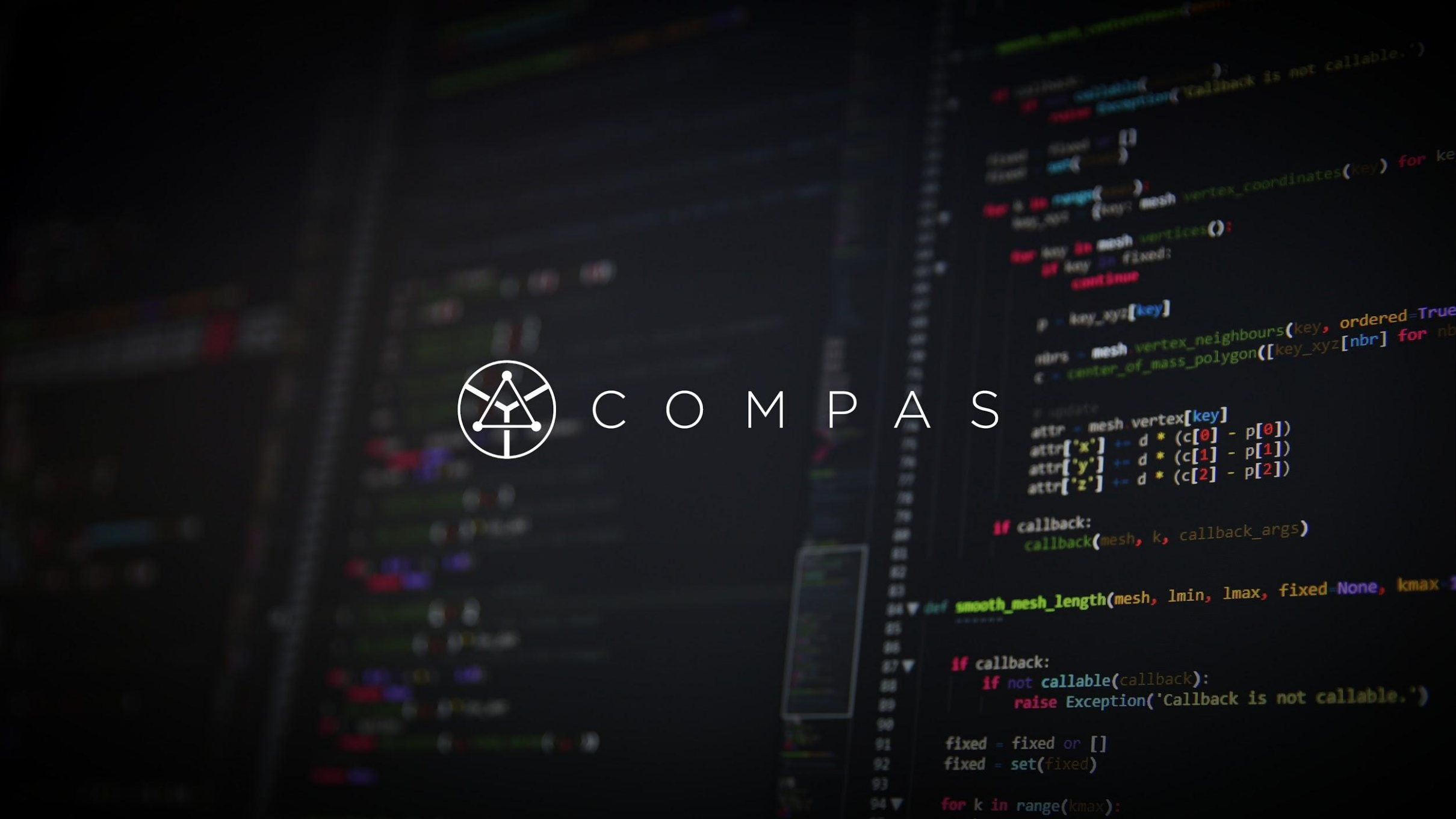
COMPAS
if callback:
if not callable(callback):
raise Exception('Callback is not callable.')
fixed = fixed or []
fixed = set(fixed)
for k in range(kmax):
def smooth_mesh_length(mesh, lmin, lmax, fixed=None, kmax
if callback:
callback(mesh, k, callback_args)
attr['x'] += d * (c[0] - p[0])
attr['y'] += d * (c[1] - p[1])
attr['z'] += d * (c[2] - p[2])

Module 3

Volumetric Modelling

dear all
for today's COMPAS course, please try to install the necessary package and library as follows:

1.in the terminal (mac) or anaconda prompt (pc), activate the environment
`conda activate ita19`
2.install compas_vol directly from github:
`pip install git+https://github.com/dbt-ethz/compas_vol`
3.if you don't have git installed, first do so by running
`conda install git`
4.you can also clone the repository with your client of choice (sourcetree, github desktop, ...), then cd into the folder and run `pip install -e .`
5.you will also need ipyvolume for the mesh display inside a notebook. install it by running
`conda install -c conda-forge ipyvolume`
let me know if you encounter any problems, i'm happy to help

Jipa, A., Bernhard, M., Ruffray, N., Wangler, T., Flatt, R., & Dillenburger, B. (2017). *skelETHon Formwork*. In SIGraDi 2017, XXI Congreso de la Sociedad Ibero-americana de Gráfica Digital. Concepción, Chile.

Jipa, A., Bernhard, M., Ruffray, N., Wangler, T., Flatt, R., & Dillenburger, B. (2017). *skelETHon Formwork 3D Printed Plastic Formwork for Load-Bearing Concrete Structures*. In Blucher Design Proceedings (pp. 345–352). São Paulo

Jipa, A., Bernhard, M., & Dillenburger, B. (2017). *Submillimeter Formwork*. 2017 TxA Emerging Design + Technology. Austin, Texas, USA.

dbt

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Concrete Canoe

Photo: Andrei Jipa

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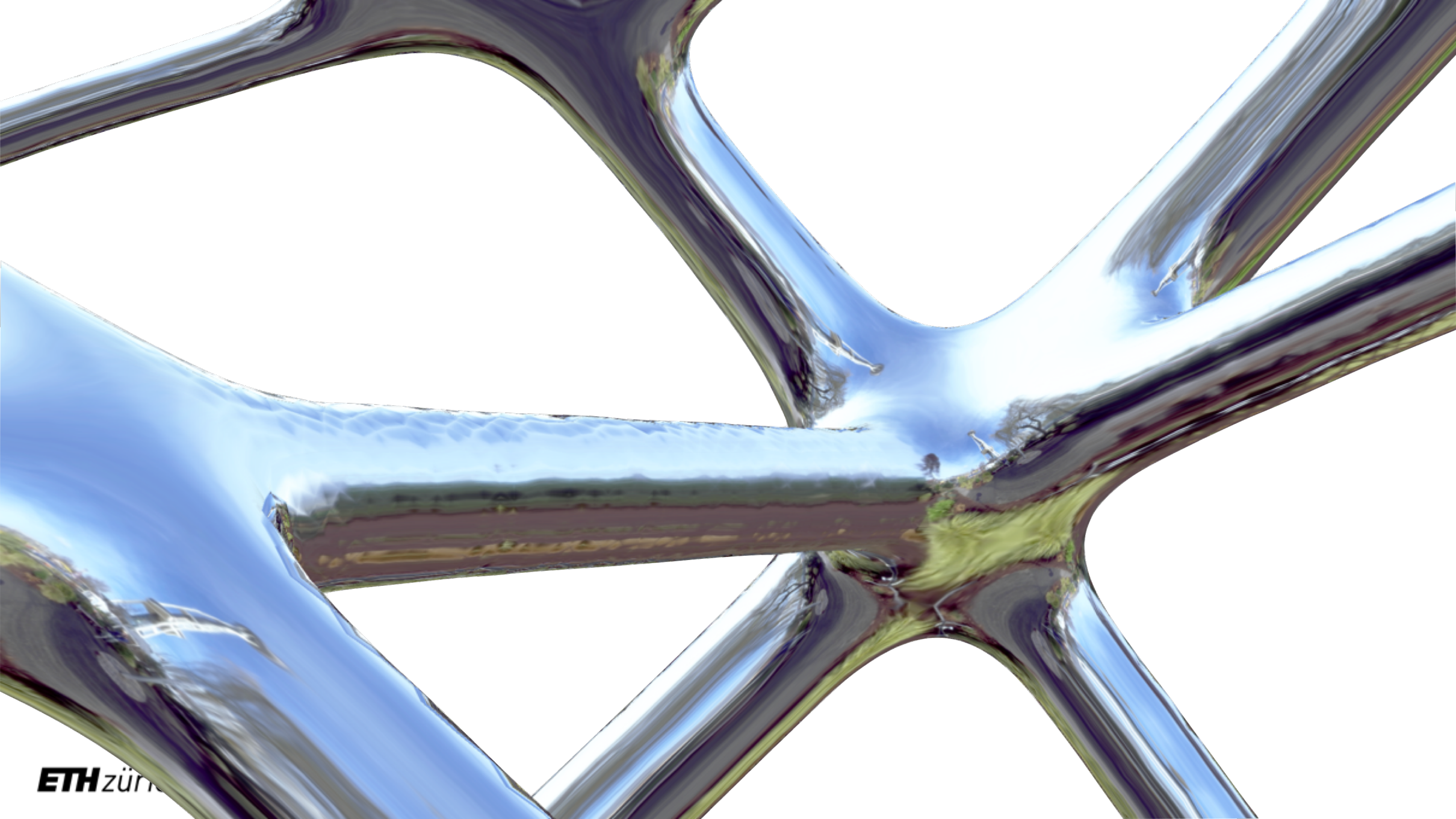
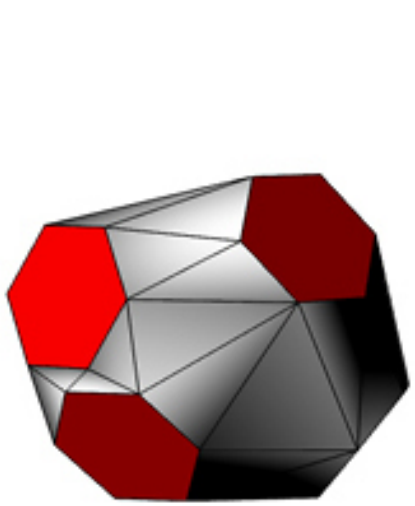
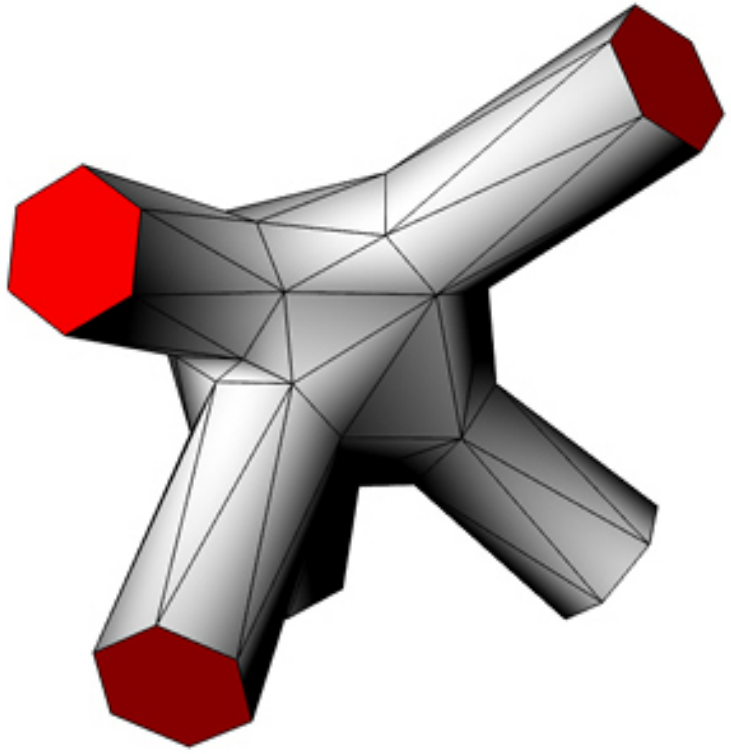
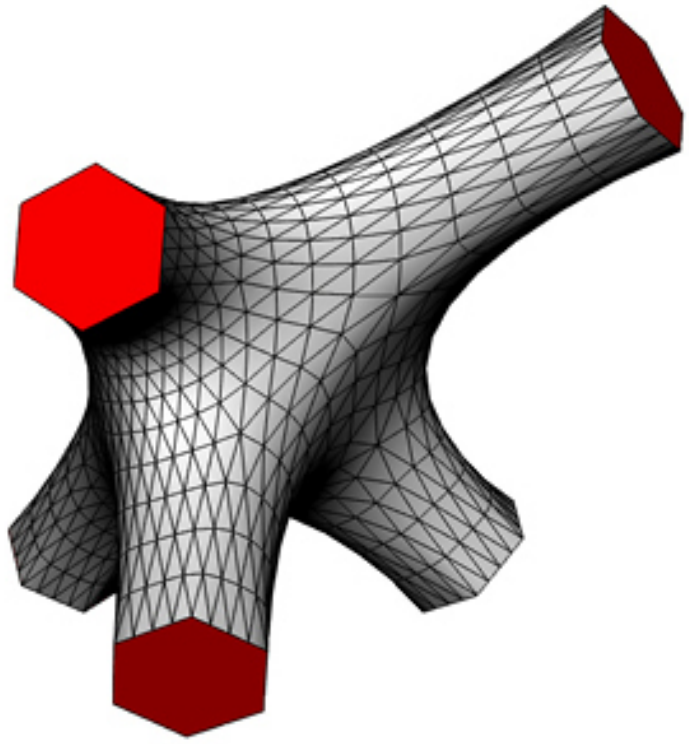
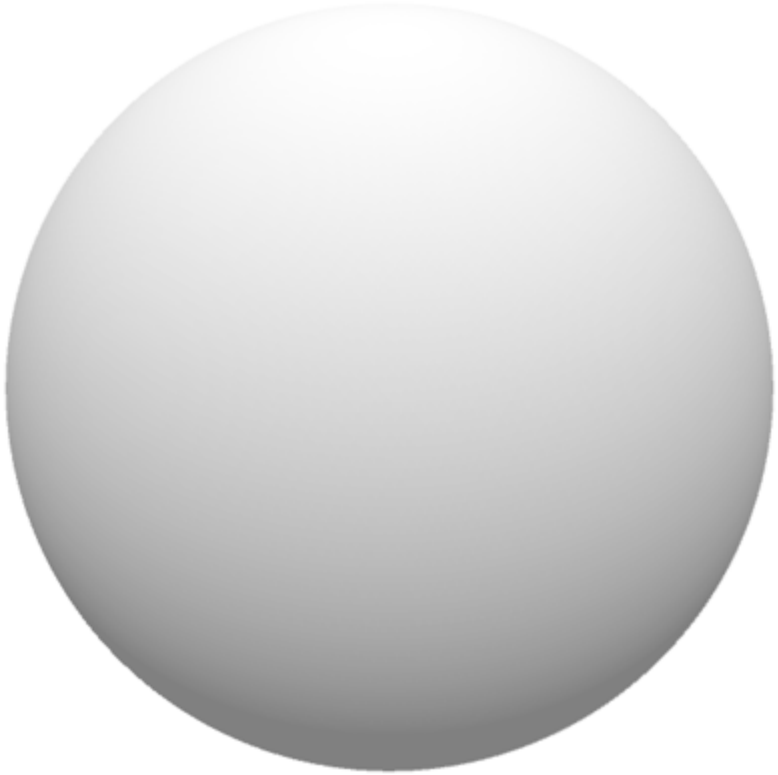


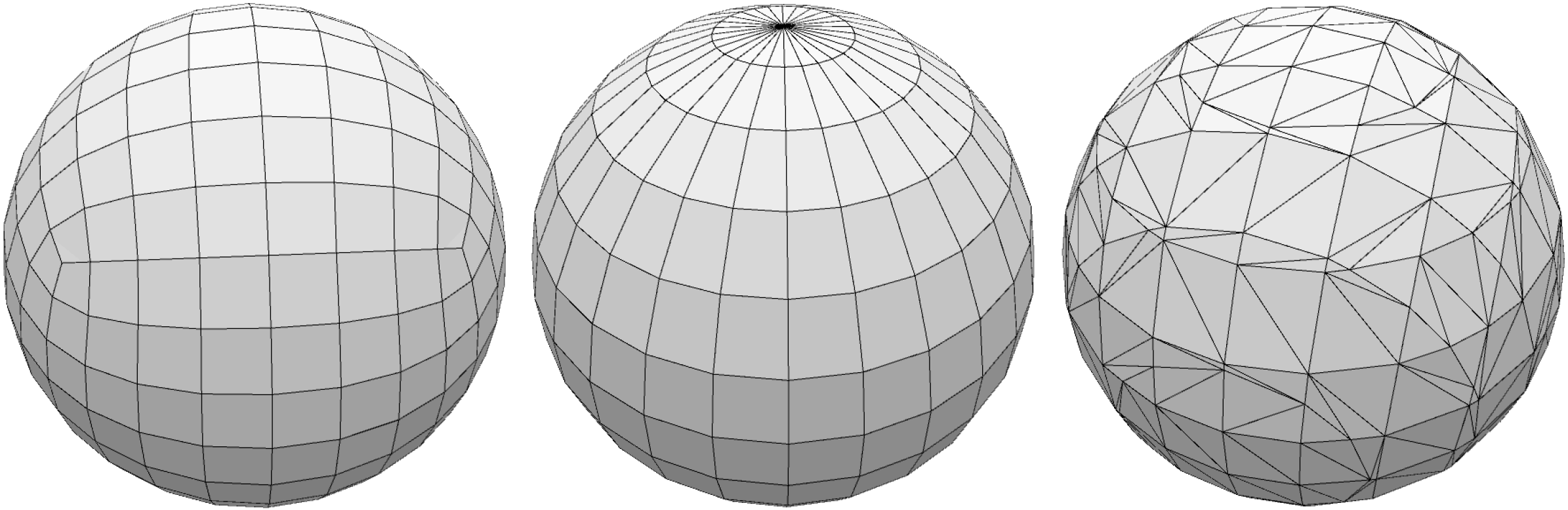
Exoskeleton



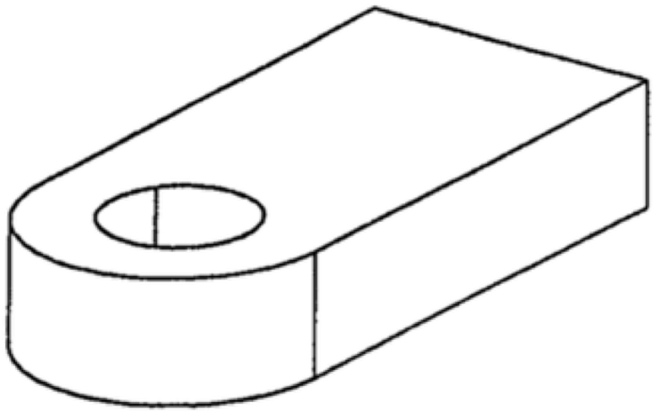


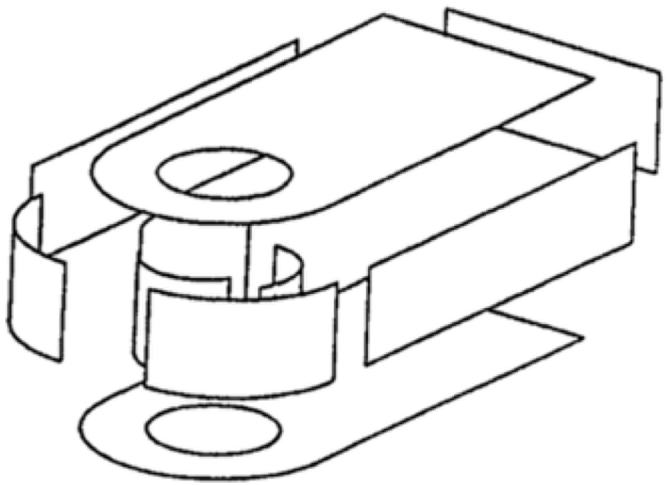


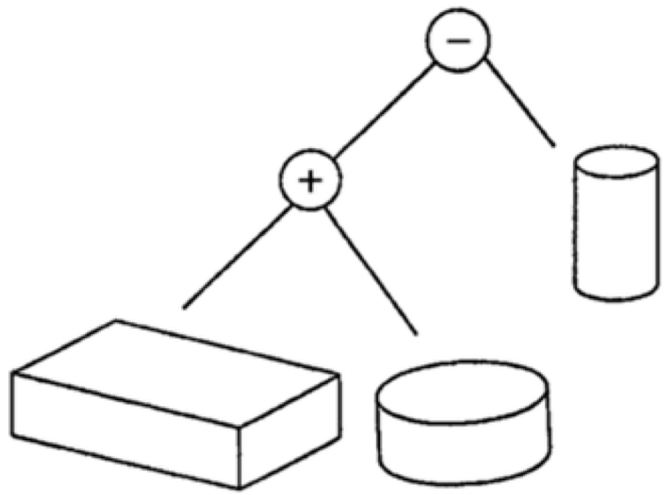




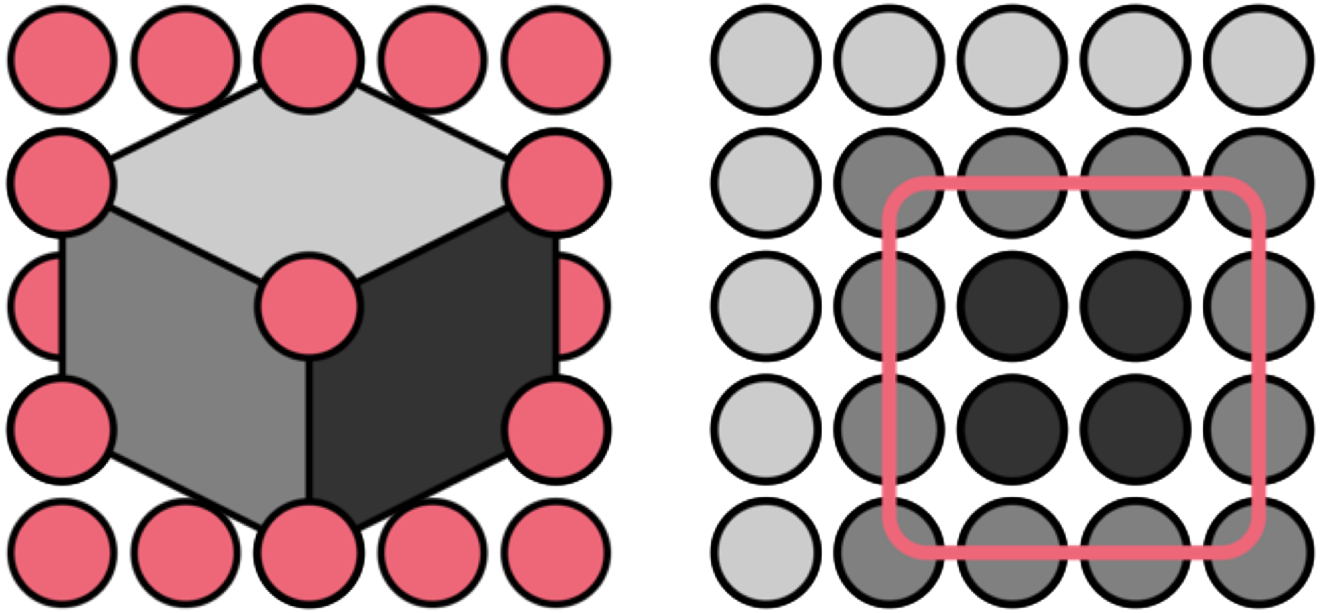
Surface versus Solid Modelling







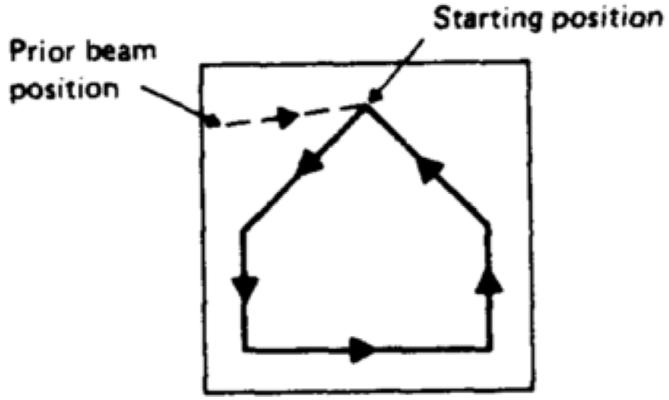
On Full and Empty Space

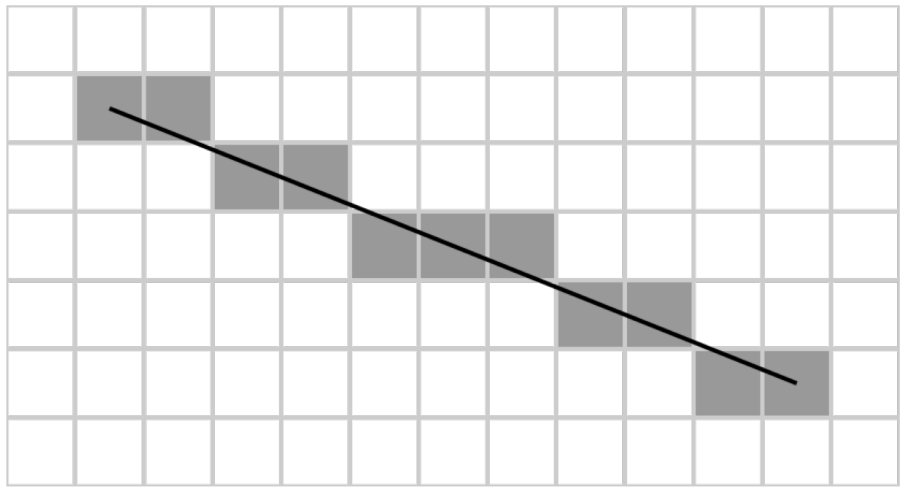


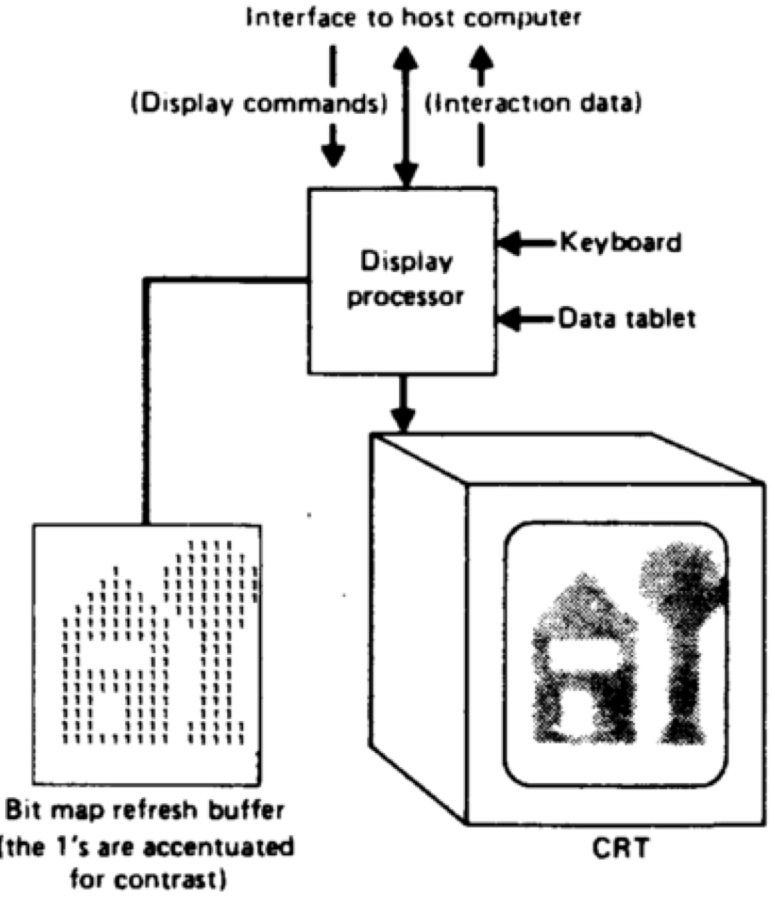
Voxels?

MagicaVoxel

Display Technology

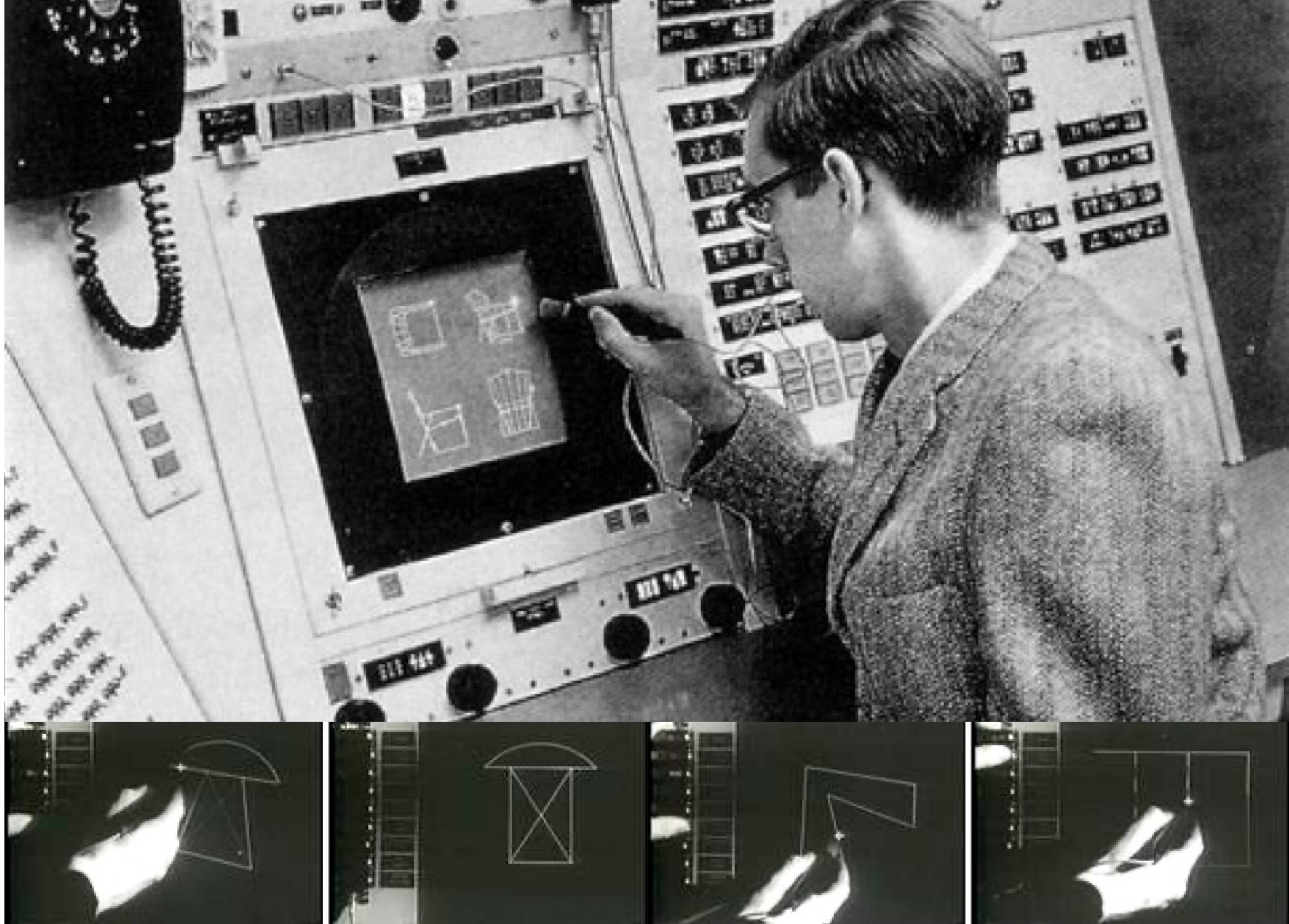






Andries van Dam, 1983
An Overview of Interactive Computer Graphics

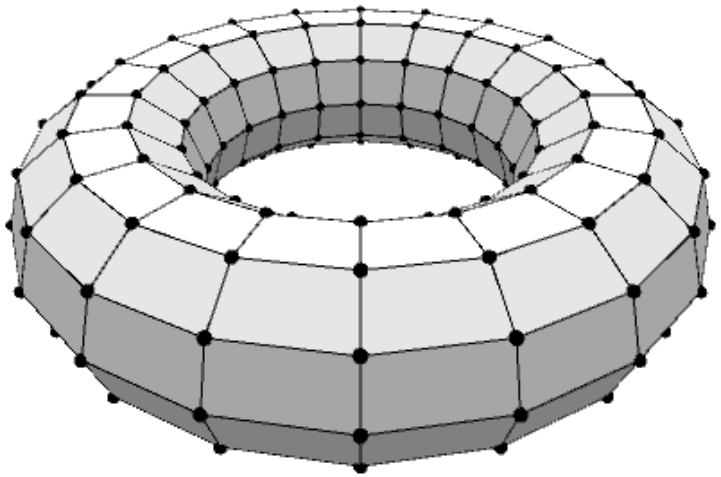
Cathode Ray Tubes

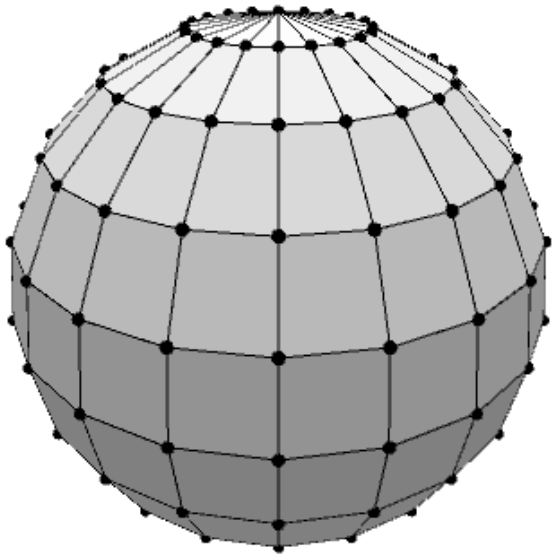


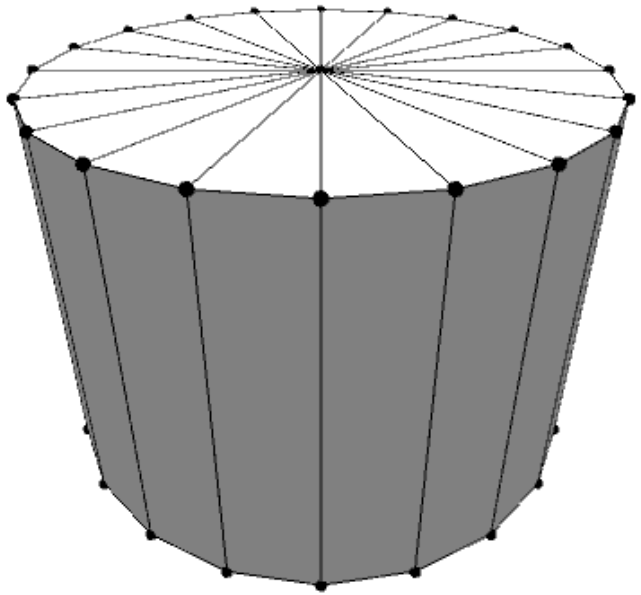
Ivan Sutherland, 1963
Sketchpad

Pixillation

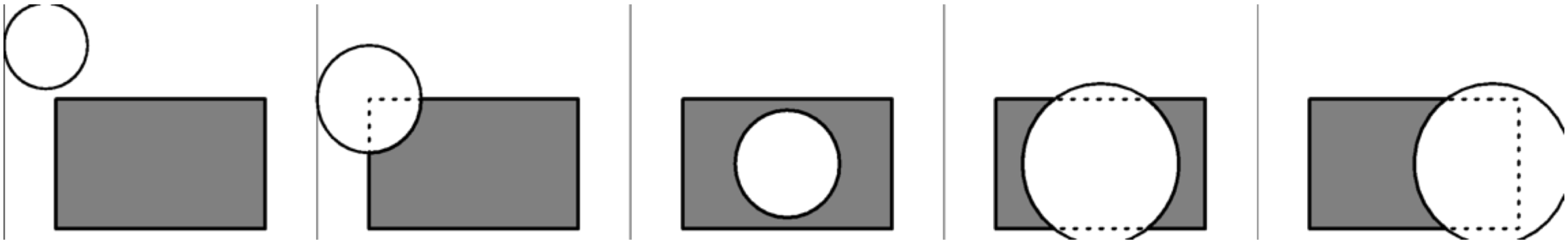
Pixillation
Lillian F. Schwartz, 1970



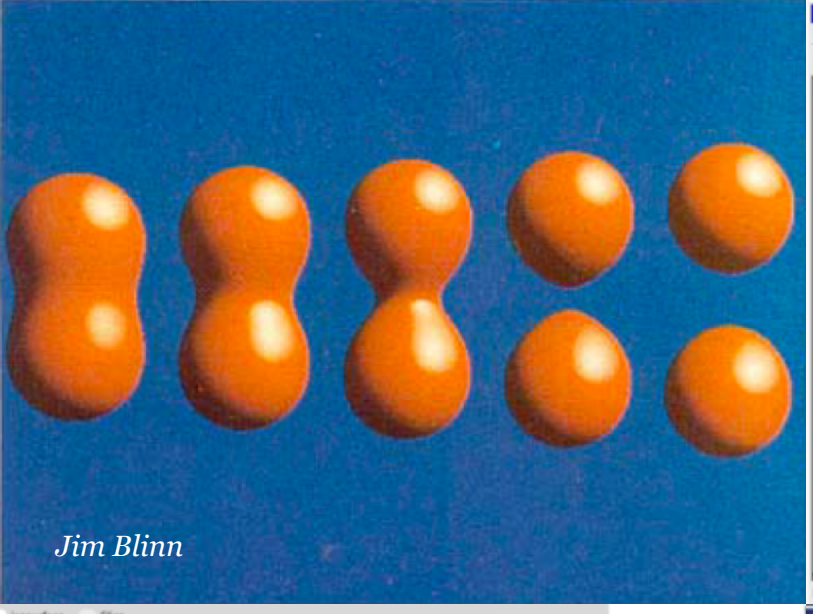




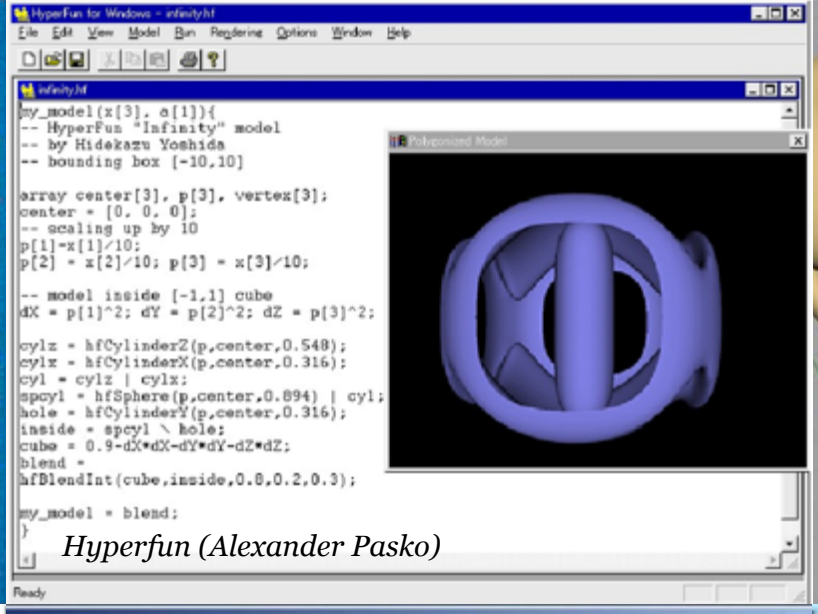
Boolean Operations



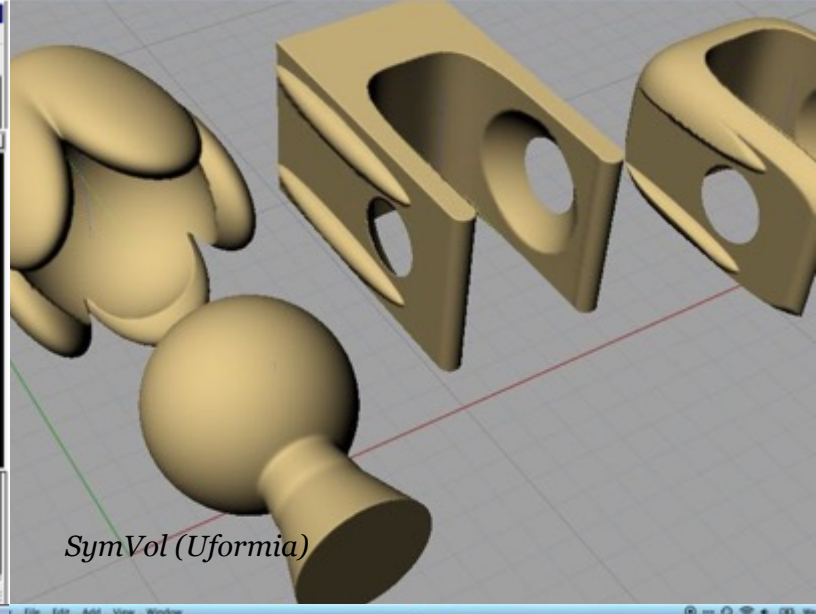
https://wiki.mcneel.com/rhino/booleanfaq
https://wiki.mcneel.com/rhino/jbbooleanfix



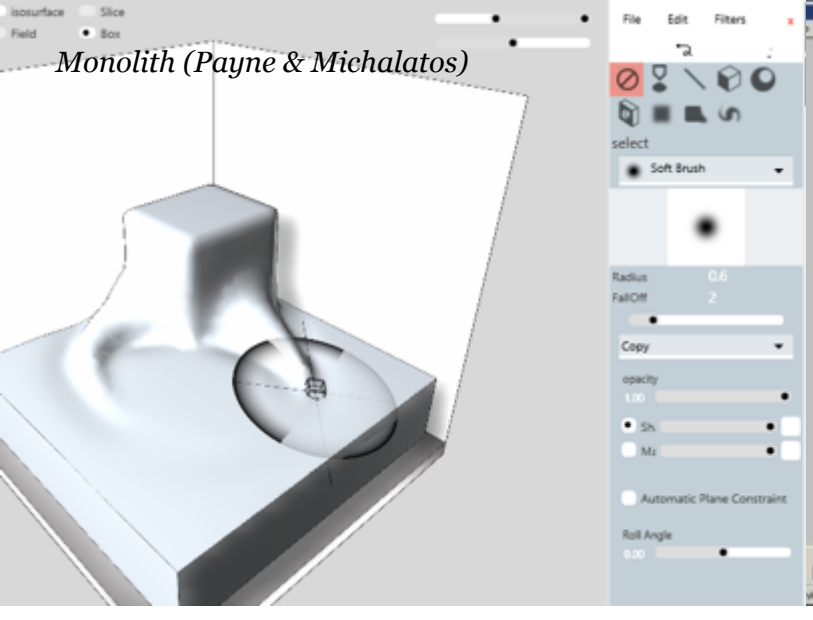
Jim Blinn



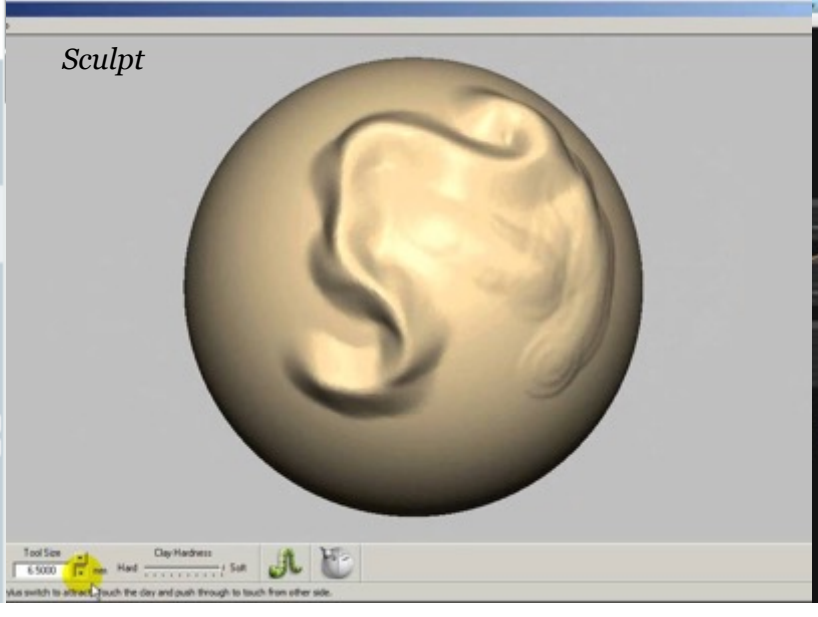
Hyperfun (Alexander Pasko)



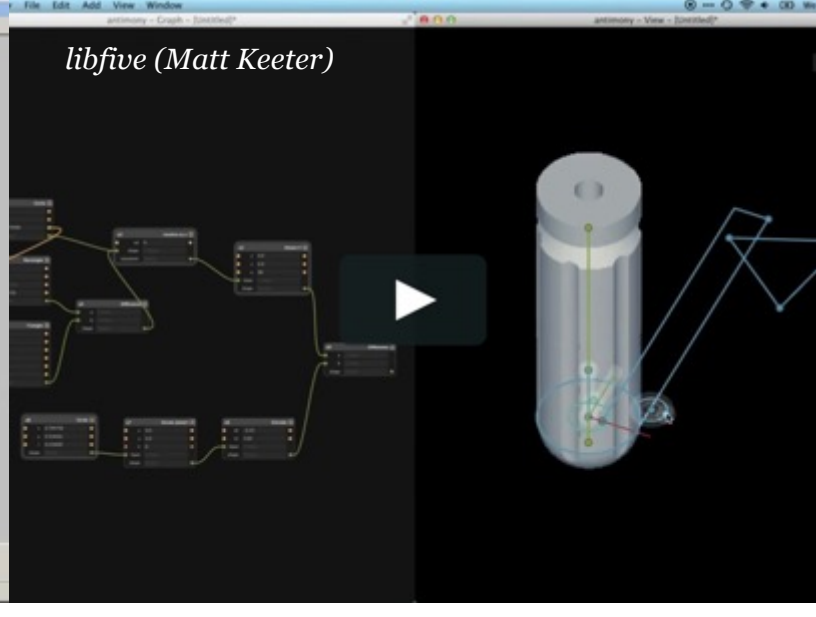
SymVol (Uformia)



Monolith (Payne & Michalatos)



Sculpt



libfive (Matt Keeter)

Signed Distance Functions (SDF)

$f(x,y) = \sqrt{((cx-x)^2+(cy-y)^2)}-r$

$u(x,y) = min(f(x,y), g(x,y))$

$s1(x,y) = max(f(x,y), -g(x,y))$

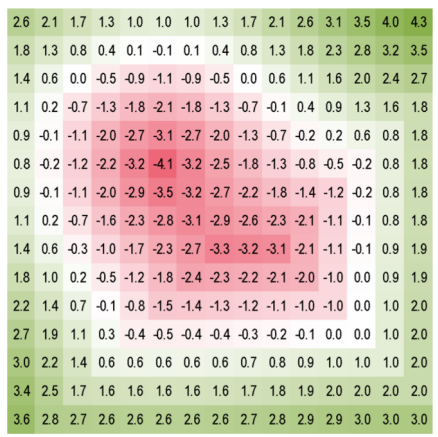
$s(x,y) = abs(u(x,y))-d/2$

$g(x,y) = max(\ abs(cx-x)-a/2,\ abs(cy-y)-b/2)$

$i(x,y) = max(f(x,y), g(x,y))$

$s2(x,y) = max(-f(x,y), g(x,y))$

$b(x,y) = u(x,y) - e^2*0.25/r$
$e = max(r-abs(f(x,y)-g(x,y)),0)$



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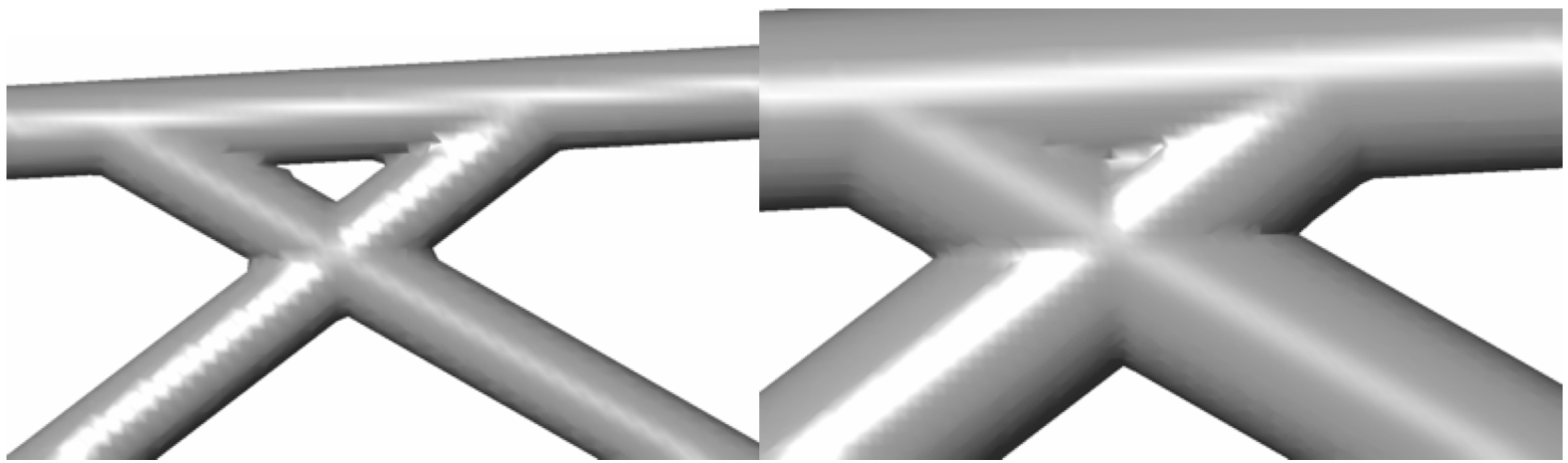
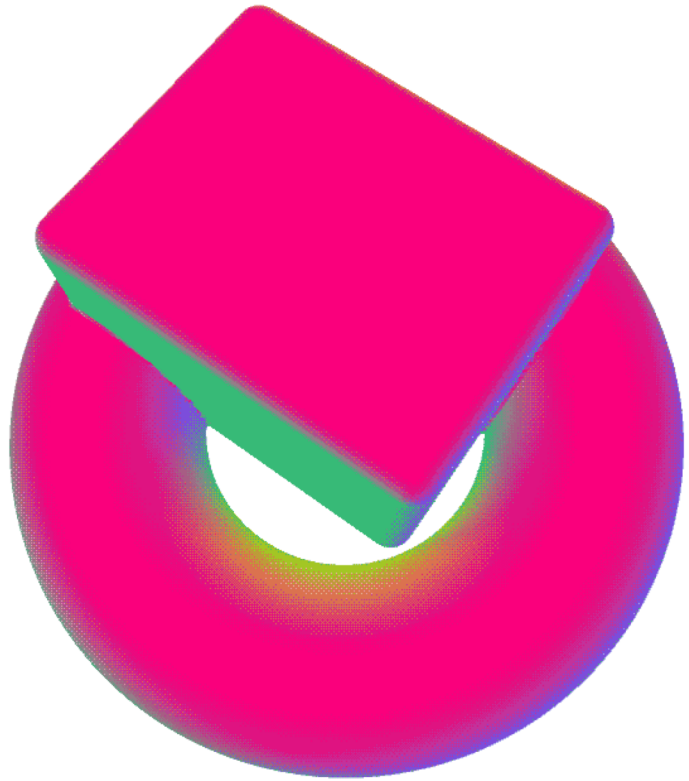
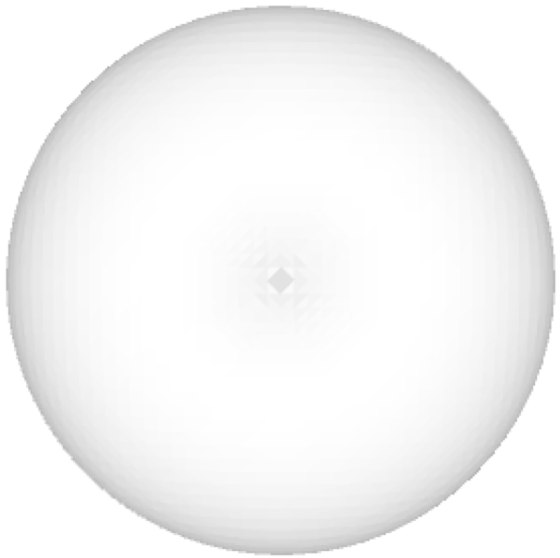
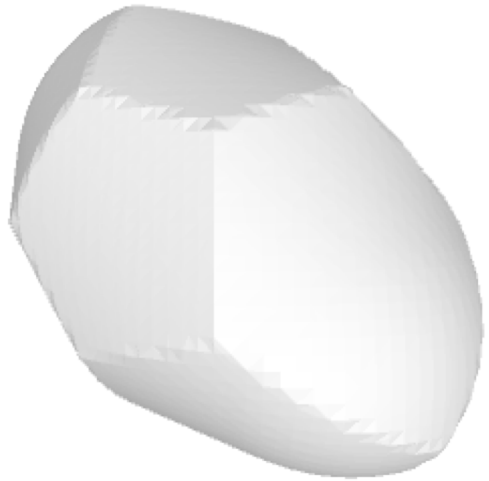
Topology



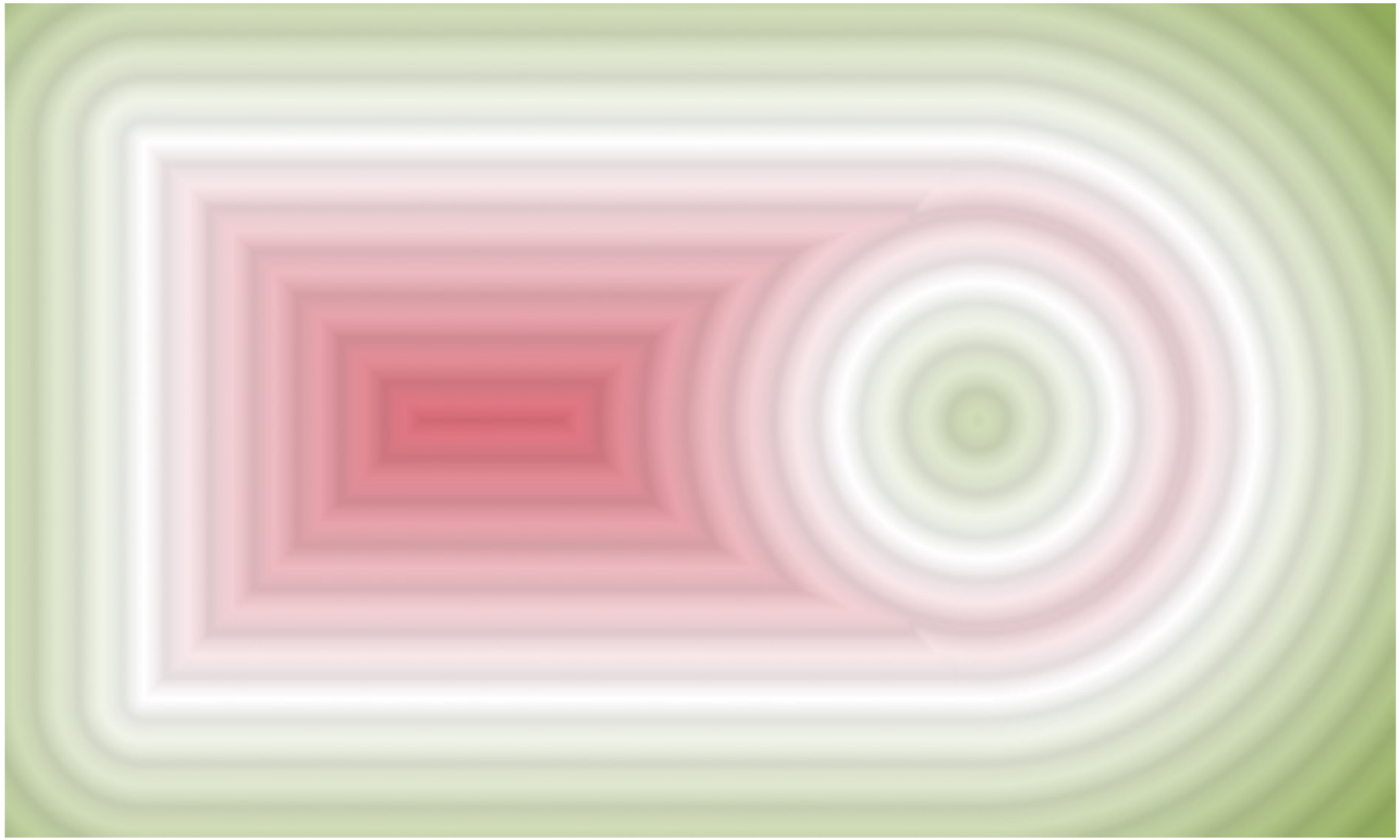


Continuous Blends



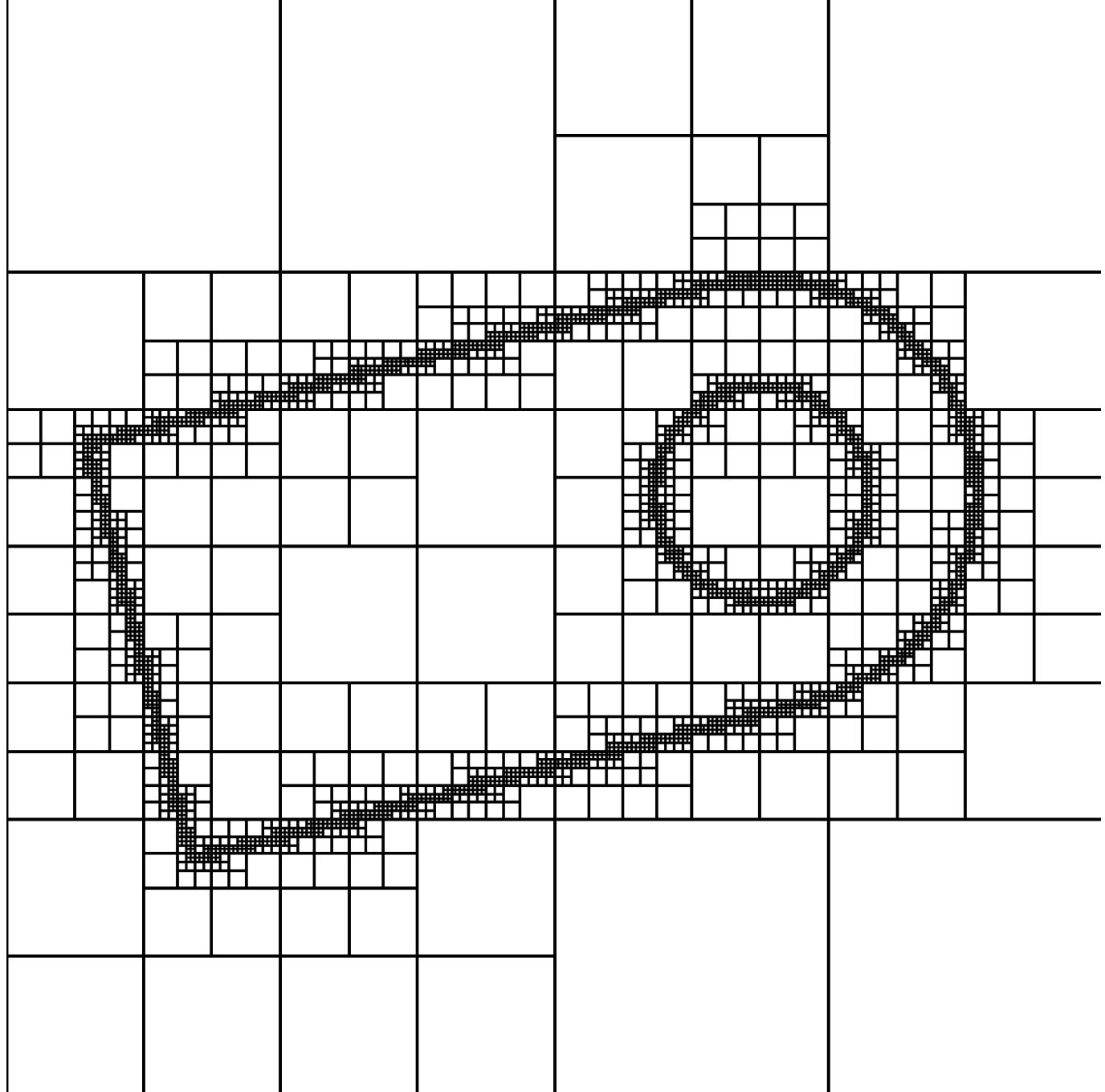


Signed
Distance
Function

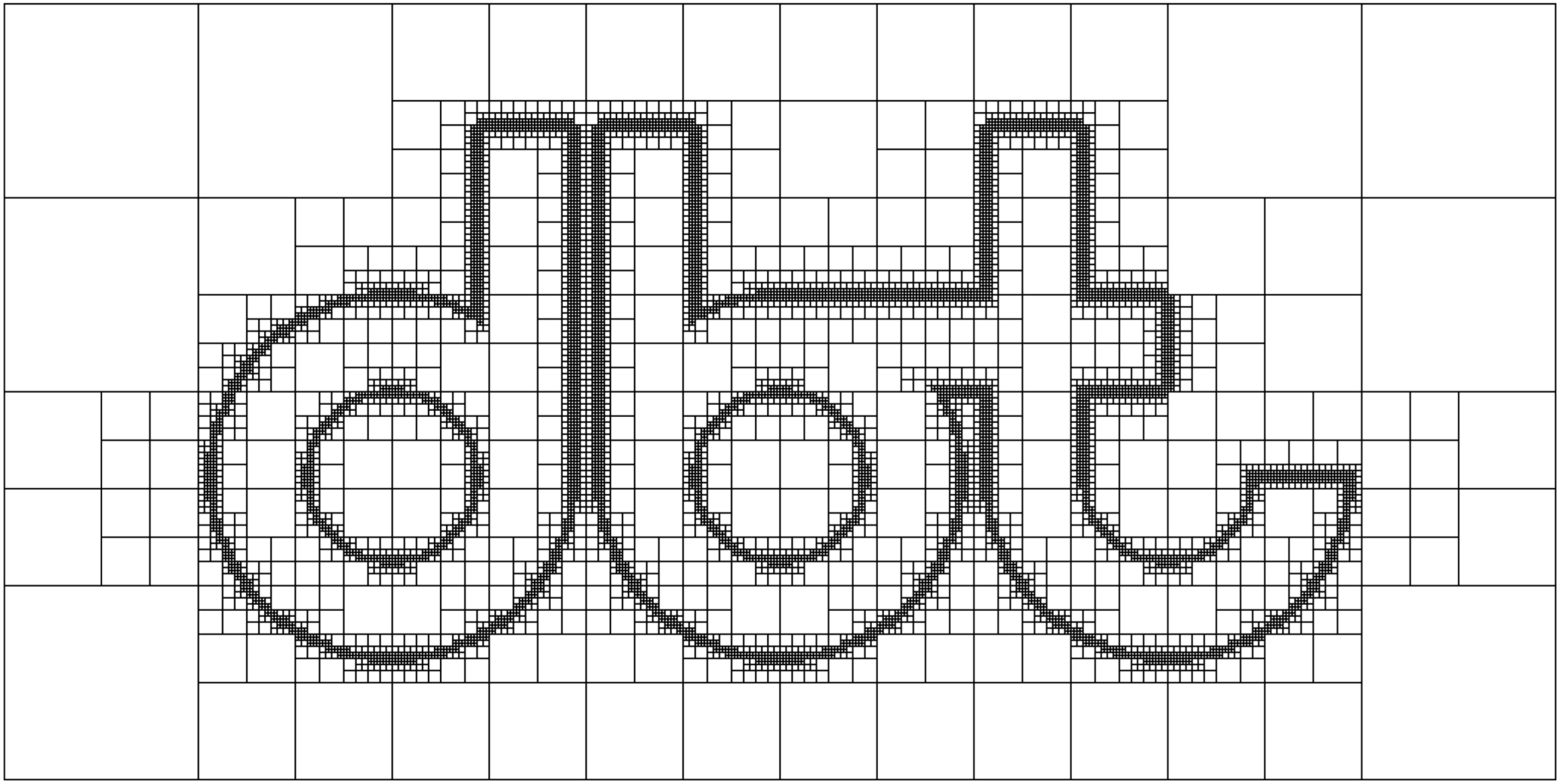



dbt

Quadtree




dbt



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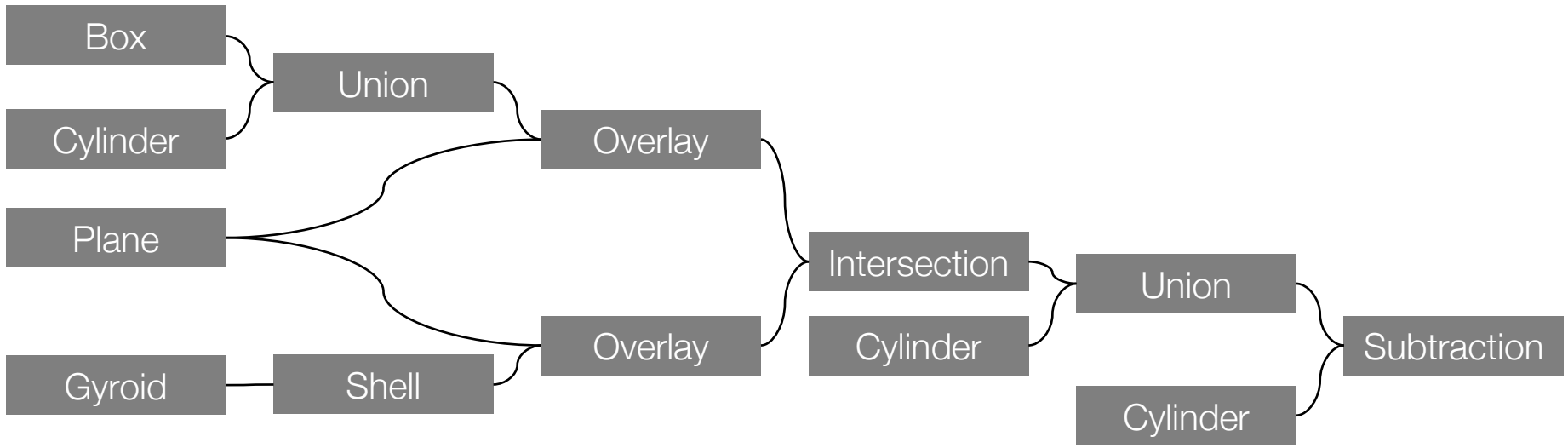
Wrench
by Frustum

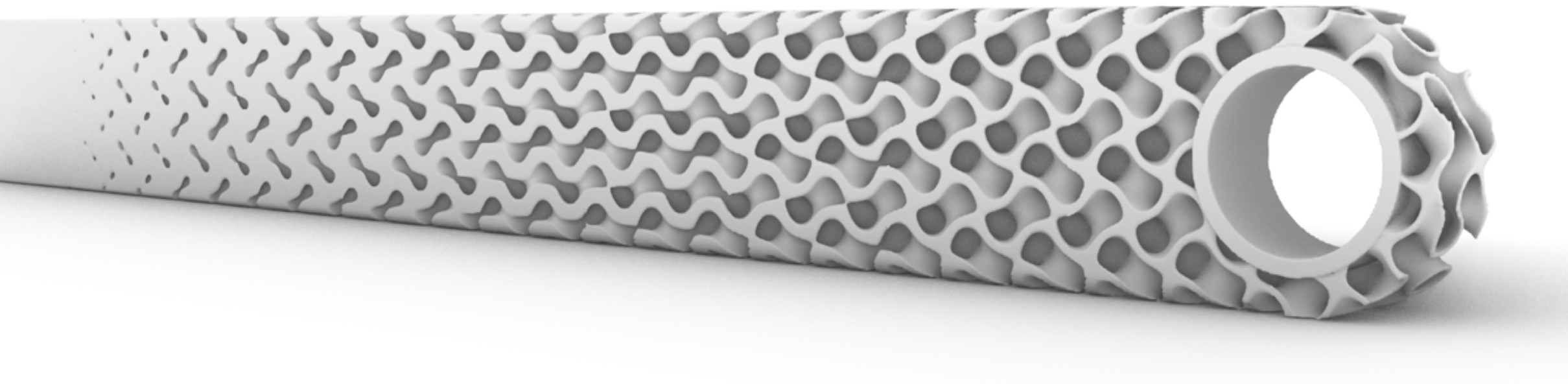
Constructive Solid Geometry Tree (CSG)



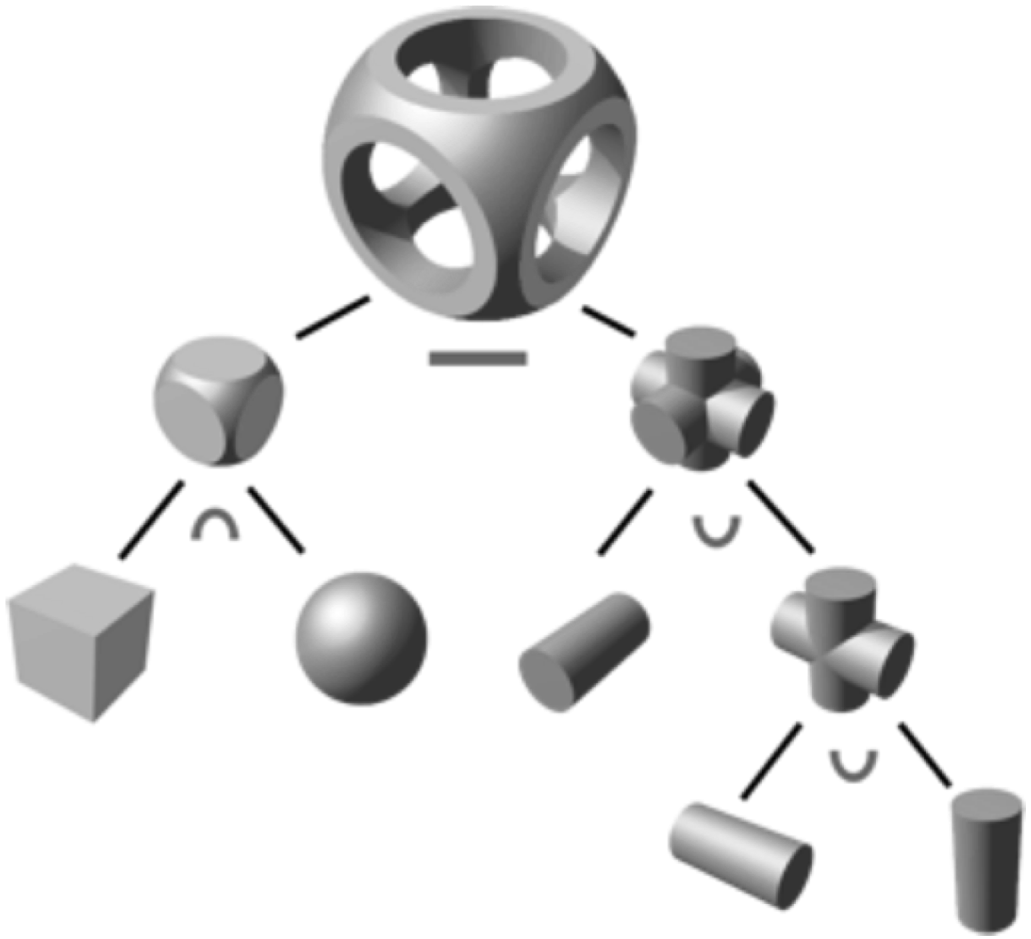
Code

```
shaft = VolBox(Box(Frame.worldXY(), 250, 30, 10), 1.5)
cyl_plane = Plane((125,0,0),(0,0,1))
roundcap = VolCylinder(Cylinder(Circle(cyl_plane, 15), 10))
handle = Union(shaft, roundcap)
gyroid = TPMS(tpmstype='Gyroid', wavelength=5.0)
shell = Shell(gyroid, 2.0, 0.5)
ol_plane = VolPlane(Plane((0,0,0), (1,0,0)))
thicken_tpms = Overlay(shell, ol_plane, 0.005)
taper = Overlay(handle, ol_plane, -0.01)
porous_handle = Intersection(thicken_tpms, taper)
solid_outer = VolCylinder(Cylinder(Circle(cyl_plane, 12), 13))
void_inner = VolCylinder(Cylinder(Circle(cyl_plane, 10), 20))
hole_reinforce = Union(porous_handle, solid_outer)
wrench = Subtraction(hole_reinforce, void_inner)
```

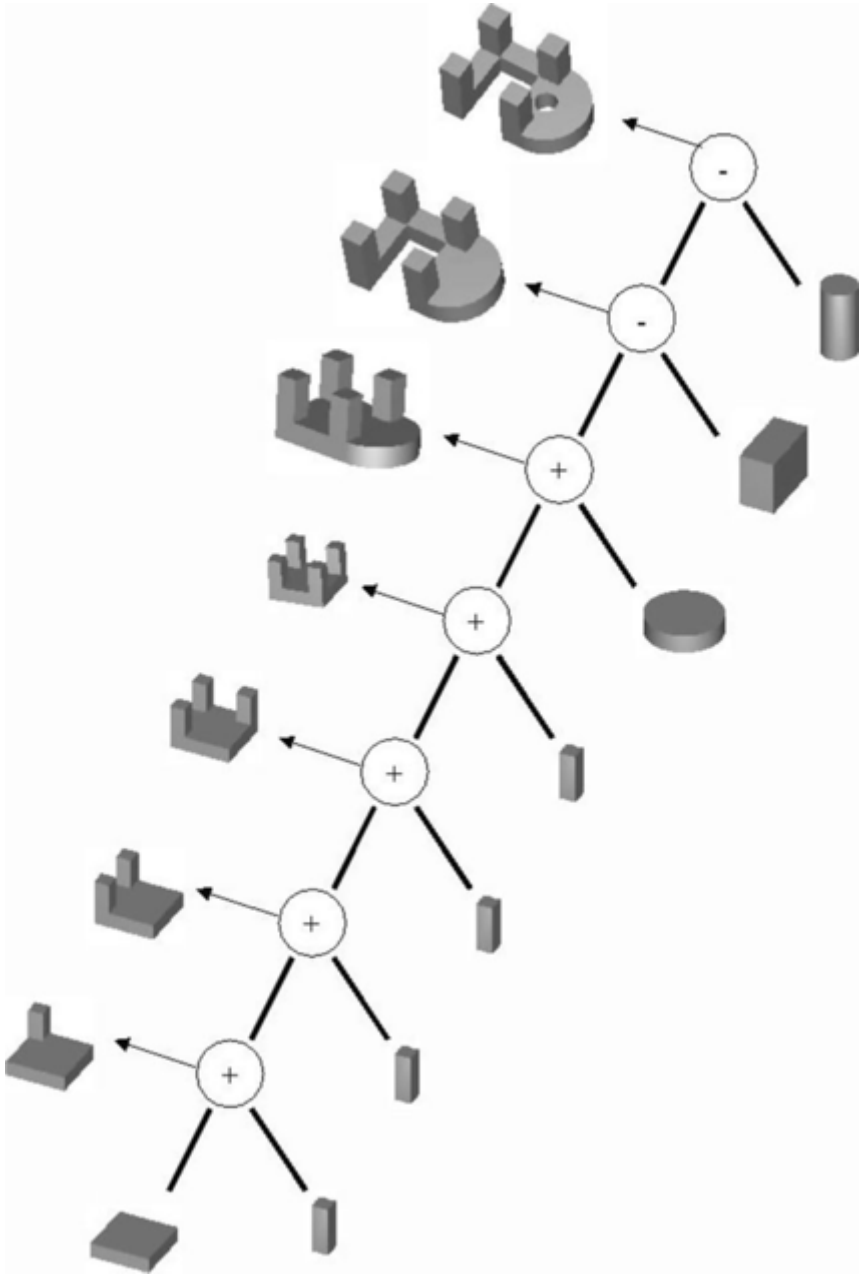
Wrench in
compas_vol

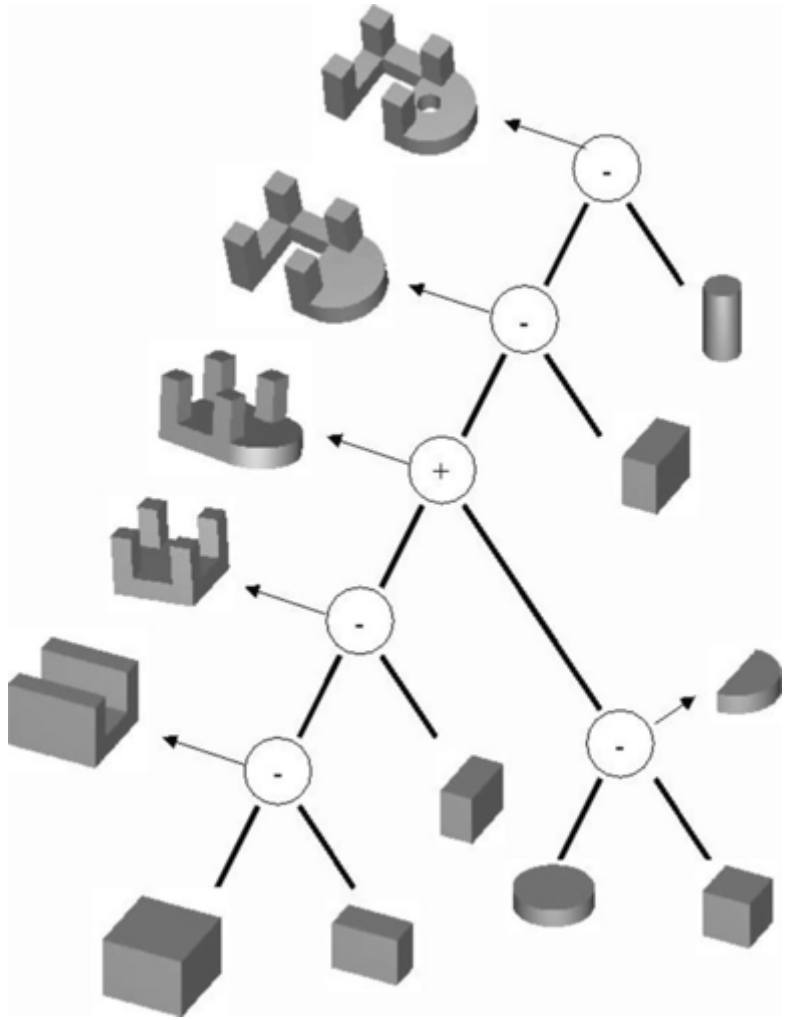


Constructive Solid Geometry (CSG)



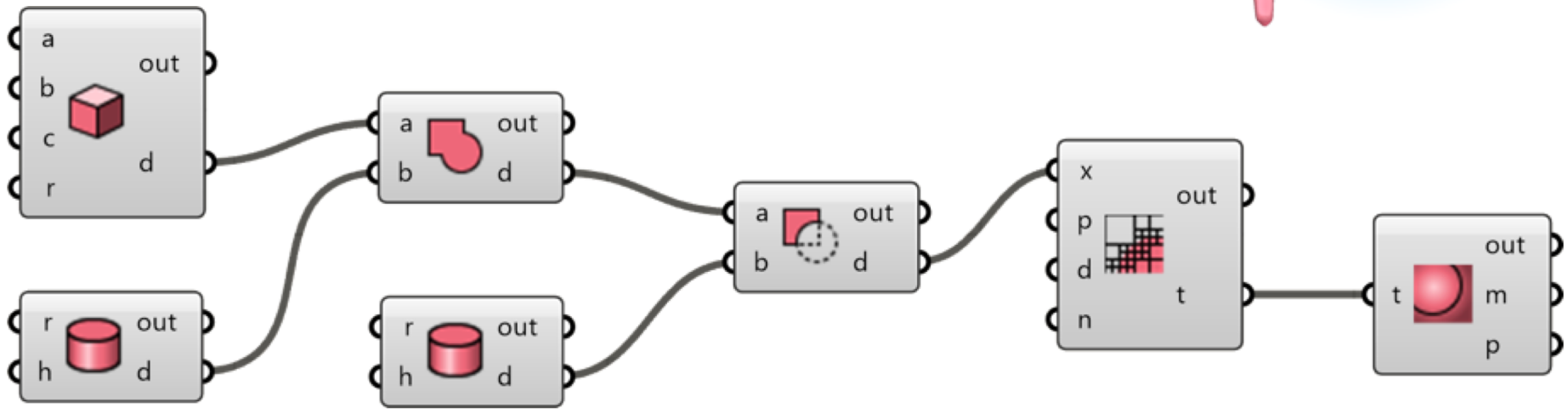
Tree Balancing





Axolotl

food4rhino.com/app/axolotl

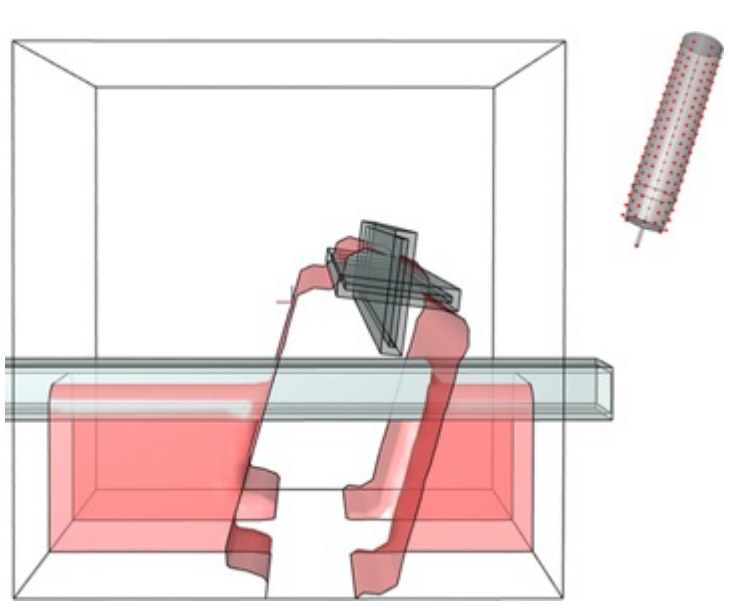


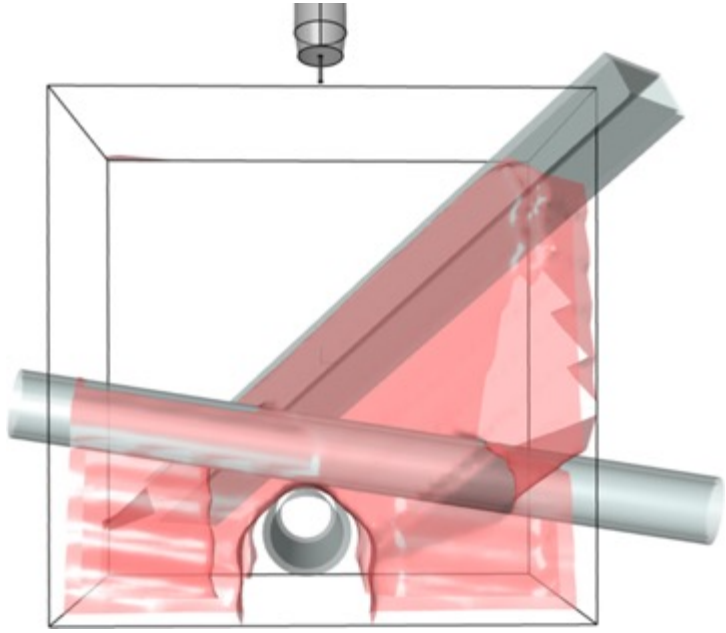
CSG tree

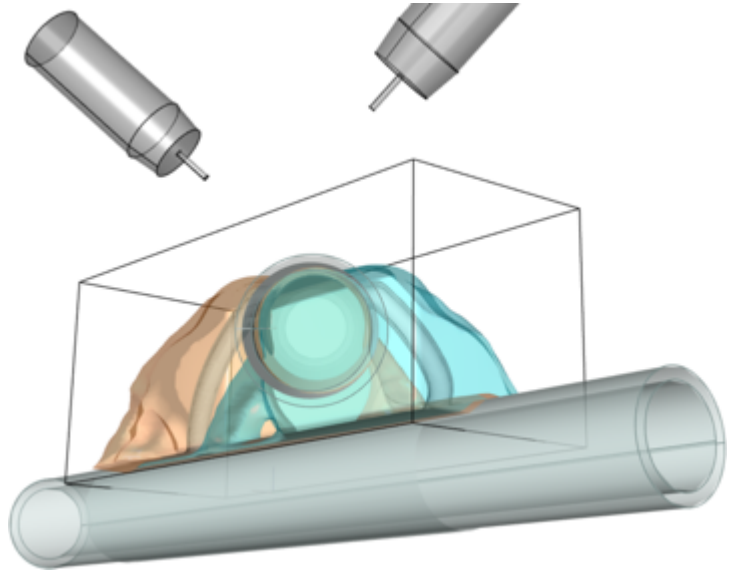
Octree

Isosurface

Numerical Sculpting







Mitropoulou, Ioanna, Inés Ariza, Mathias Bernhard, Benjamin Dillenburger, Fabio Gramazio, and Matthias Kohler. 2019. "Numerical Sculpting - Volumetric Modelling Tools for in Place Spatial Additive Manufacturing." In DMSB - Impact: Design with All Senses. Springer.