



Level 7 – Design for Industry 4.0

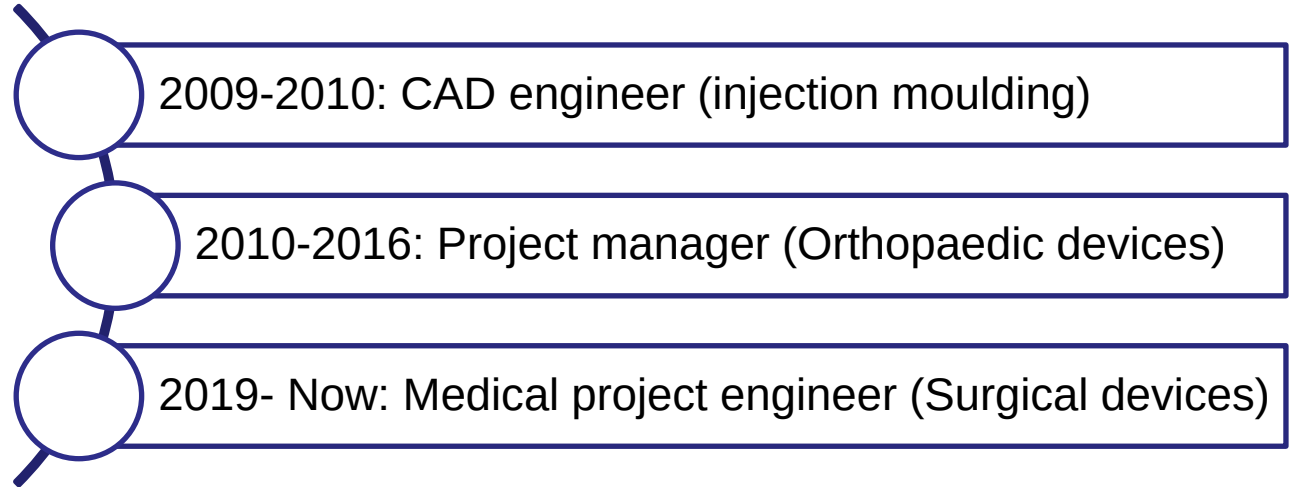
Design for Additive Manufacture (DfAM)

About me...

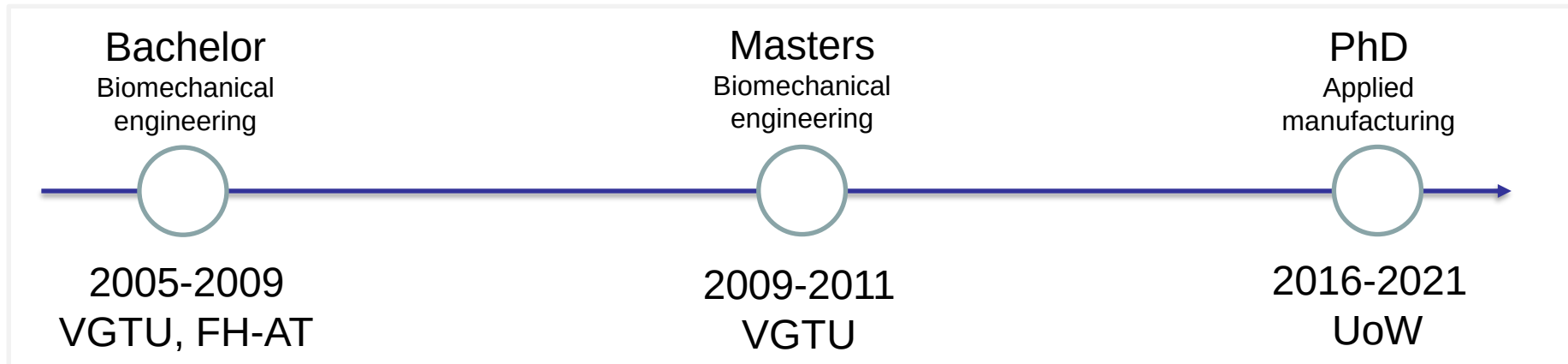


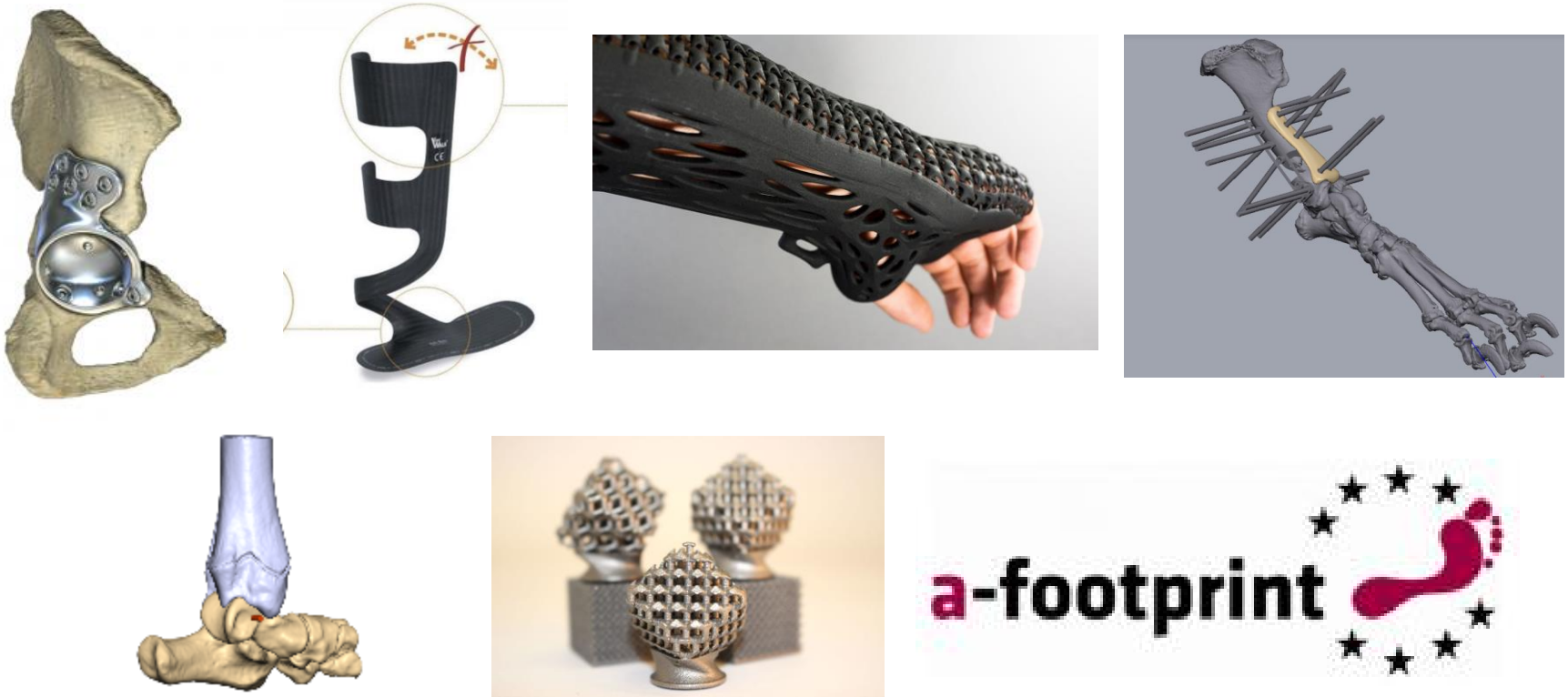
Ilja Asanovic, PhD

Professional experience



Education





Main expertise

- Computer-Aided Design
- Algorithms-Aided Design
- Object-Oriented programming
- 3D scanning/post-processing
- Reverse Engineering
- Additive Manufacture

Centre of advanced Batch Manufacture (CBM Wales)



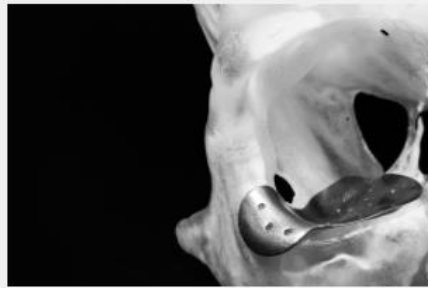
 <https://www.cbmwales.co.uk/>

 UWTSD, IQ Building, Kings Rd, SA18EW

Services



New Product Development
More Information 



Bespoke Medical Devices
More Information 



3D Printing & Scanning
More Information 



Prototype and Production
More Information 

ARCAM Q10



Vacuum casting



Optical 3d scanner

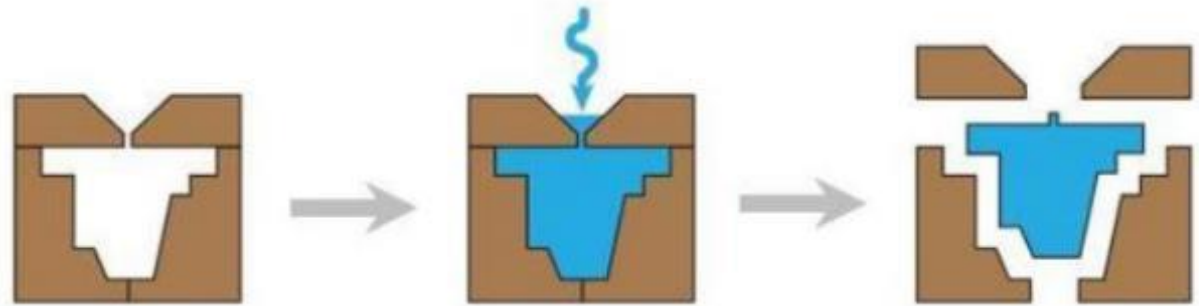


Stereolithography (SLA)

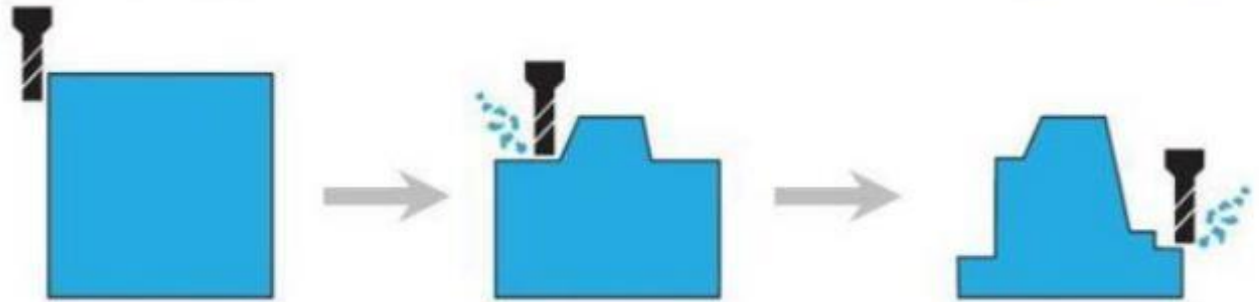


**How many manufacture
techniques do we know?**

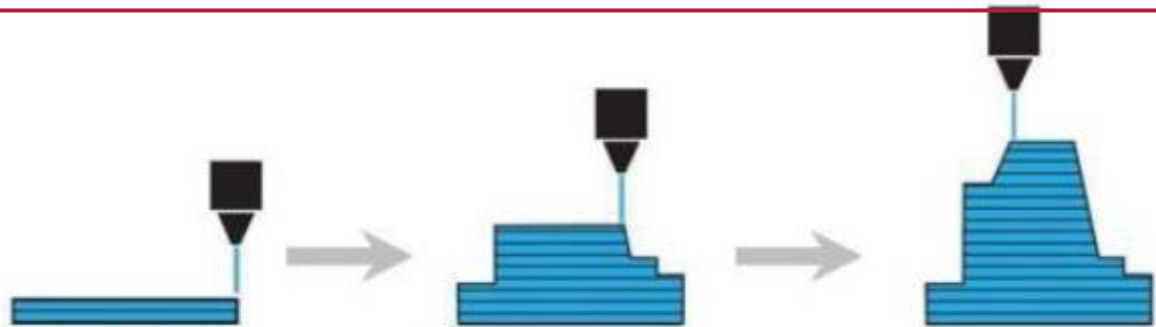
Formative



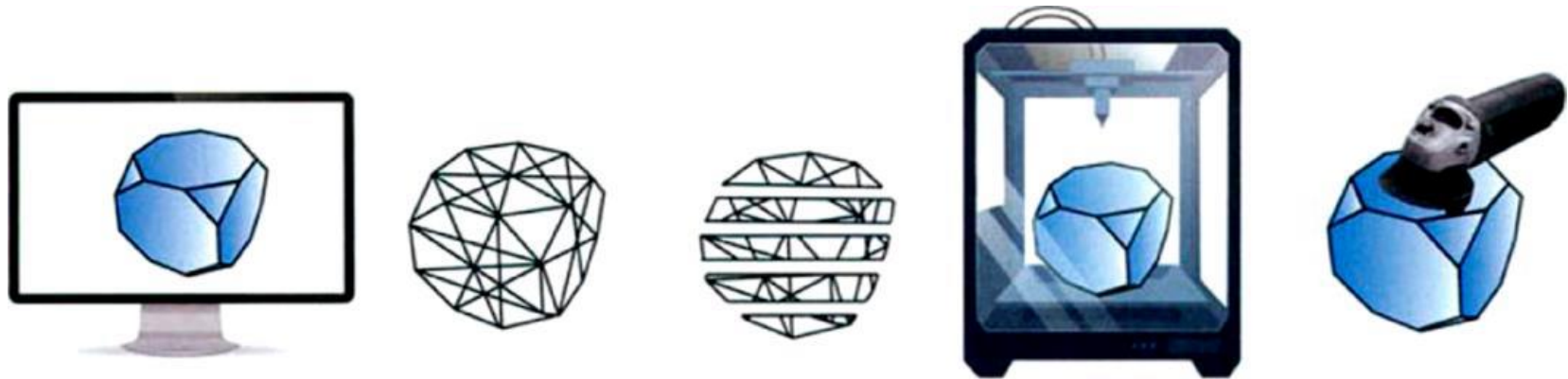
Subtractive



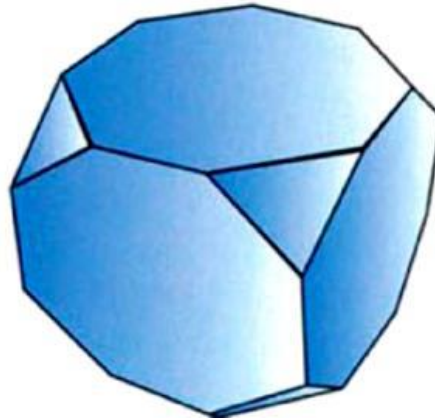
Additive



Additive Manufacture (AM) process flow



1	2	3	4	5
CAD-based 3D model	.STL file	Sliced layers	AM system	End part finishing



1. Design

- Computer-Aided Design (CAD) techniques

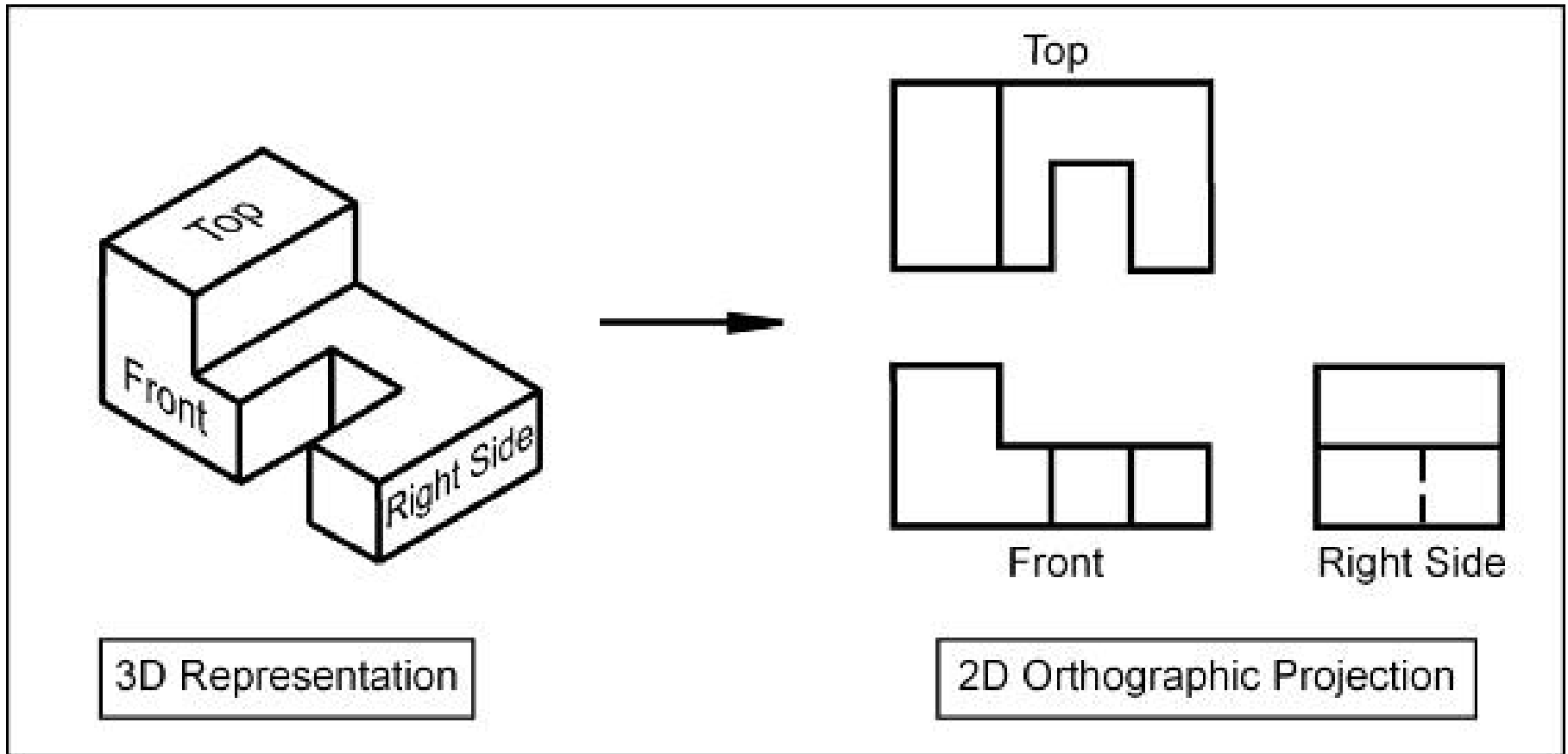
2. AM

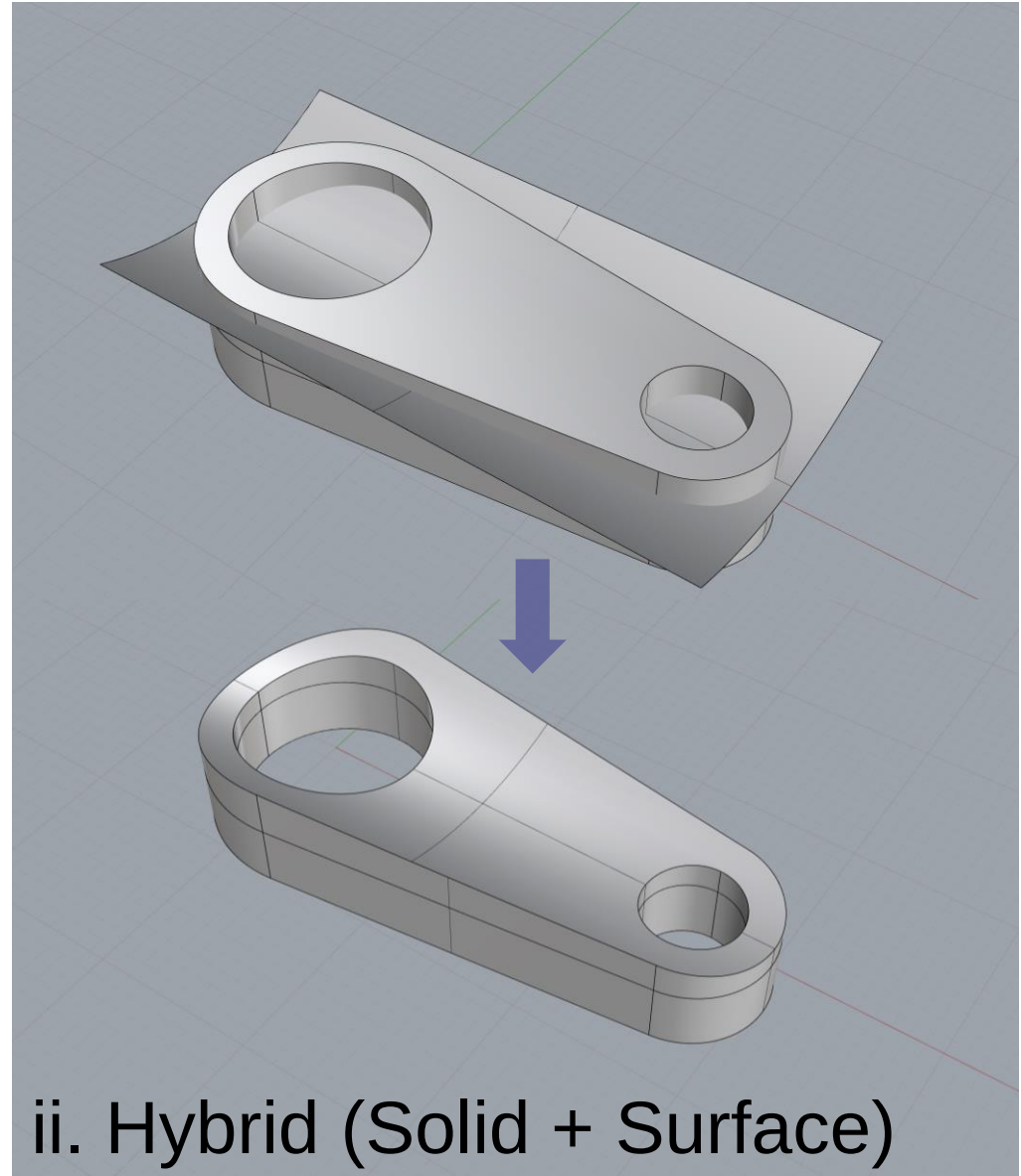
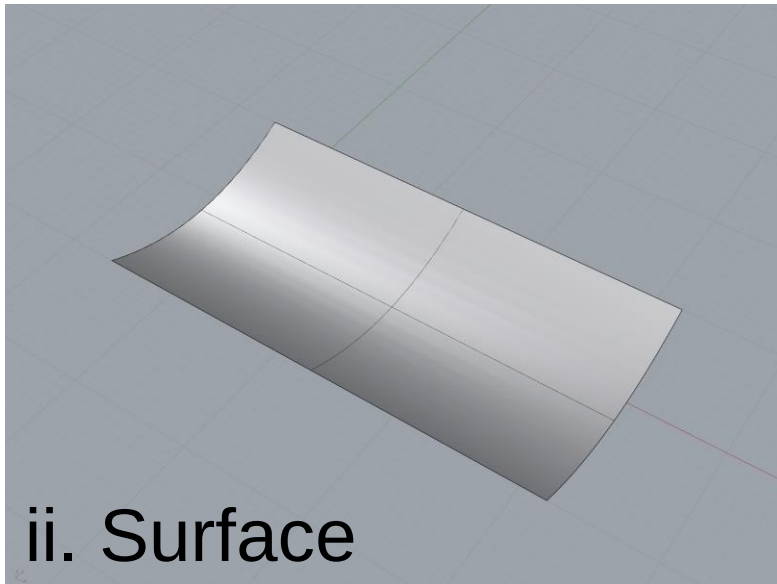
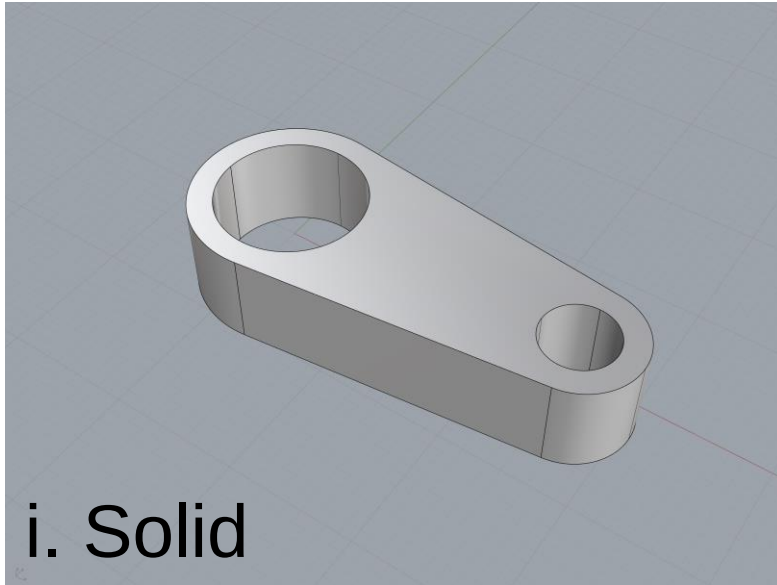
- Overview of AM technologies

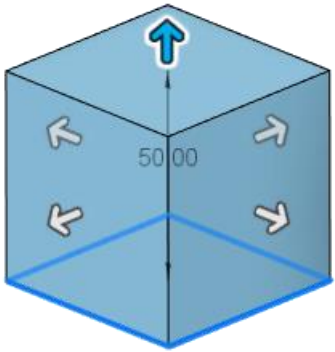
3. DfAM

- CAD rules for AM technologies + CAD data processing

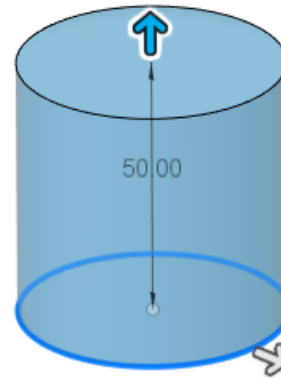
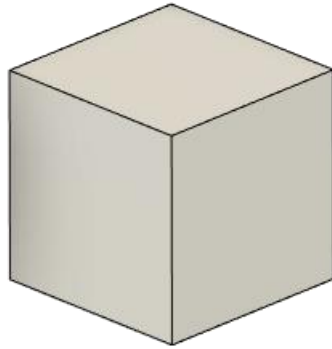
Before we start... What is 3D modelling?



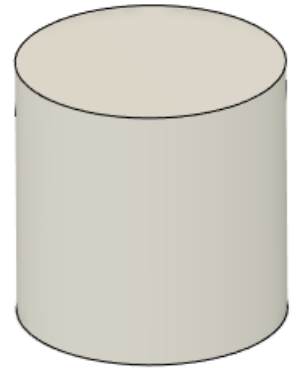




Cube (Box)



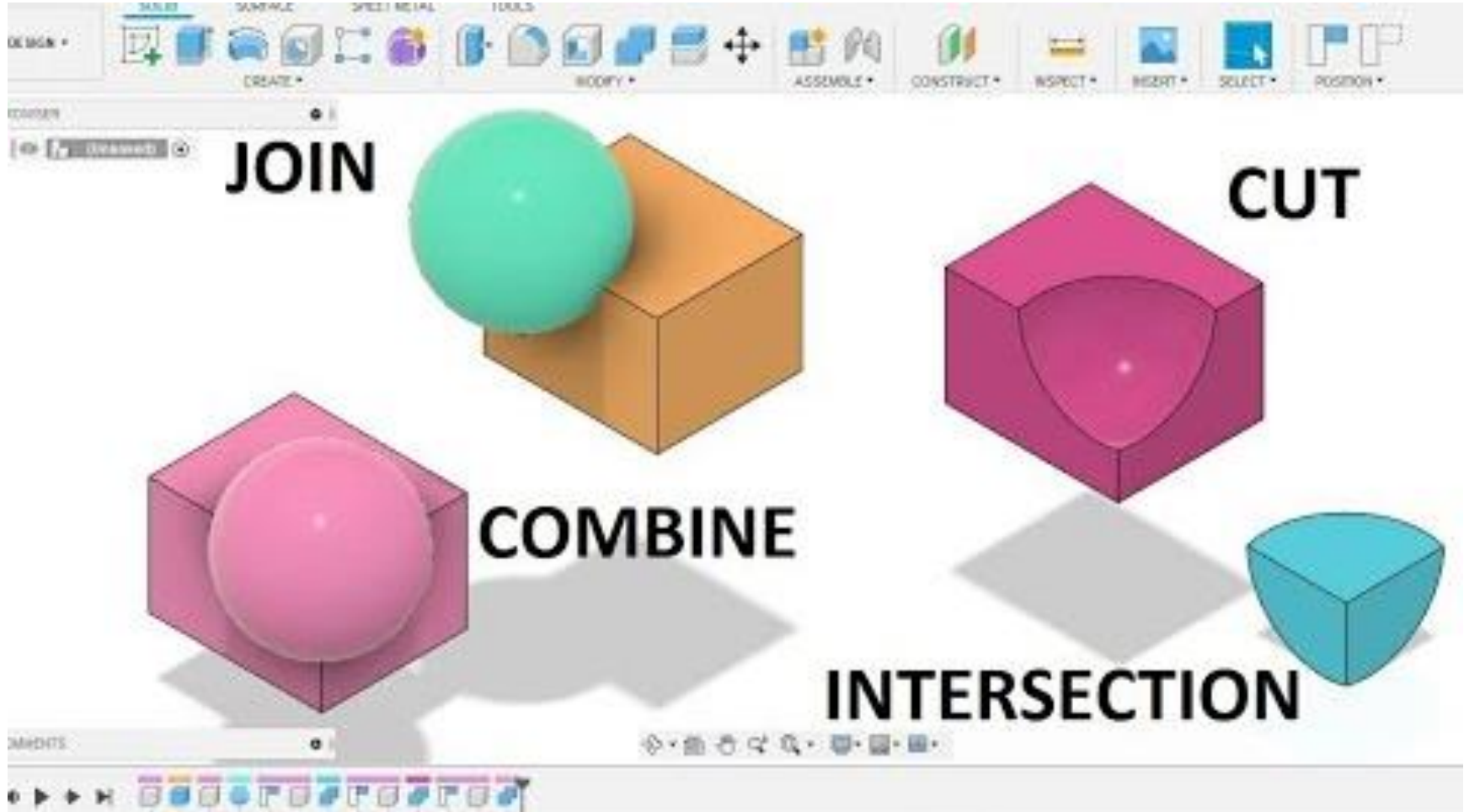
Cylinder



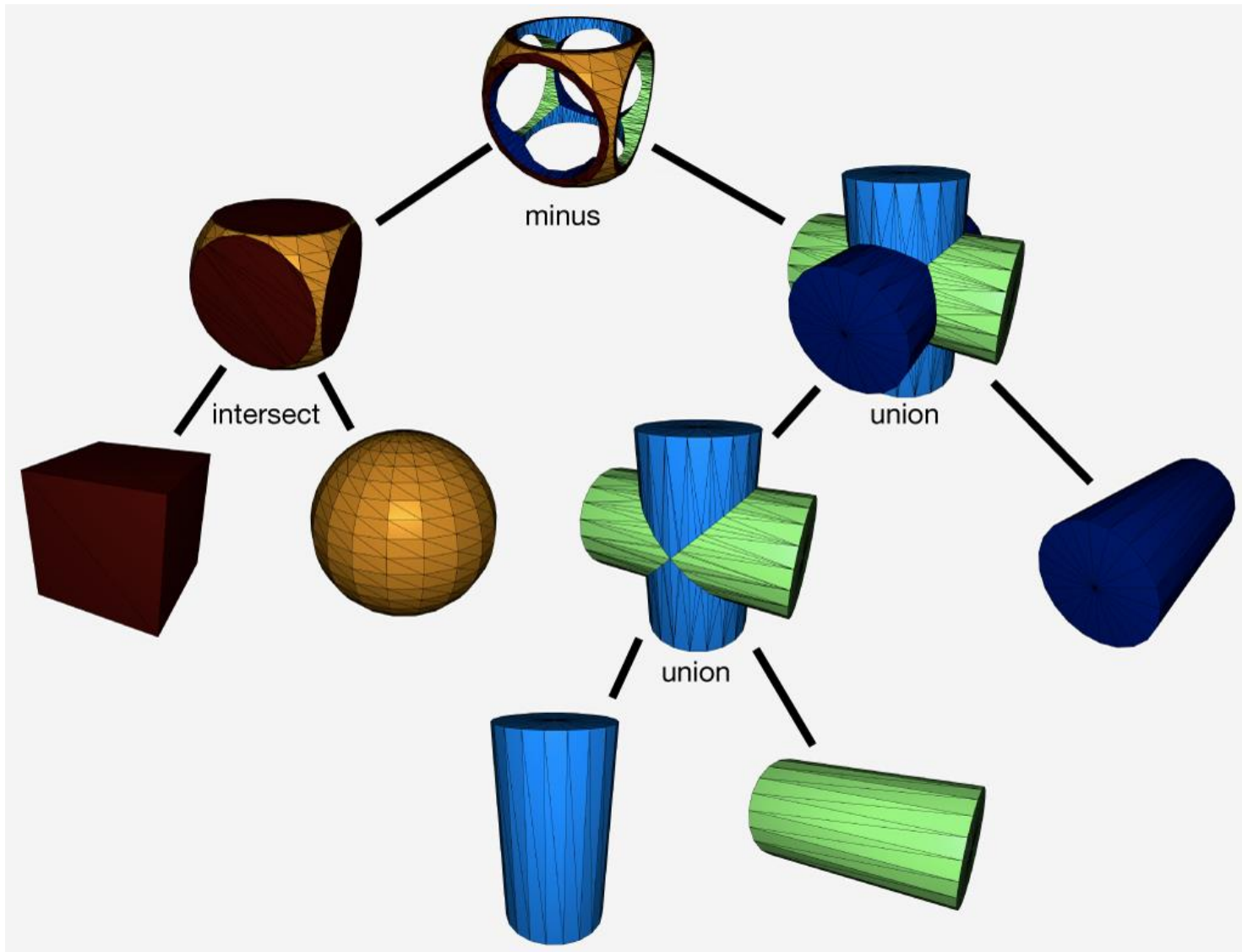
Sphere



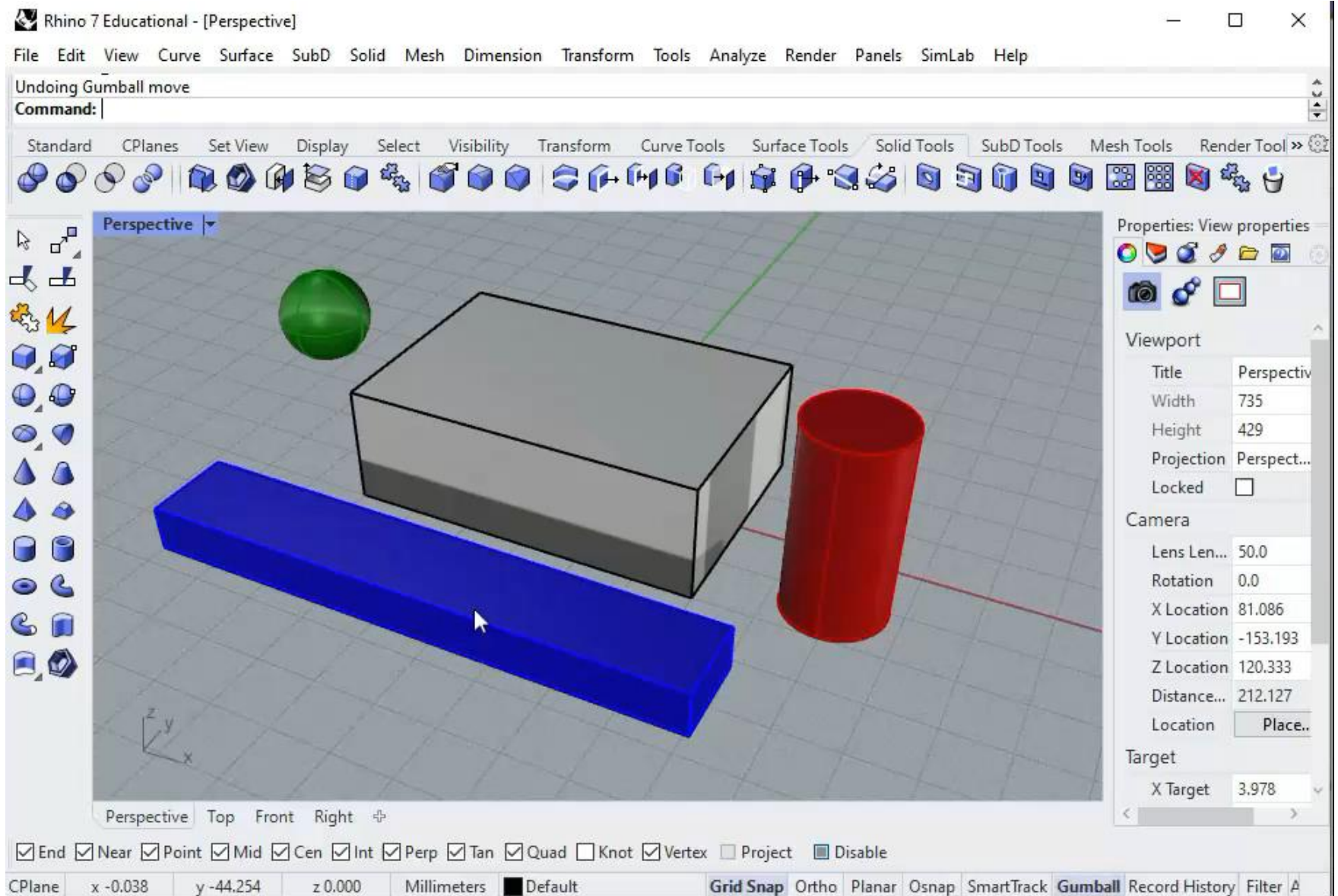
Solid modelling: Constructive Solid Geometry (CSG)



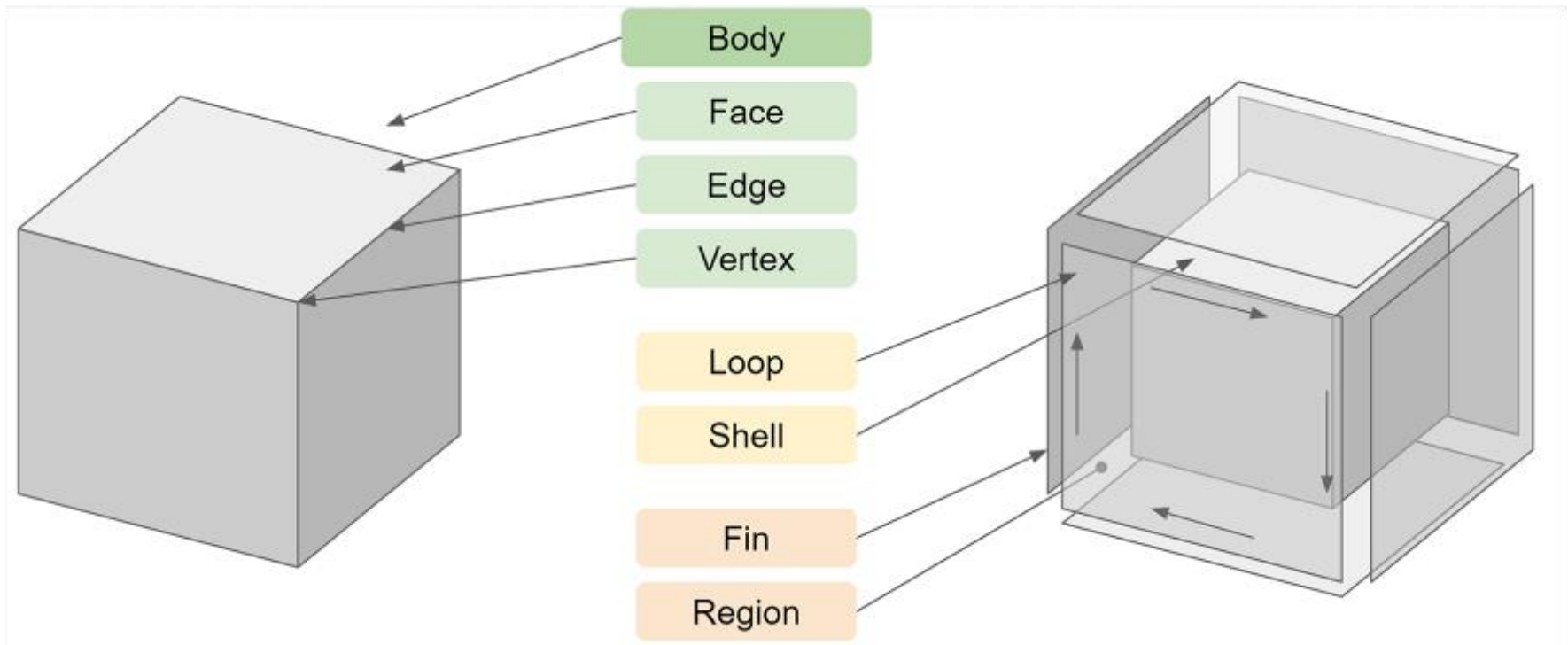
Solid modelling: Constructive Solid Geometry (CSG)



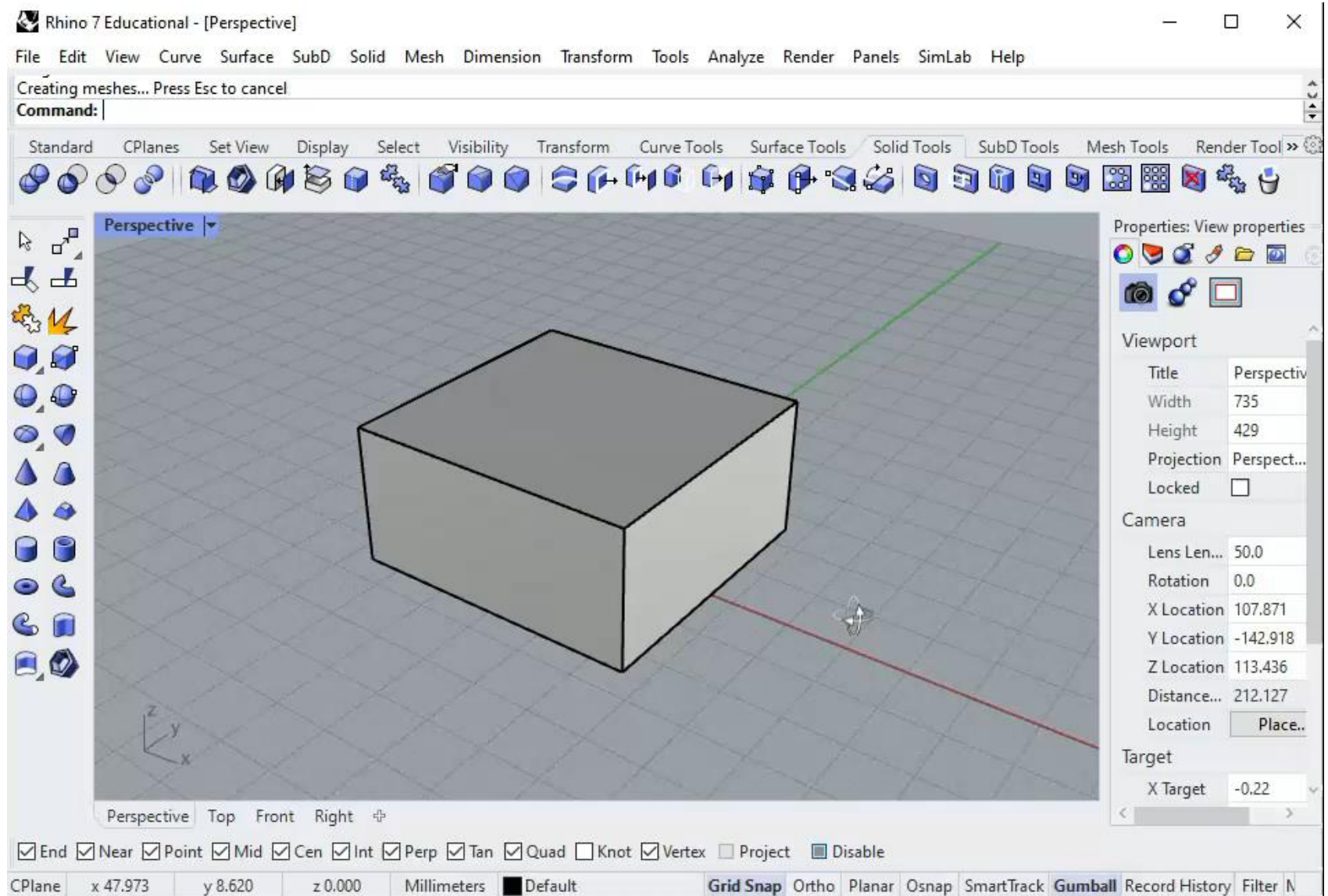
Solid modelling: SCG (Rhinoceros 3D example)

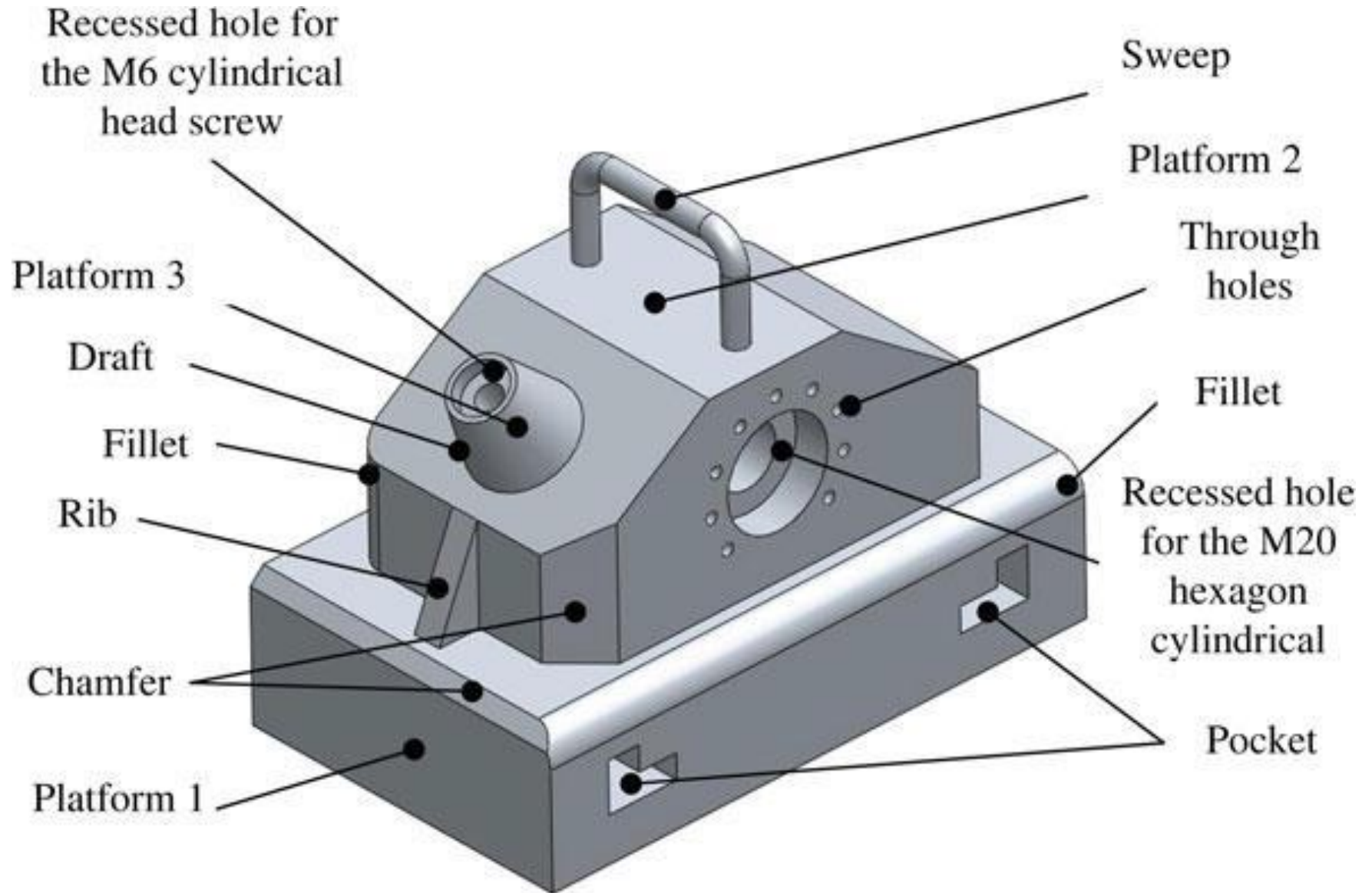


Solid modelling: Boundary Representation (B-Rep)

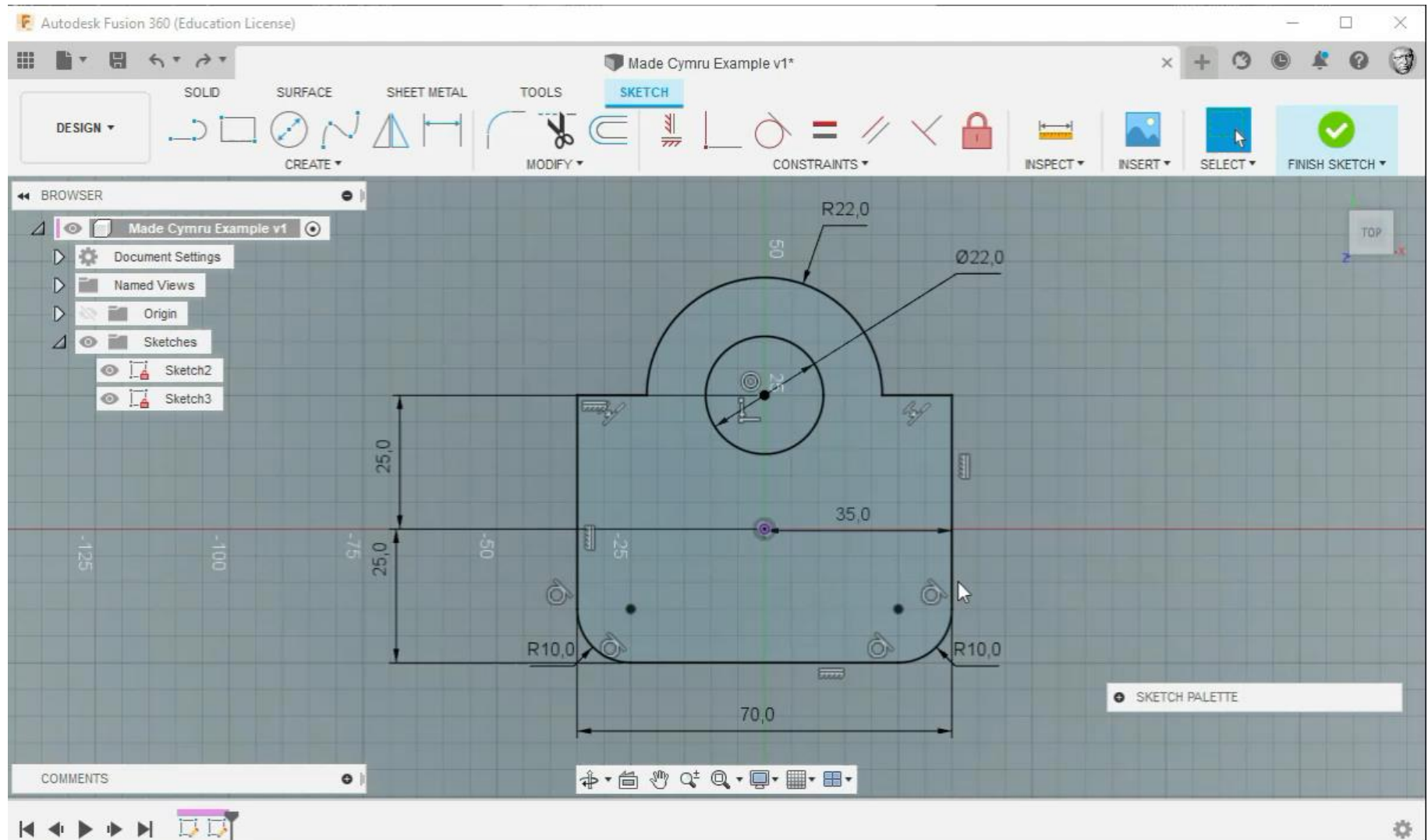


Solid modelling: B-Rep (Rhino 3D Example)

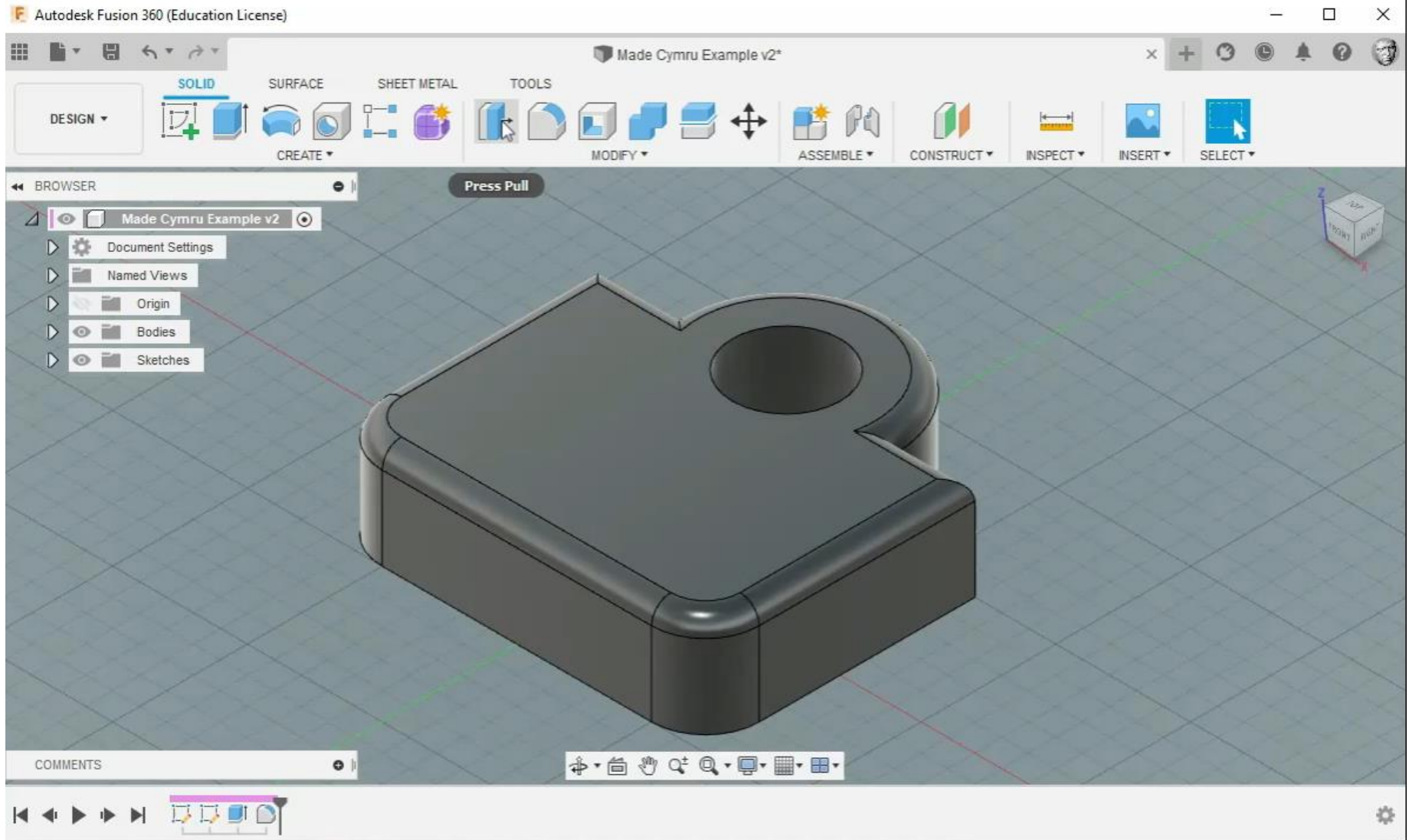


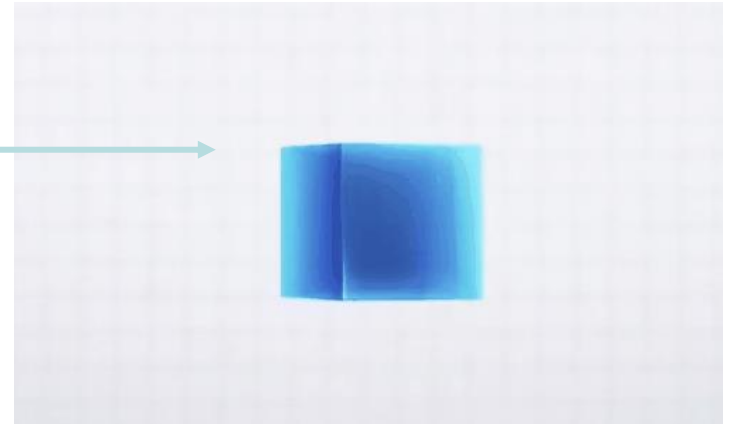
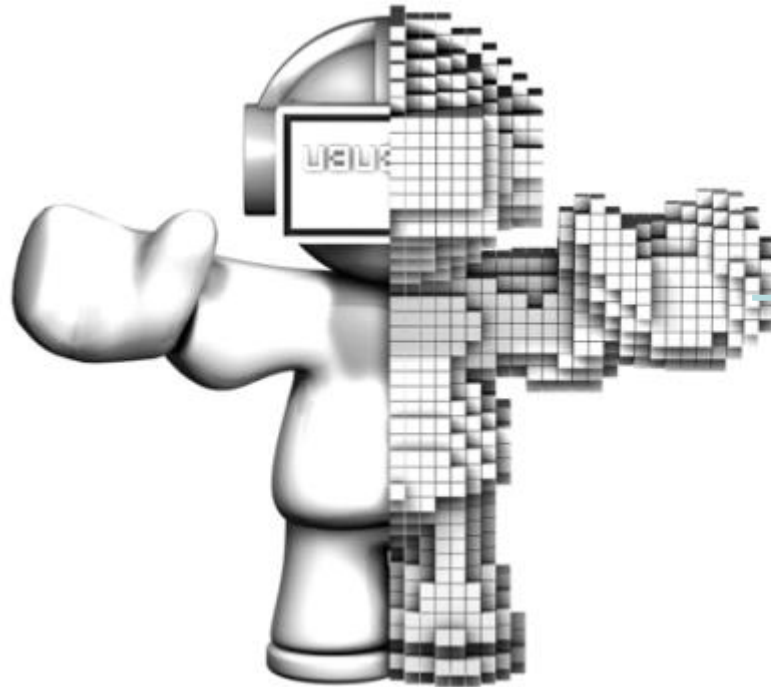


Solid modelling: Parametric design (Fusion 360)



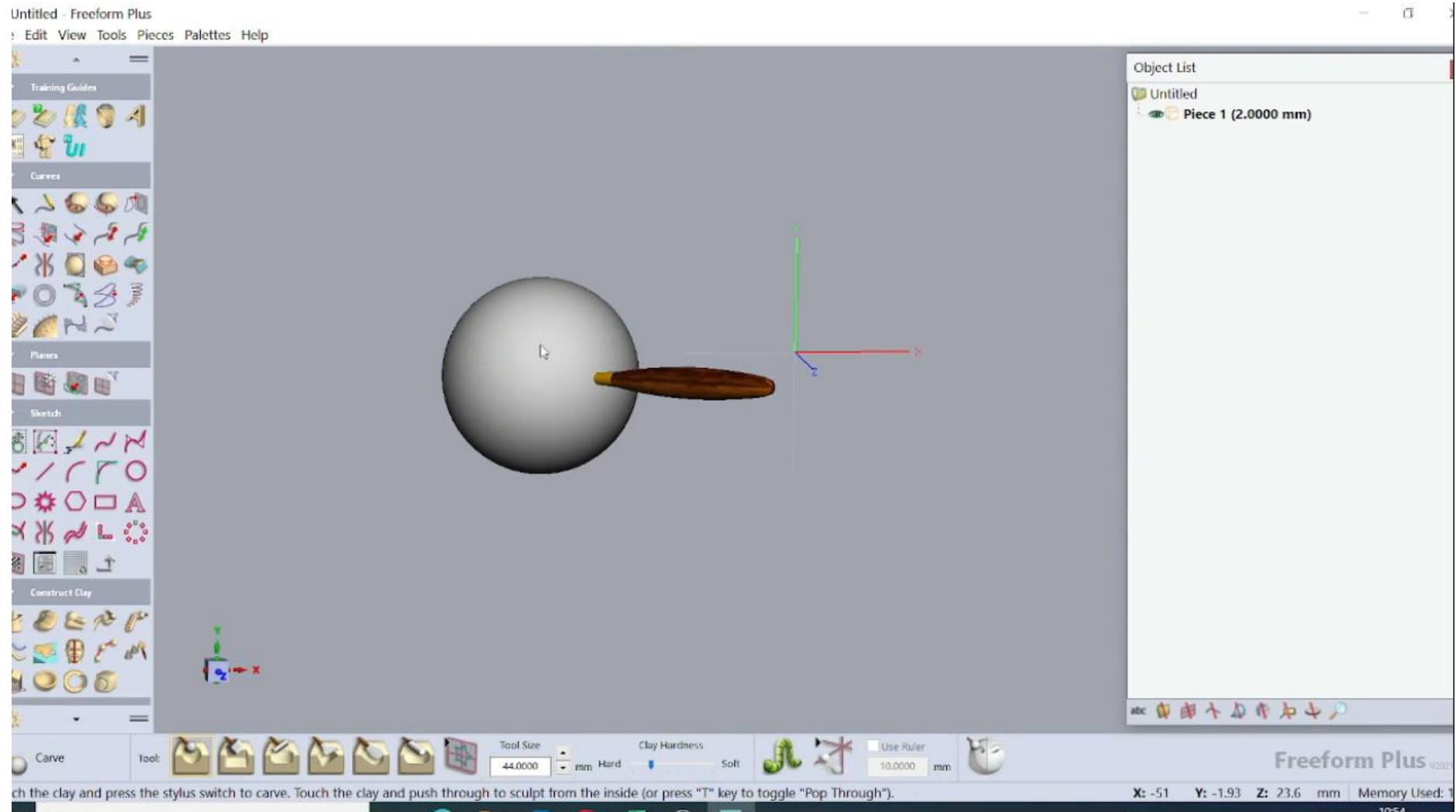
Solid modelling: Parametric B-Rep (Press-Pull example)



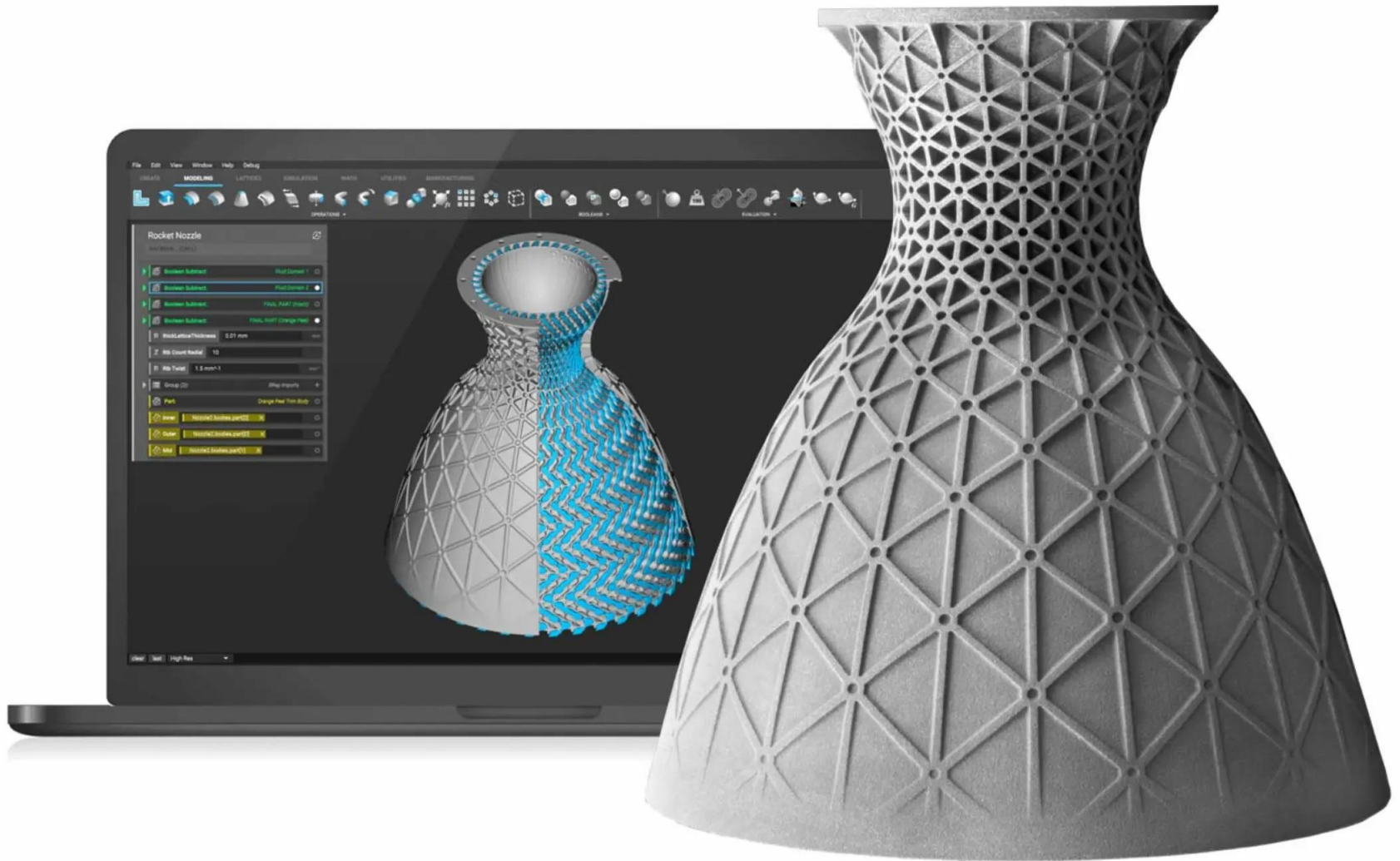




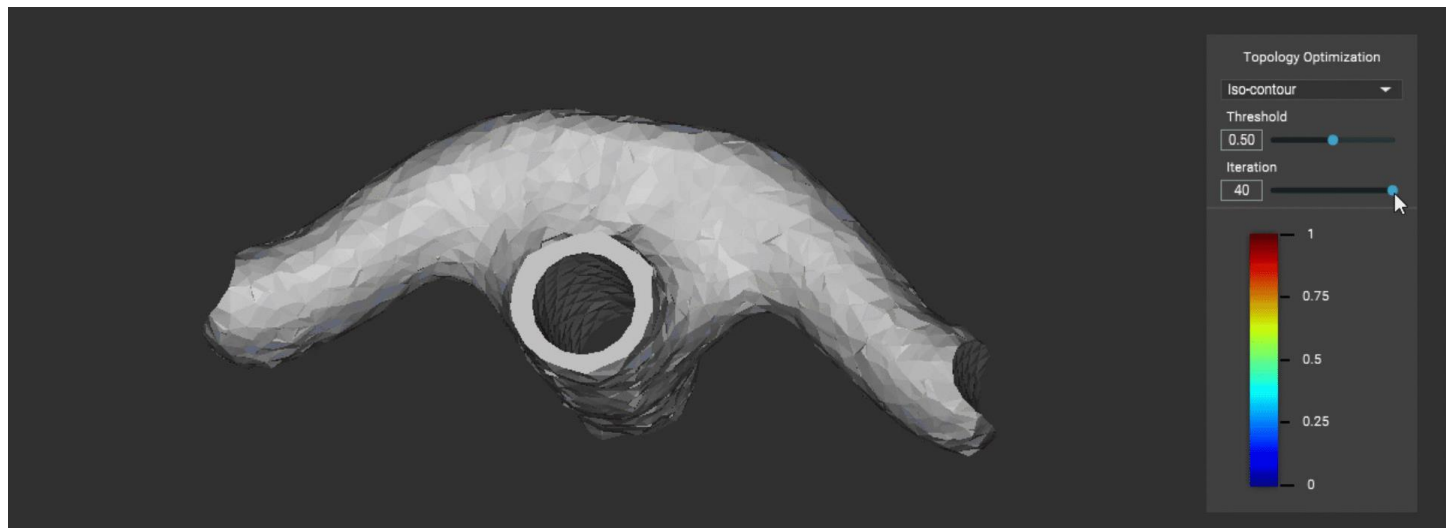
Voxel-based/Volumetric modelling (Freeform example)



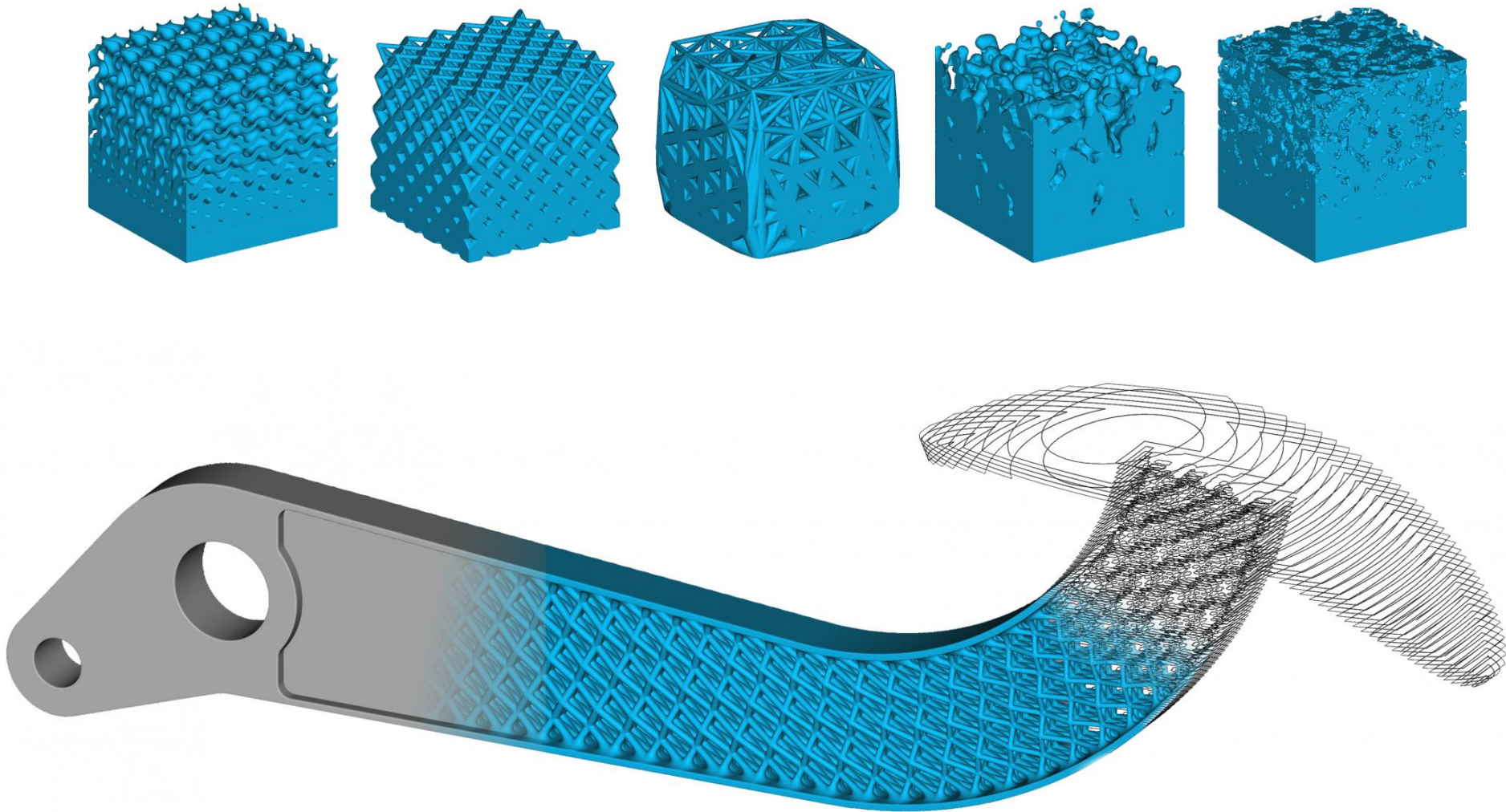
Voxel-based/Volumetric modelling (nTopology)



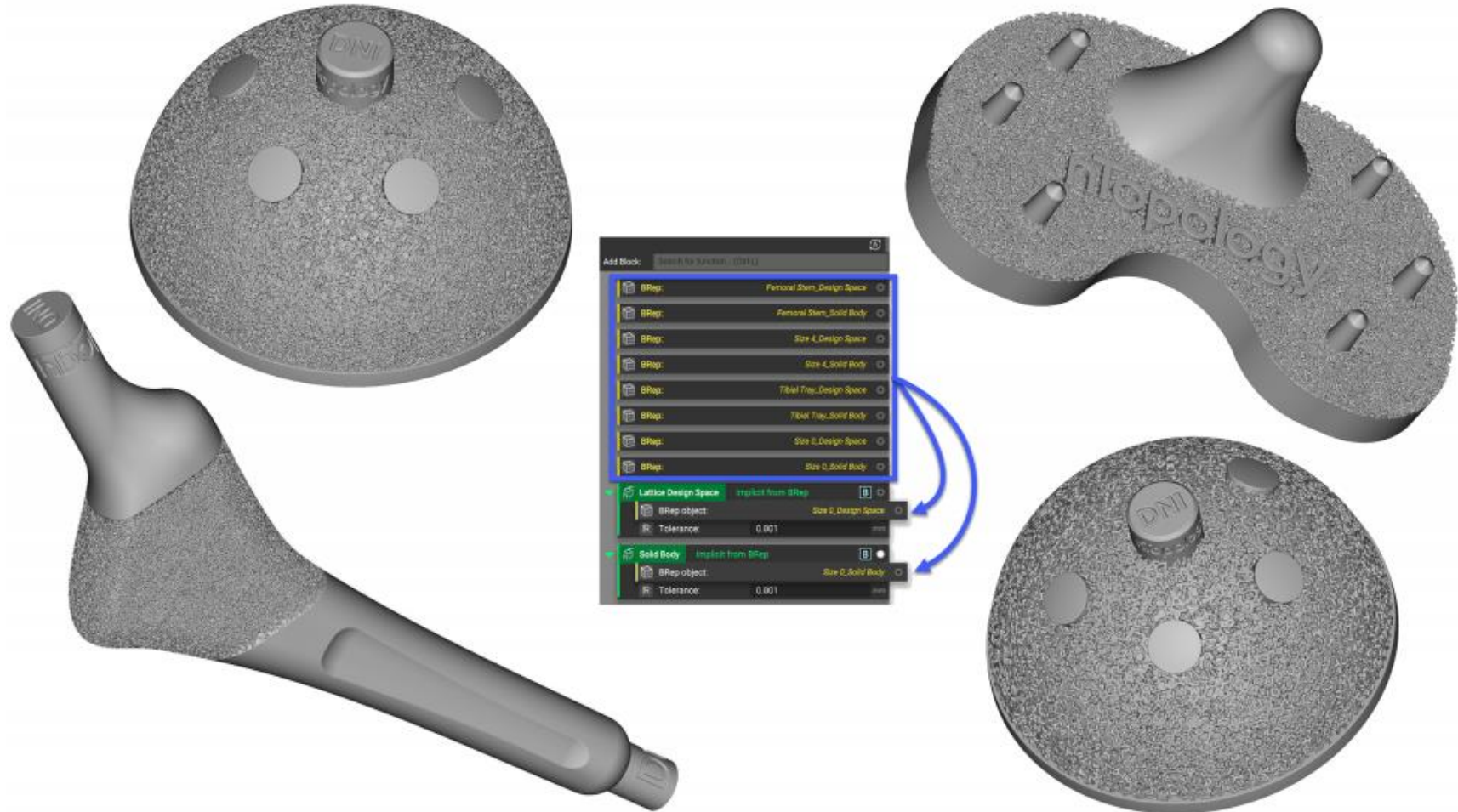
Voxel-based/Volumetric modelling (nTopology)



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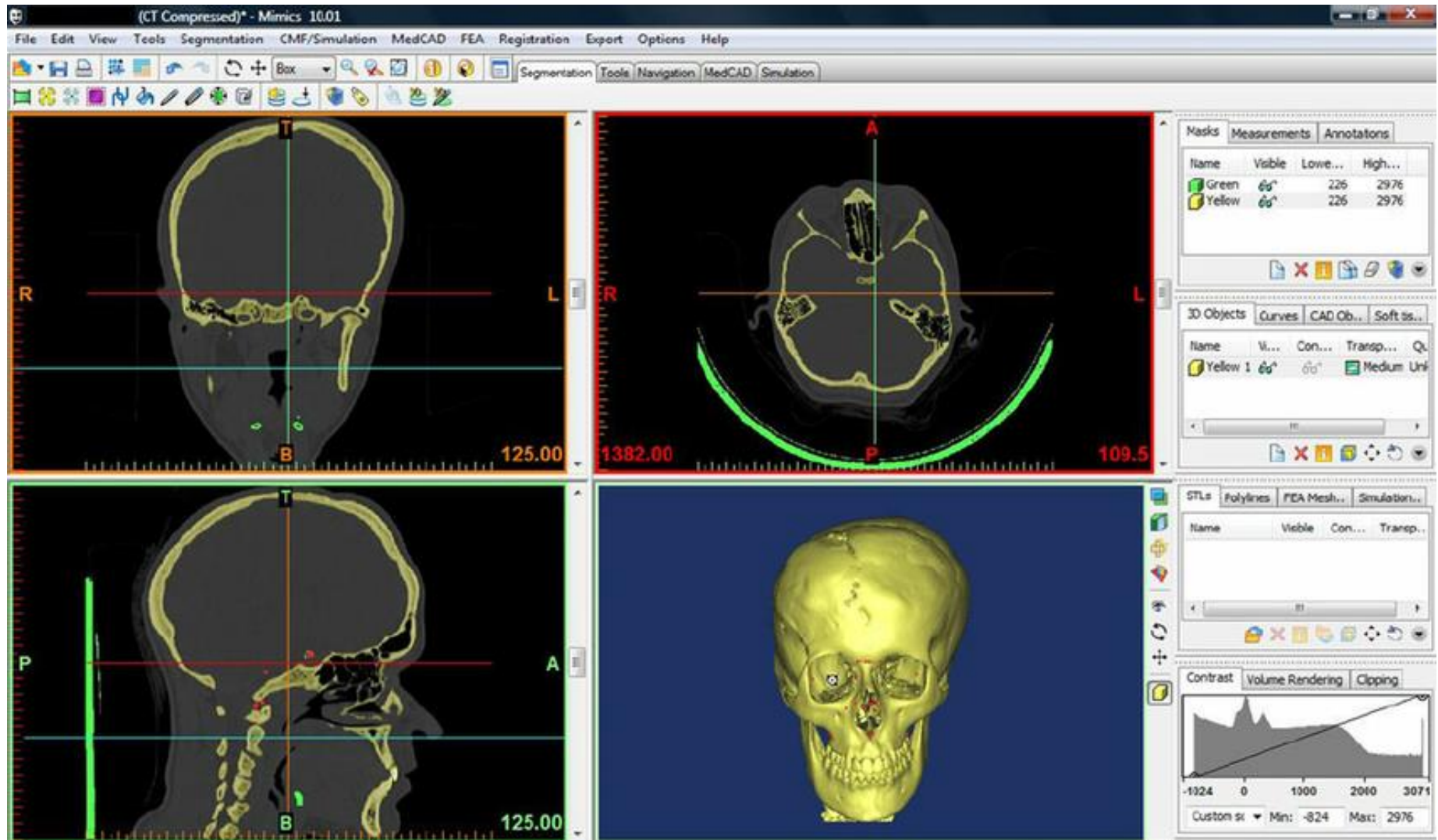


Voxel-based/Volumetric modelling (nTopology)

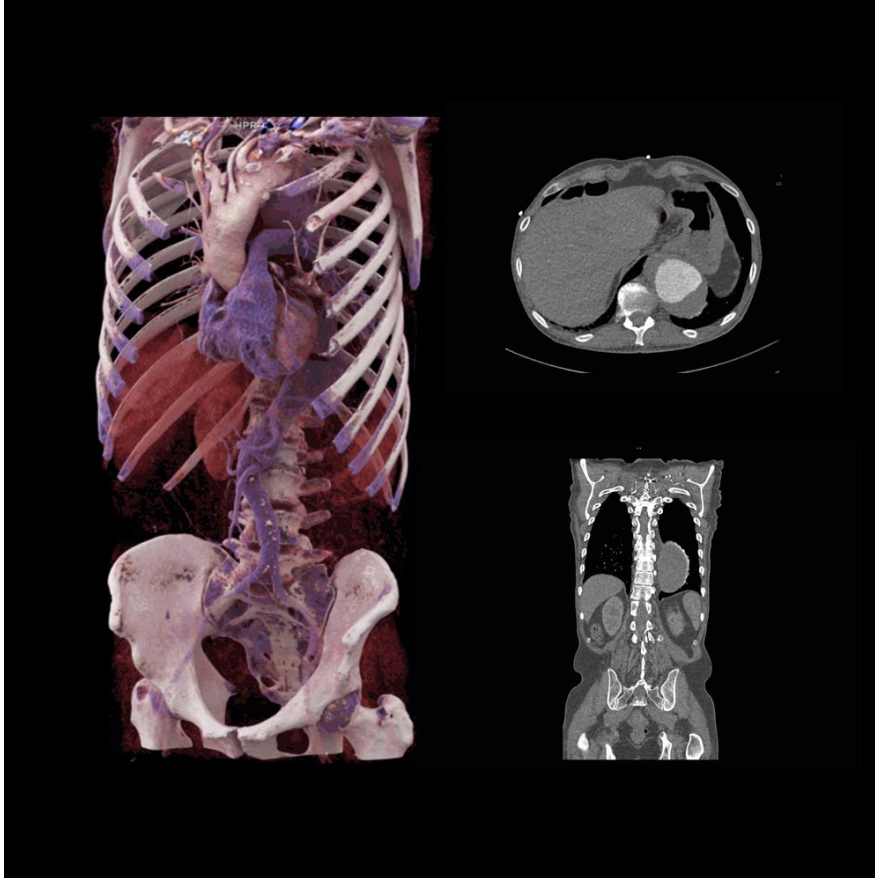


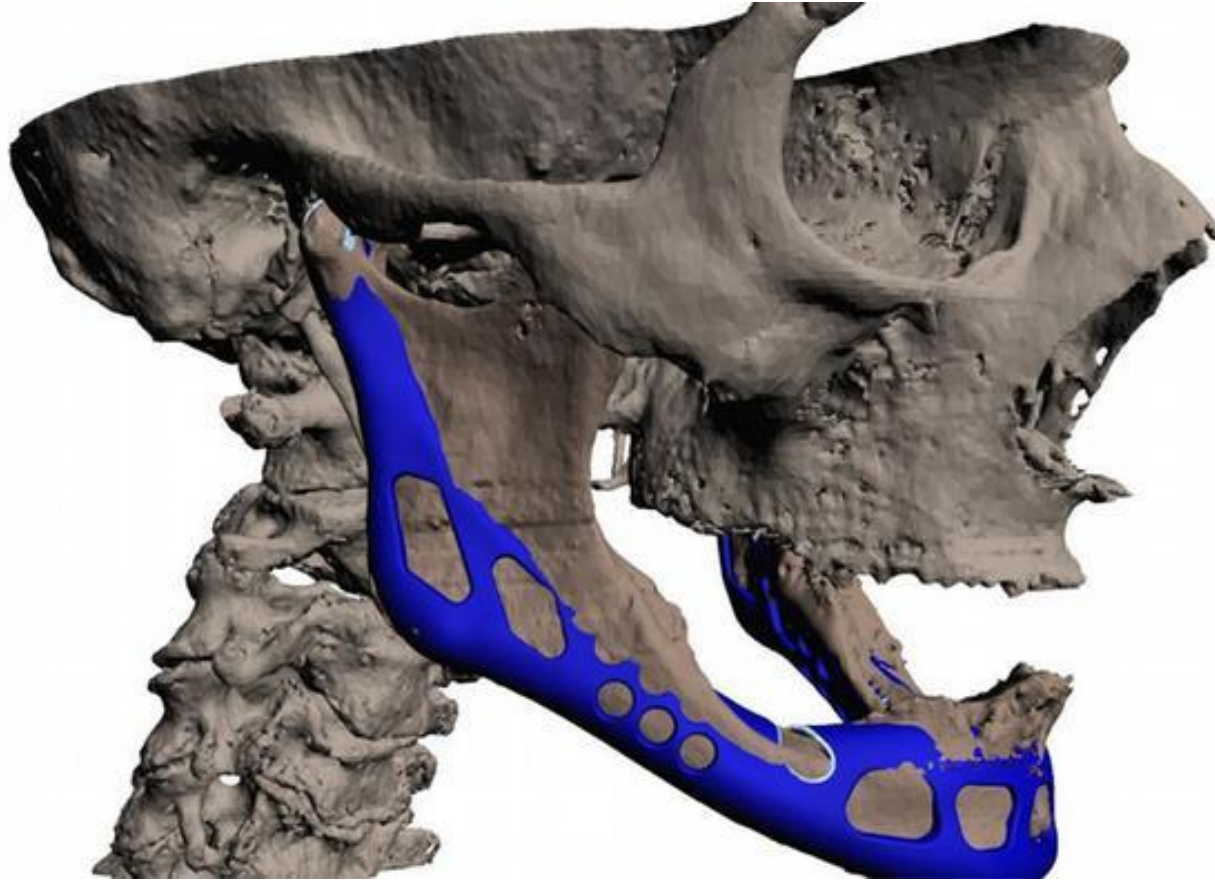


Solid modelling: Voxel-based/Volumetric (Mimics)



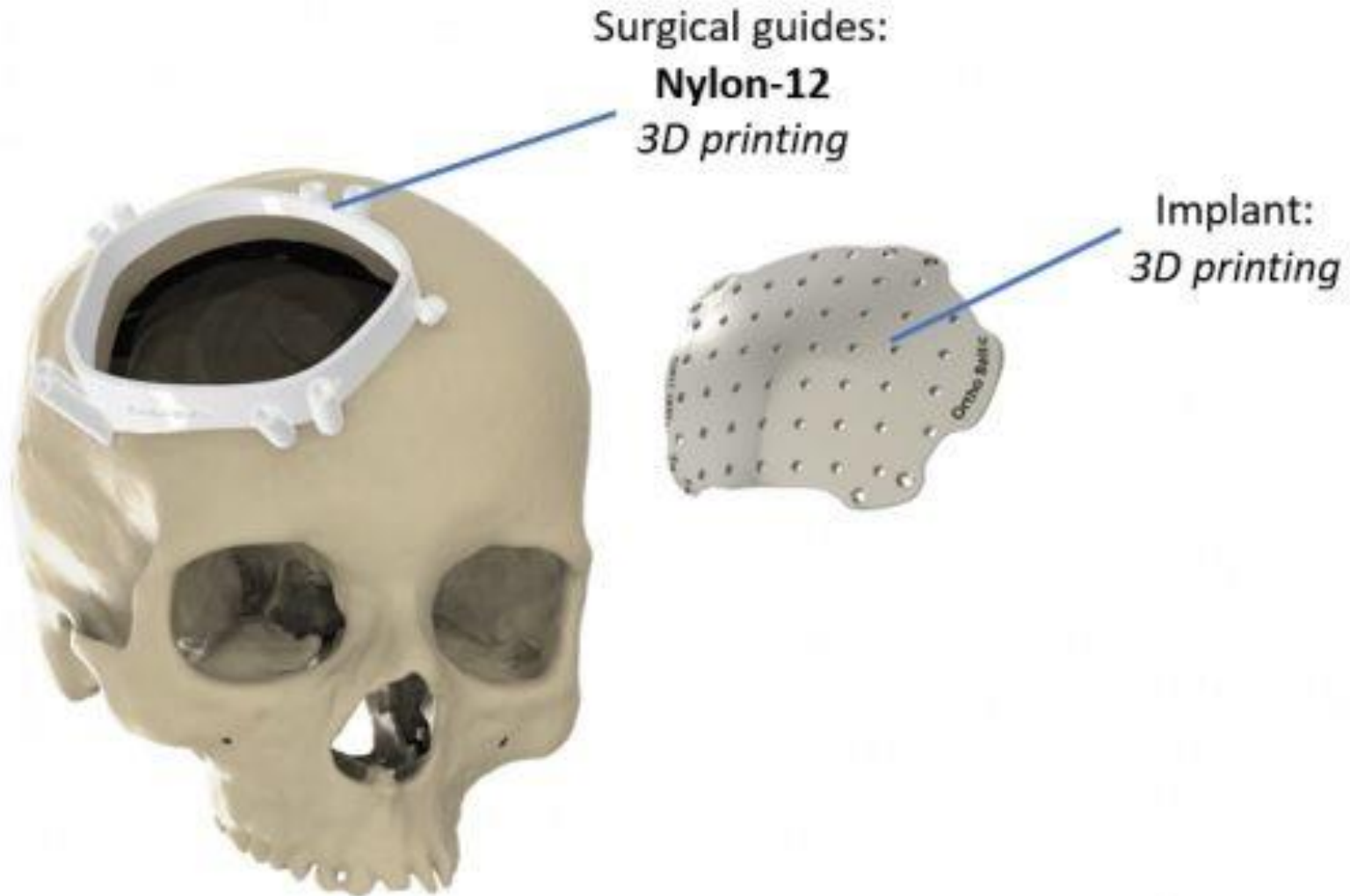
Solid modelling: Voxel-based/Volumetric (Segmentation)

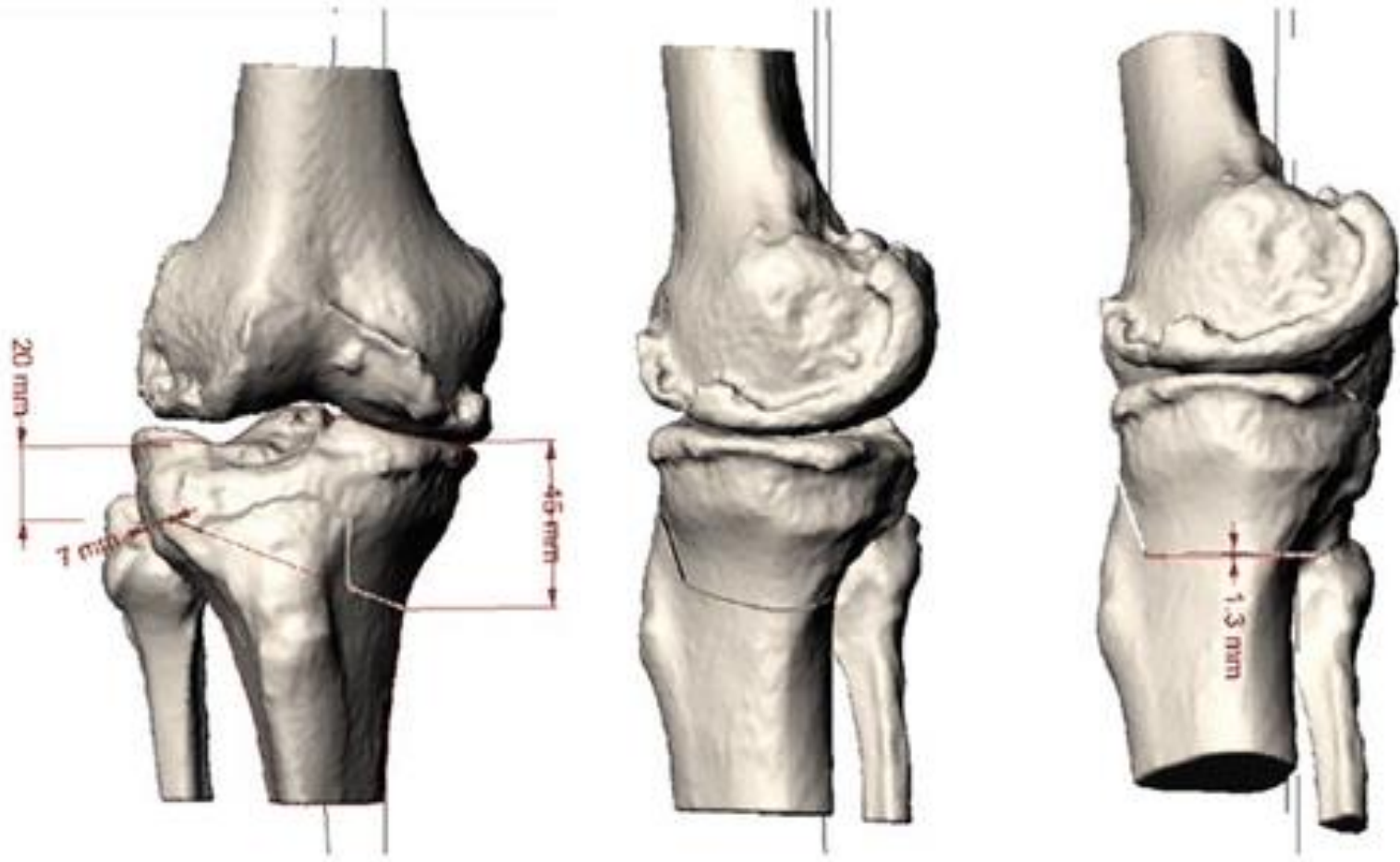


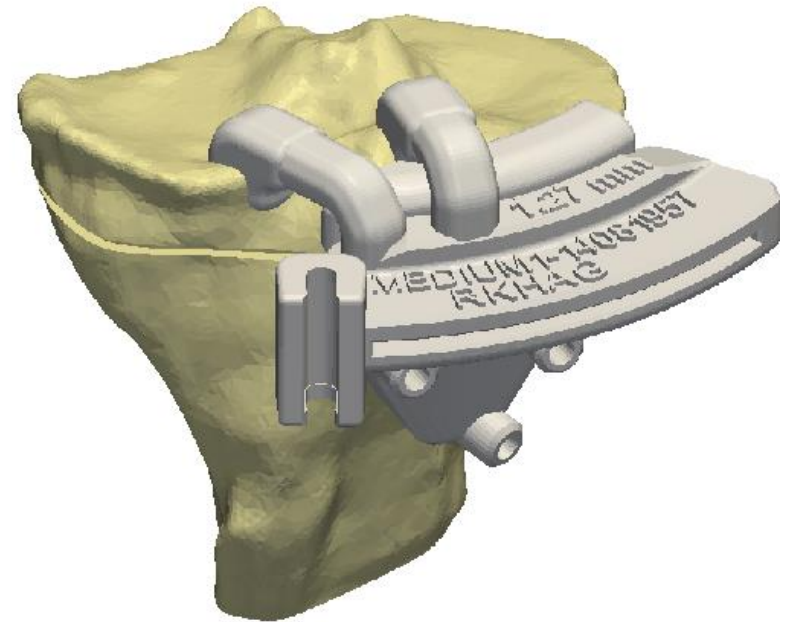
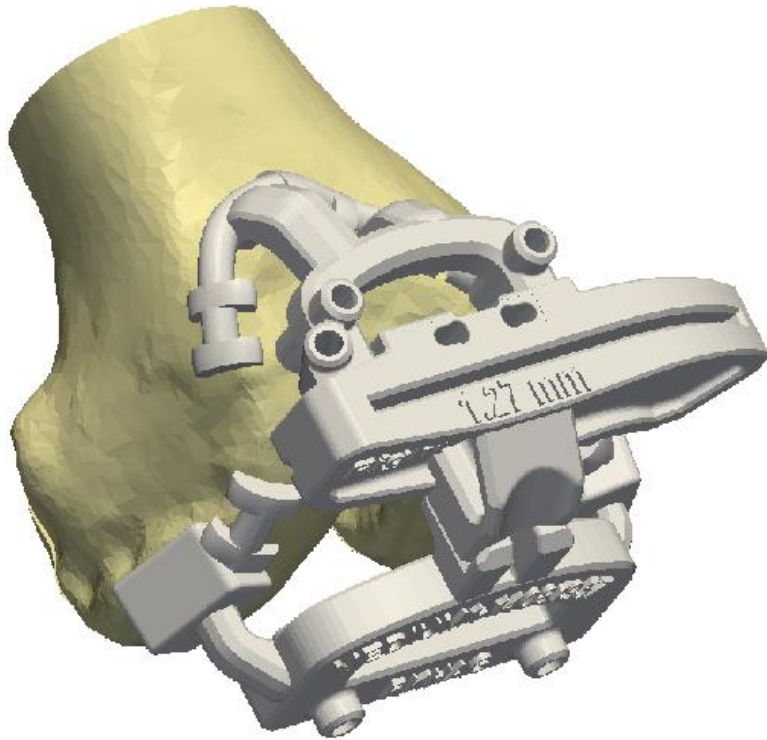


© LayerWise

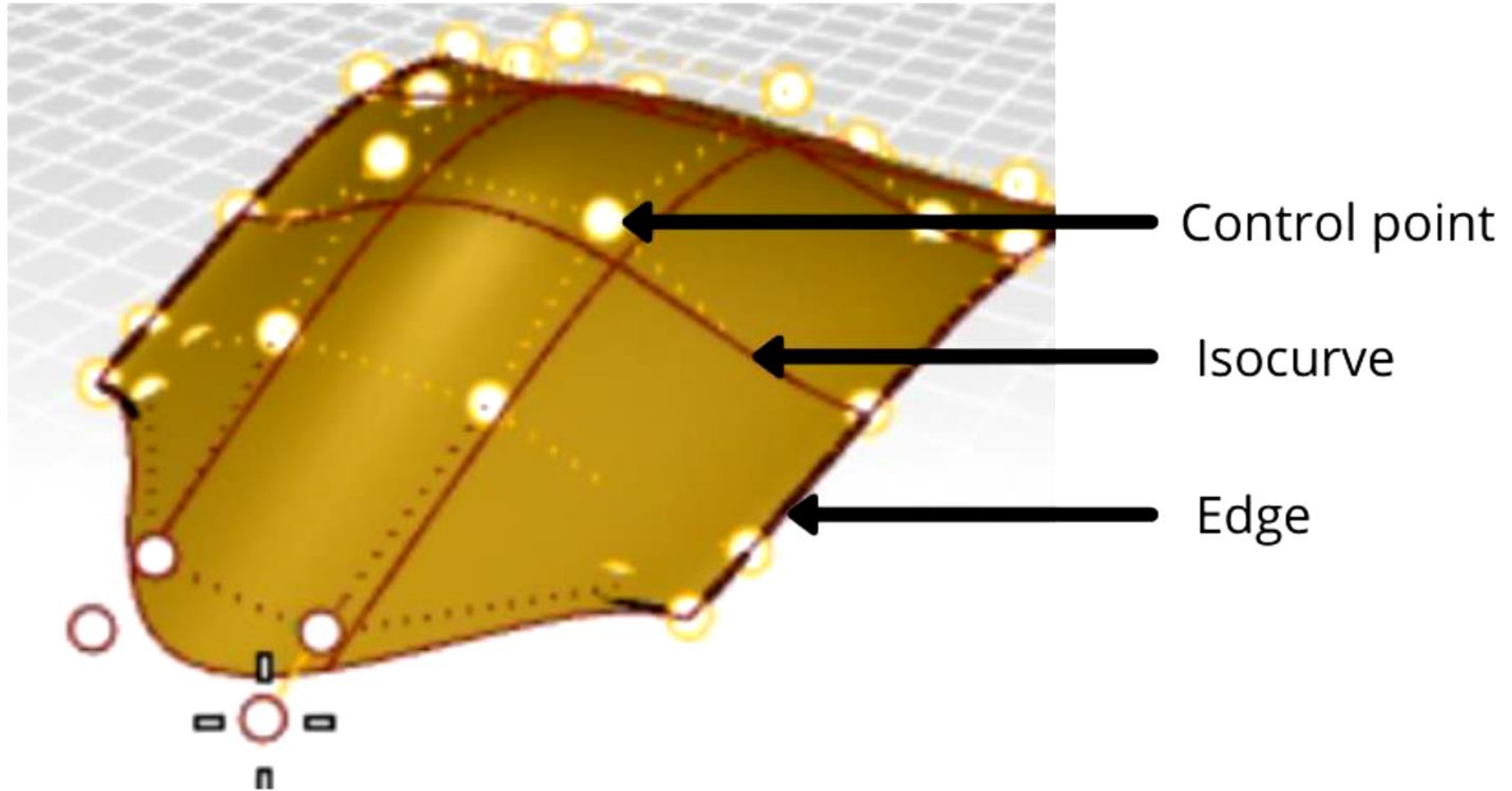
Solid modelling: Voxel-based/Volumetric (Segmentation)



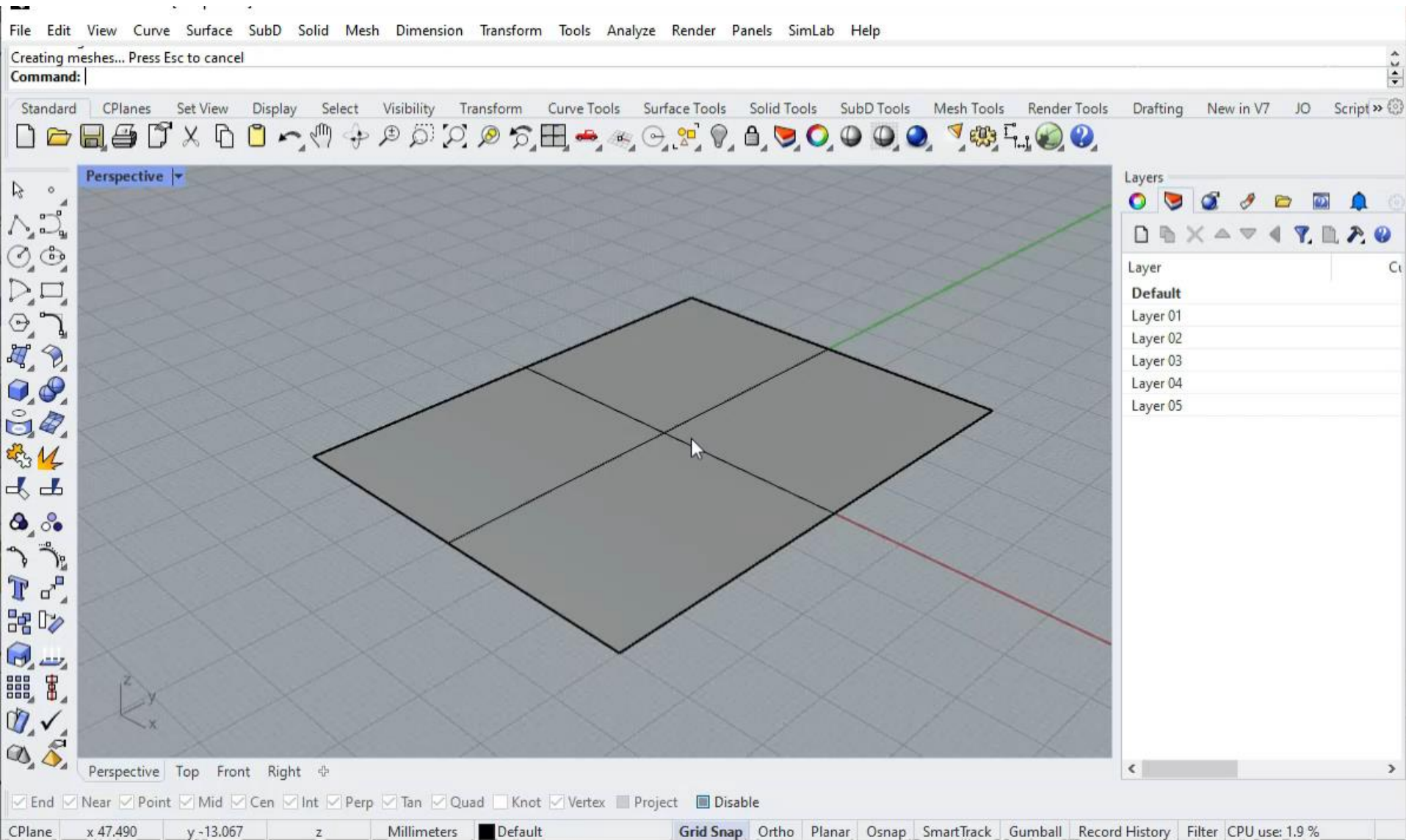


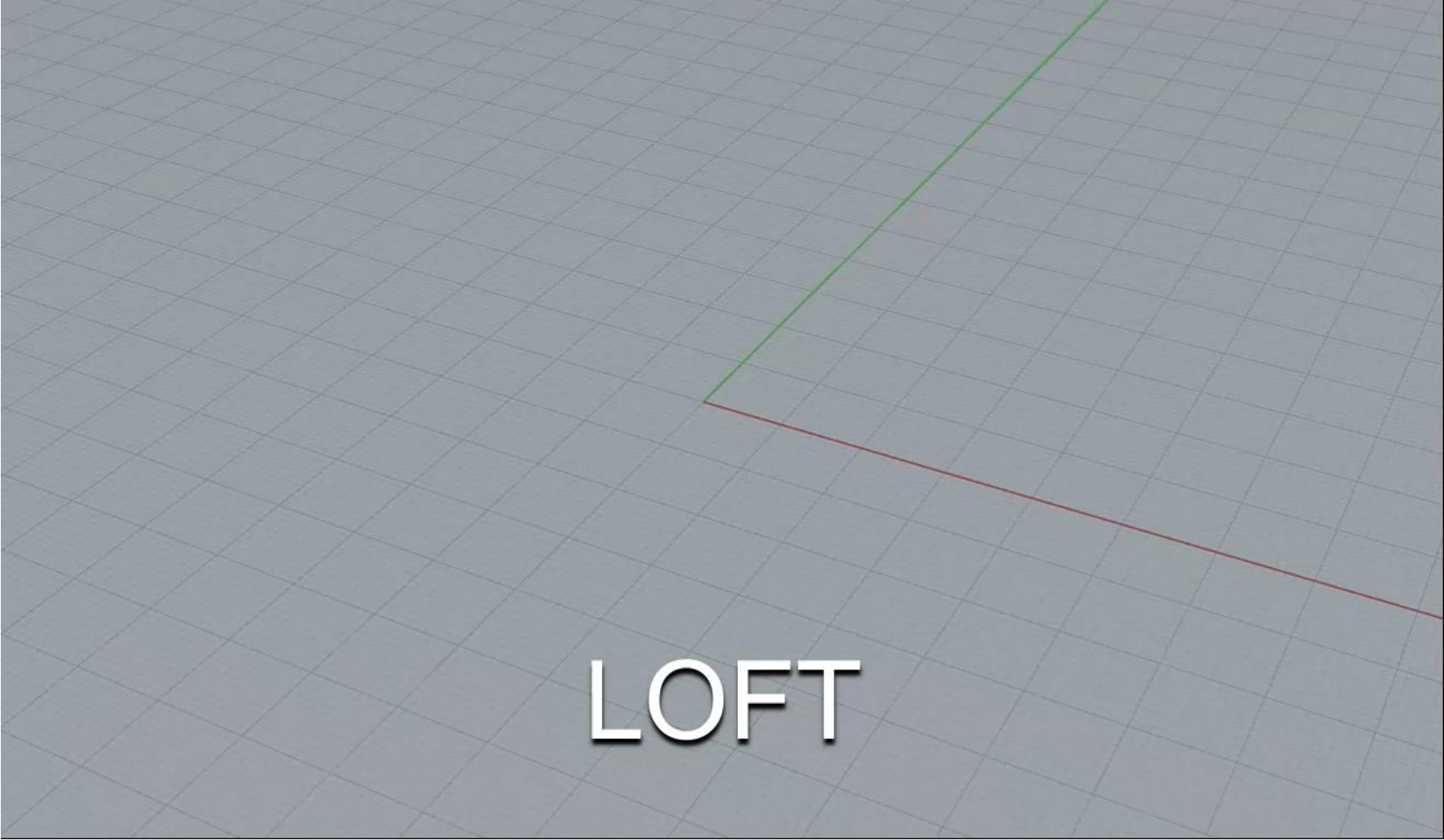


Surface modelling: Non-Uniform Rational Basis Spline (NURBS)



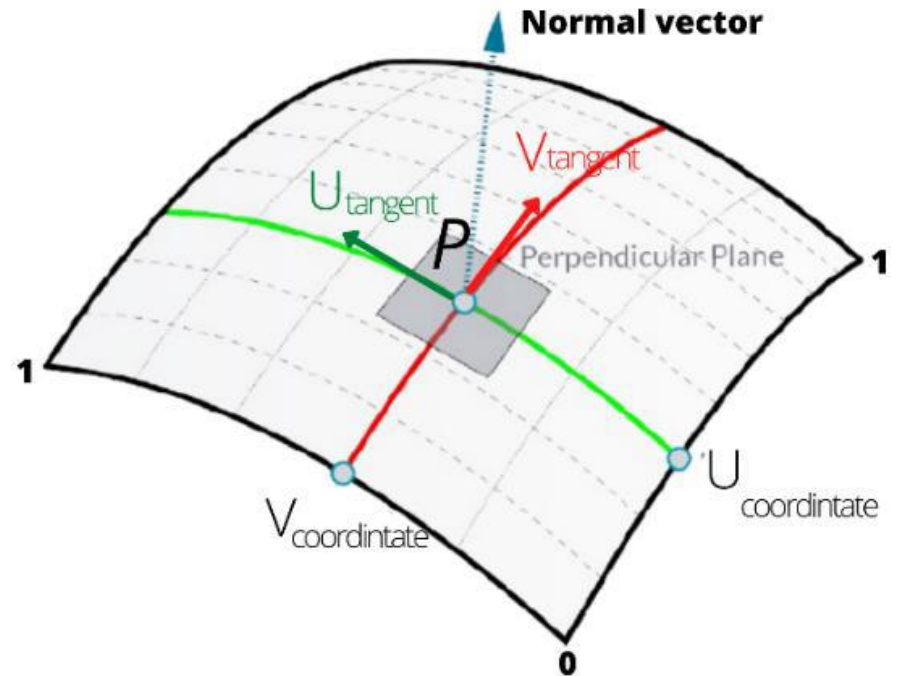
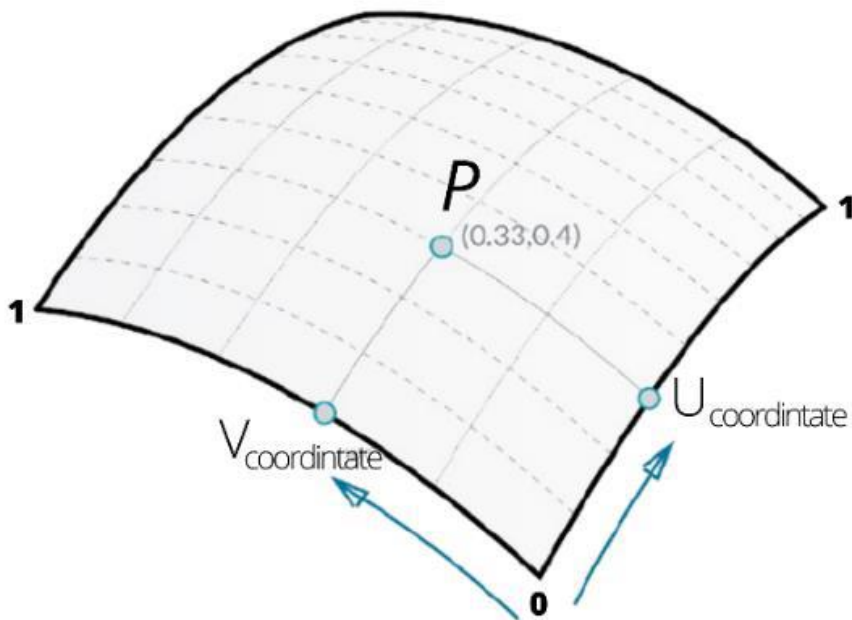
Surface modelling. NURBS (Rhino 3D example)



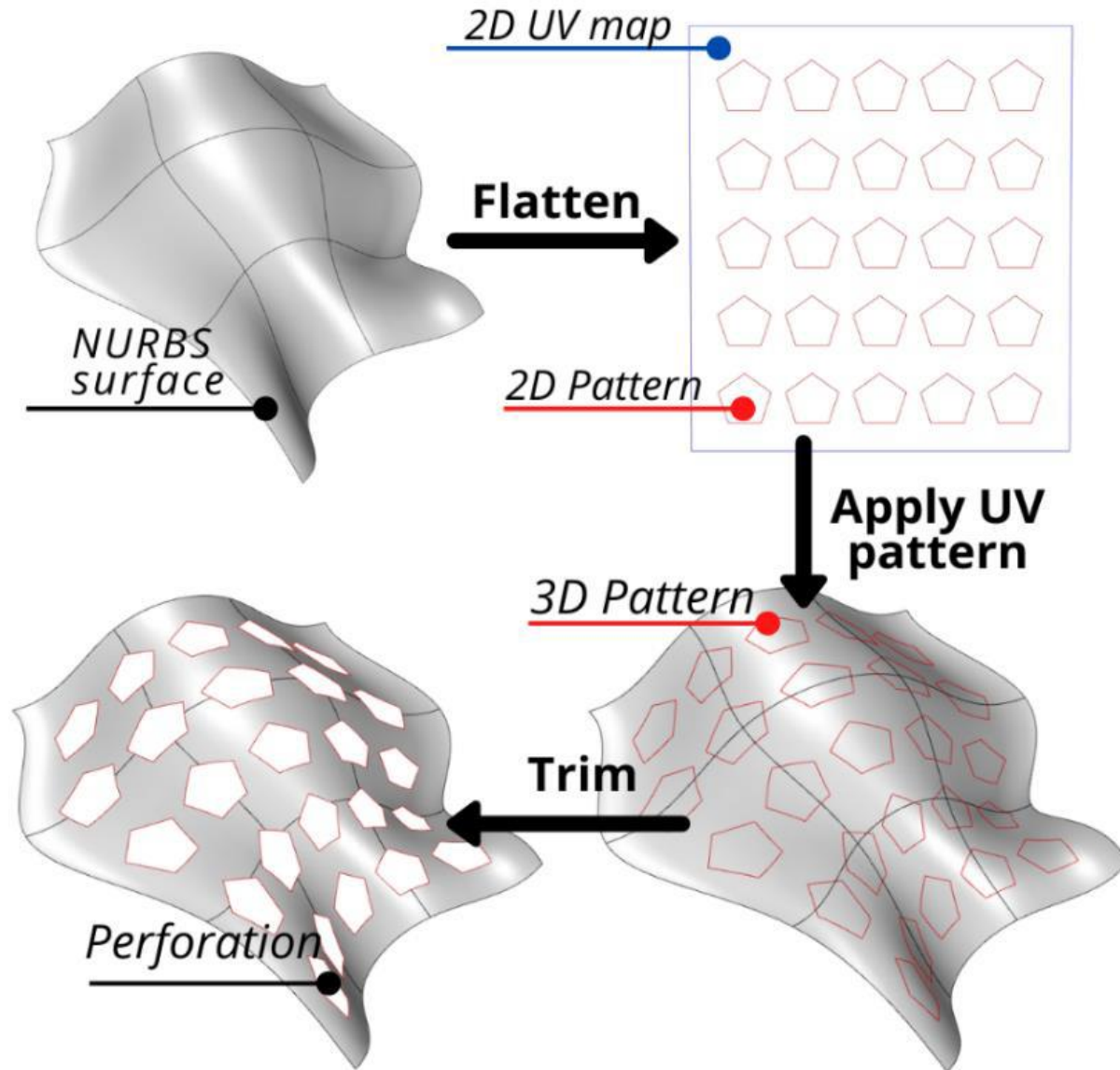


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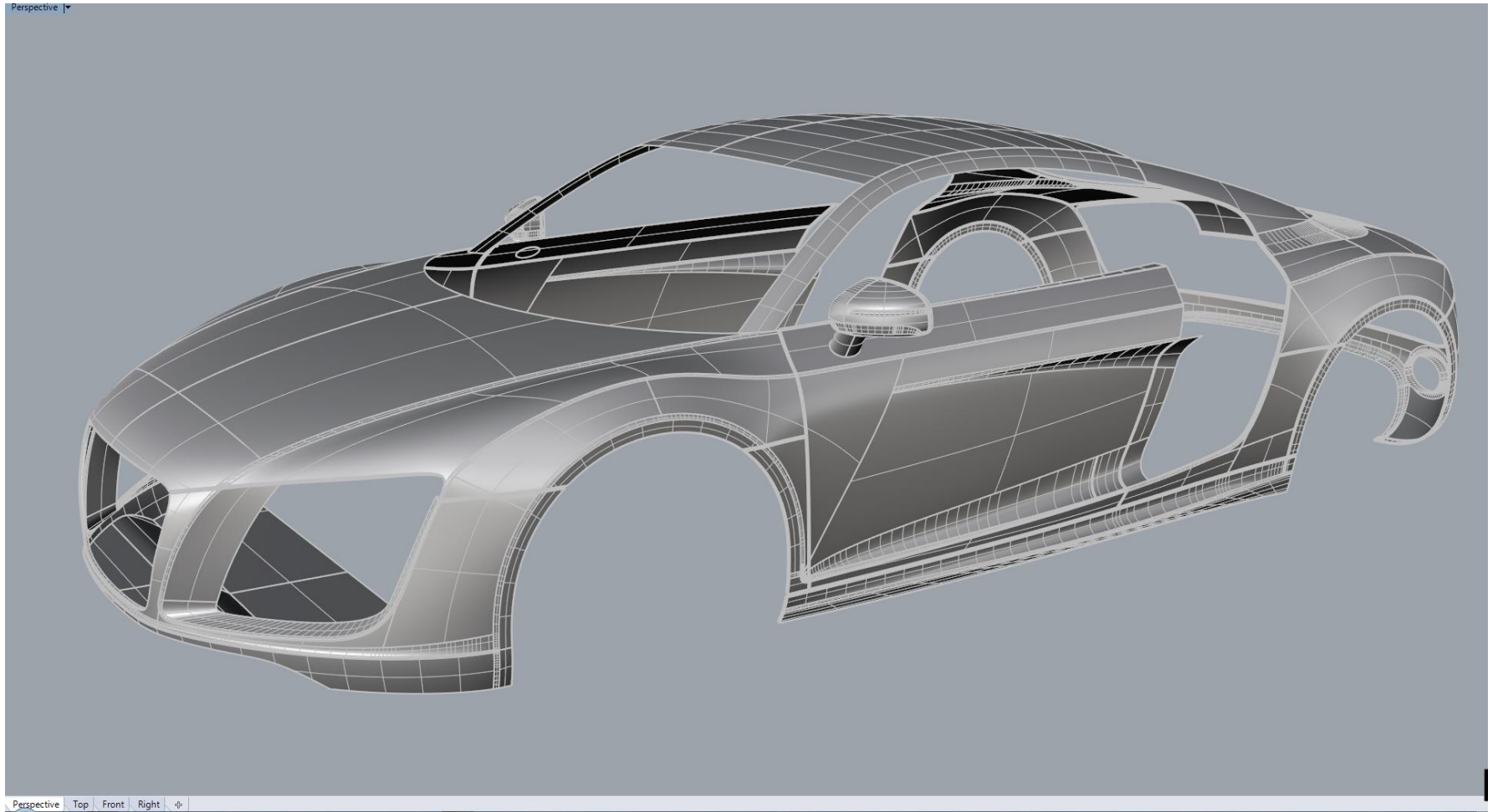
Surface modelling: Non-Uniform Rational Basis Spline (NURBS)



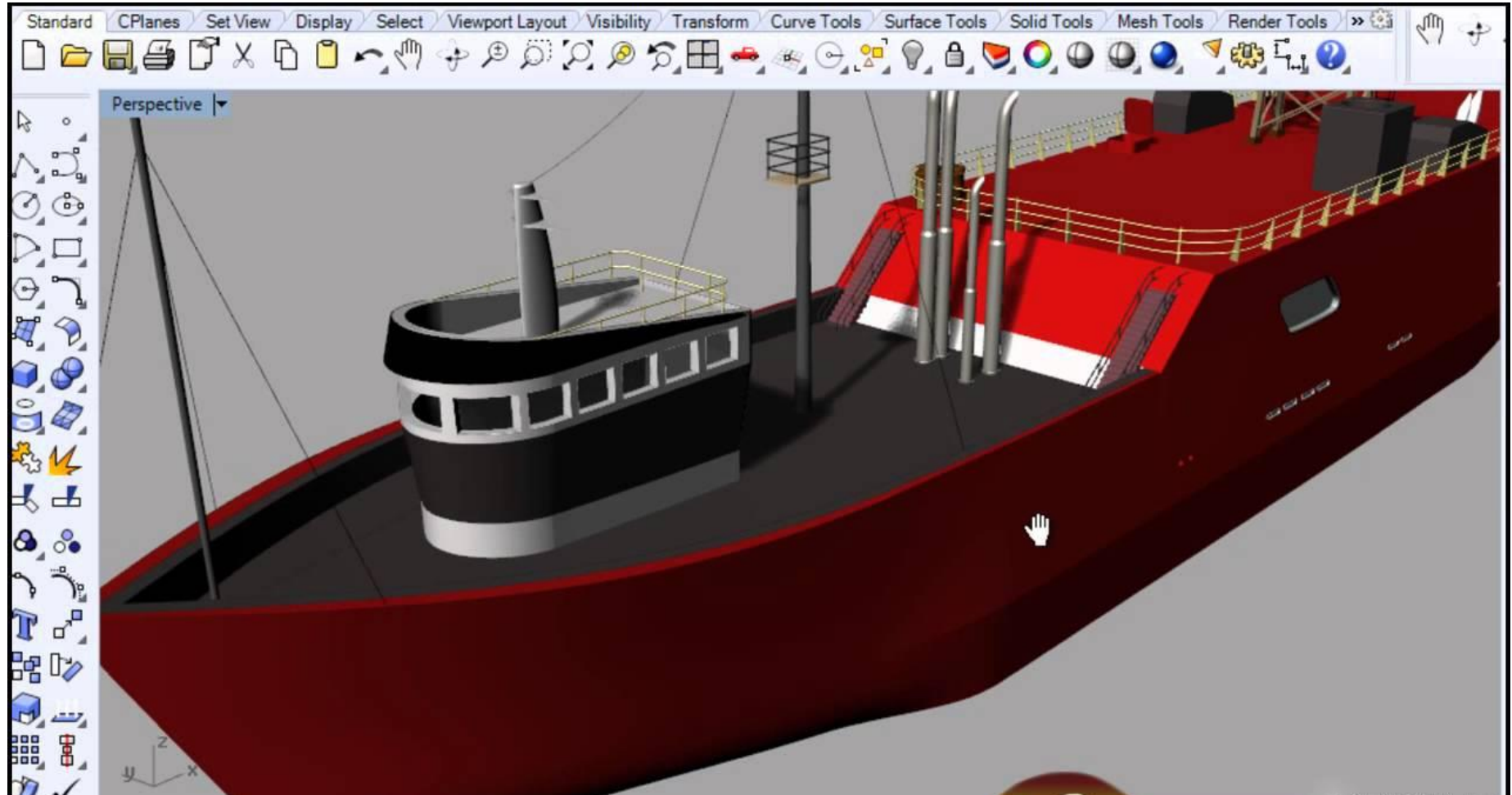
Surface modelling: Non-Uniform Rational Basis Spline (NURBS)



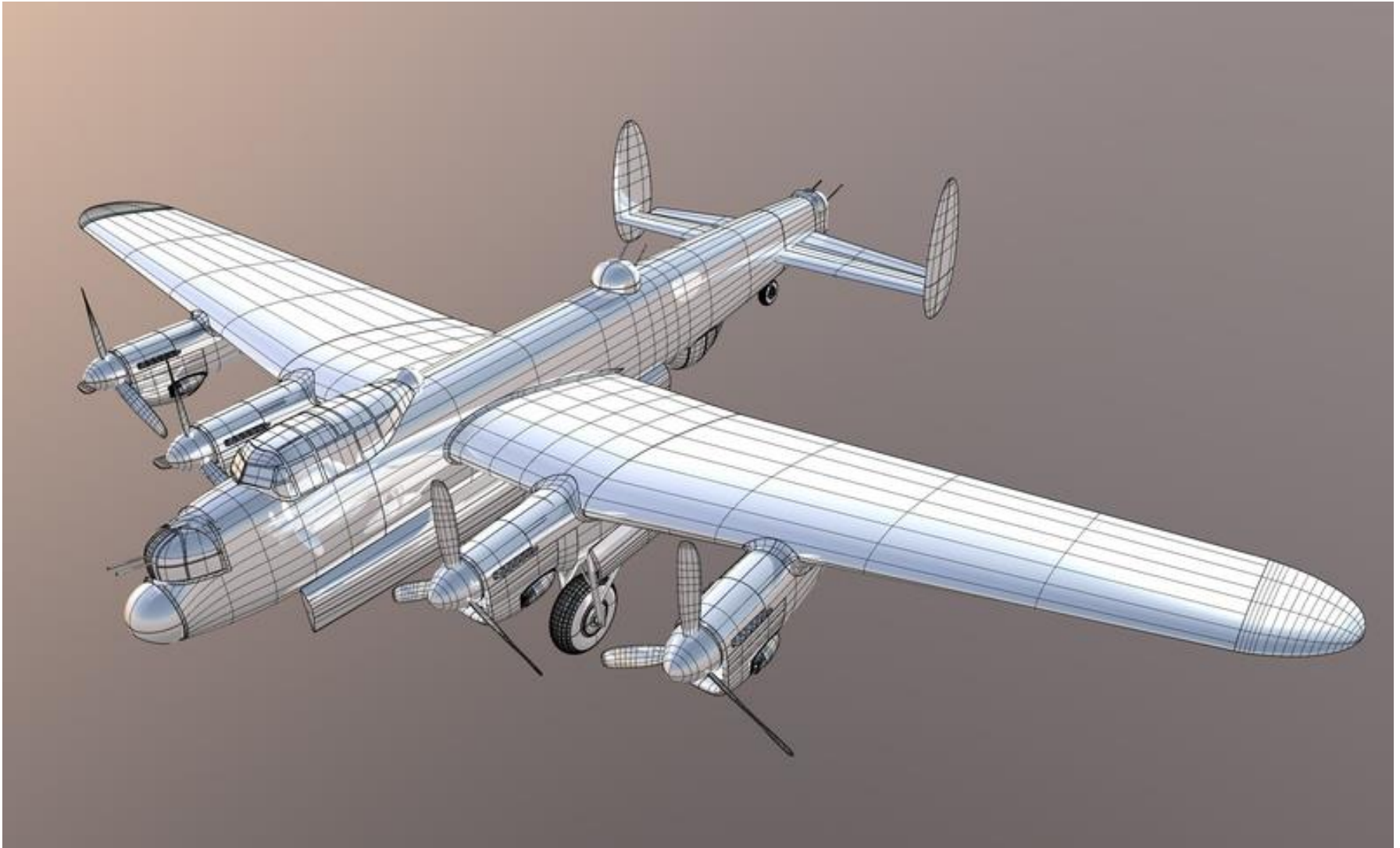
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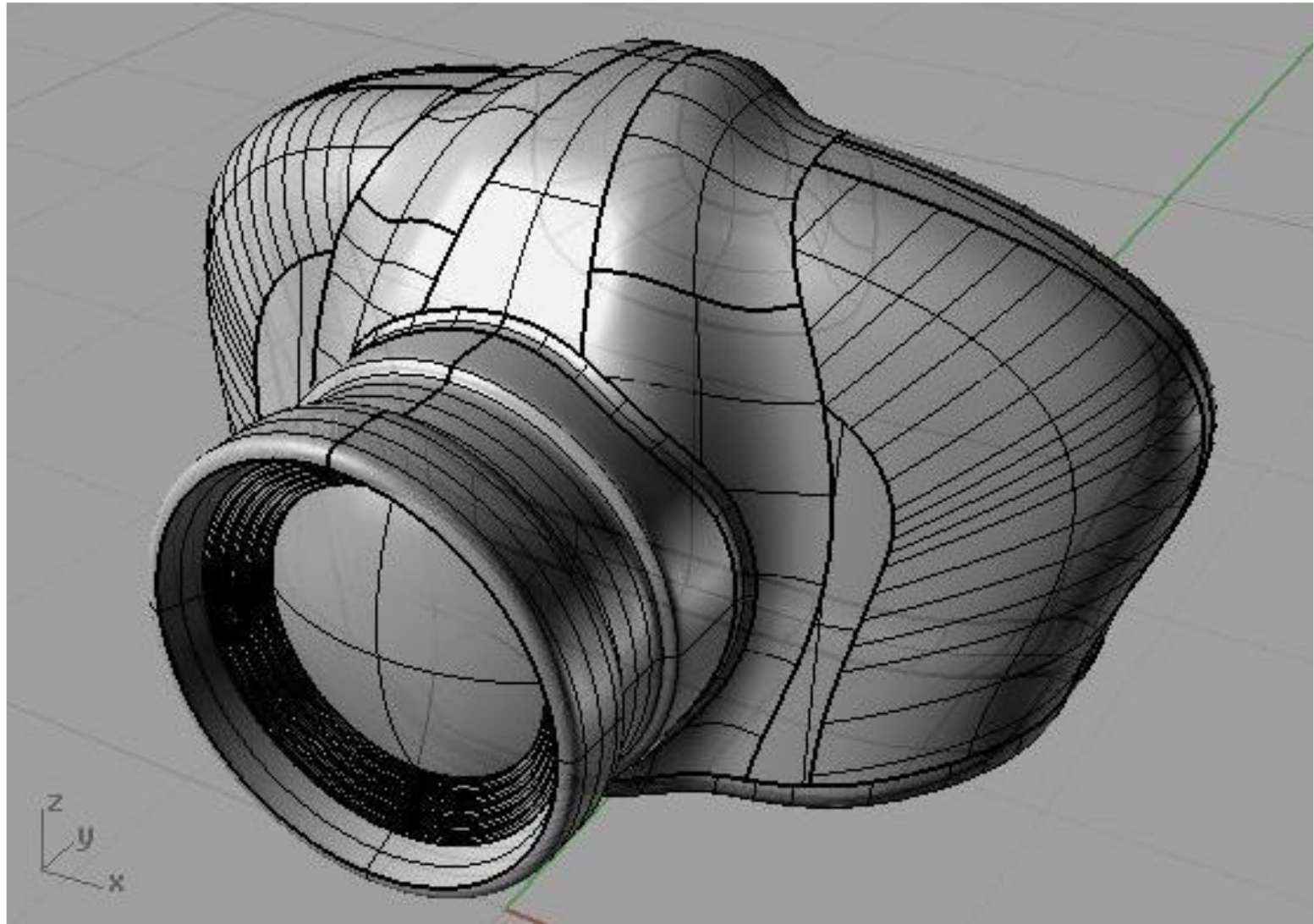
Surface modelling: Non-Uniform Rational Basis Spline (NURBS)



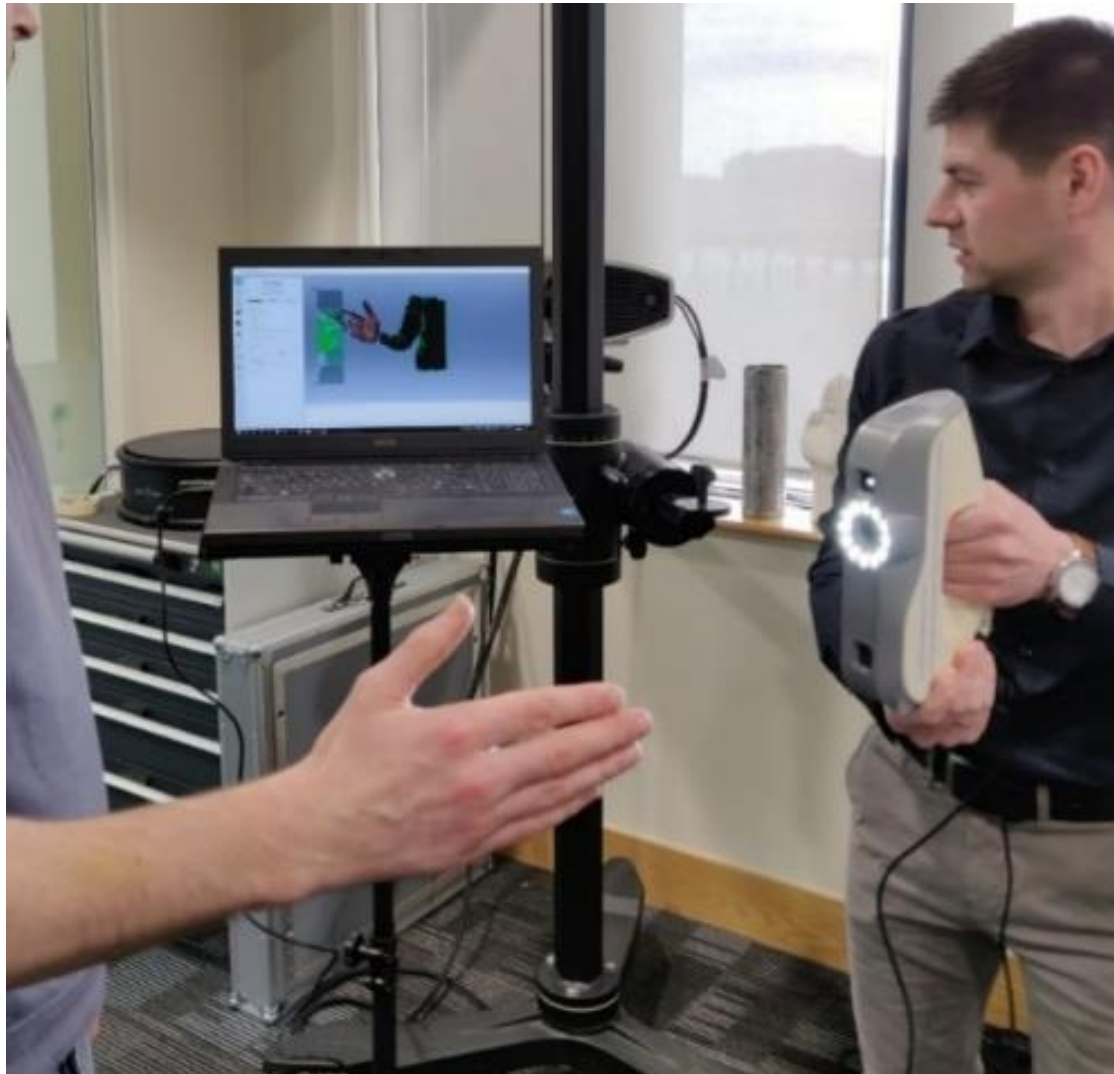
Surface modelling: Non-Uniform Rational Basis Spline (NURBS)



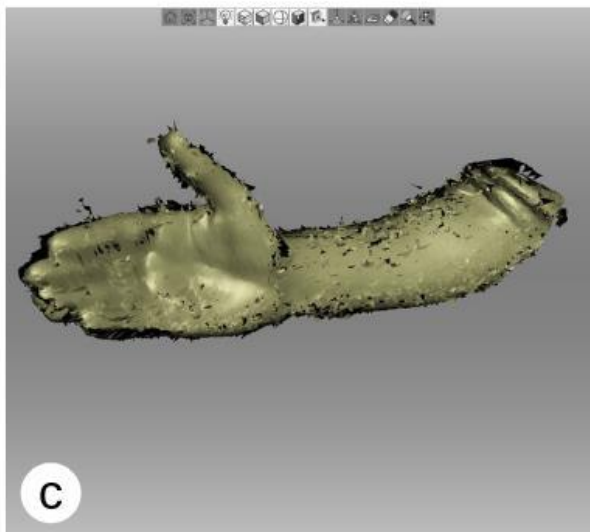
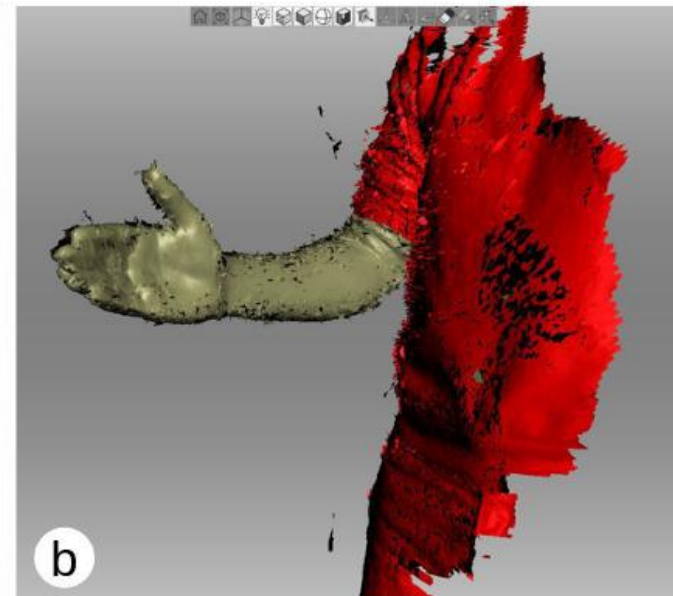
Surface modelling: Non-Uniform Rational Basis Spline (NURBS)



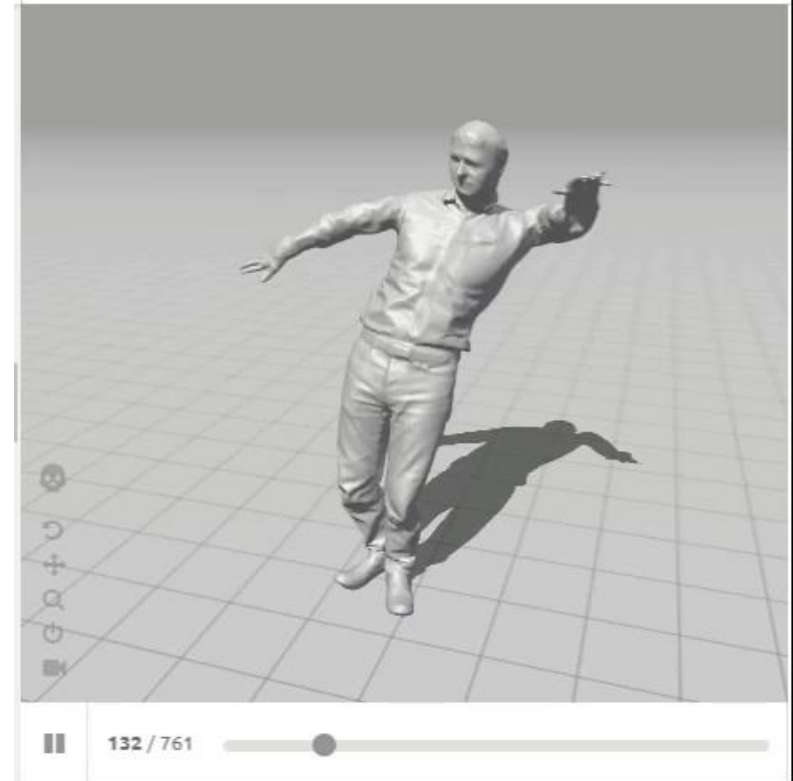
Surface modelling: 3D scan data (Digital twins)



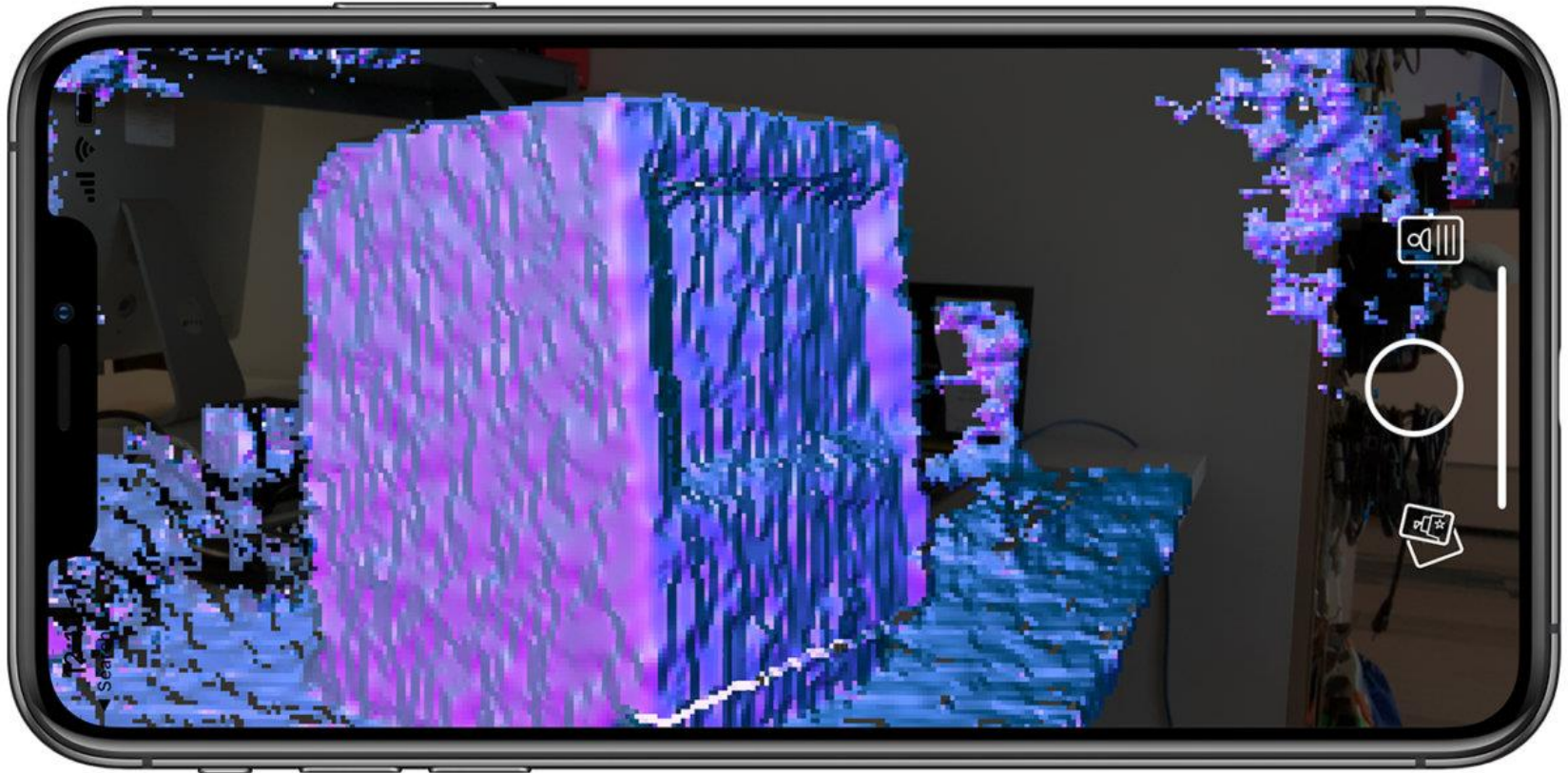
Surface modelling: 3D scan data (meshes)



Surface modelling: 3D scan data (Digital twins)

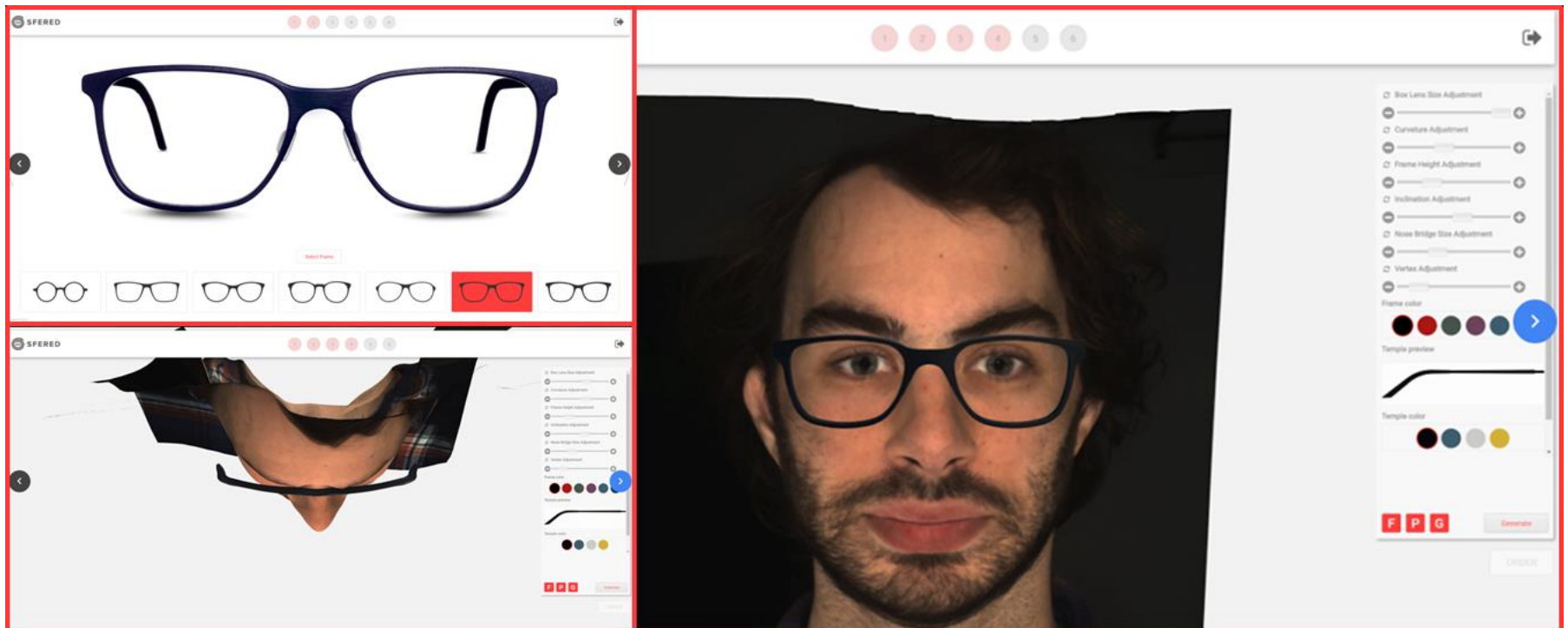


Surface modelling: 3D scan data (Mobile scanning)



<https://www.standardcyborg.com/>

Surface modelling: 3D scan data (Digital twins)

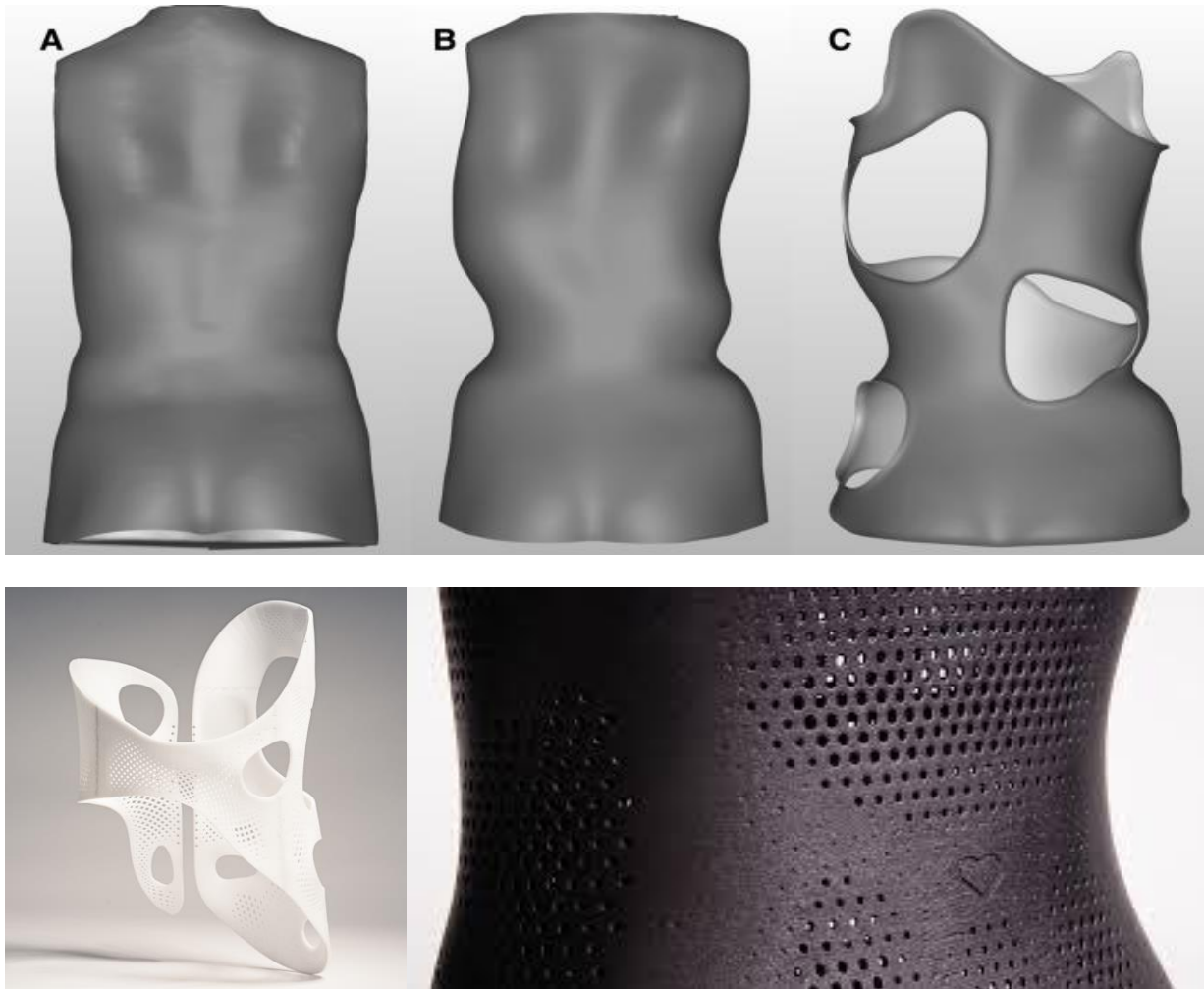


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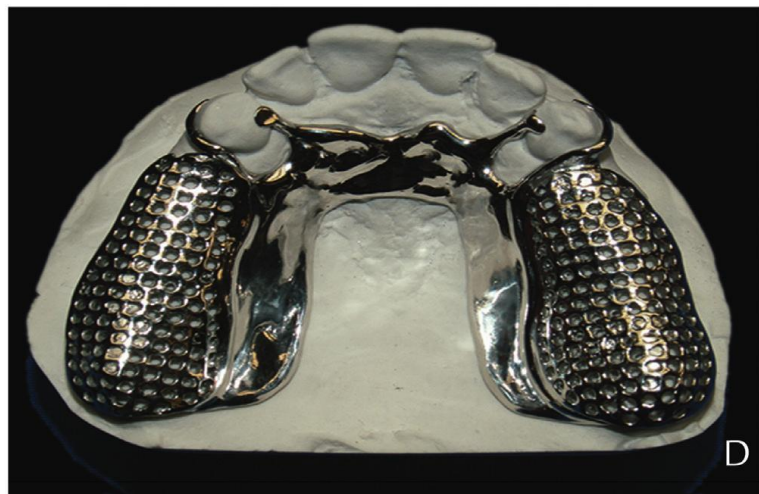
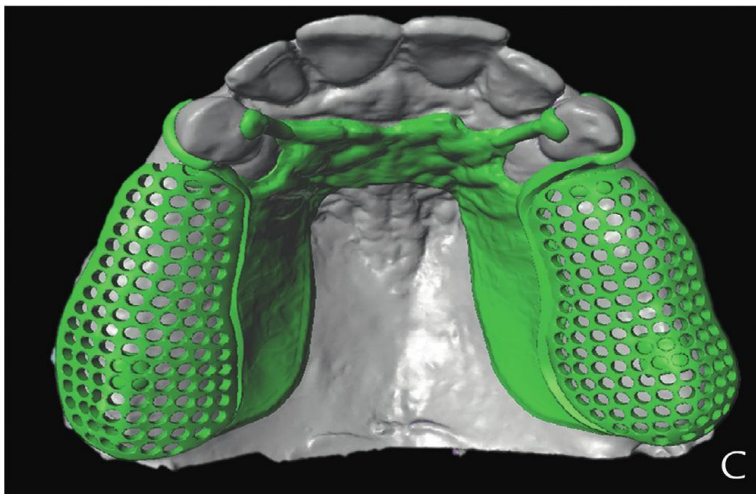
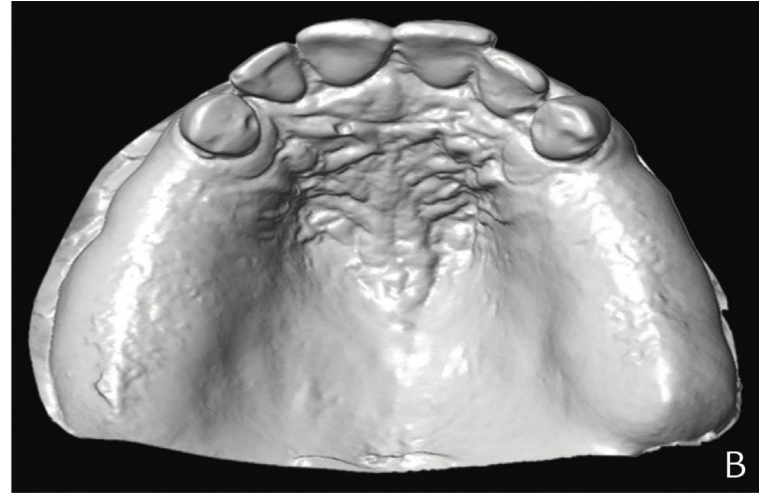


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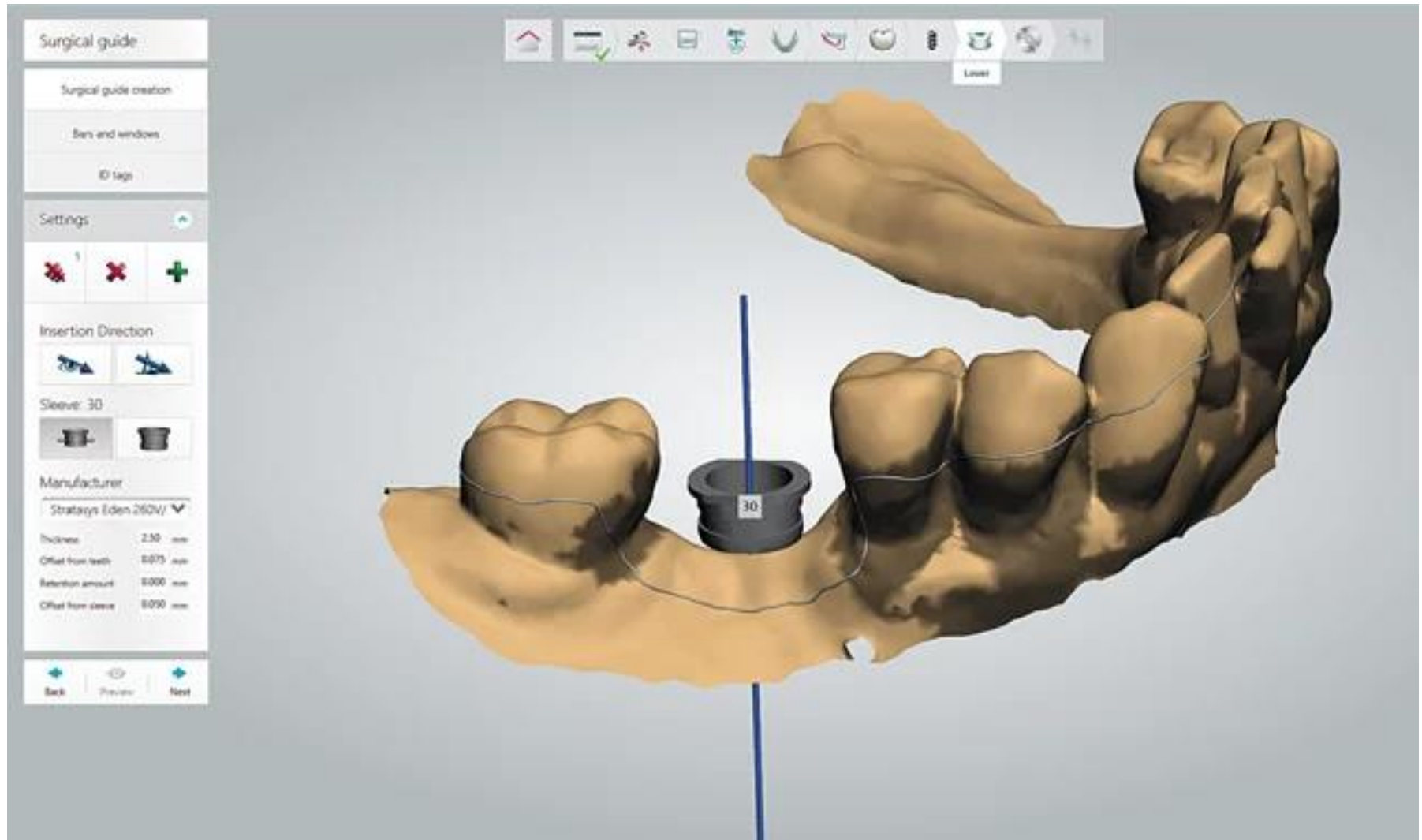
Surface modelling: 3D scan data



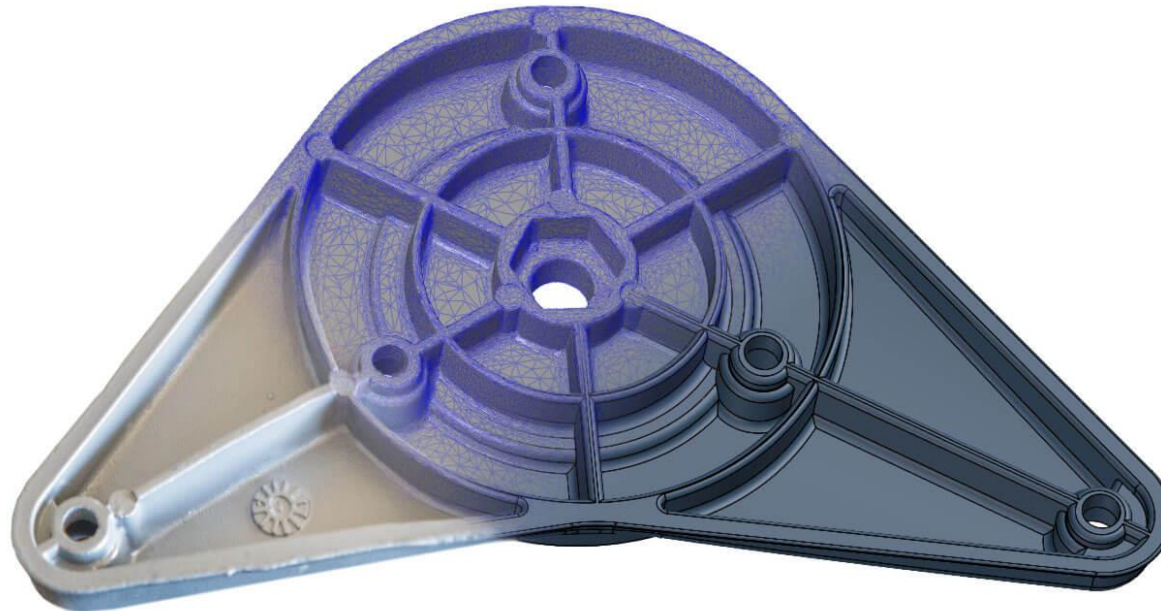
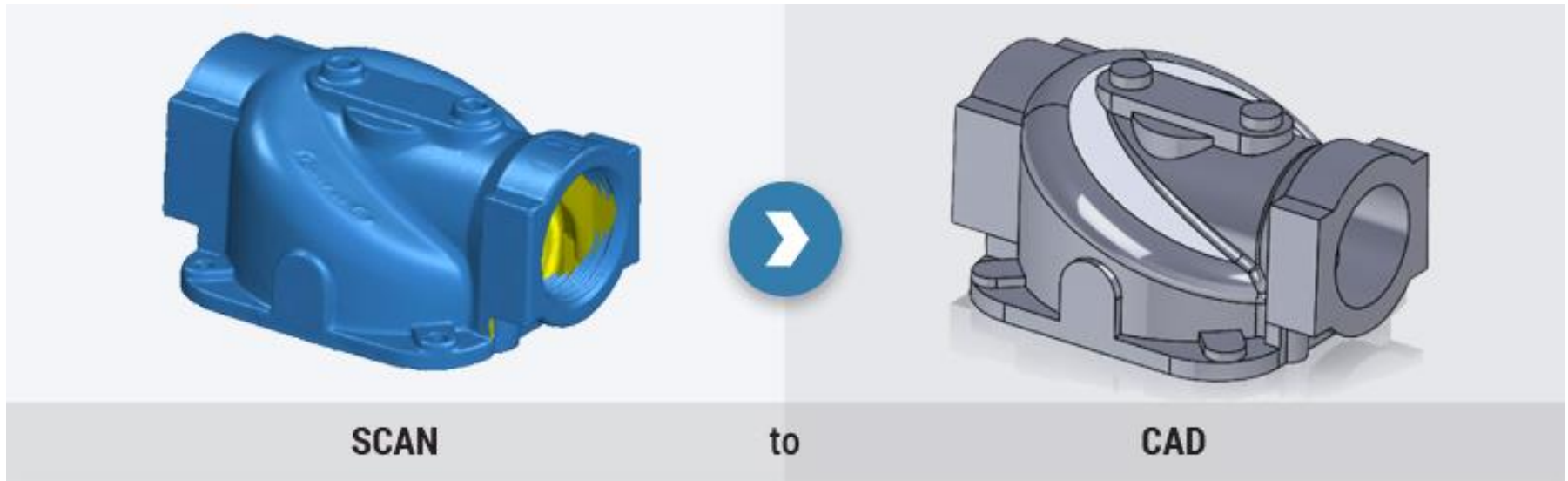
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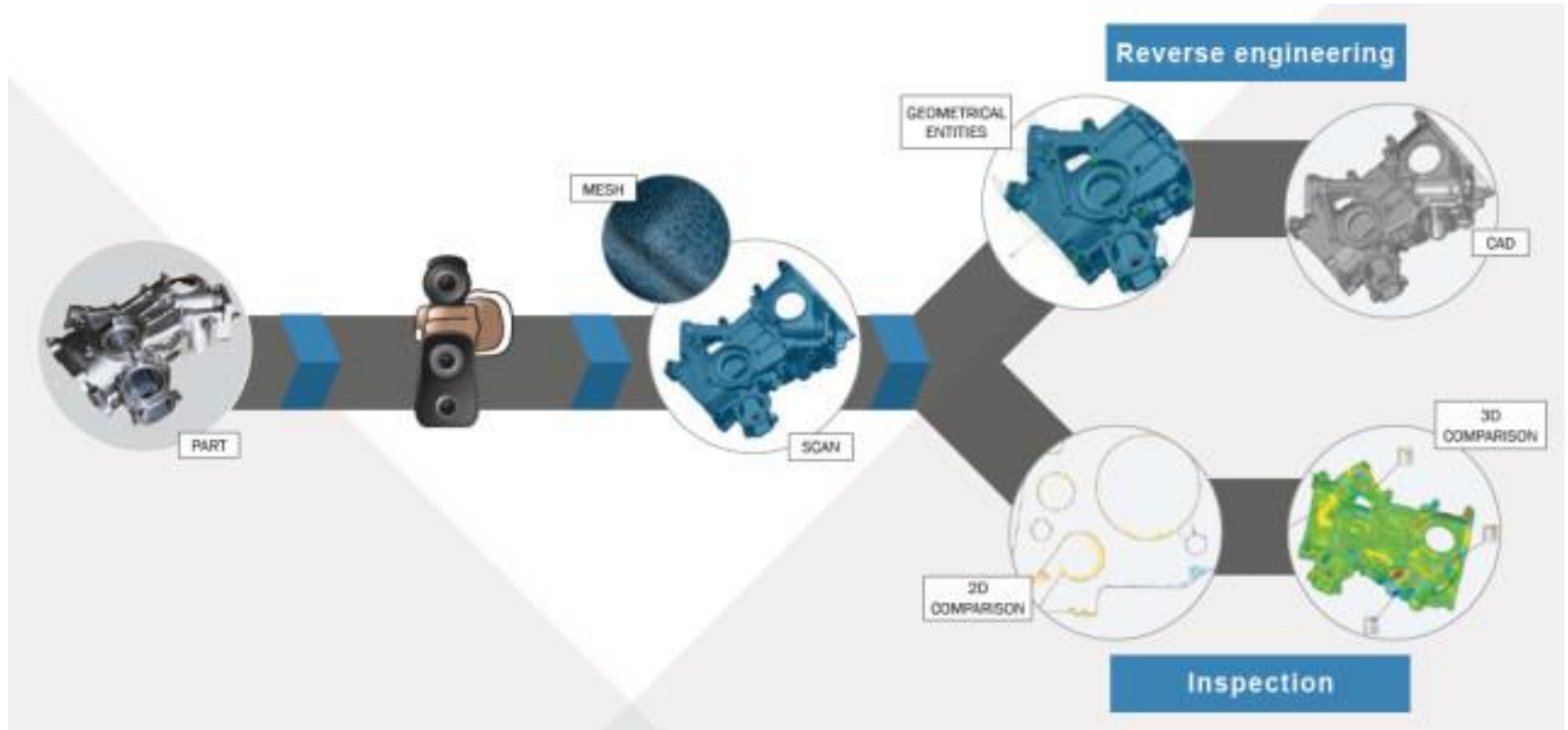
Surface modelling: 3D scan data



Surface modelling: 3D scan data

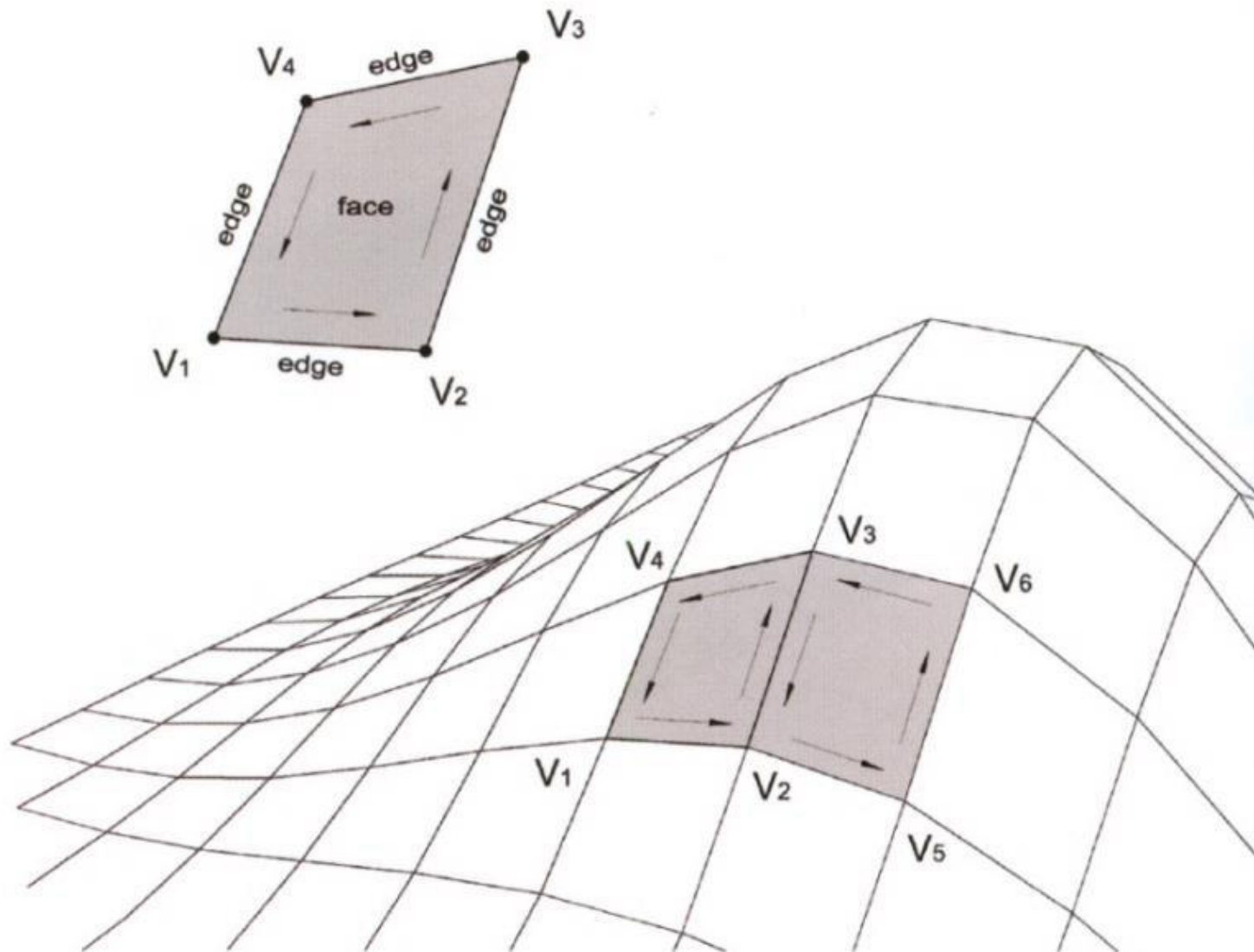


Surface modelling: 3D scan data

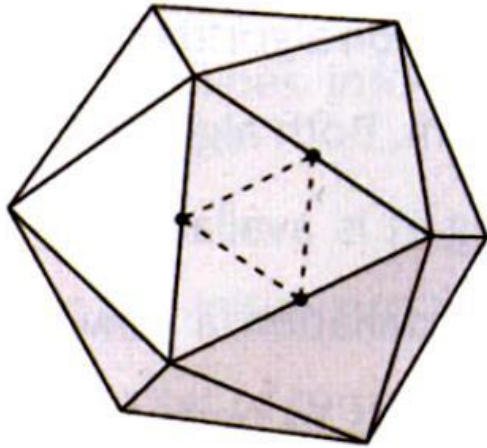




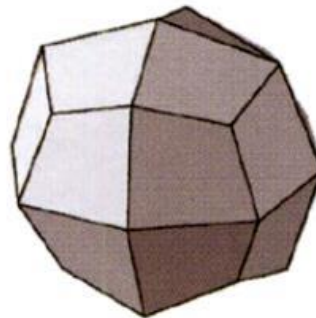
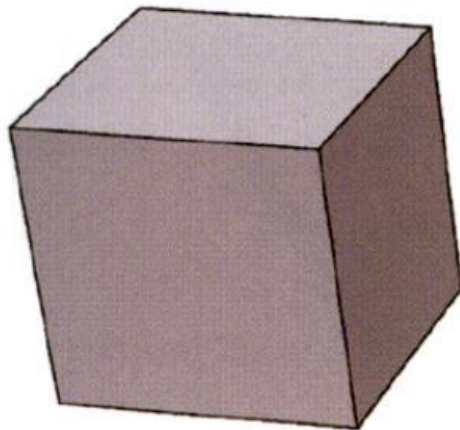
Surface modelling: Polygons (meshes)



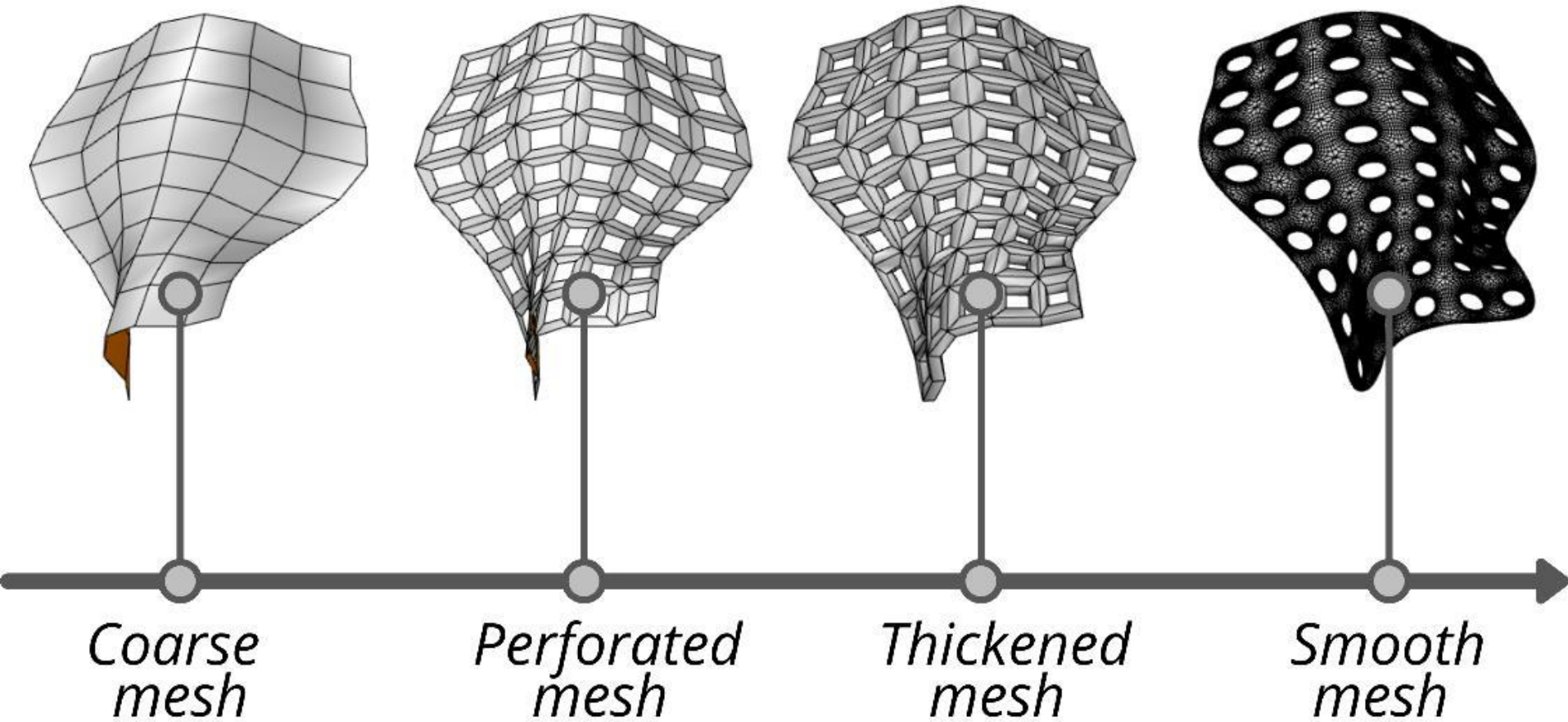
Loop subdivision scheme

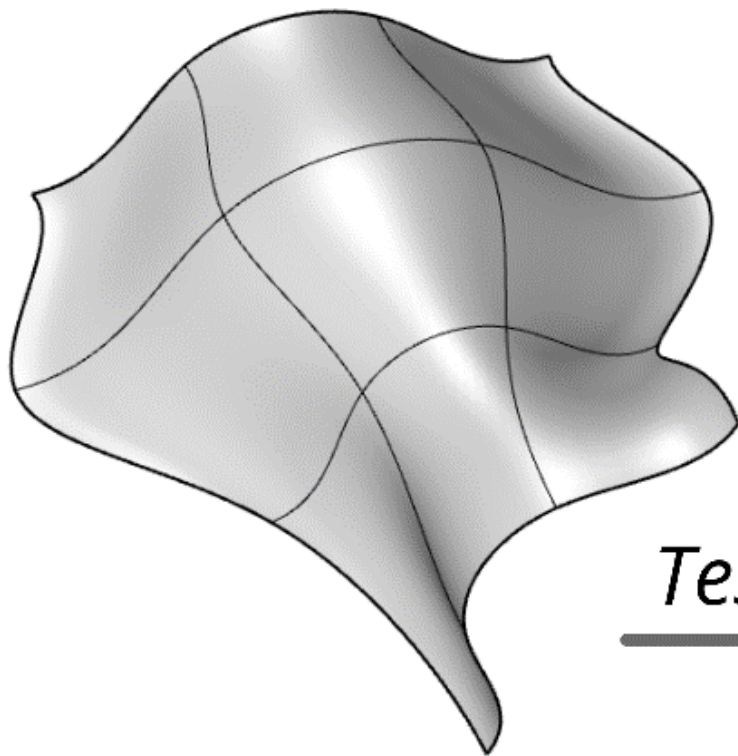


Catmull-Clark subdivision scheme



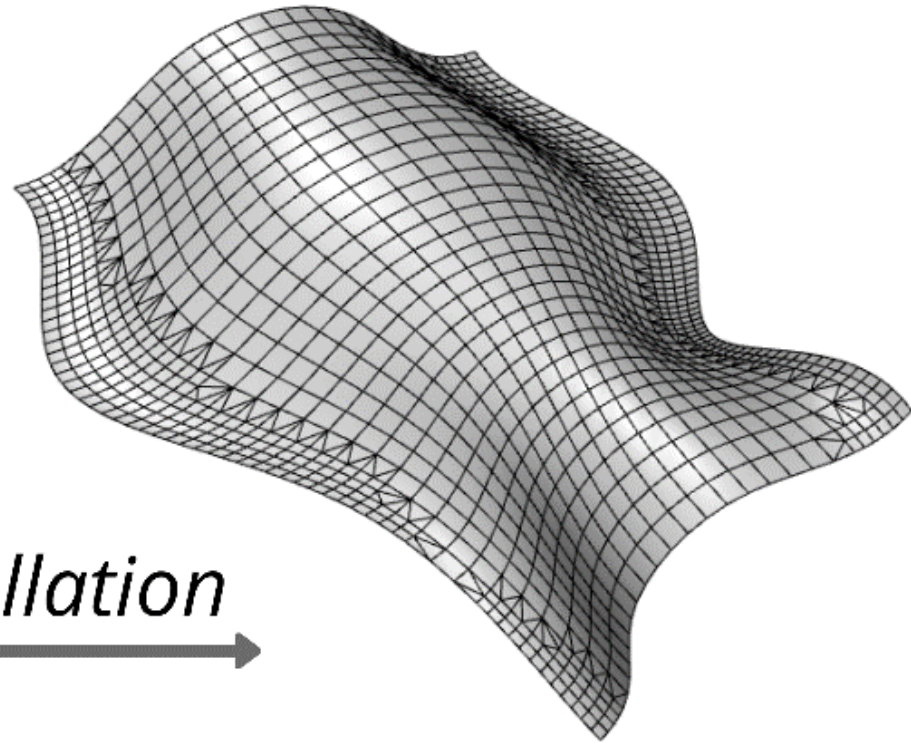
Surface modelling: Polygons (meshes)





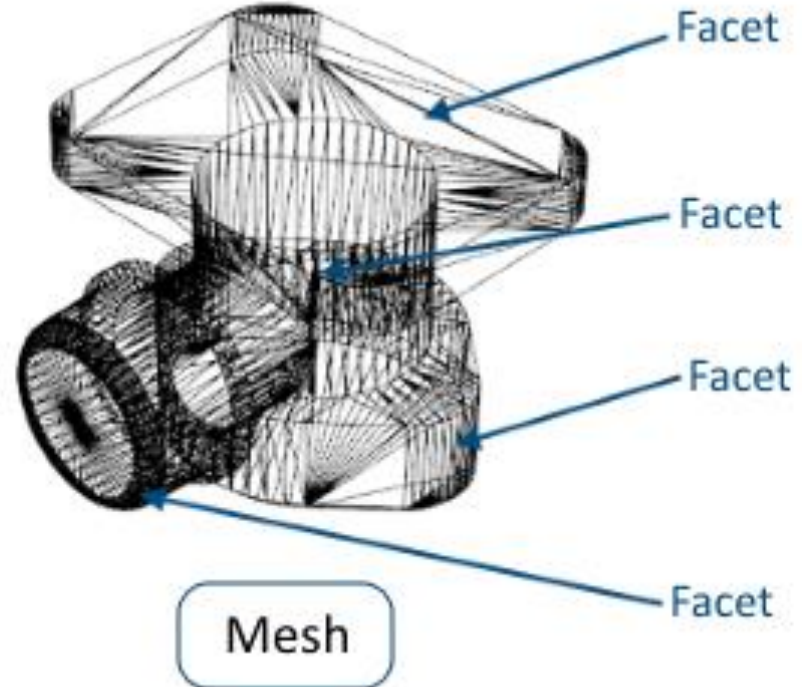
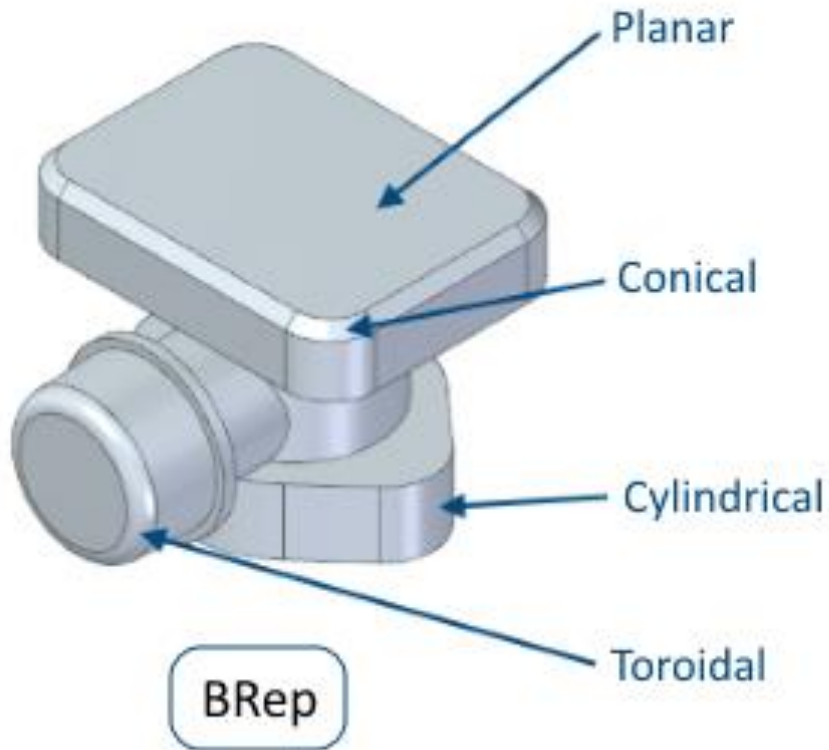
NURBS surface

Tessellation



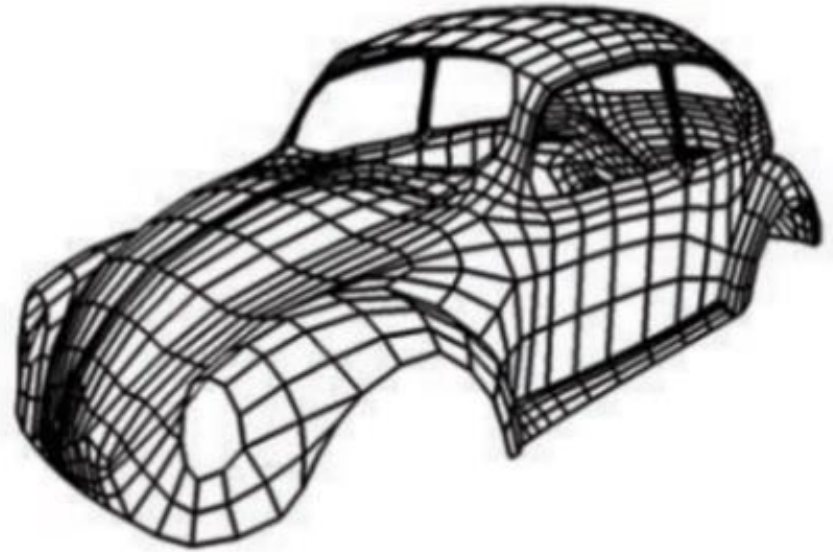
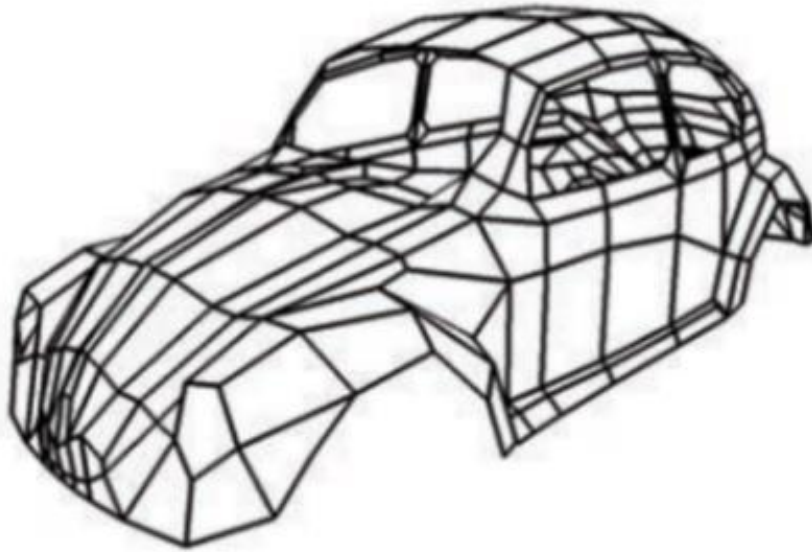
Mesh surface

Surface modelling: Polygons (meshes)

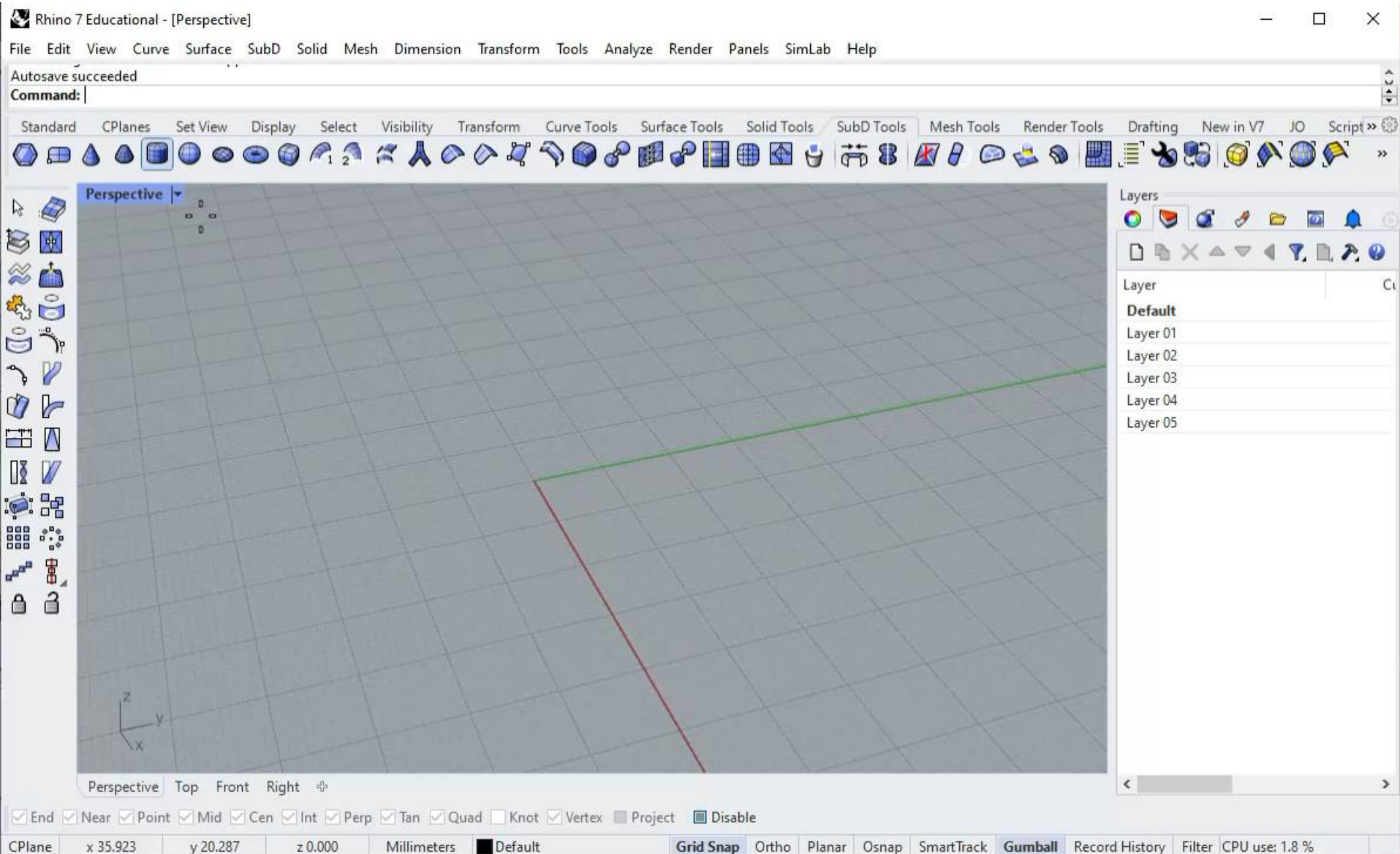


Faces and Facets

Surface modelling. Subdivision (SubD)



Surface modelling. Subdivision (SubD)



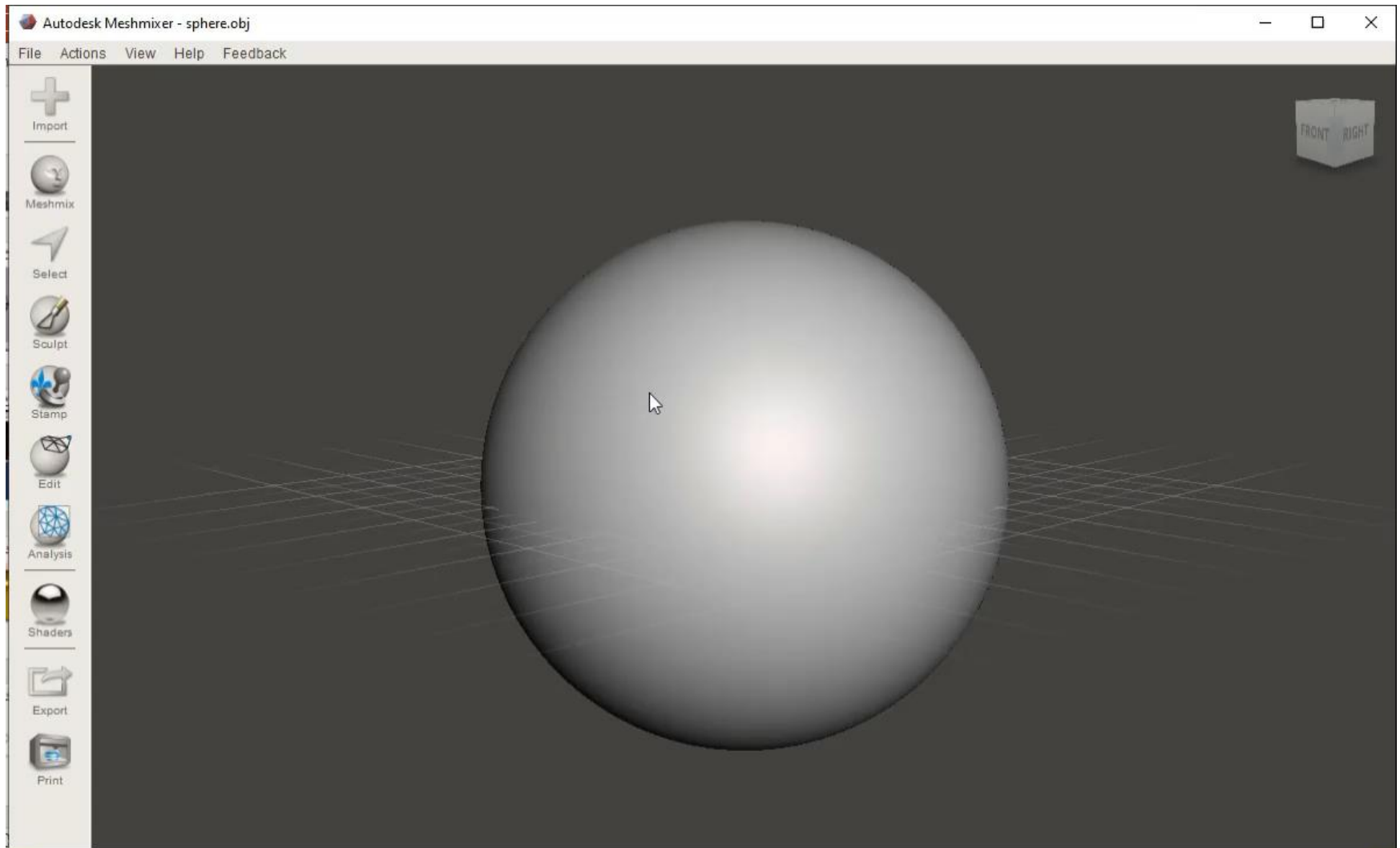




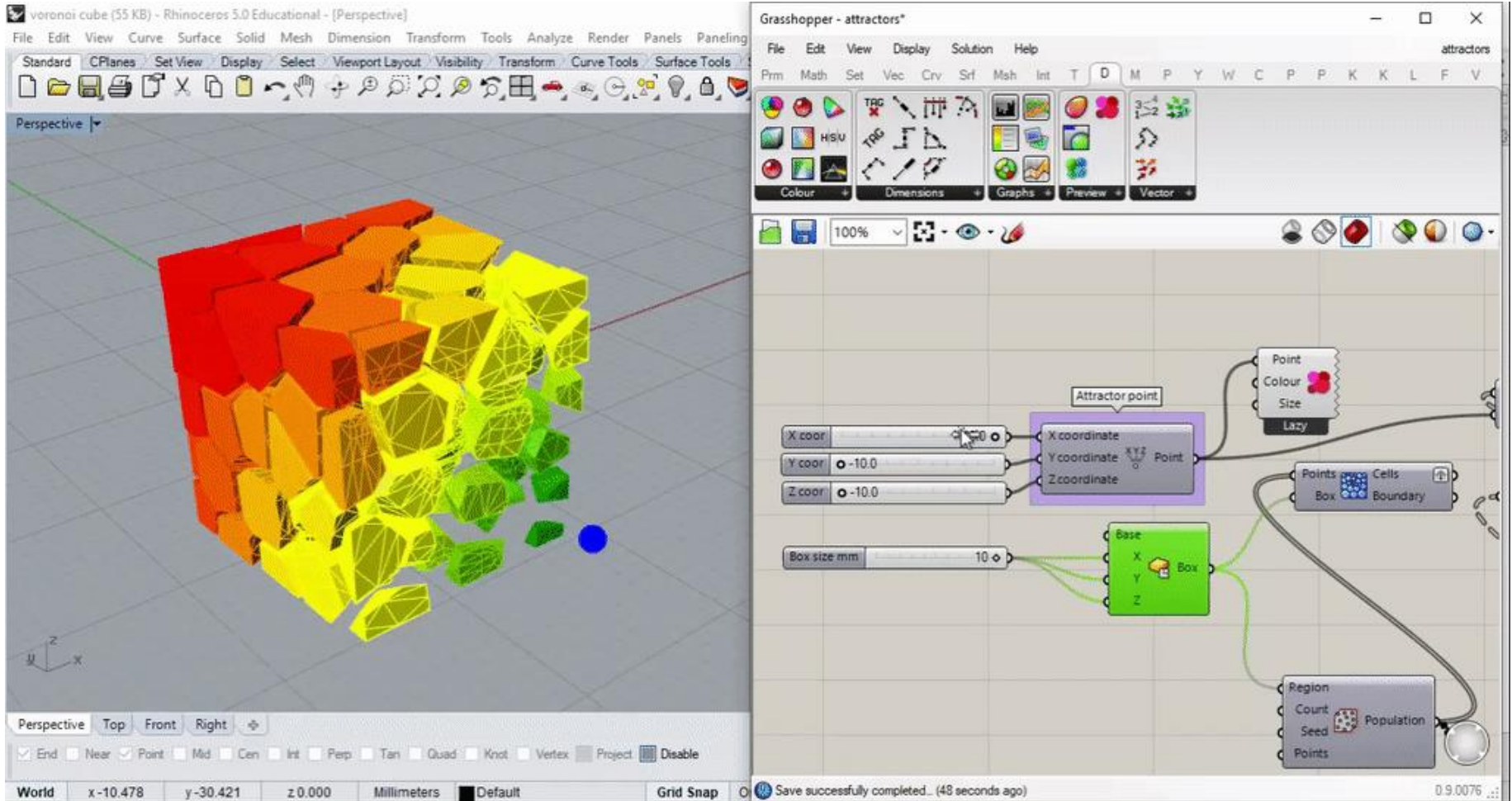
Surface modelling: 3D sculpting

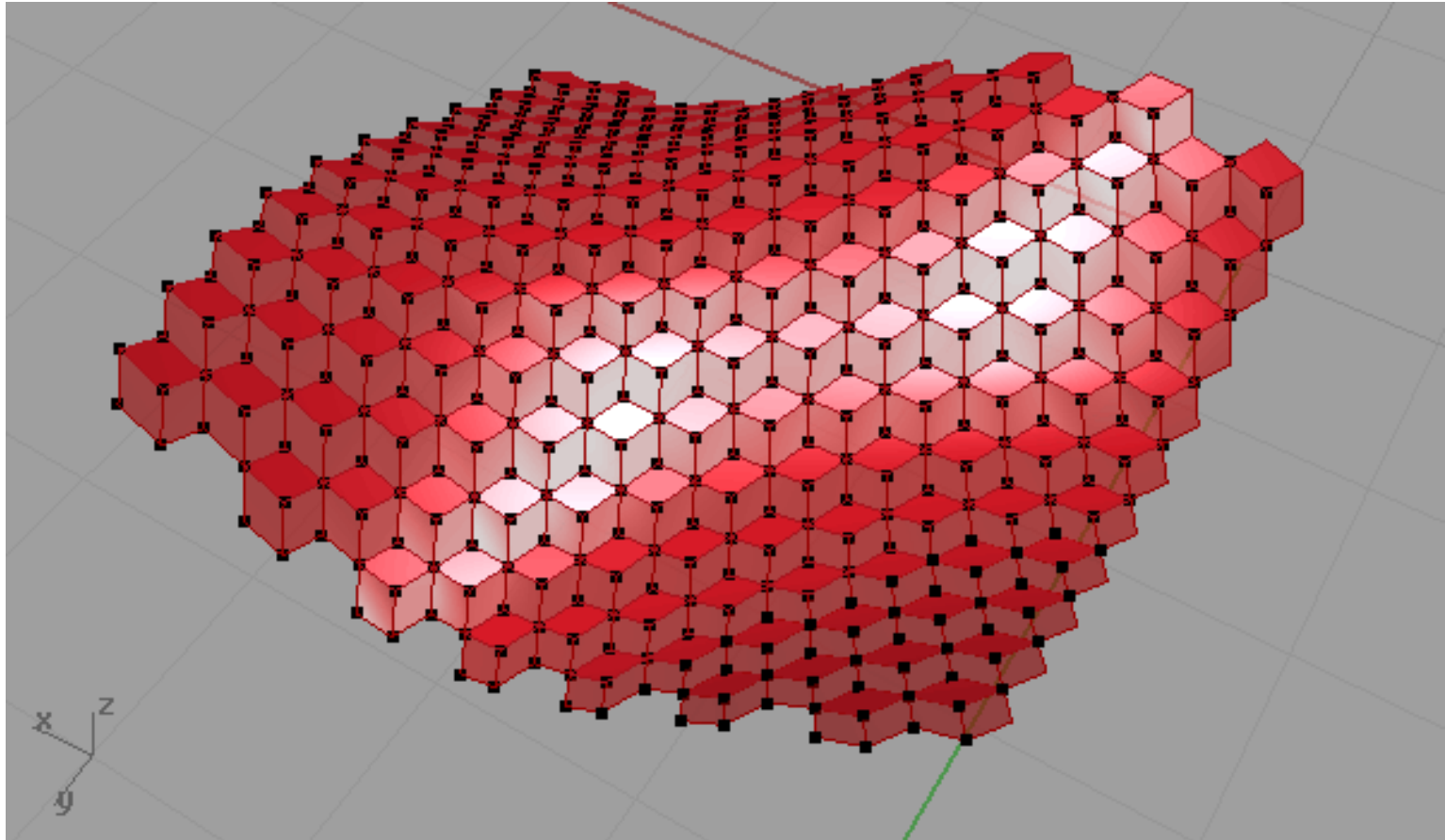


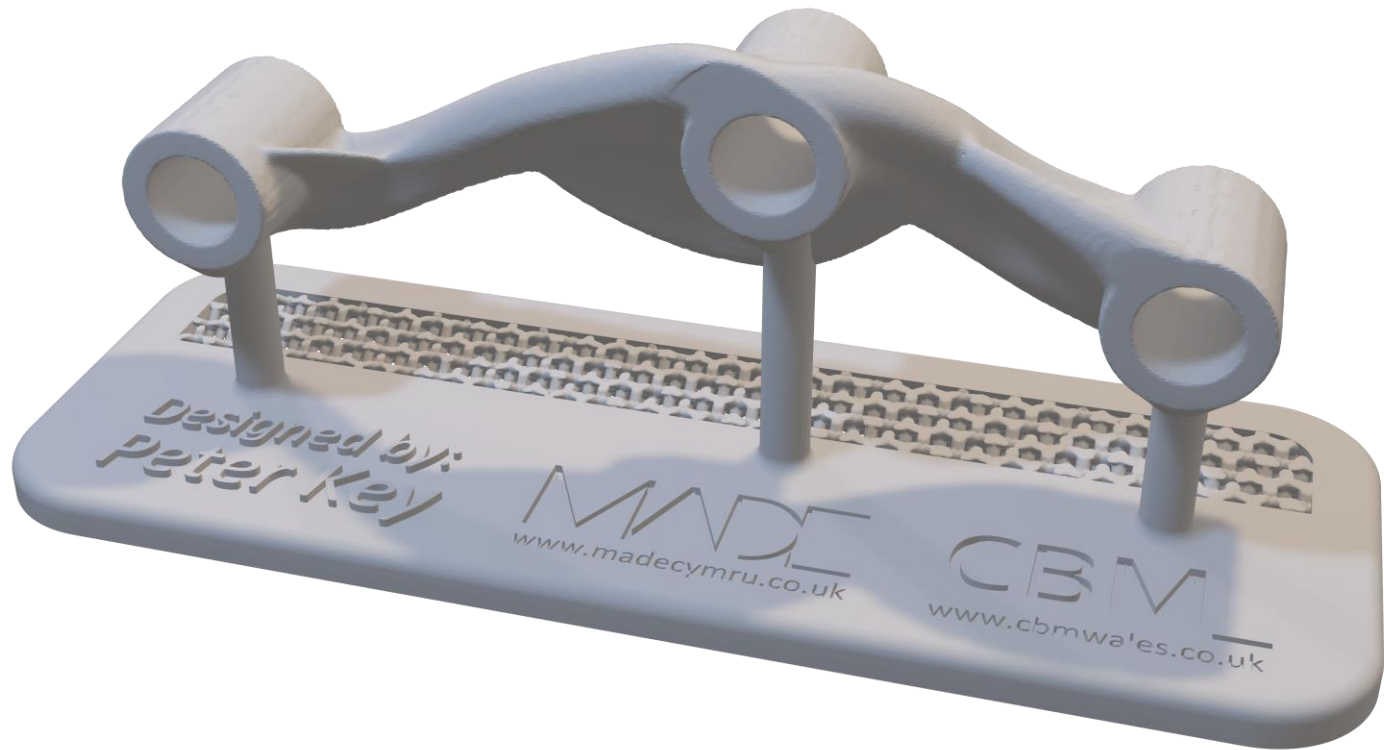
Surface modelling: 3D sculpting



Algorithms-Aided design (Rhino3D+Grasshopper+Python) MADE







- www.rhino3d.com – CAD sw (NURBS)
- www.autodesk.com – CAD sw (Fusion 360)
- www.meshmixer.com – CAD sw (3D sculpting)
- www.ntopology.com – CAD sw (volumetric)
- www.artec3D.com – 3D scanning sw (Artec Studio)
- www.3Dsystems.com – CAD, 3D scan processing
- www.standardcyborg.com – iPhone X 3D scanning

Questions?