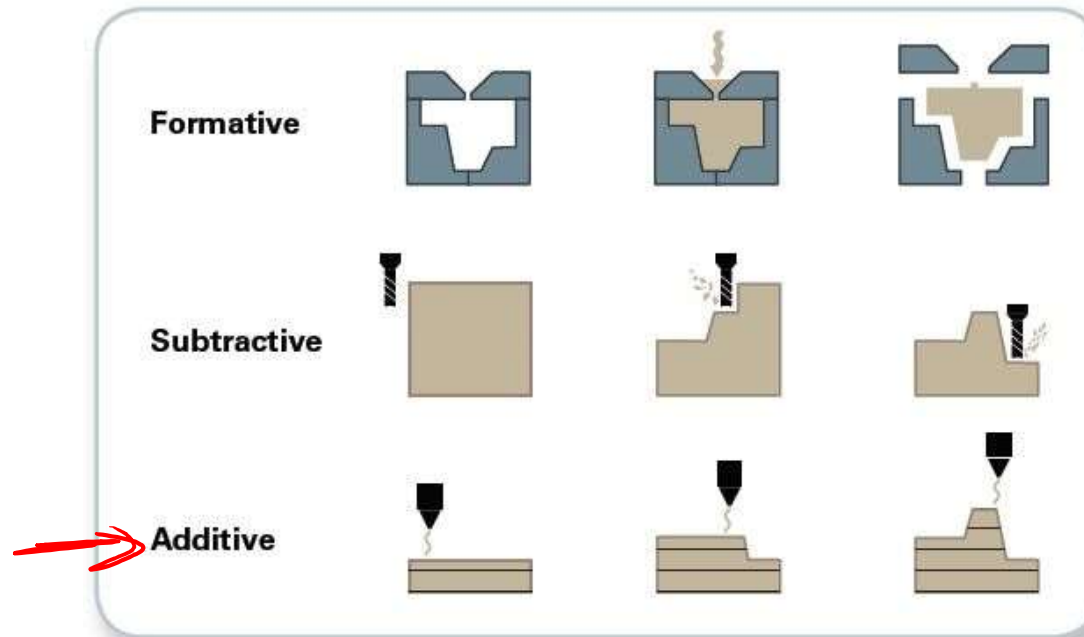
1. File CAD
 2. File STL
 3. G-code
- Slic3r



STL: Standard Triangle Language -> STL file describes a raw, *unstructured triangulated surface* by the unit normal and vertices;

G-code is a language in which people tell computerized machine tools how to make something. The "how" is defined by *g-code instructions provided to a machine controller* (industrial computer) that tells the motors where to move, how fast to move, and what path to follow

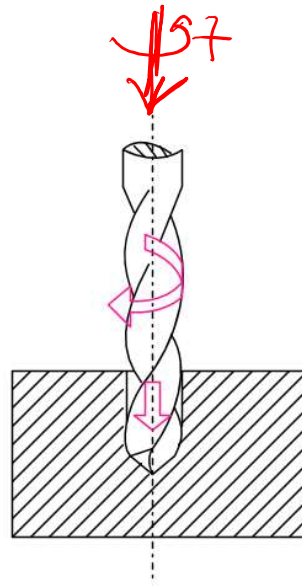
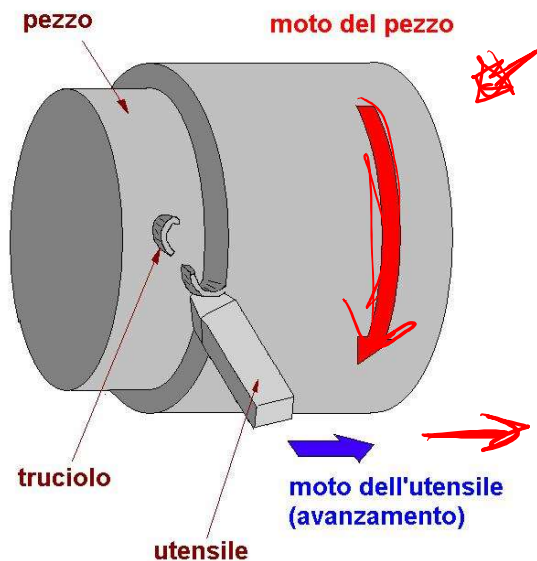
Manufacturing techniques



- **Casting** : Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify.
- **Subtractive manufacturing** : Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process.

Subtractive manufacturing

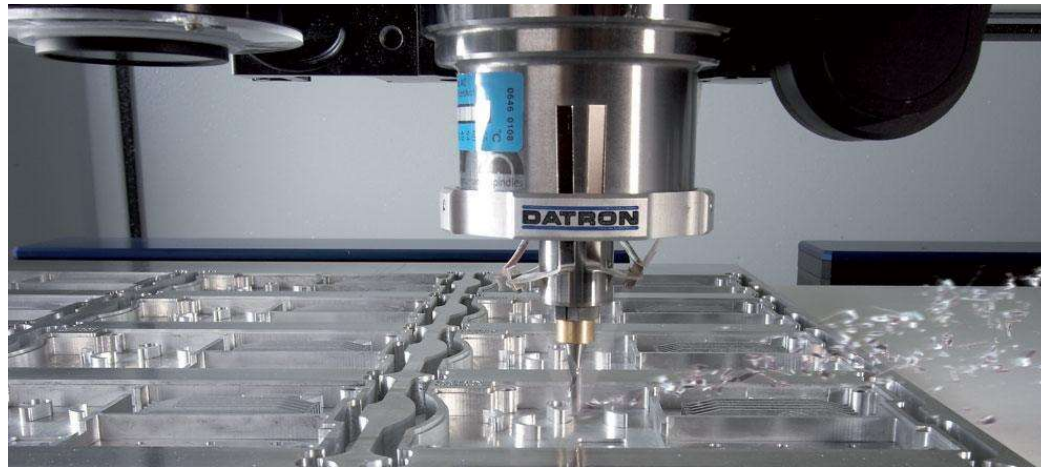
- **Turning** (tornitura): a cutting tool with a single cutting edge is used to remove material from a rotating workpiece to generate a cylindrical shape.
- **Drilling** (foratura) is used to create a round hole. It is accomplished by a rotating tool that typically has two or four helical cutting edges
- In **milling** (fresatura), a rotating tool with multiple cutting edges is moved slowly relative to the material to generate a plane or straight surface. The direction of the feed motion is perpendicular to the tool's axis of rotation. The speed motion is provided by the rotating milling cutter.



CNC Machining

Computer numerical control (CNC) is the **automation of machine tools** by means of computers executing pre-programmed sequences of machine control commands. This is in contrast to machines that are manually controlled by hand wheels or levers.

The parts are defined using **computer-aided design (CAD)** software, and then translated into manufacturing directives by **computer-aided manufacturing (CAM)** software. The resulting directives are transformed (by "post processor" software) into the specific commands necessary for a particular machine to produce the component, and then are loaded into the CNC machine.



Subtractive Manufacturing

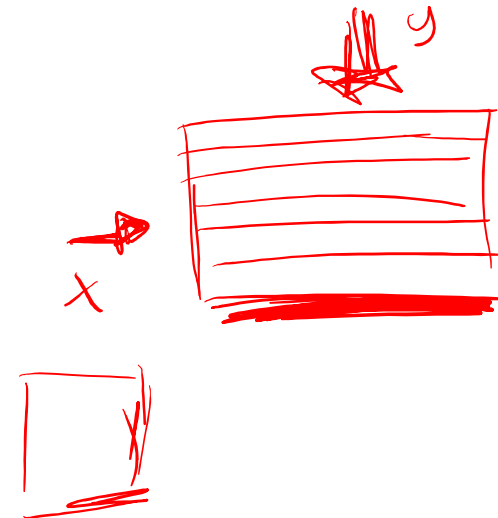
PROCESS	MATERIALS
CNC machining (turning, drilling, boring, milling, reaming)	Hard thermoplastics, thermoset plastics, soft metals, hard metals (industrial machines)
Electrical discharge machining (EDM)	Hard metals
Laser cutting	Thermoplastics, wood, acrylic, fabrics, metals (industrial machines)
Water jet cutting	Plastics, hard and soft metals, stone, glass, composites



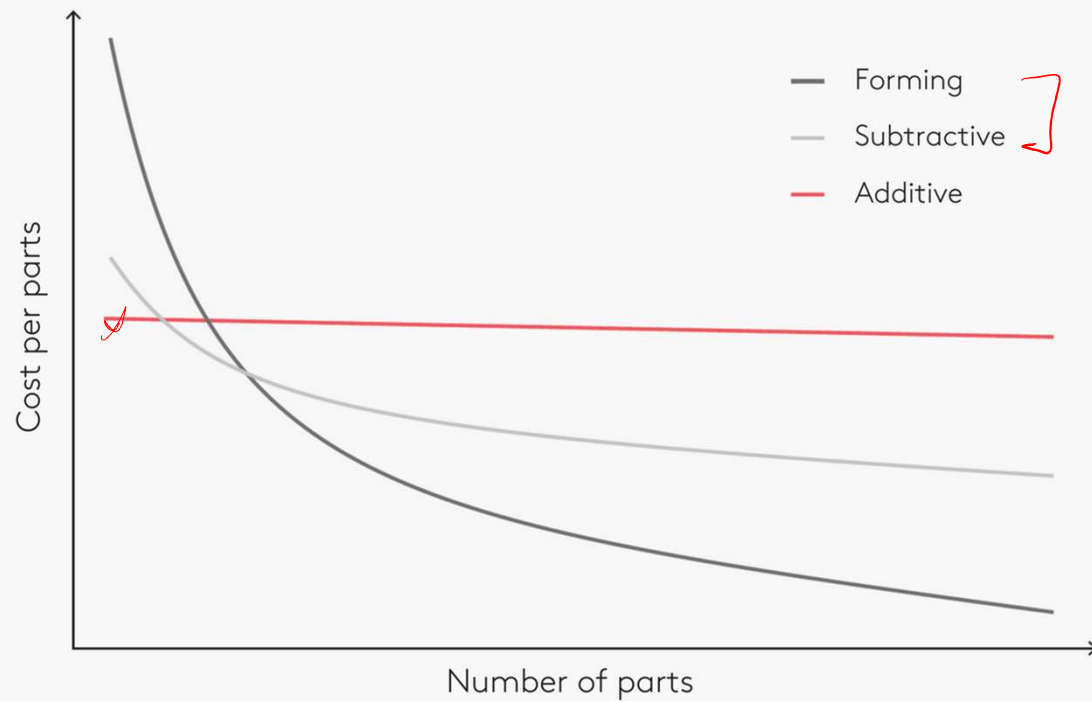
Material Classes

- Metals: aluminum, steel -> sintering, casting, machining
corrosion, mechanical strength, magnetic properties
- Polymers: ABS, PVA, PLA, PC (thermoplastic) -> FDM, casting, machining
Teflon, Delrin -> machining
mechanical strength, transparency
- Ceramics and glass -> sintering, casting
mechanical strength, transparency

Others: sterilisability, biocompatibility, weight, machinability, cost



Costs

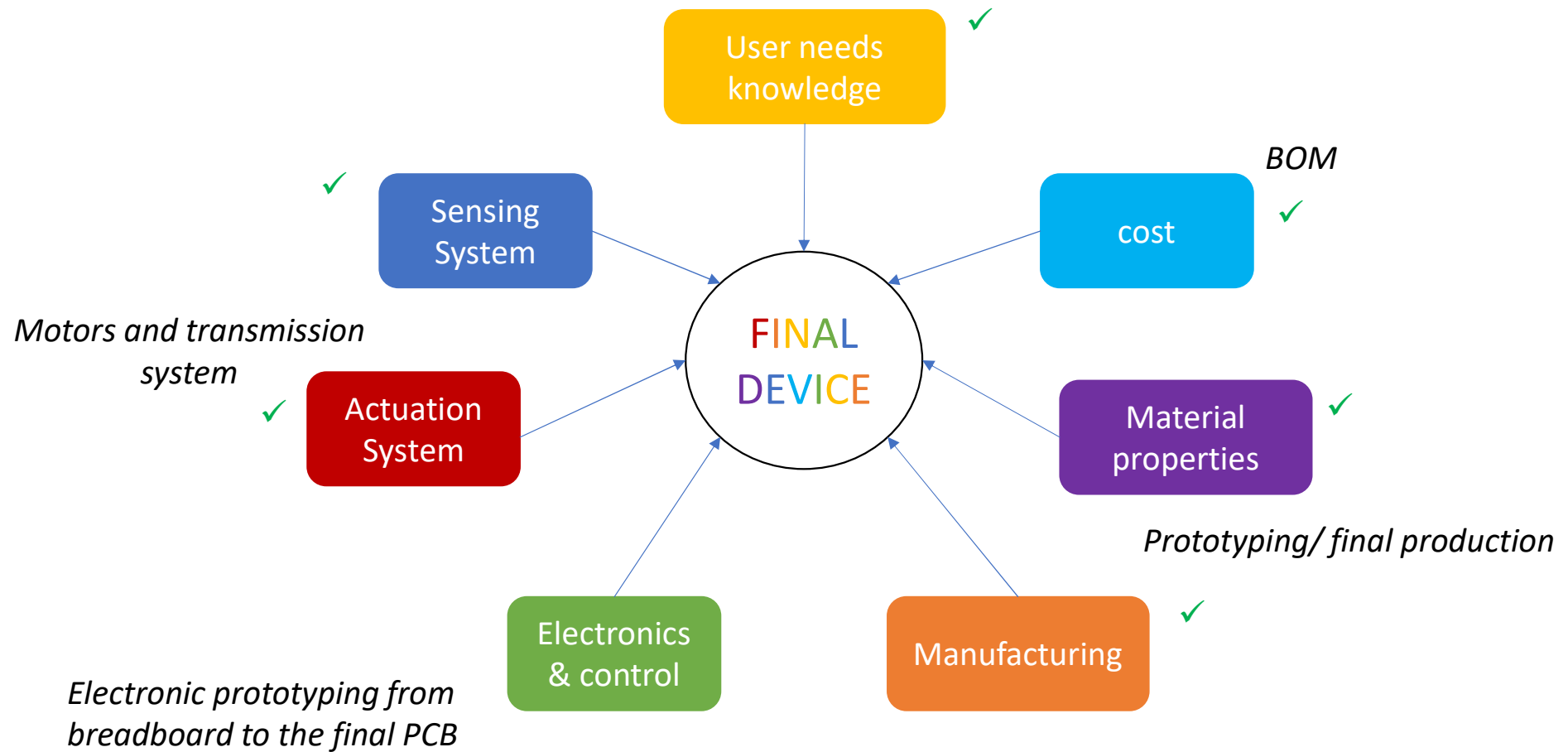


- Physical size of the part
- Density
- Number of parts
- finishing, coloring, handling or post-production processing

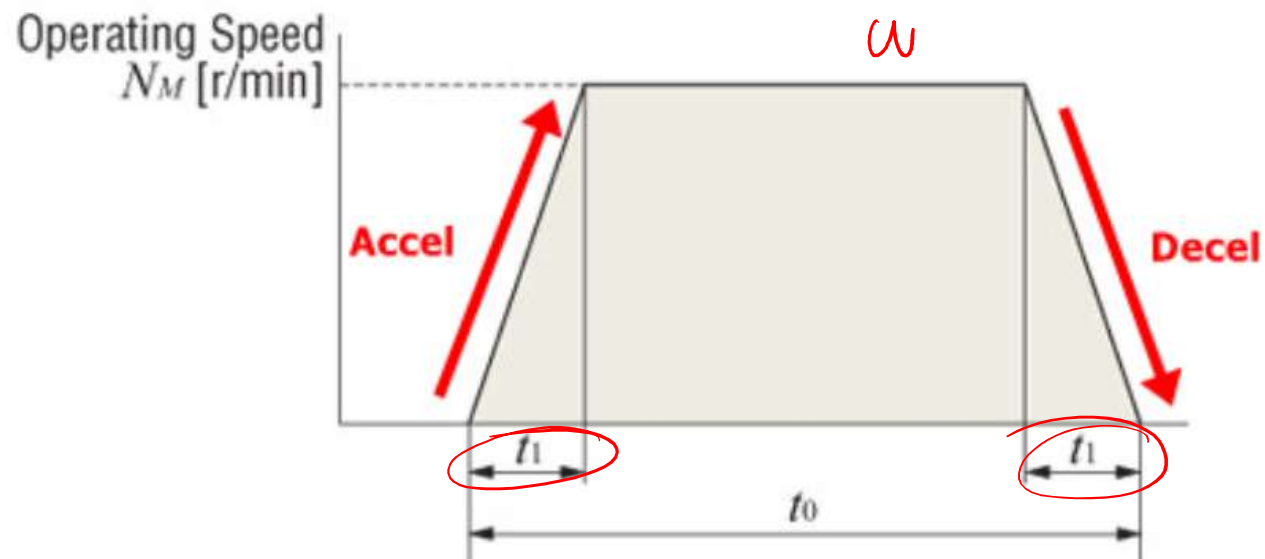
Esercitazione LAB3

- Identificare materiali/tecniche prototipazione e per il prodotto finito
- Cercare possibili materiali intelligenti alternativi per la parte di sensing ed attuazione, evidenziando vantaggi/svantaggi.

Design of innovative testing systems



Note Motori



$$T_a = J \dot{\omega} = \frac{\omega}{t_1}$$

File in
formato
STL



Insight - PIASTRA_INF

File Edit View Modelers STL Slice Support Toolpaths Help

Open...
Close
Paste Job from clipboard

Save
Save As...
Delete...

Print...

Build...
Preferences...
Customize

Exit

Modeler Setup

Configure the modeler to build the part.

Fortus 250mc	0.2540 slice height
Model T14 tip	ABS P430
Support T16 tip	ABS SR30

Part interior style Sparse - high density

Visible surface style Enhanced

Support style SMART

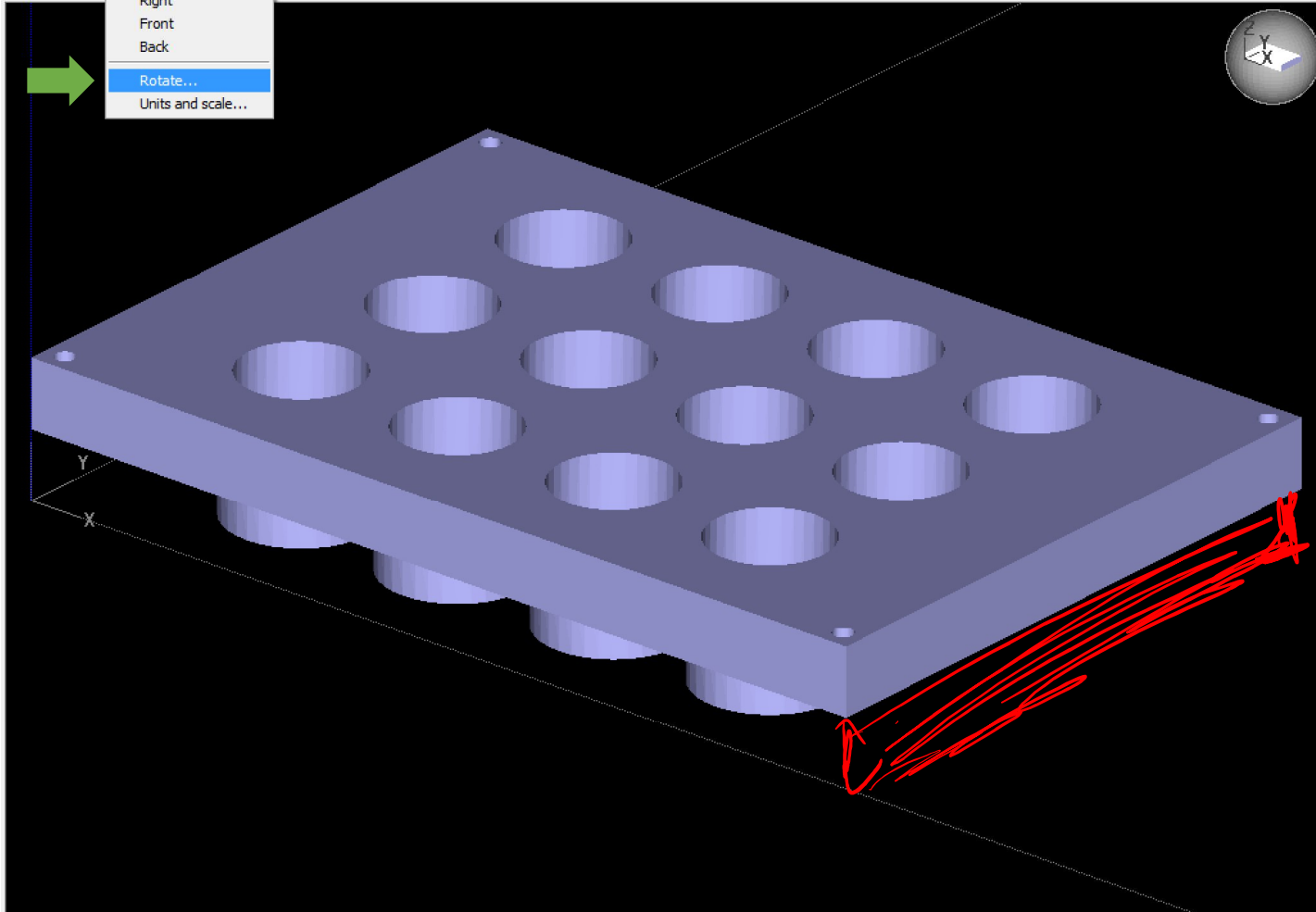
STL size mm X = 135.0010 Y = 89.9998 Z = 20.0000

STL | 135.00; 89.9998; 20.0000 | Z | 0.2540

FORTUS 250mc



- Top
- Bottom
- Left
- Right
- Front
- Back
- Rotate...
- Units and scale...



STL Rotate

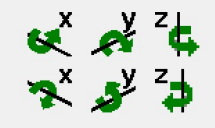
Rotate the STL model by specifying rotation angles or incrementally nudging the model using the buttons. STL display under the STL menu must be checked.

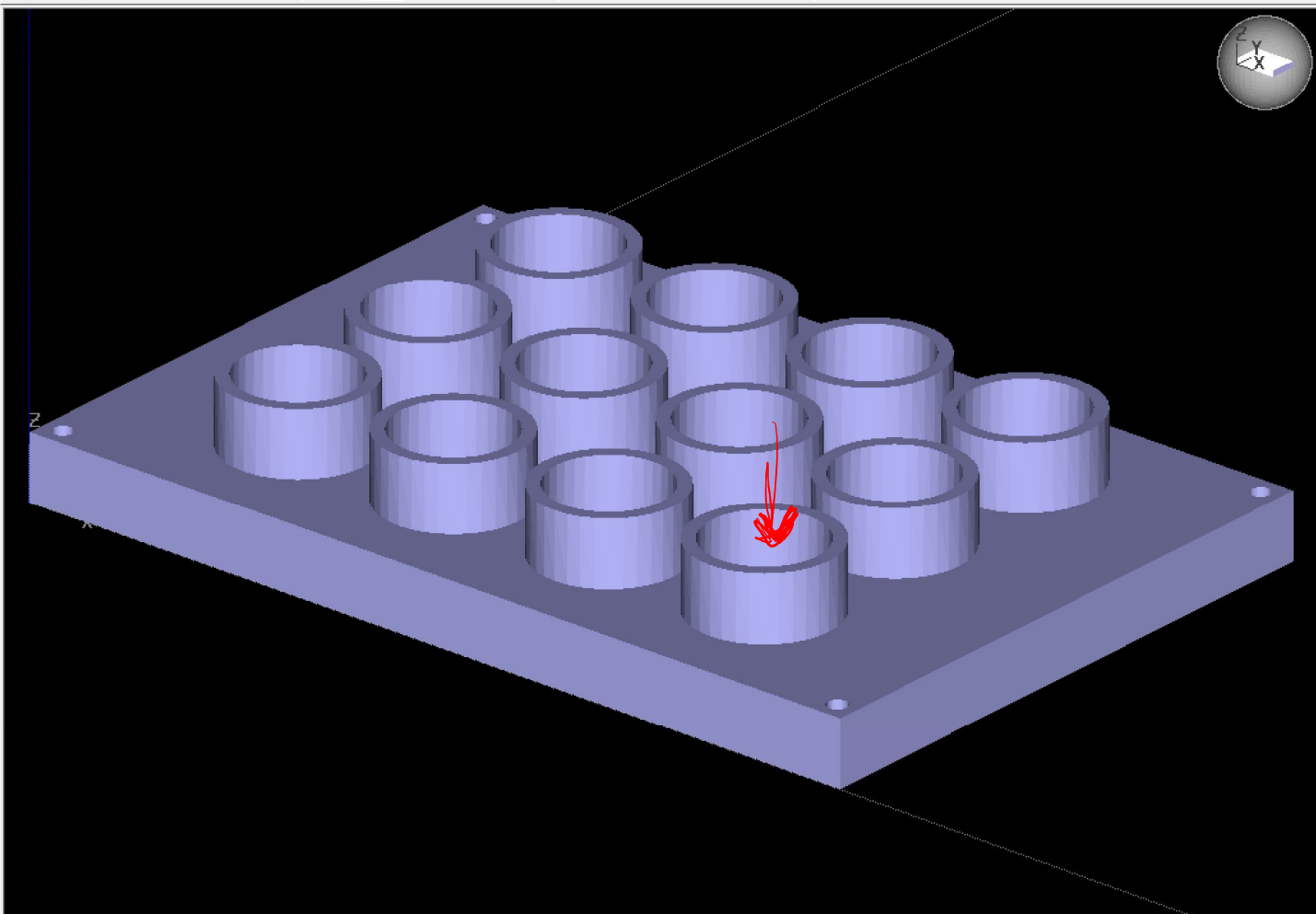
Rotation about X

about Y

about Z

Rotate increment





STL Rotate

Rotate the STL model by specifying rotation angles or incrementally nudging the model using the buttons. STL display under the STL menu must be checked.

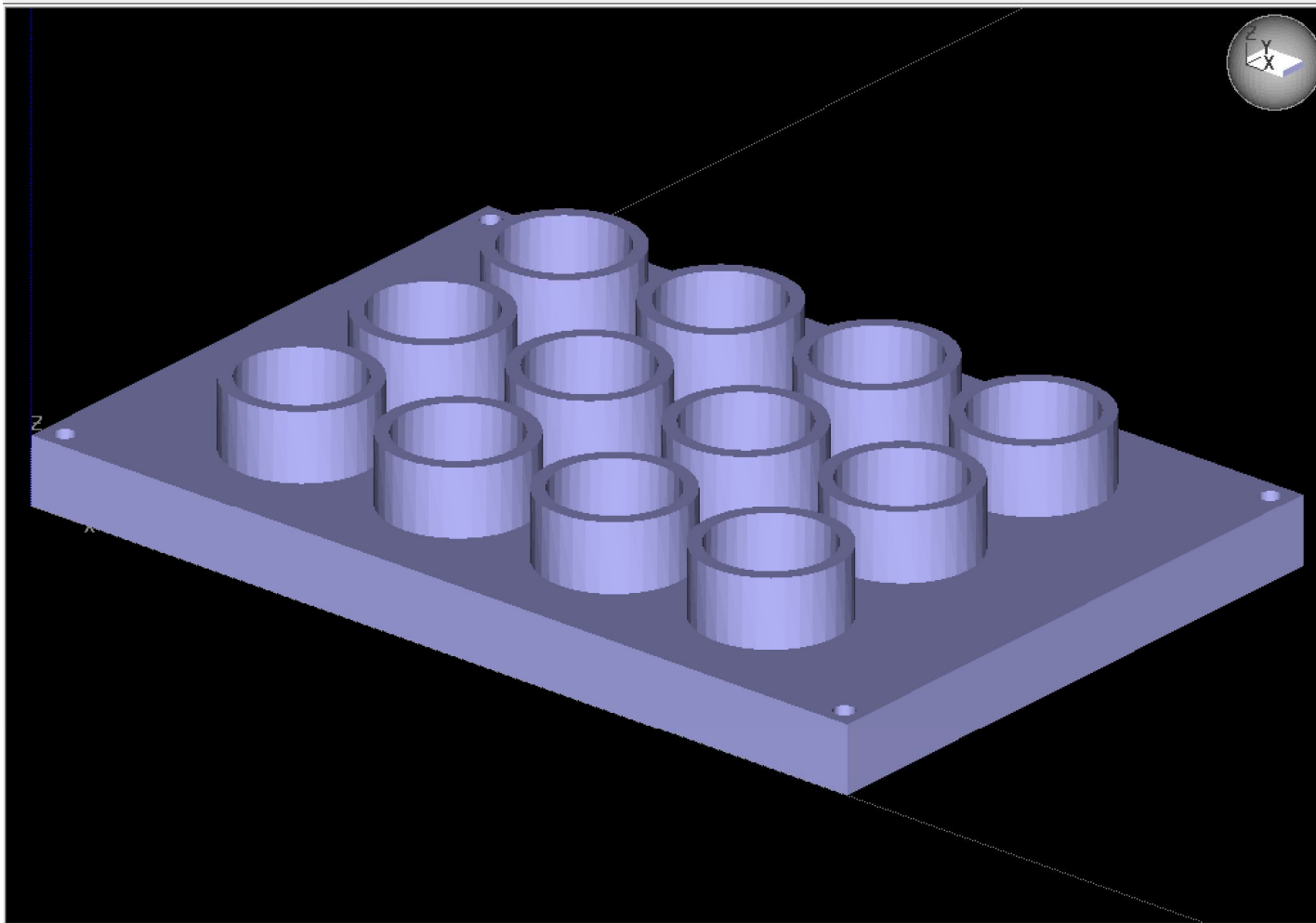
Rotation about X

about Y

about Z

Rotate increment

A set of icons for rotating the model around the X, Y, and Z axes. Each axis has a green icon with a dollar sign and a red icon with a dollar sign, representing different rotation directions.



Modeler Setup

Configure the modeler to build the part.

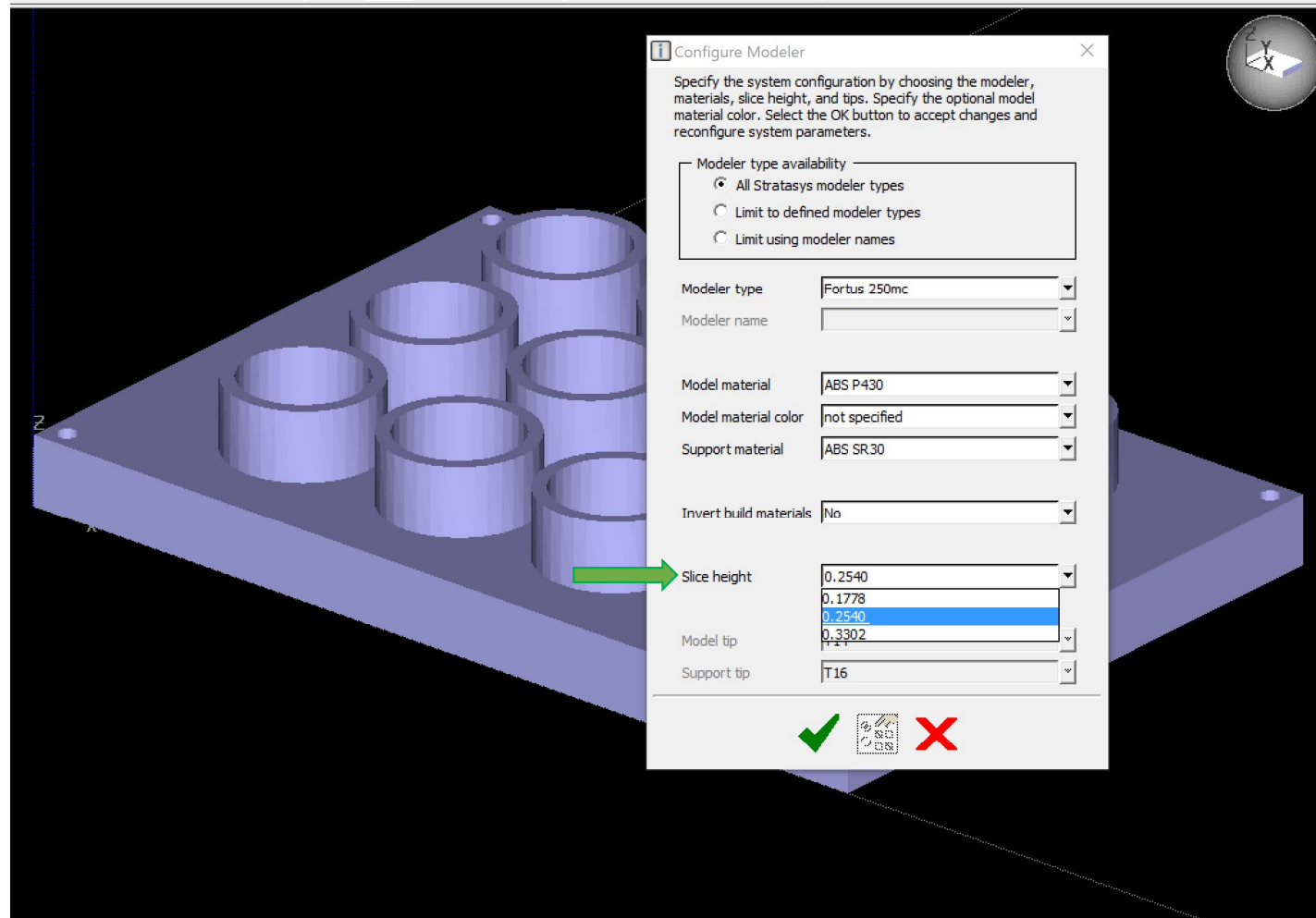
Fortus 250mc	0.2540 slice height
Model T14 tip	ABS P430
Support T16 tip	ABS SR30

Part interior style: Sparse - high density

Visible surface style: Sparse - high density

Support style: Sparse - double dense

FORTUS 250mc



Configure Modeler

Specify the system configuration by choosing the modeler, materials, slice height, and tips. Specify the optional model material color. Select the OK button to accept changes and reconfigure system parameters.

Modeler type availability

- All Stratasys modeler types
- Limit to defined modeler types
- Limit using modeler names

Modeler type: Fortus 250mc

Modeler name: [empty]

Model material: ABS P430

Model material color: not specified

Support material: ABS SR.30

Invert build materials: No

Slice height: 0.2540 (highlighted)

Model tip: 0.3302

Support tip: T16

OK [checkmark] Cancel [X]

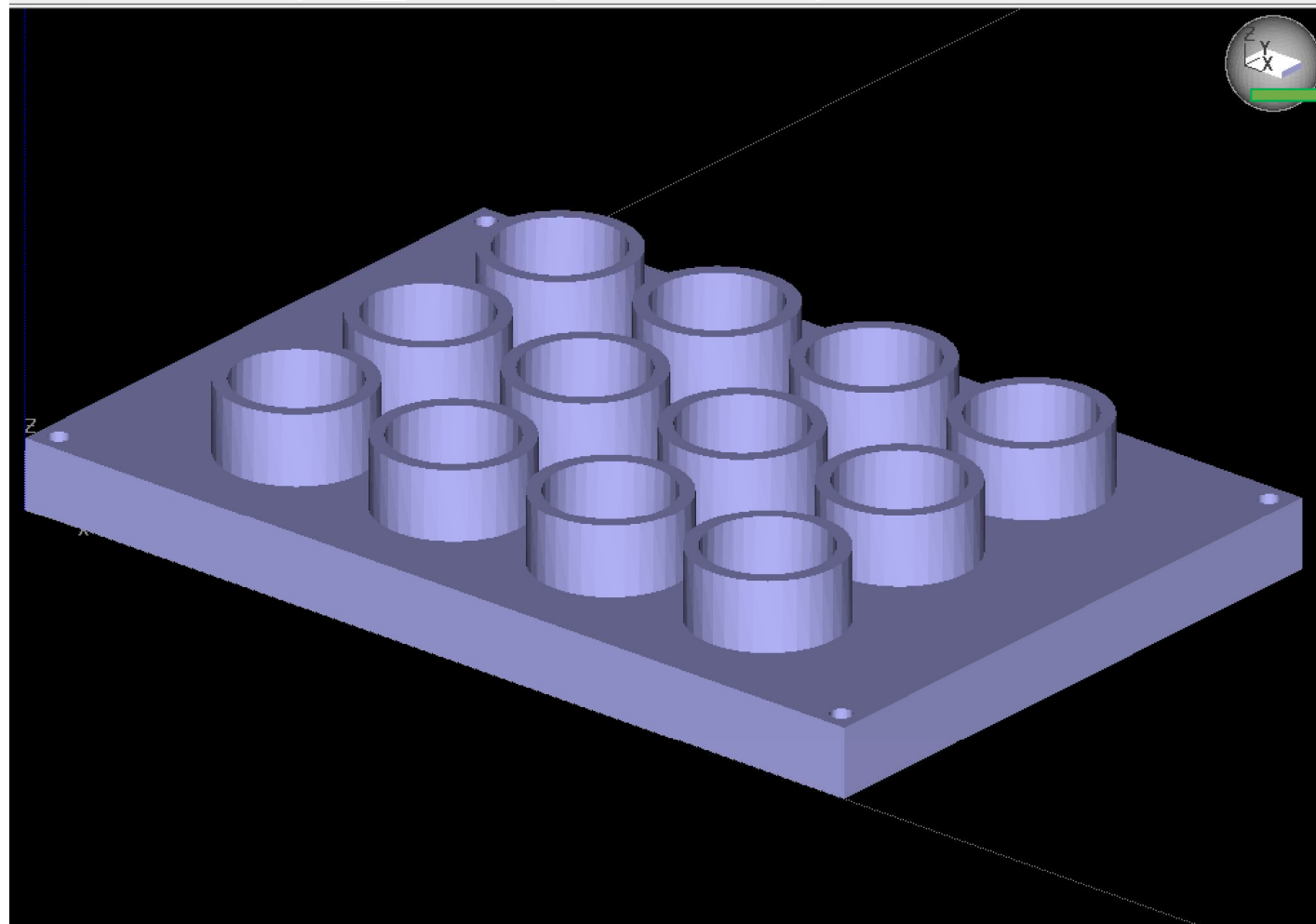
Modeler Setup

Configure the modeler to build the part.

Fortus 250mc	0.2540 slice height
Model T14 tip	ABS P430
Support T16 tip	ABS SR.30

- Part interior style: Sparse - low density
- Visible surface style: Enhanced
- Support style: SMART





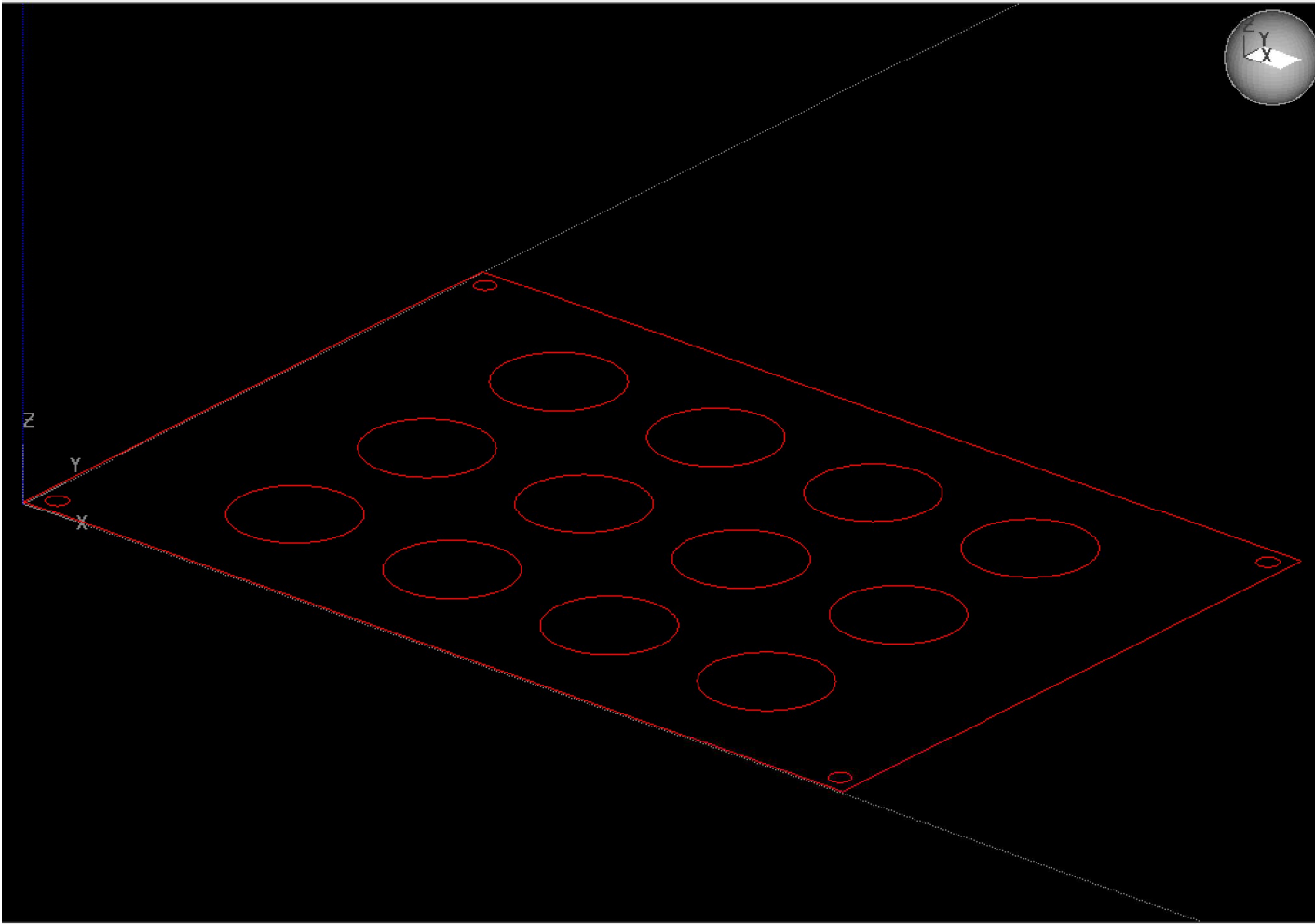
Toolpath Setup

Fortus 250mc 0.2540 slice height
Model T14 tip ABS P430
Support T16 tip ABS SR30

Part fill style	One contour / rasters
Contour width	0.5080
Number of contours	0.3556 0.3806
Part raster width	0.4056 0.4306
Part interior style	0.4556 0.4806
Number of interior contours	0.5056
Visible surface style	0.5306 0.5556
Visible surface rasters	0.5806 0.6056
Internal rasters	0.6306



FORTUS 250mc



Modeler Setup



Processing Model

The current calculation can be halted at any time with the stop button. Use the minimize button to hide Insight until processing is complete.

- Slice
- Create supports
- Write boundary curves
- Create toolpaths
- Write CMB file

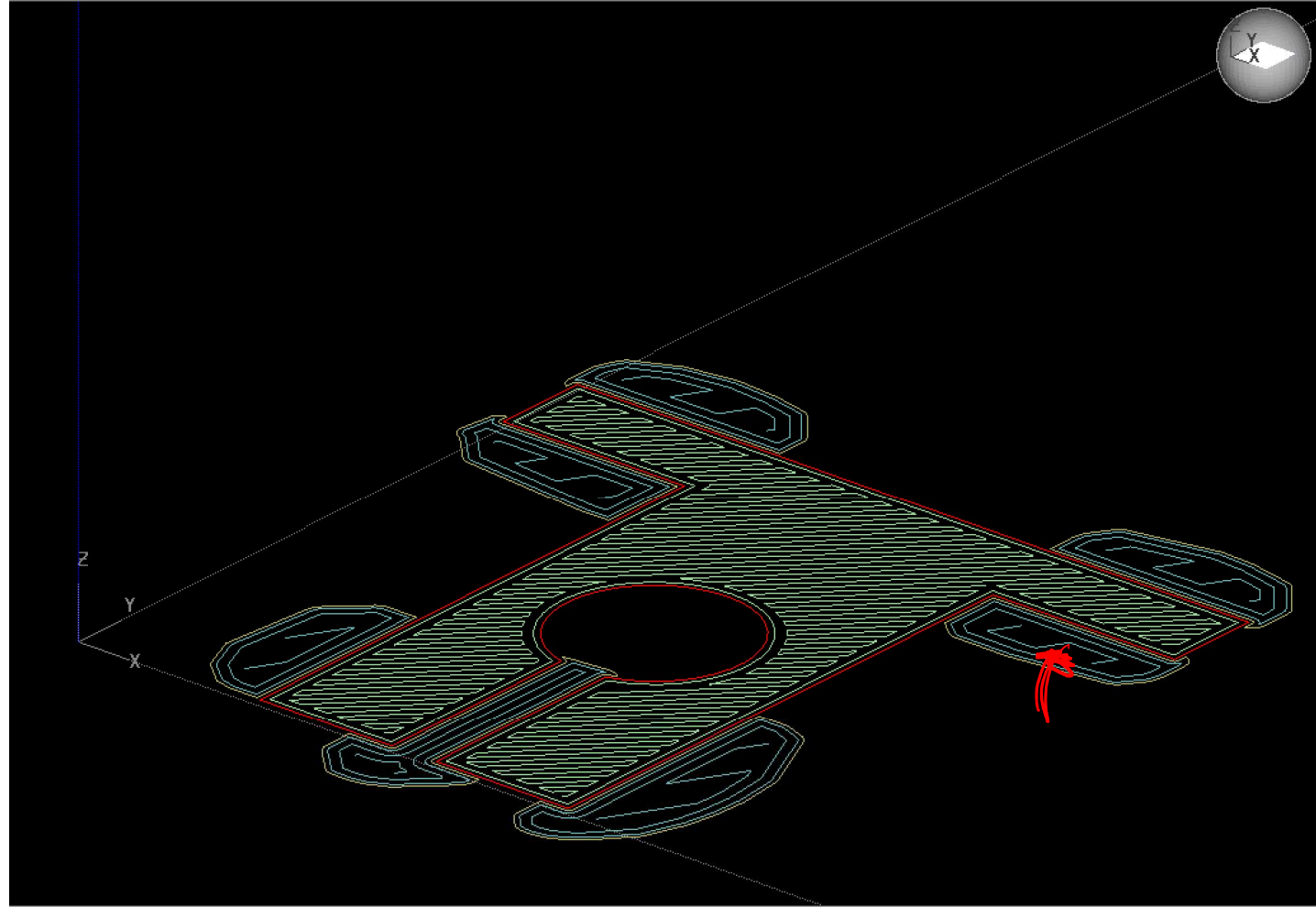
Supports at Z = 10.160

Processing time

Insight - PINZA

File Edit View Modelers STL Slice Support Toolpaths Help



Modeler Setup

Configure the modeler to build the part.

Fortus 250mc	0.2540 slice height
Model T14 tip	ABS P430
Support T16 tip	ABS SR30

Part interior style

Visible surface style

Support style



FORTUS 250mc

Saved job: C:/Users/ludov/OneDrive - University of Pisa/Lezioni/2018 Materiali Intelligenti/SW/7/STL/ssys_PINZA/PINZA.sjb, approximate build time 54 min STL [30.500;27.000;14.00] Z [0.2540]

Control Center

File Tools Systems Help

Insert CMB...

Print Screen Image...

Exit

Name:

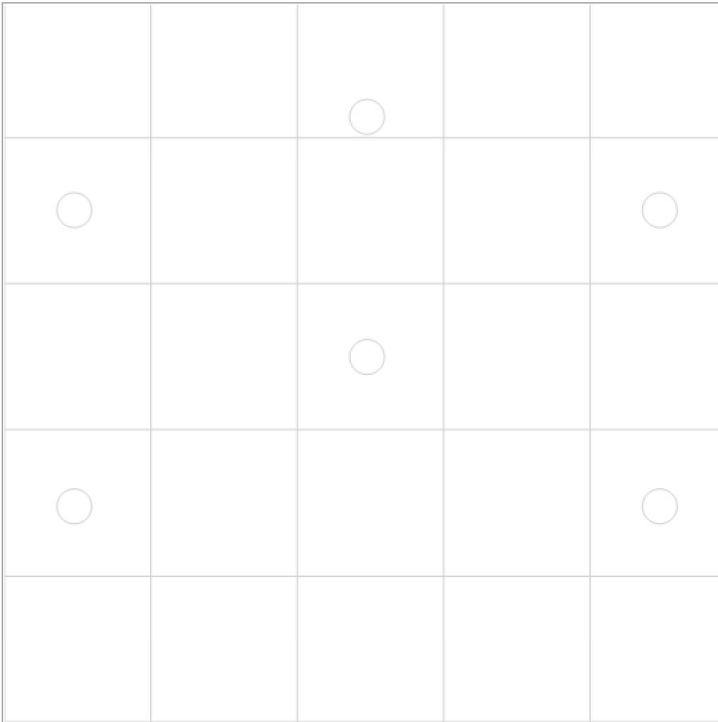
Manage FDM Systems

Material: Model: P430_RED T14: 622,10 cm³ Support: SR30 T16: 423,56 cm³

Status: Building - print_ruote_dentate_gemma1

Platen

X: 254,00 mm Y: 254,00 mm



Insert CMB

Copy

Remove

Repack

90

Center

CMB Info

Pack Details

Name:

Model Material: 0,00 cm³

Support Material: 0,00 cm³

Time: 0:00

Notes:

ID	Name
----	------

Options

Clear Pack

Estimate Pack

Save As



Build Job

Cancel

Add Model to the Pack

« Lezioni » 2018 Materiali Intelligenti » SW » 7 » STL » ssys_PIASTRA_INF

Cerca in ssys_PIASTRA_INF

Organizza Nuova cartella

Nome	Stato	Ultima modifica	Tipo	Dimensione
PIASTRA_INF	✓	10/05/2018 09:00	Stratasys CMB File	2.129 KB

Nome file: PIASTRA_INF Toolpath Files (*.cmb.gz; *.cmb)

Apri Annulla

- Insert CMB
- Copy
- Remove
- Repack
- 90
- Center
- CMB Info

Pack Details

Name: PIASTRA_INF

Model Material: 59.48 cm³

Support Material: 8.75 cm³

Time: 5:06

Notes: ...

ID	Name
1	PIASTRA_INF

- Options
- Clear Pack
- Estimate Pack
- Save As

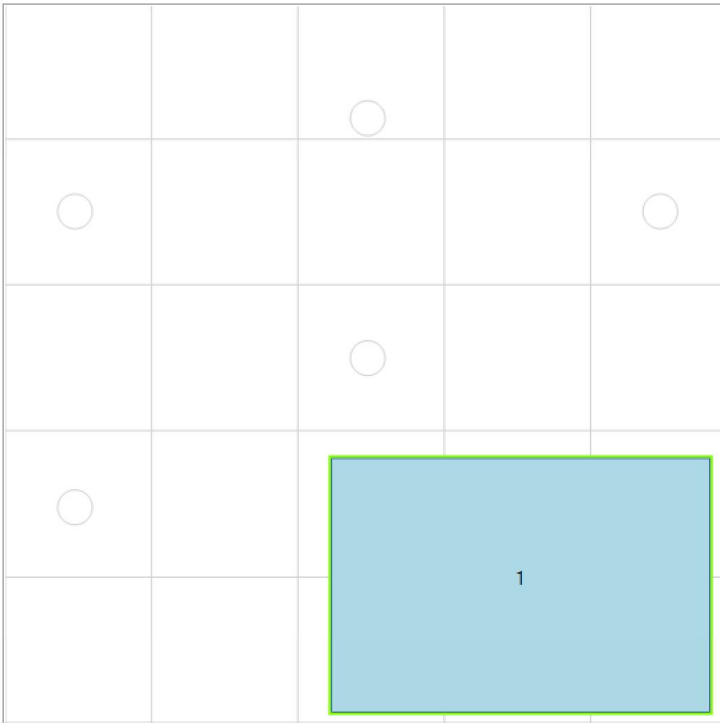
Pack Queue Systems View Services

Fortus 250mc

Name:
Material: **Model: P430_RED T14: 621,94 cm³ Support: SR30 T16: 422,94 cm³**
Status: Building - print_roots_dentate_gamma.1

Sparse-low density

Platen X: 254,00 mm Y: 254,00 mm



-
-
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-

Pack Details

Name:
Model Material: 59,48 cm³
Support Material: **9,75 cm³**
Time: **506**
Notes:

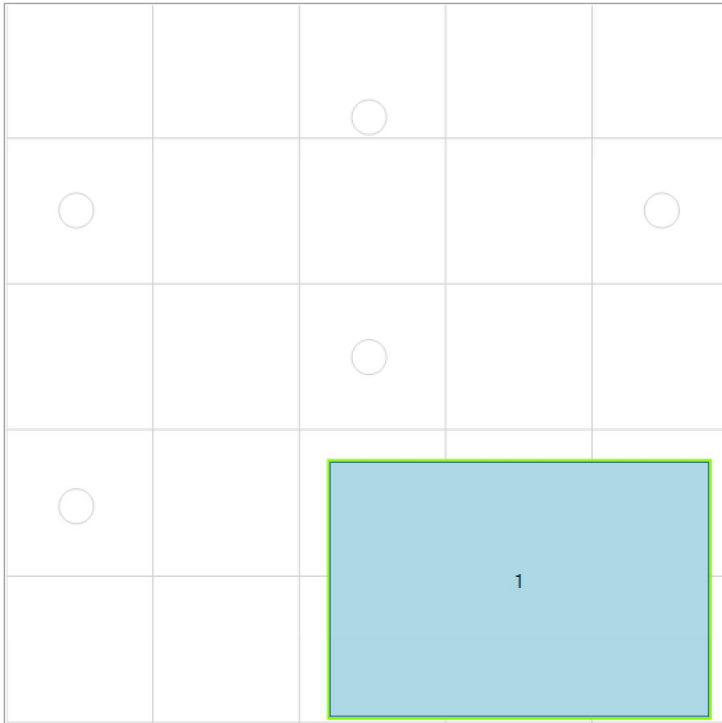
ID	Name
1	PIASTRA_INF

-
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-

Fortus 250mc

Name: Manage FDM Systems
Material: Model: P430_RED T14: 621,90 cm³ Support: SR30 T16: 422,91 cm³
Status: Building - print_ruote_dentate_gemma1

Platen X: 254,00 mm Y: 254,00 mm



Solid

Pack Details

Name:
Model Material: 108,32 cm³
Support Material: 9,75 cm³
Time: 5:37
Notes:

ID	Name
1	PIASTRA_INF2

- Insert CMB
- Copy
- Remove
- Repack
- 90°
- Center
- CMB Info

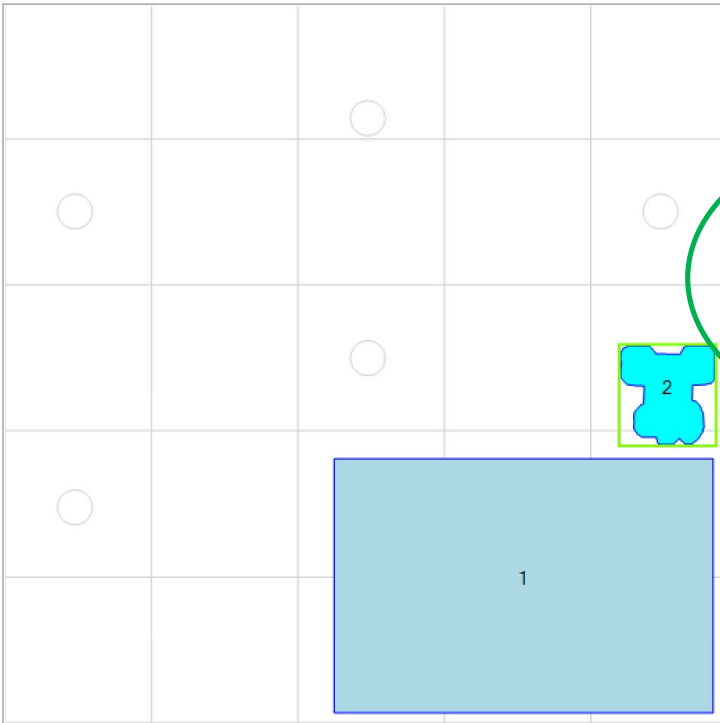
- Options
- Clear Pack
- Estimate Pack
- Save As

Pack Queue Systems View Services

Fortus 250mc

Name: Manage FDM Systems
Material: Model: P430_RED T14: 621,77 cm³ Support: SR30 T16: 422,91 cm³
Status: Building - print_ruote_dentate_gem m a 1

Platen X: 254,00 mm Y: 254,00 mm



Number of copies

Number of copies:

OK Cancel

- Insert CMB
- Copy
- Remove
- Repack
- 90
- Center
- CMB Info

Pack Details

Name:
Model Material: 64,67 cm³
Support Material: 11,62 cm³
Time: 6:00
Notes:

ID	Name
1	PIASTRA_INF
2	PINZA

- Options
- Clear Pack
- Estimate Pack
- Save As

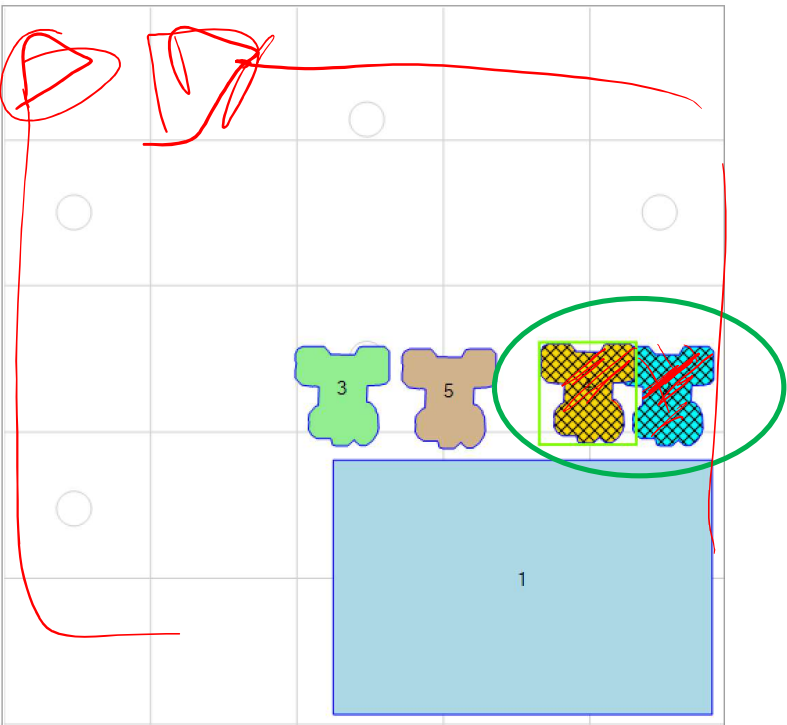


Build Job Cancel

Fortus 250mc

Name:
Material: Model: P430_RED T14: 621,77 cm³ Support: SR30 T16: 422,91 cm³
Status: Building - print_ruote_dentate_gemma1

Platen X: 254,00 mm Y: 254,00 mm



Pack Details

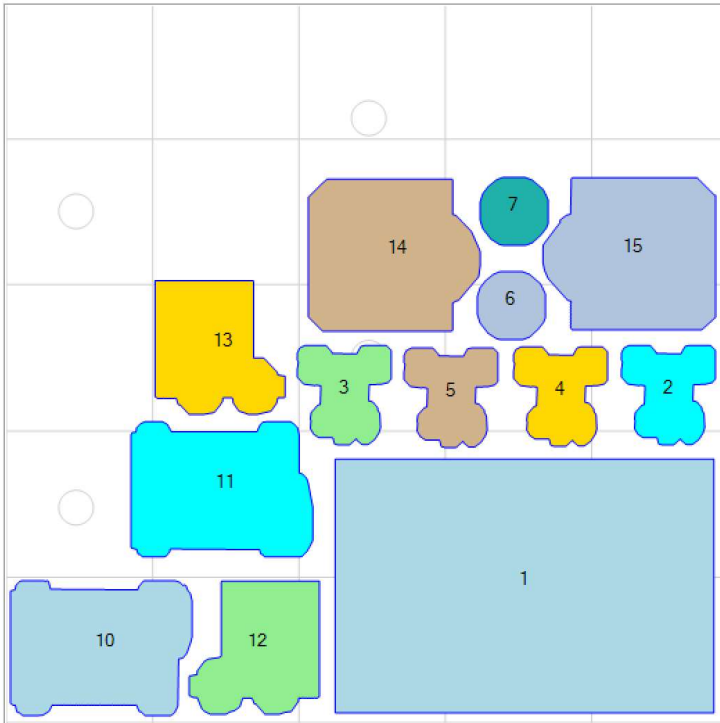
Name:
Model Material: 80,24 cm³
Support Material: 17,25 cm³
Time: 8:42
Notes:

ID	Name
1	PIASTRA_INF
2	PINZA
3	PINZA
4	PINZA
5	PINZA

Fortus 250mc

Name: Manage EDM Systems
Material: **Model: P430_RED T14: 621,25 cm³ Support: SR30 T16: 422,59 cm³**
Status: Building print_jobs_data_gamma1

Platen X: 254,00 mm Y: 254,00 mm



Insert CMB
Copy
Remove
Repack
90
Center
CMB Info

Pack Details

Name:
Model Material: 222,19 cm³
Support Material: 50,95 cm³
Time: 21:20
Notes:

ID	Name
1	PIASTRA_INF
2	PINZA
3	PINZA
4	PINZA
5	PINZA
6	PISTONE
7	PISTONE
10	X-END-LEFT
11	X-END-RIGHT
12	Z-AXES-TOP-LEFT
13	Z-AXES-TOP-RIGHT
14	Z-AXIS-BOTTOM-LEFT
15	Z-AXIS-BOTTOM-RIGHT

Options
Clear Pack
Estimate Pack
Save As

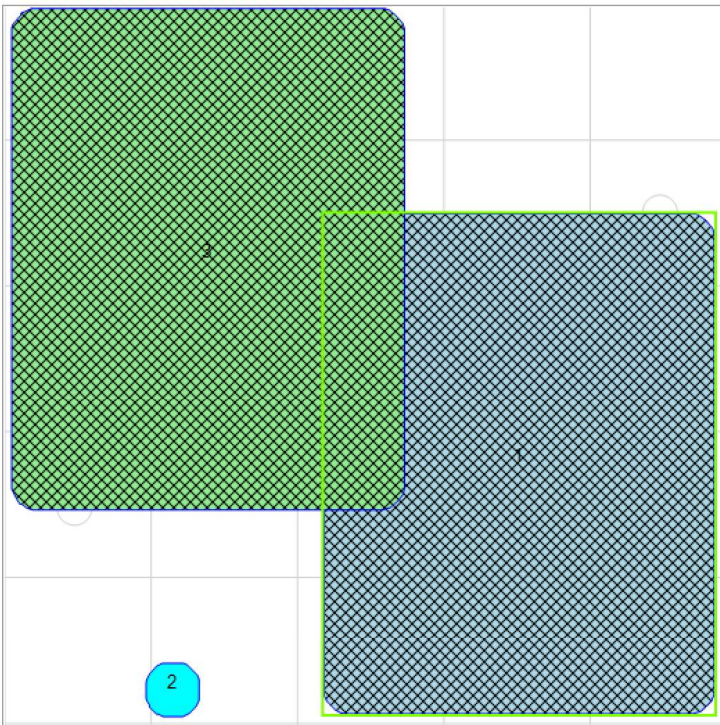
Build Job Cancel



Fortus 250mc

Name:
Material: **Model: P430_RED T14: 618,83 cm³** **Support: SR30 T16: 421,63 cm³**
Status: **Building - print_ruote_dentate_gemma1**

Platen X: 254,00 mm Y: 254,00 mm



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Pack Details

Name:
Model Material: **127,84 cm³**
Support Material: **76,36 cm³**
Time: **7:54**
Notes:

ID	Name
1	CARRELLINO
2	perno
3	poggia_perno

-
-
-
-

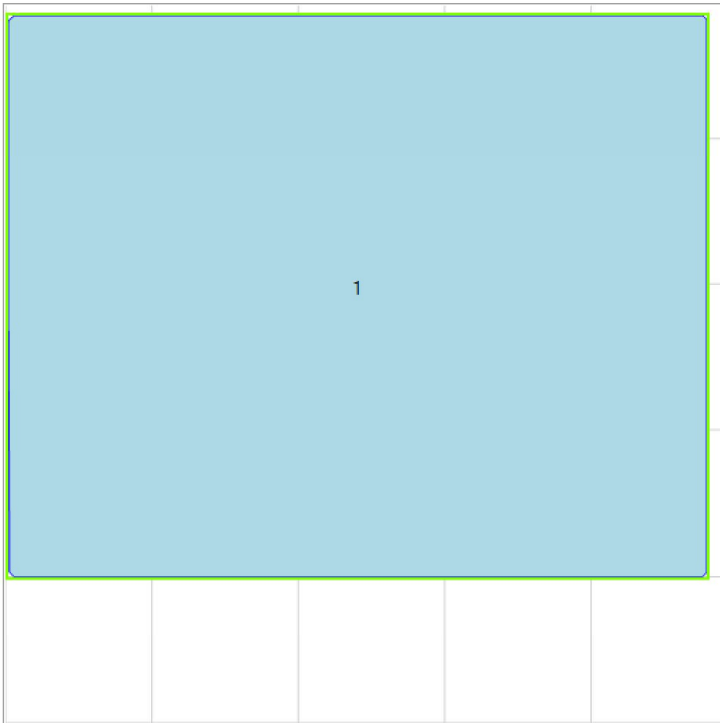
Fortus 250mc

Name:

Material: Model: P430_RED T14: 618,49 cm³ Support: SR30 T16: 421,45 cm³

Status: Building - print_ruote_dentate_gemma1

Platen X: 254,00 mm Y: 254,00 mm



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-
-
-
-

Pack Details

Name:

Model Material: 380,32 cm³

Support Material: 44,52 cm³

Time: 18:03

Notes: ...

ID	Name
1	assieme finale - Base-2

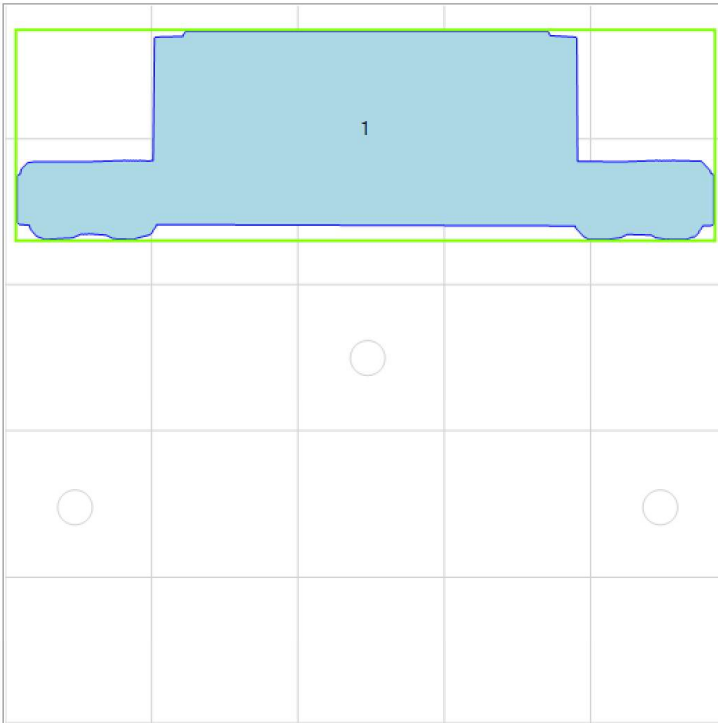
-
-
-
-



Fortus 250mc

Name:
Material: Model: P430_RED T14: 617,72 cm³ Support: SR30 T16: 420,94 cm³
Status: Building - print_ruote_dentate_gemma1

Platen X: 254,00 mm Y: 254,00 mm



-
-
-
-
-
-
-

Pack Details

Name:
Model Material: 146,66 cm³
Support Material: 160,85 cm³
Time: 17:30
Notes: ...

ID	Name
1	piatto_base

-
-
-
-



NO (altrimenti lo mandate in coda per la stampa)