Building Interactive Devices and Objects

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Today

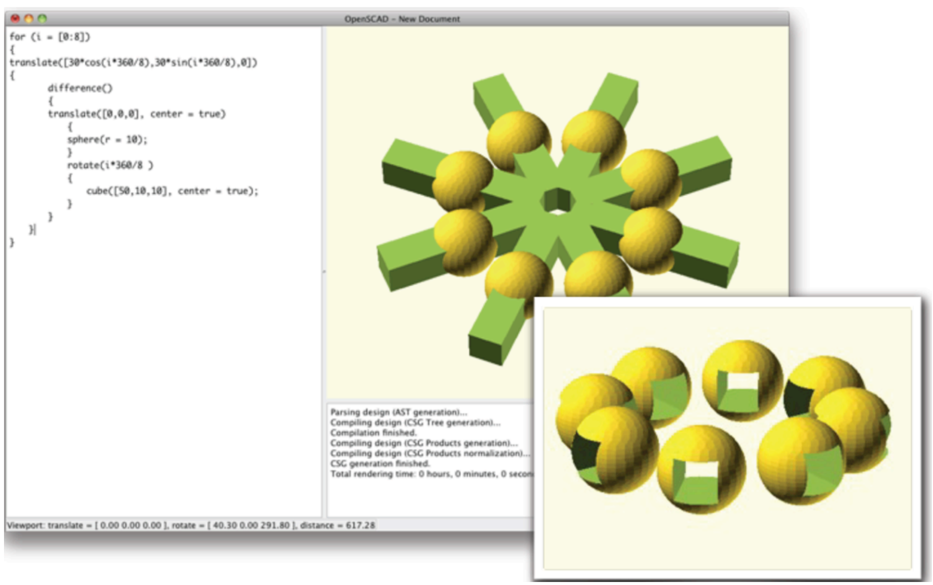
- OpenSCAD
- Laser cutter
- Milling machine
- 3D printer

Schedule

#	Date	Topic	Group Activity
1	19.4.2012	Session 1: Introduction	Team building
2	26.4.2012	Session 2: Microcontrollers & Electronics	
3	3.5.2012	Session 3: Sensors	Concept development
4	10.5.2012	CHI	Concept development
5	17.5.2012	Christi Himmelfahrt	Concept development
6	24.5.2012	Session 4: Actuators	Concept presentation, Hardware requ.
7	31.5.2012	Session 5: Physical Objects (Sven)	
8	7.6.2012	Frohnleichnam	Project
9	14.6.2012		Project
10	21.6.2012		Project
11	28.6.2012		Project
12	5.7.2012		Project
13	12.7.2012		Evaluation
14	19.7.2012		Evaluation, Presentation

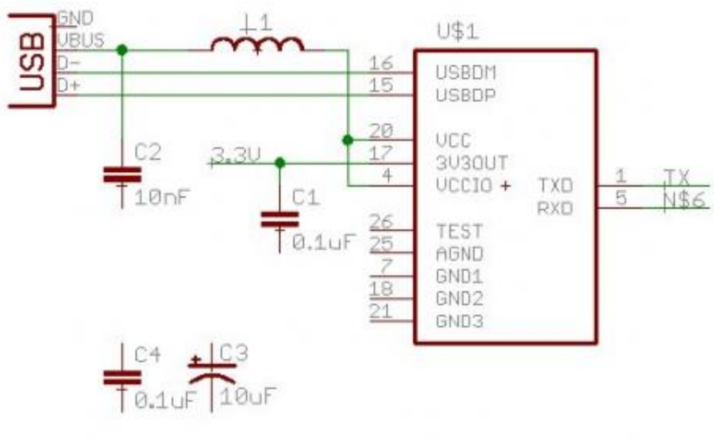
Session 5: Physical Objects

- Building physical objects: 3D printing, modeling with OpenSCAD, later cutter usage, introduction to workshop
- Exercises
  1. Model a simple object and laser-cut it
  2. Create detailed list of additional hardware to order

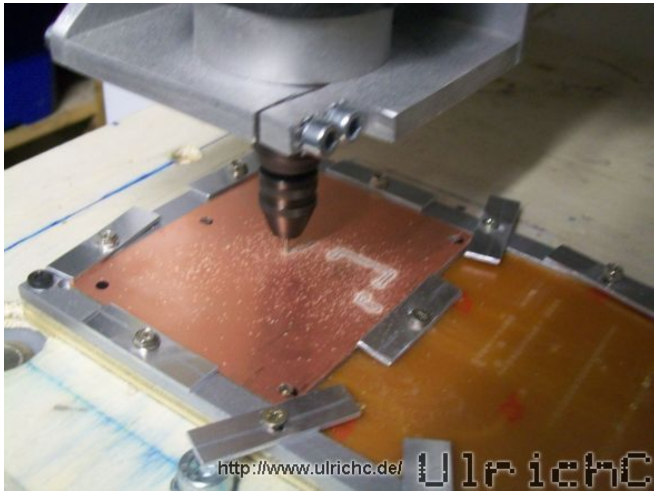


CAD und CAM

- CAD: **C**omputer-**A**ided **D**esign
  - Erstellung eines Objektes auf einer hohen Abstraktionsebene
  - Z.B. Schaltplan, Platinenlayout
  - Automatisierte Designhilfen,z.B. Auto-Router



- CAM
  - Detaillierte Anweisungen für Fertigungsmaschinen
  - Ätzen, Fräsen, 3D Druck
  - Meistens **Open-Loop**: Maschine arbeitet Befehlssequenz ab
  - “Intelligenz” in der CAM-Anwendung



Vorteile CAD und CAM

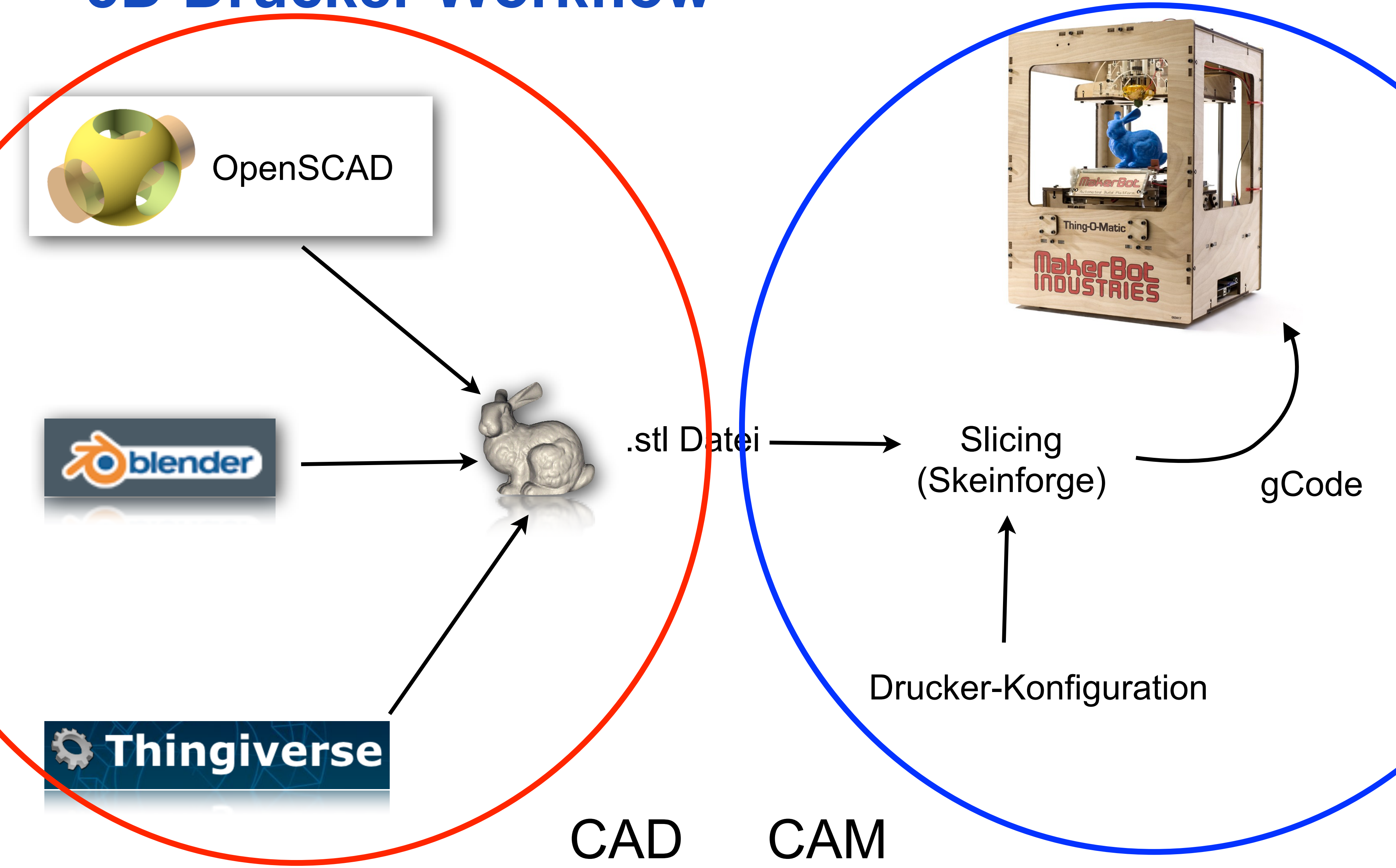
- CAD
  - Parametrisierbarkeit
  - Wiederverwendbarkeit
  - Besserer Überblick durch Abstraktion

- CAM
  - Maschine muss nicht mehr handgesteuert werden
  - Komplexe Strukturen möglich
  - Schritt “from bits to atoms”

Mit CAD und CAM wird rapid prototyping von physikalischen Objekten möglich.

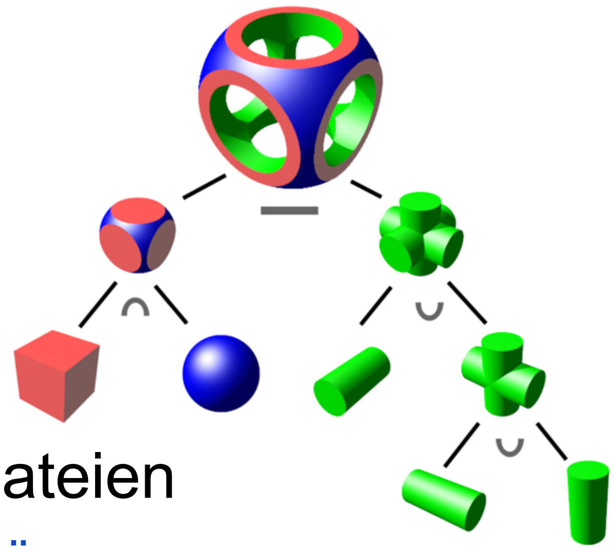
OPENSCAD

3D Drucker Workflow



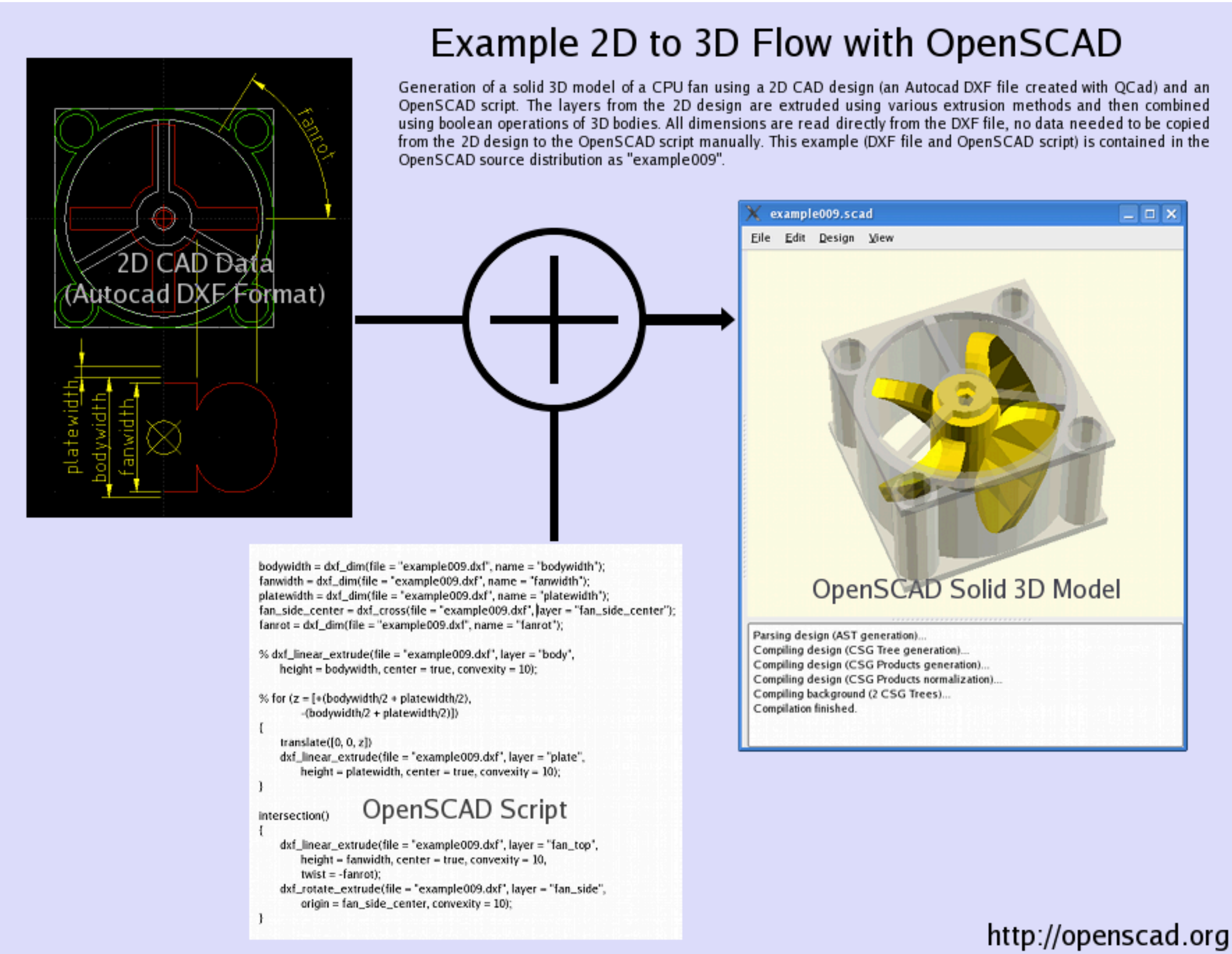
OpenSCAD

- Programmatische Erzeugung von 3D Modellen
- Basierend auf primitiven 3D Objekten, sowie Extrusionen von 2D-Formen
- Konstruktion der Modelle durch Operationen der **Constructive Solid Geometry (CSG)**
  - **Vereinigung**
  - **Differenz**
  - **Schnitt**



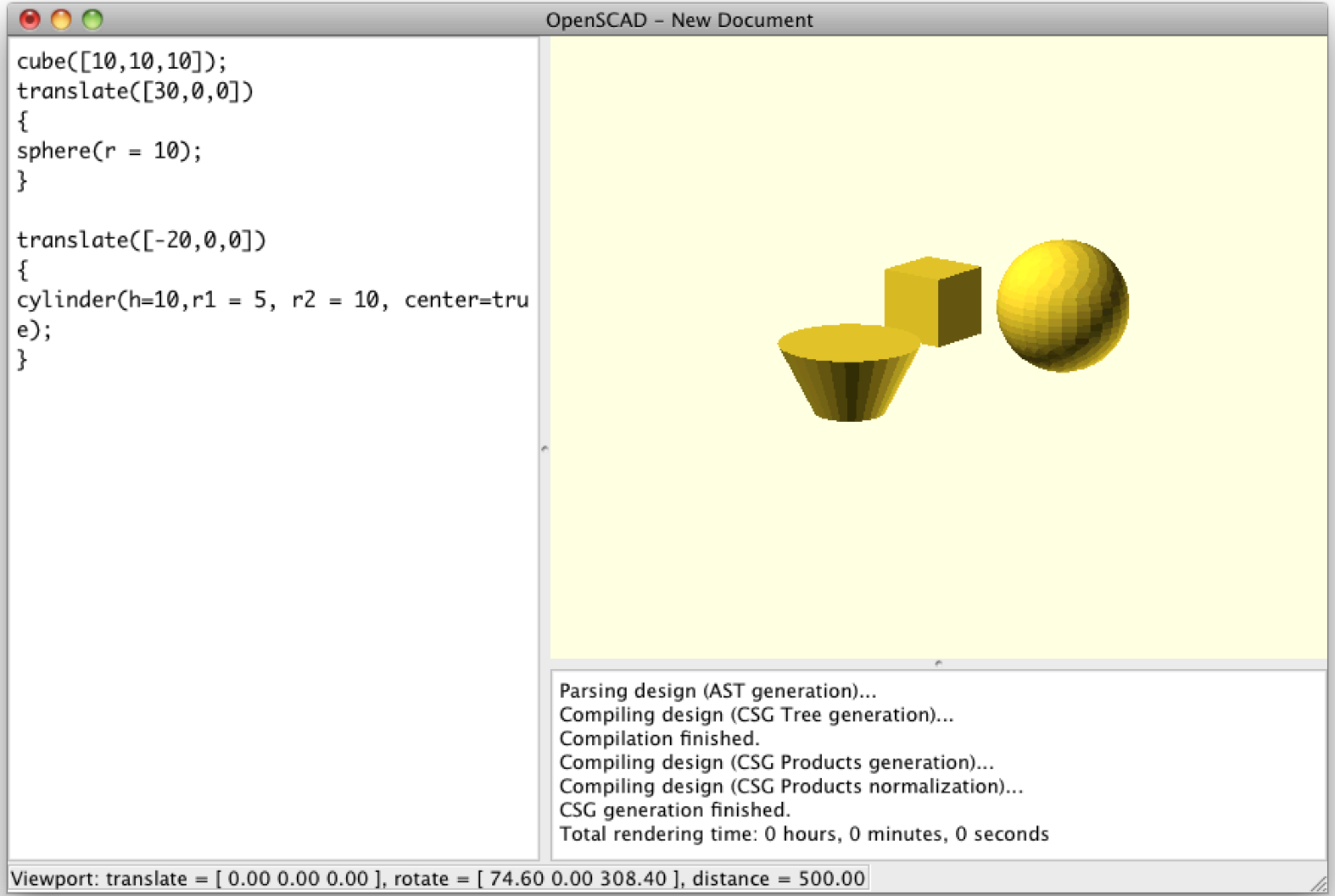
- Ausgabe von “wasserdichten” Mesh-Dateien
  - Verwendung am 3D Drucker oder CNC-Fräse

OpenSCAD

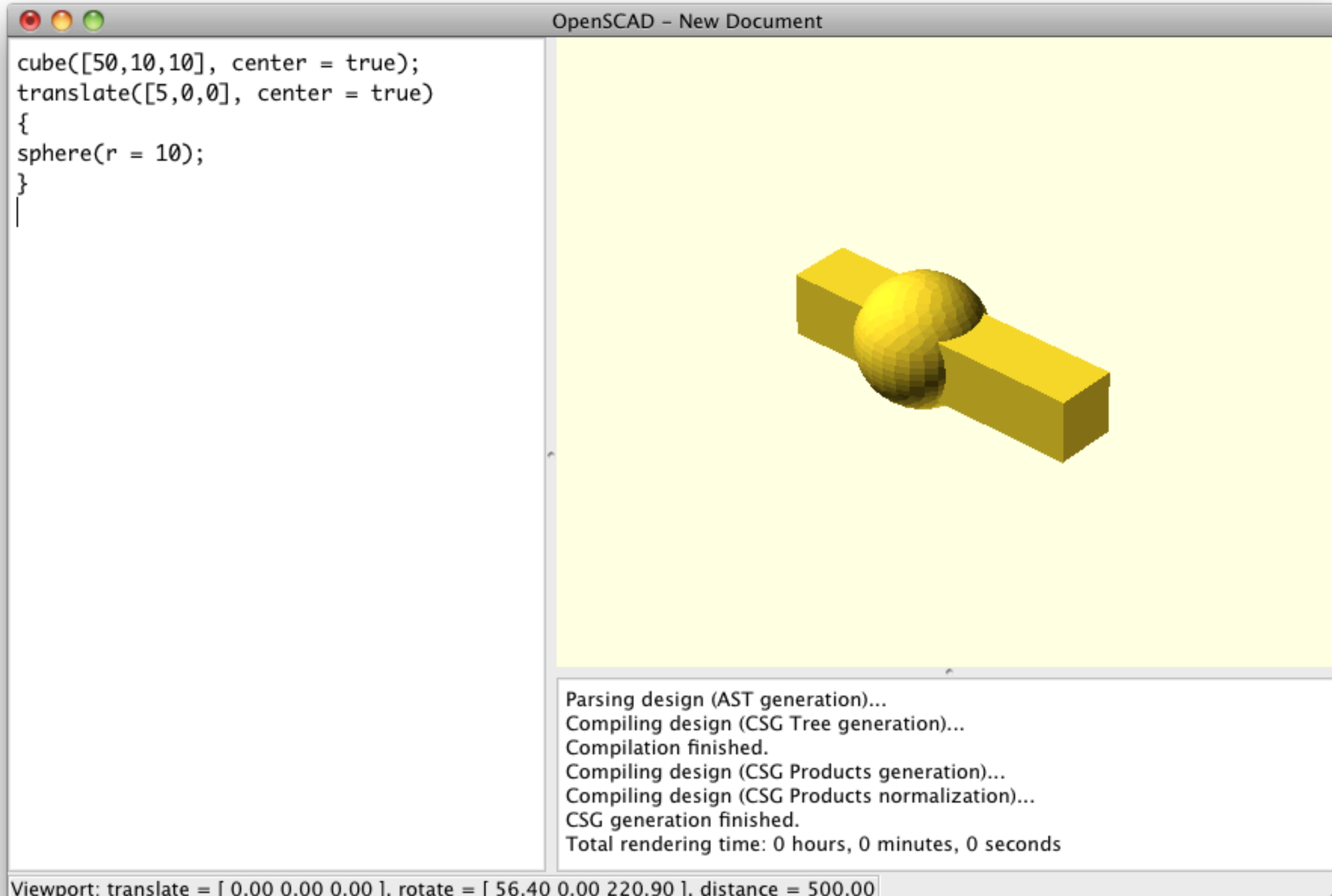


Example 2D to 3D Flow with OpenSCAD
Generation of a solid 3D model of a CPU fan using a 2D CAD design (an Autocad DXF file created with QCad) and an OpenSCAD script. The layers from the 2D design are extruded using various extrusion methods and then combined using boolean operations of 3D bodies. All dimensions are read directly from the DXF file, no data needed to be copied from the 2D design to the OpenSCAD script manually. This example (DXF file and OpenSCAD script) is contained in the OpenSCAD source distribution as "example009".
fanrot
2D CAD Data
(Autocad DXF Format)
platewidth
bodywidth
fanwidth
bodywidth = dxf_dim(file = "example009.dxf", name = "bodywidth");
fanwidth = dxf_dim(file = "example009.dxf", name = "fanwidth");
platewidth = dxf_dim(file = "example009.dxf", name = "platewidth");
fan_side_center = dxf_cross(file = "example009.dxf", layer = "fan_side_center");
fanrot = dxf_dim(file = "example009.dxf", name = "fanrot");
% dxf_linear_extrude(file = "example009.dxf", layer = "body",
height = bodywidth, center = true, convexity = 10);
% for (z = [+(bodywidth/2 + platewidth/2),
-(bodywidth/2 + platewidth/2)])
{
translate([0, 0, z])
dxf_linear_extrude(file = "example009.dxf", layer = "plate",
height = platewidth, center = true, convexity = 10);
}
intersection()
{
dxf_linear_extrude(file = "example009.dxf", layer = "fan_top",
height = fanwidth, center = true, convexity = 10,
twist = -fanrot);
dxf_rotate_extrude(file = "example009.dxf", layer = "fan_side",
origin = fan_side_center, convexity = 10);
}
OpenSCAD Script
example009.scad
File Edit Design View
OpenSCAD Solid 3D Model
Parsing design (AST generation)...
Compiling design (CSG Tree generation)...
Compiling design (CSG Products generation)...
Compiling design (CSG Products normalization)...
Compiling background (2 CSG Trees)...
Compilation finished.
http://openscad.org

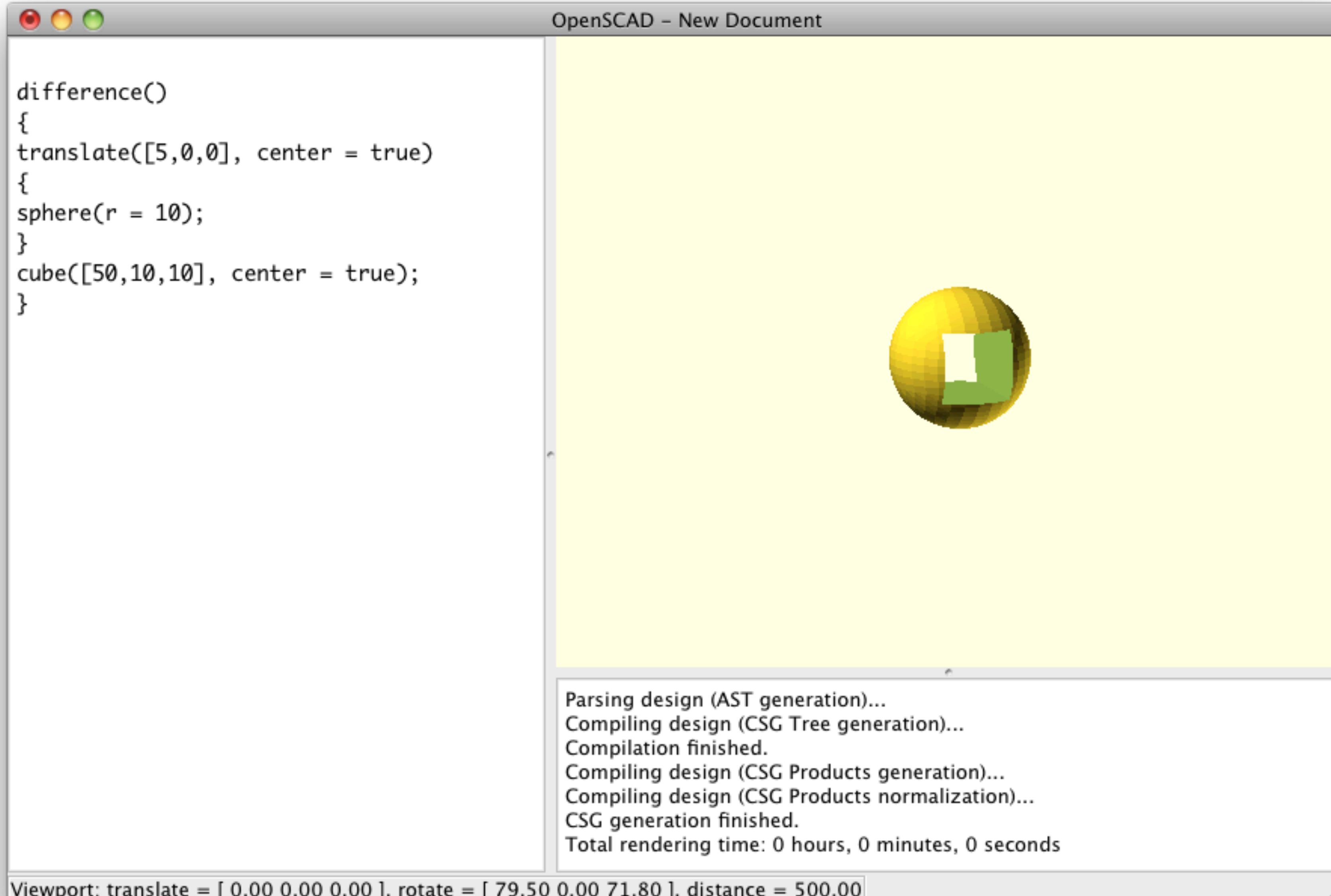
Primitive


OpenSCAD – New Document
cube([10,10,10]);
translate([30,0,0])
{
sphere(r = 10);
}
translate([-20,0,0])
{
cylinder(h=10,r1 = 5, r2 = 10, center=tru
e);
}
Parsing design (AST generation)...
Compiling design (CSG Tree generation)...
Compilation finished.
Compiling design (CSG Products generation)...
Compiling design (CSG Products normalization)...
CSG generation finished.
Total rendering time: 0 hours, 0 minutes, 0 seconds
Viewport: translate = [0.00 0.00 0.00], rotate = [74.60 0.00 308.40], distance = 500.00

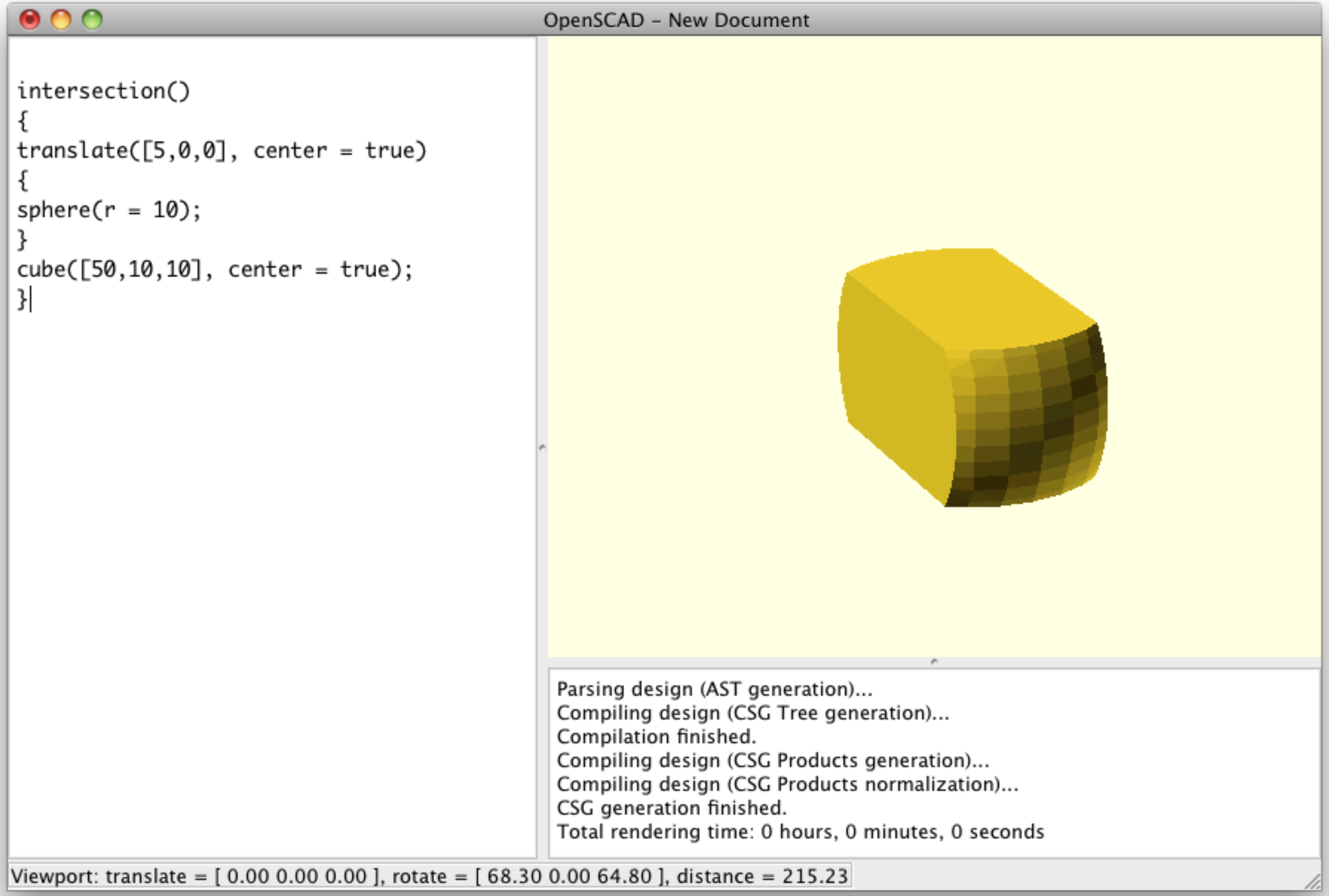
CSG


OpenSCAD – New Document
cube([50,10,10], center = true);
translate([5,0,0], center = true)
{
sphere(r = 10);
}
Parsing design (AST generation)...
Compiling design (CSG Tree generation)...
Compilation finished.
Compiling design (CSG Products generation)...
Compiling design (CSG Products normalization)...
CSG generation finished.
Total rendering time: 0 hours, 0 minutes, 0 seconds
Viewport: translate = [0.00 0.00 0.00], rotate = [56.40 0.00 220.90], distance = 500.00

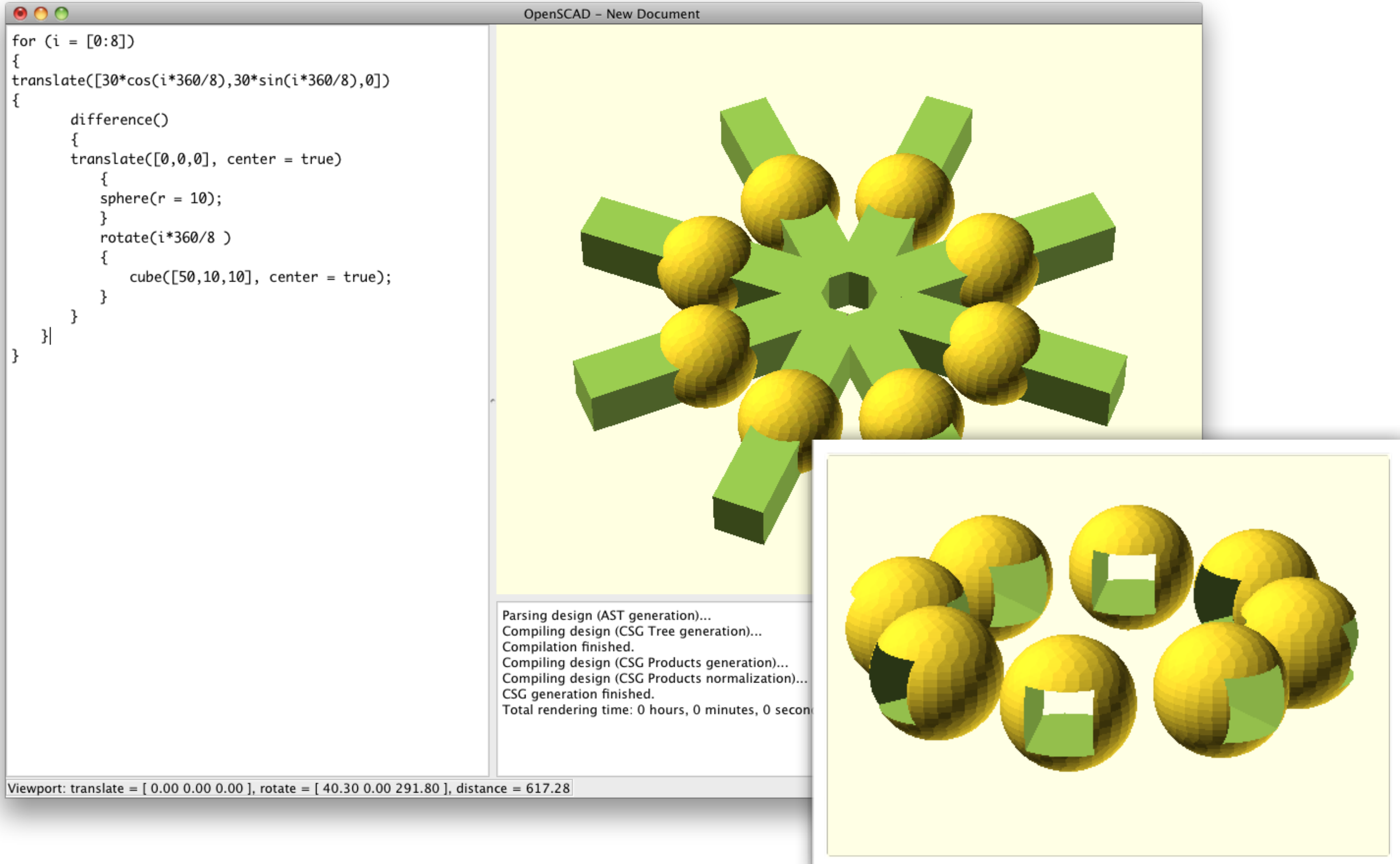
CSG


OpenSCAD – New Document
difference()
{
translate([5,0,0], center = true)
{
sphere(r = 10);
}
cube([50,10,10], center = true);
}
Parsing design (AST generation)...
Compiling design (CSG Tree generation)...
Compilation finished.
Compiling design (CSG Products generation)...
Compiling design (CSG Products normalization)...
CSG generation finished.
Total rendering time: 0 hours, 0 minutes, 0 seconds
Viewport: translate = [0.00 0.00 0.00], rotate = [79.50 0.00 71.80], distance = 500.00

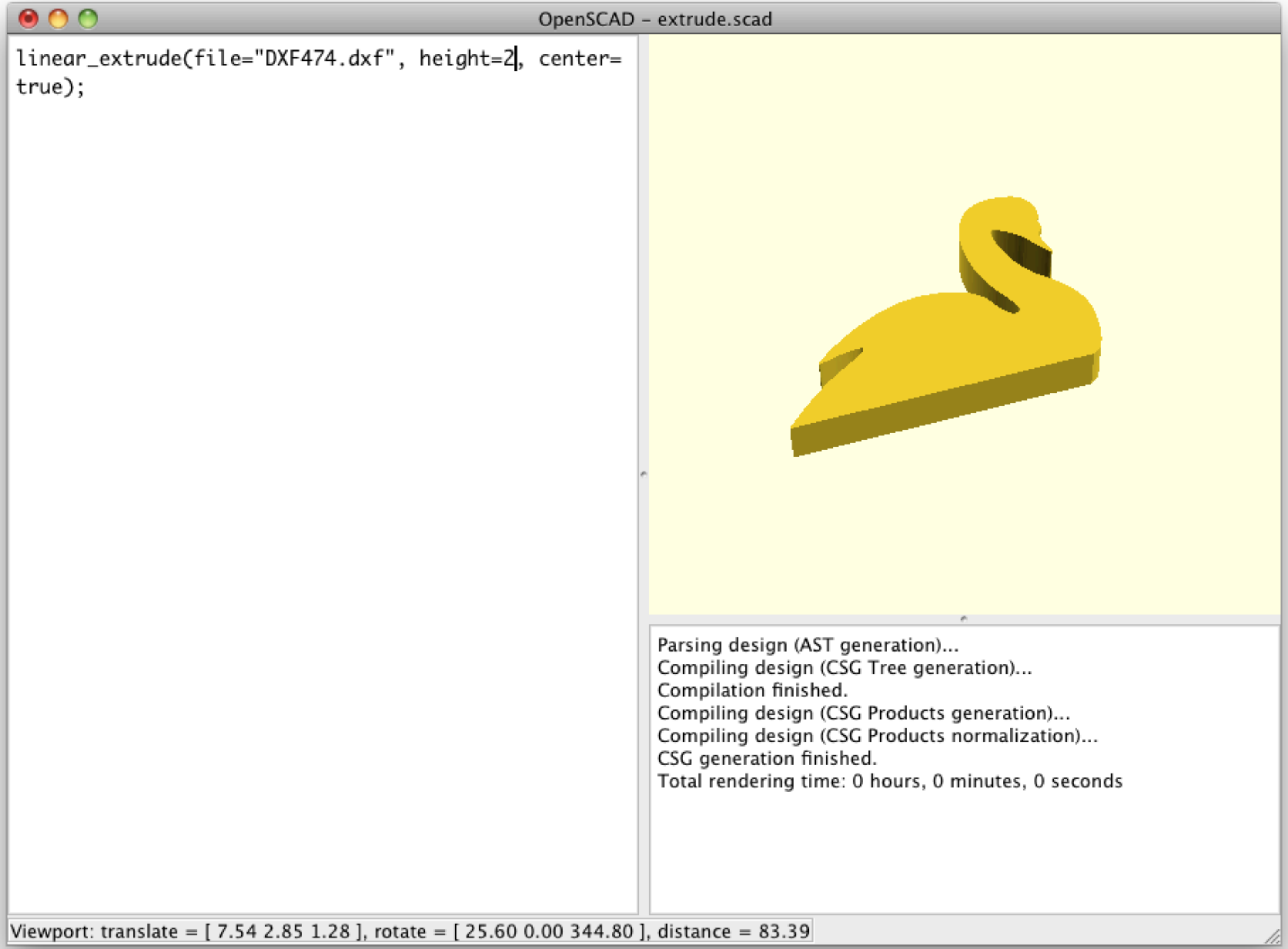
CSG


OpenSCAD – New Document
intersection()
{
translate([5,0,0], center = true)
{
sphere(r = 10);
}
cube([50,10,10], center = true);
}
Parsing design (AST generation)...
Compiling design (CSG Tree generation)...
Compilation finished.
Compiling design (CSG Products generation)...
Compiling design (CSG Products normalization)...
CSG generation finished.
Total rendering time: 0 hours, 0 minutes, 0 seconds
Viewport: translate = [0.00 0.00 0.00], rotate = [68.30 0.00 64.80], distance = 215.23

Iteration + CSG



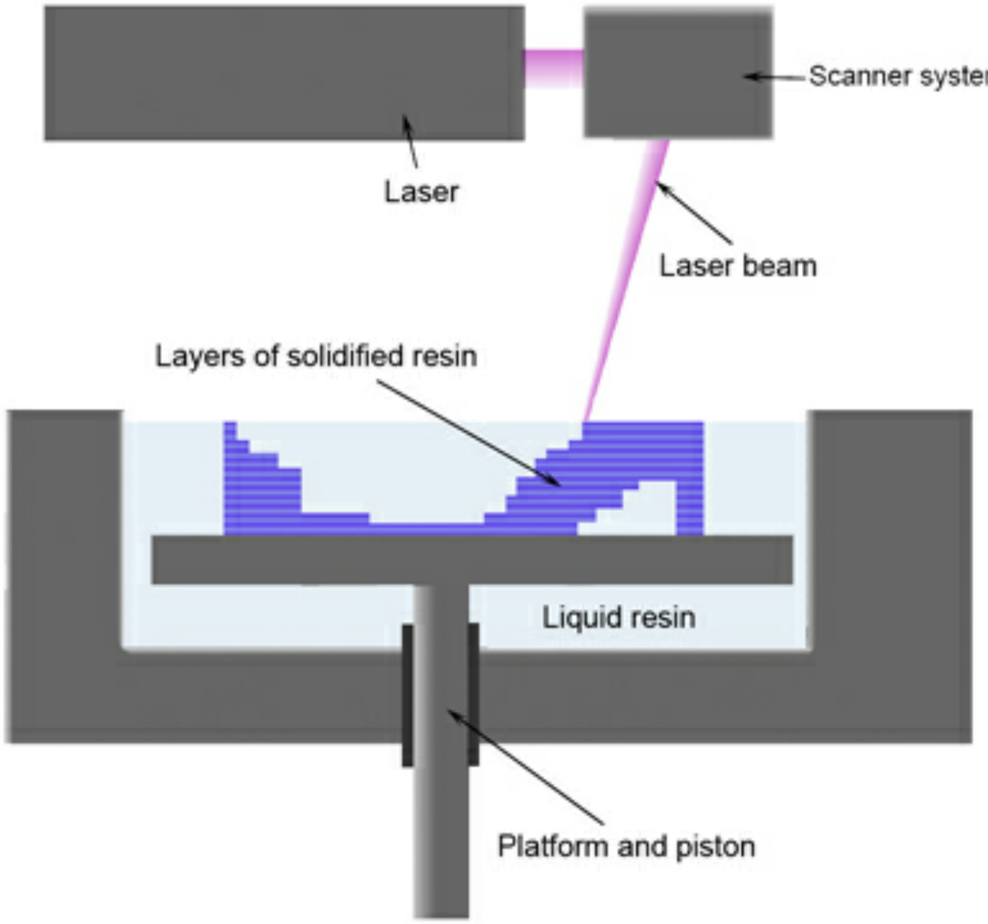
Extrusion von 2D-Formen



3D PRINTER

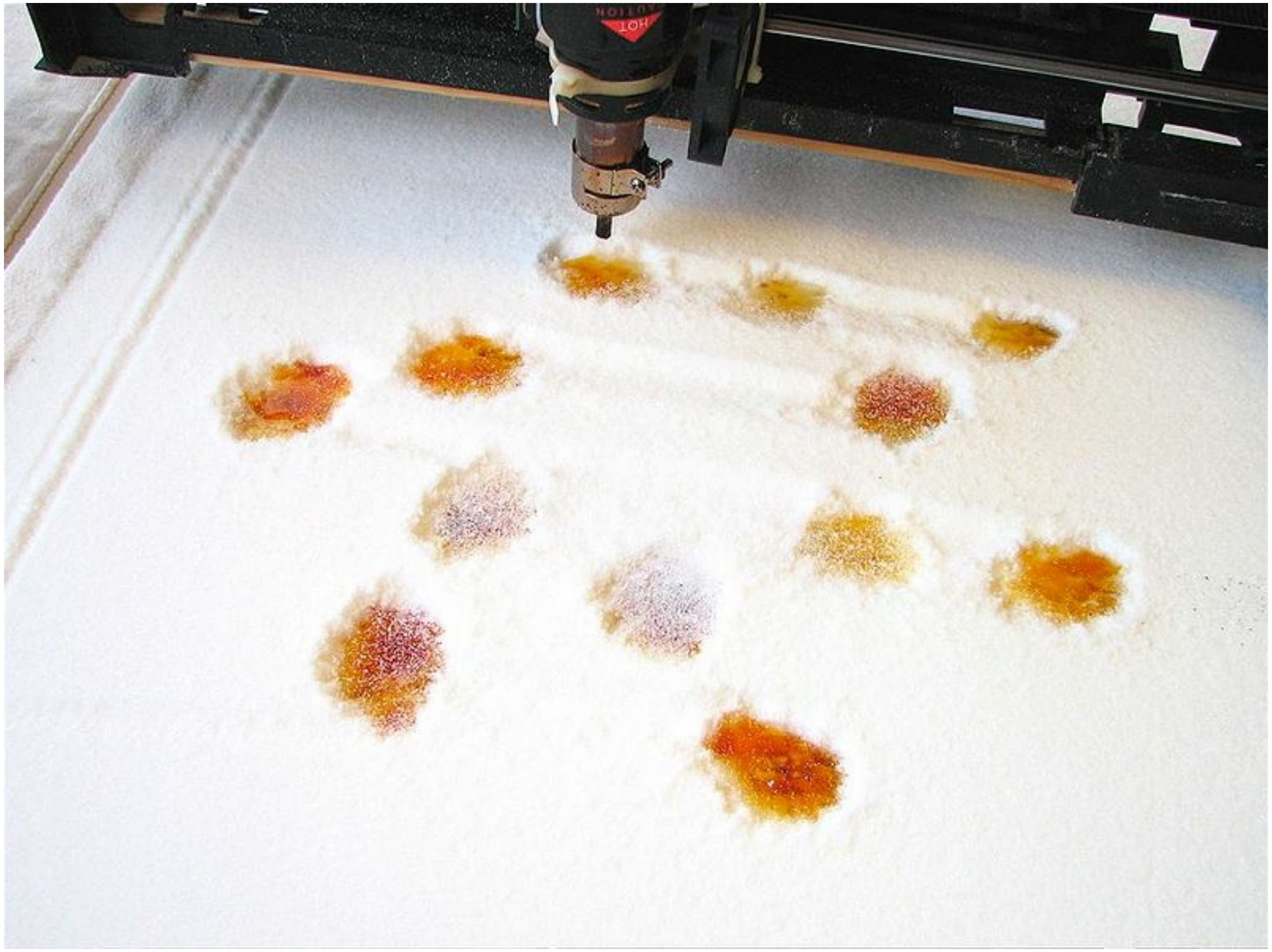
Stereolithographie

- Verhärtung durch fokussierten Laserstrahl



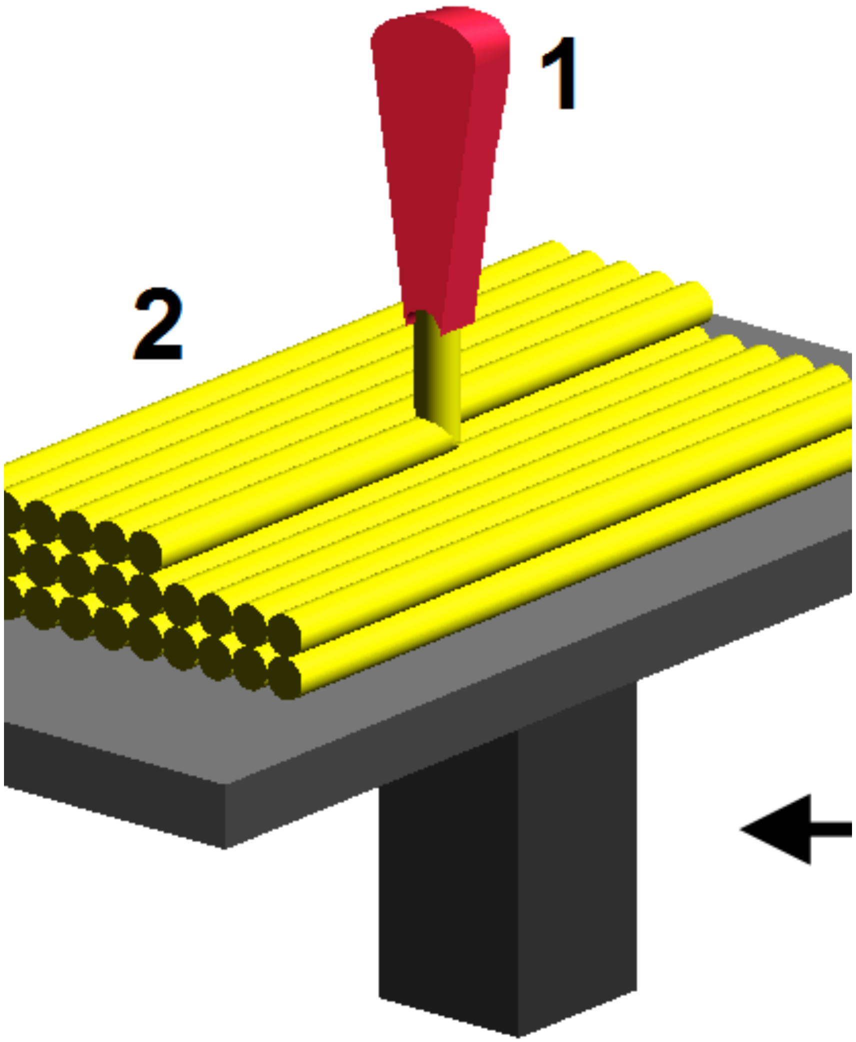
Sintern

- Beruht auf Schmelzen eines Granulats



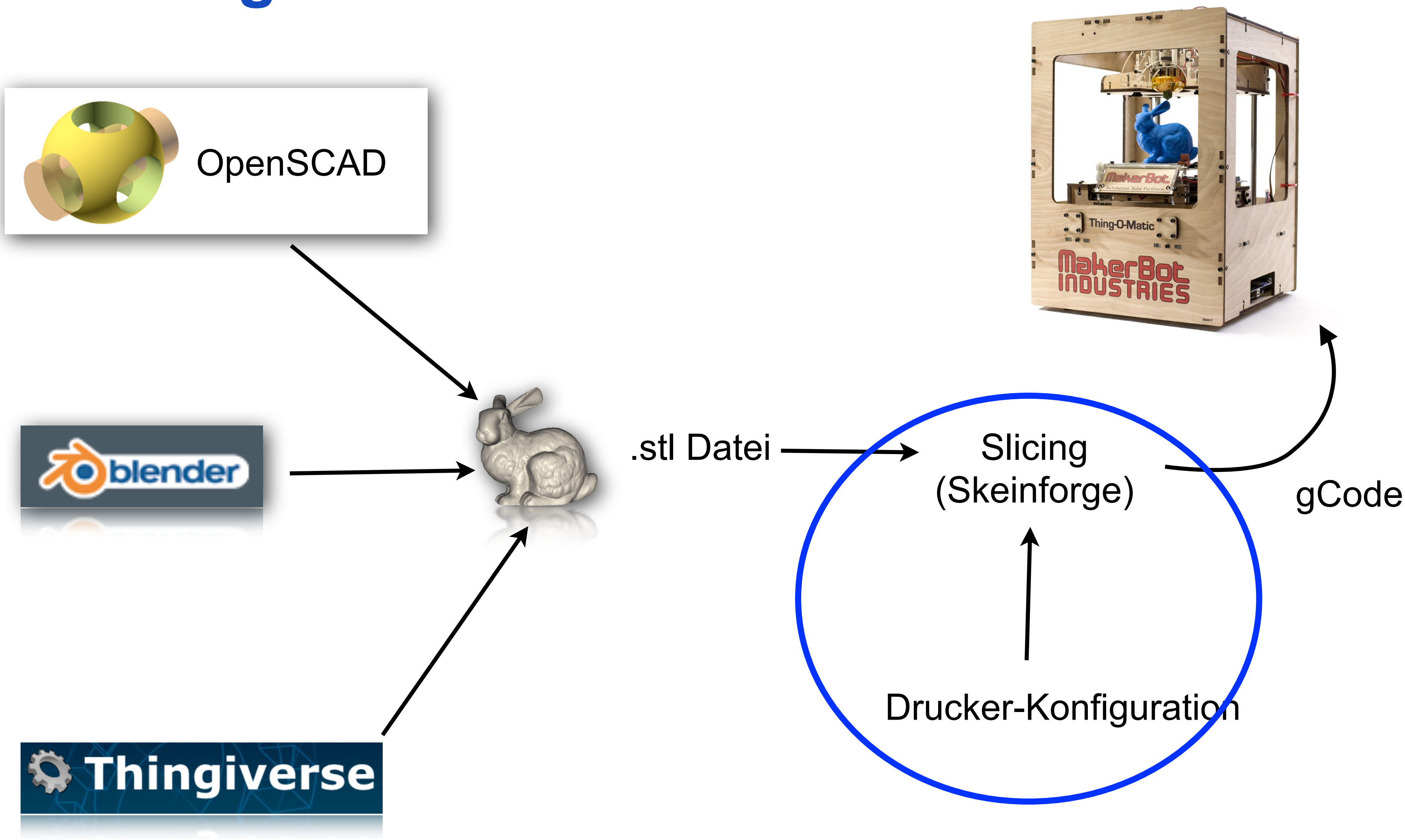
CandyFab

Fused-Deposition Modeling (FDM)

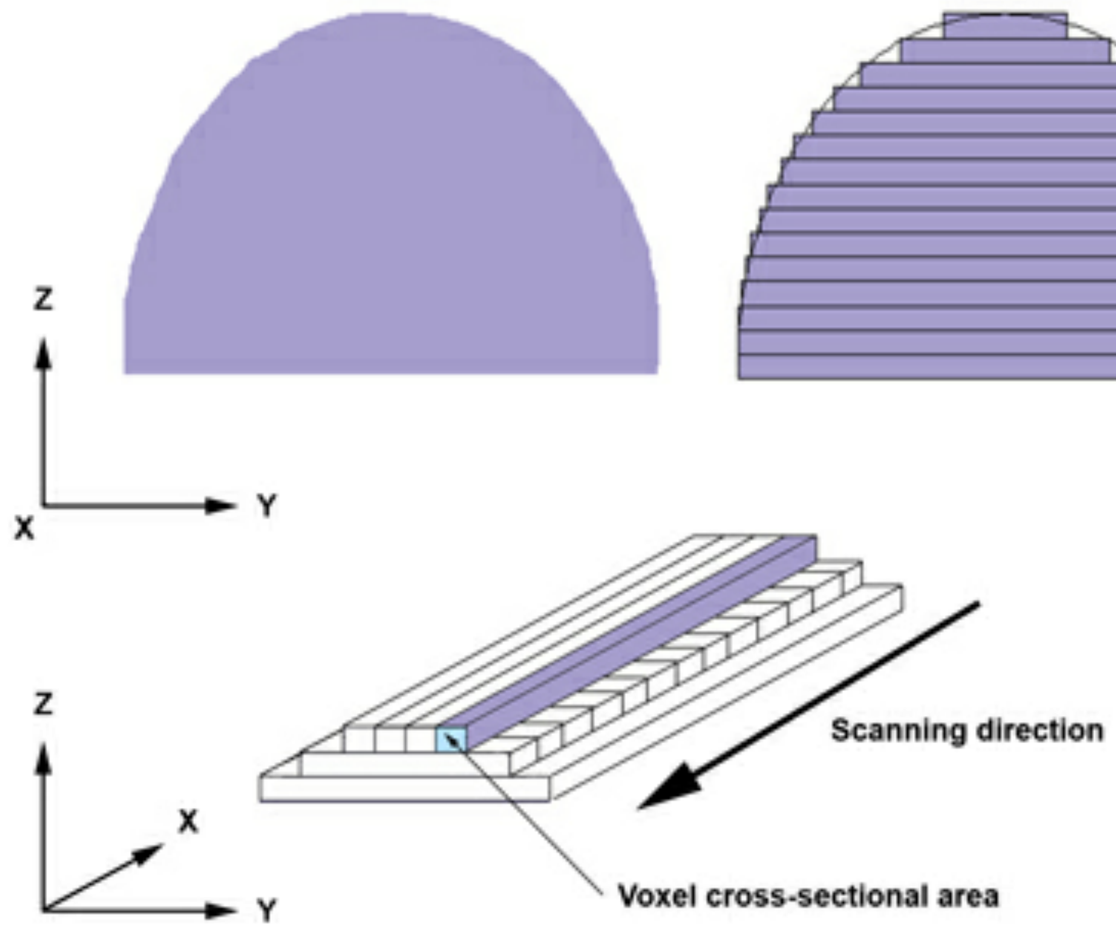


- Additives Fertigungsverfahren
- Objekt wird schichtweise aufgebaut
- Komplexe Strukturen möglich (Hohlkörper)
- Große Überhänge ohne Stützmaterial schwierig

Slicing

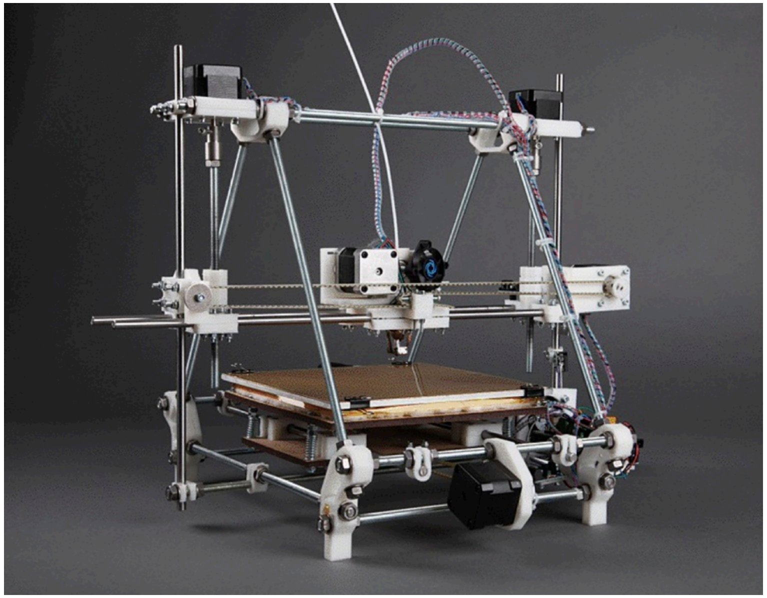

OpenSCAD
blender
Thingiverse
.stl Datei
Slicing
(Skeinforge)
Drucker-Konfiguration
gCode
Thing-O-Matic
MakerBot
INDUSTRIES

Slicing



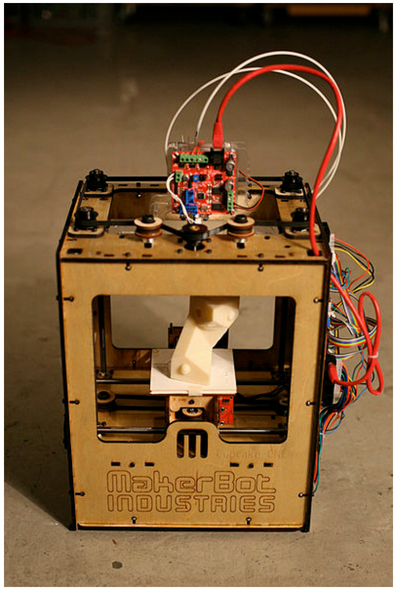
3D Drucker

Dimension

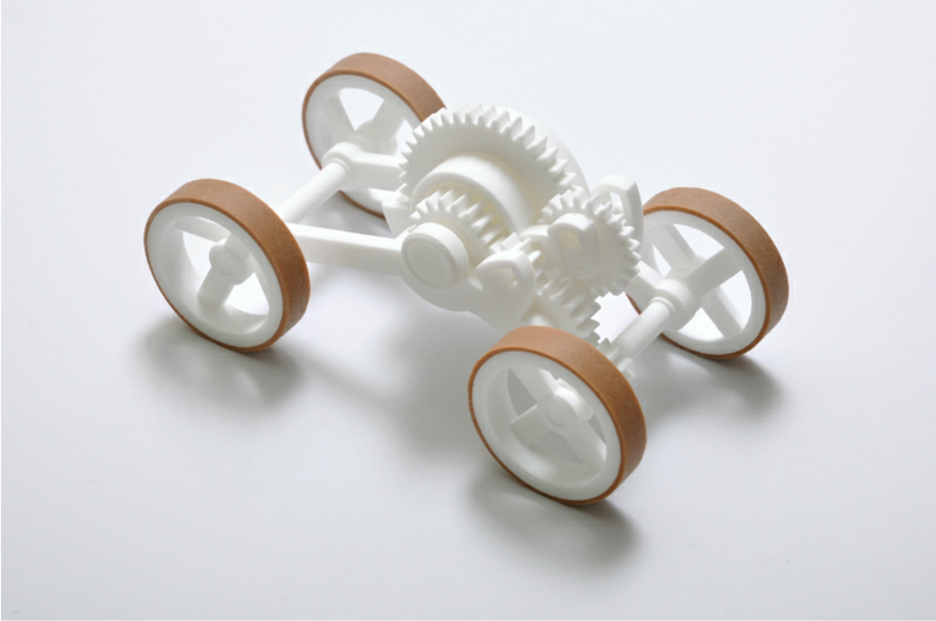


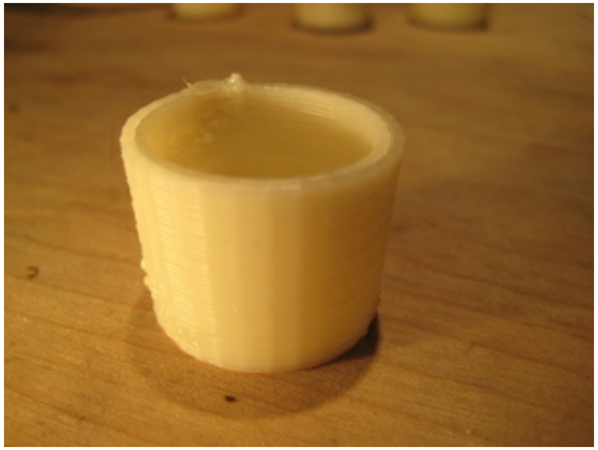
Mendel

Makerbot



3D Drucker: Output





LASERCUTTER

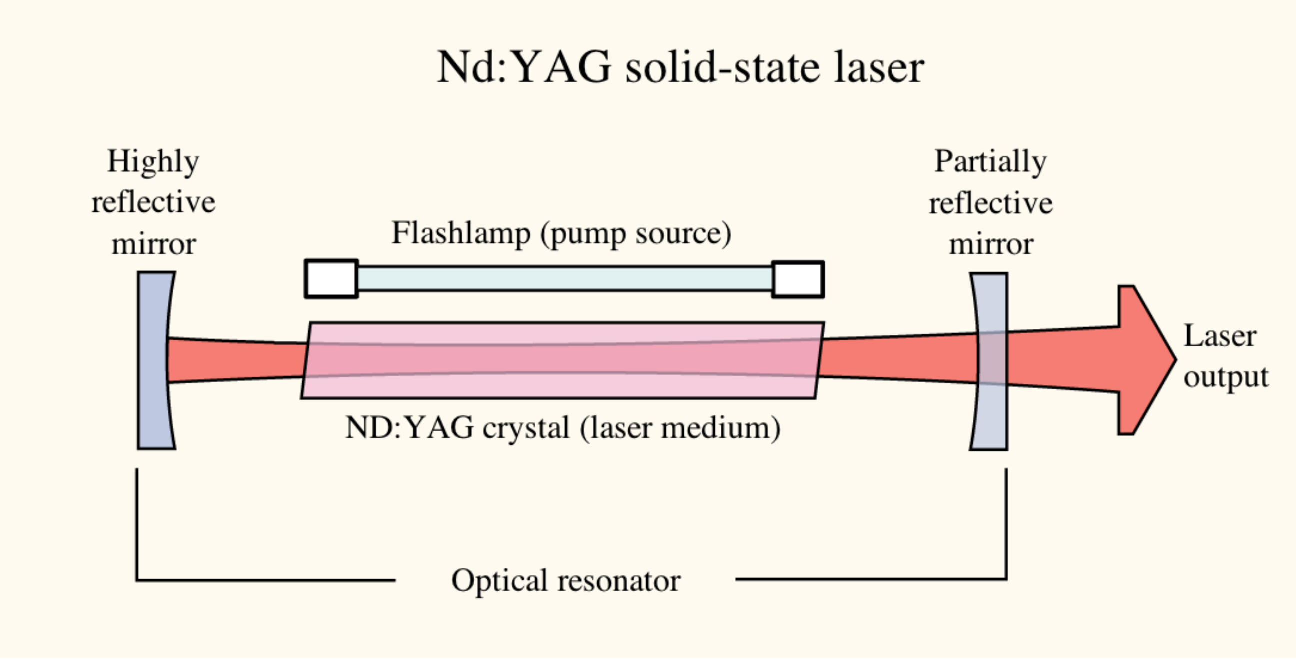
Lasercutter

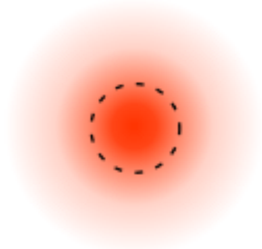
- Elektronisch gesteuerte Schneide- und Graviermaschine beruhend auf einem Laser

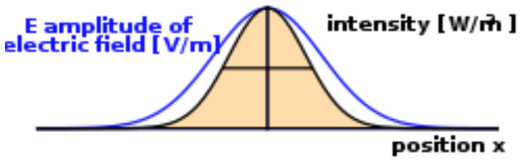
- Einfach zu bedienen
- Schnell

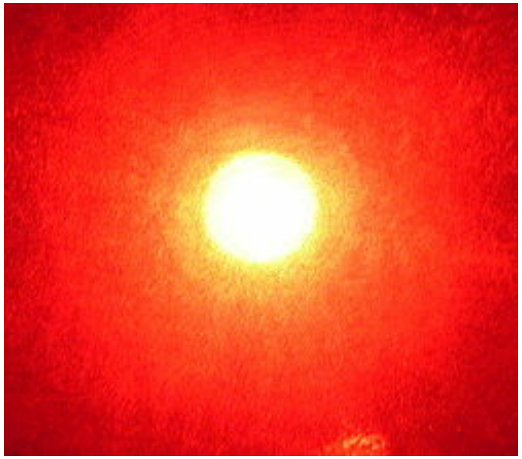
Laser

- Optischer Resonator → kohärentes Licht (gleiche Wellenlänge und Phase wird ausgegeben)
- Hohe Energiedichte durch Kohärenz
- Gute Fokussierbarkeit









Lasertechnik in Lasercuttern

- CO_2-Laser
  - In den meisten Lasercuttern verbaut
  - Reicht zum Gravieren/Schneiden von nichtmetallischen Materialien
  - Wellenlänge ca. 10 µm (mittlerer IR-Bereich)

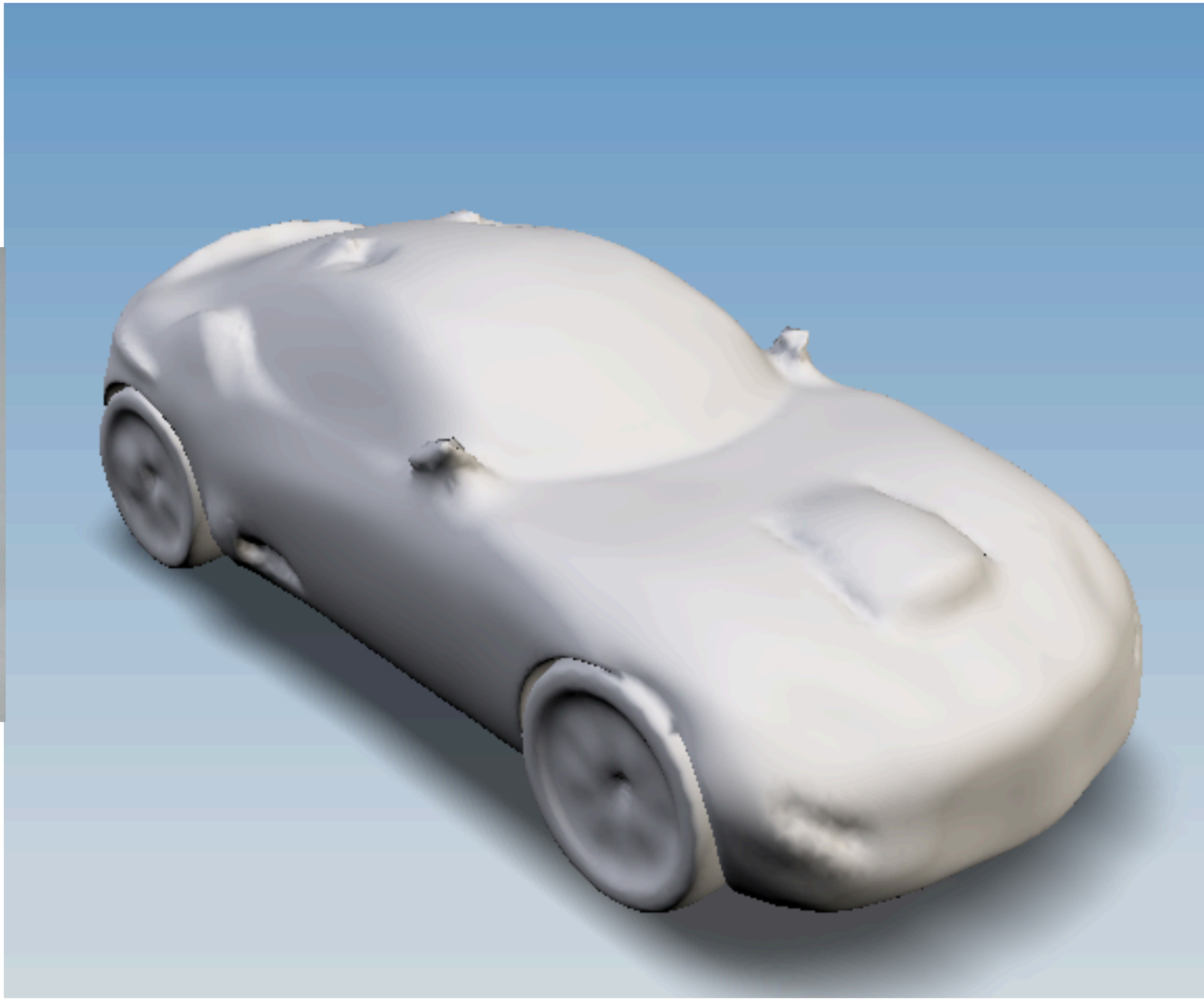
- Faserlaser
  - In “high-end” Lasercuttern
  - Damit können auch Metalle geschnitten werden
  - Wellenlänge ca. 1062 nm (naher IR-Bereich)

Laser Cutter Modi: Raster vs. Vektor

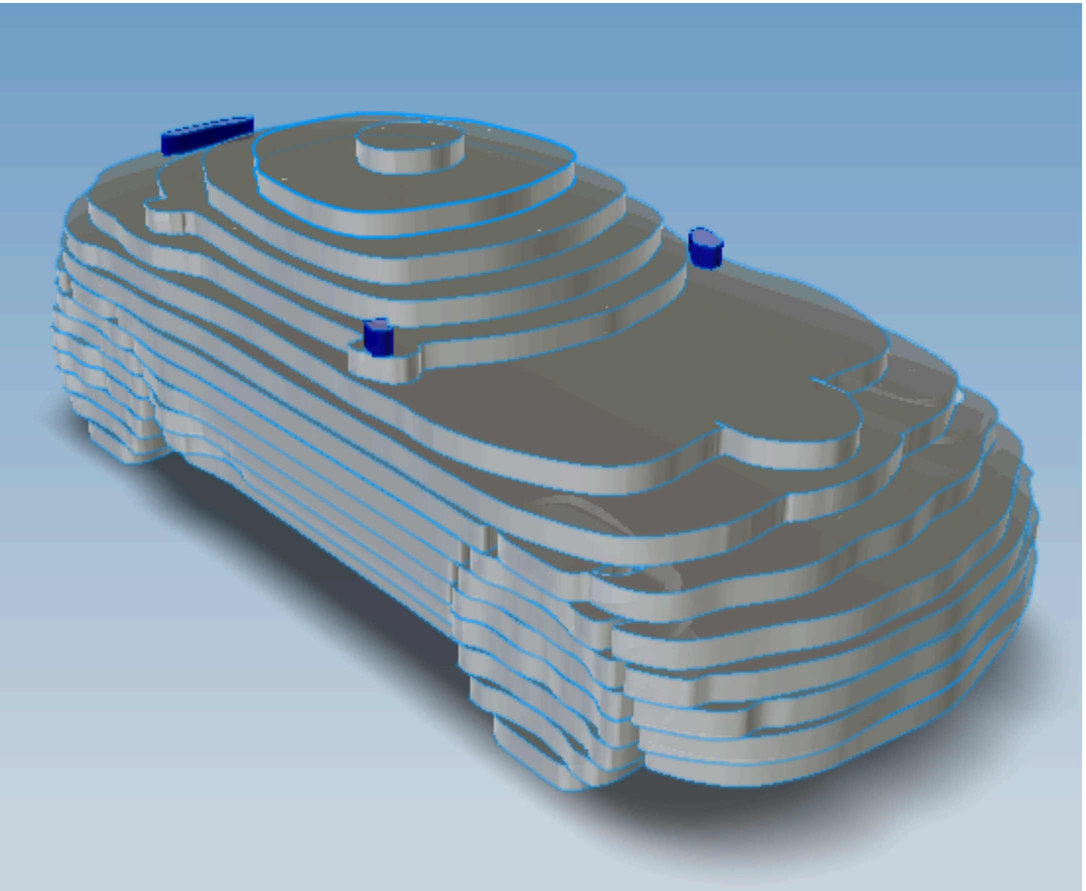
- Vektor: **Schneiden**
  - In Illustrator: Liniendicke = 0.001mm, schwarz
  - Langsamer
  - Zusatzluftmodul unbedingt anschalten (ausblasen der Stichflamme)

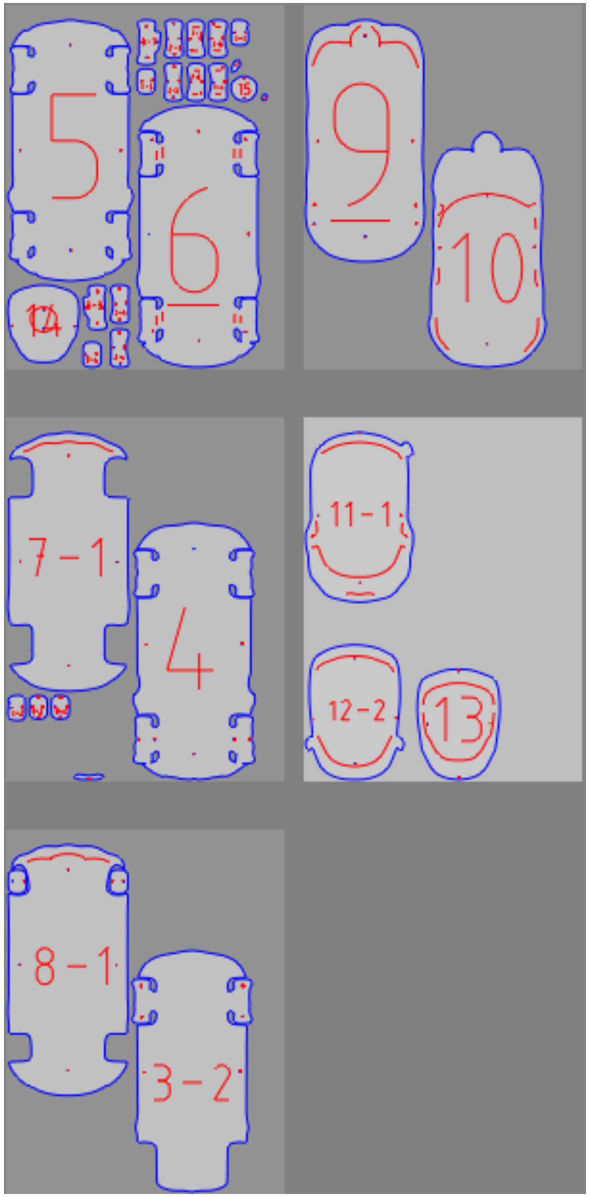
- Raster: **Gravieren**
  - Trägt nur oberste Materialschicht ab
  - Bitmap-Farben können auf verschiedene Impulsstärken abgebildet werden

Dreidimensionale Objekte?

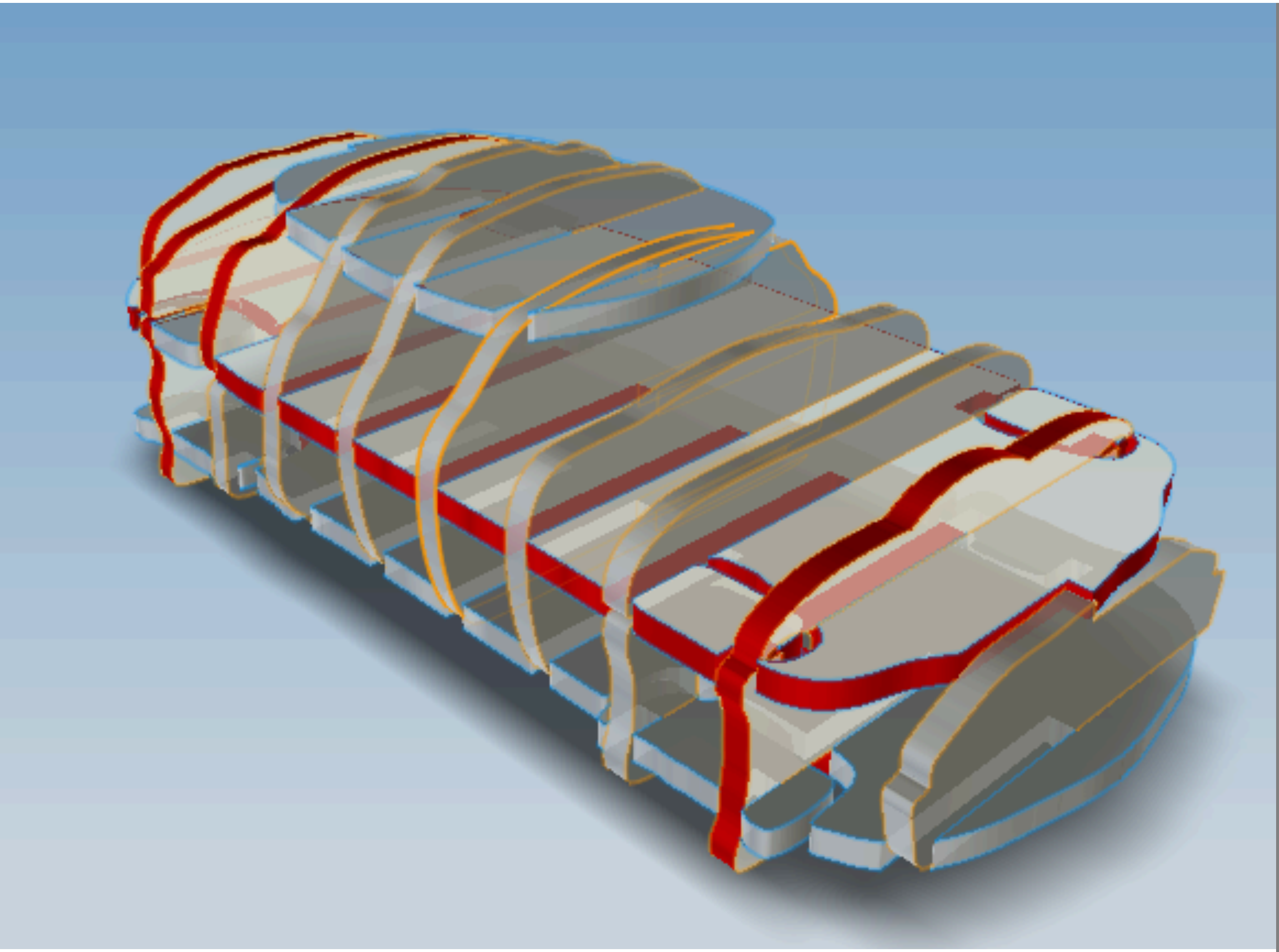


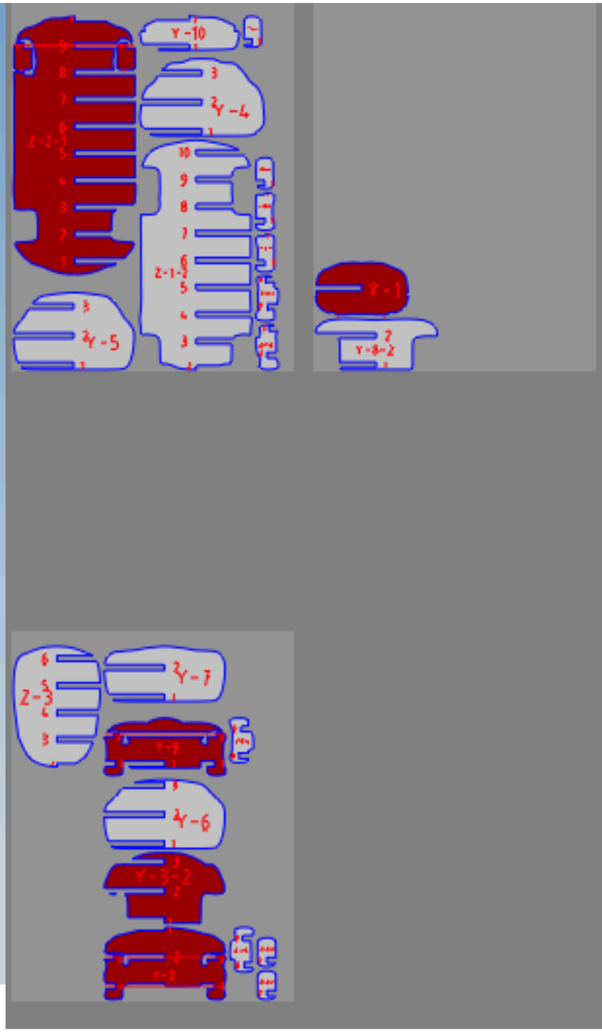
Schichtweise ausschneiden

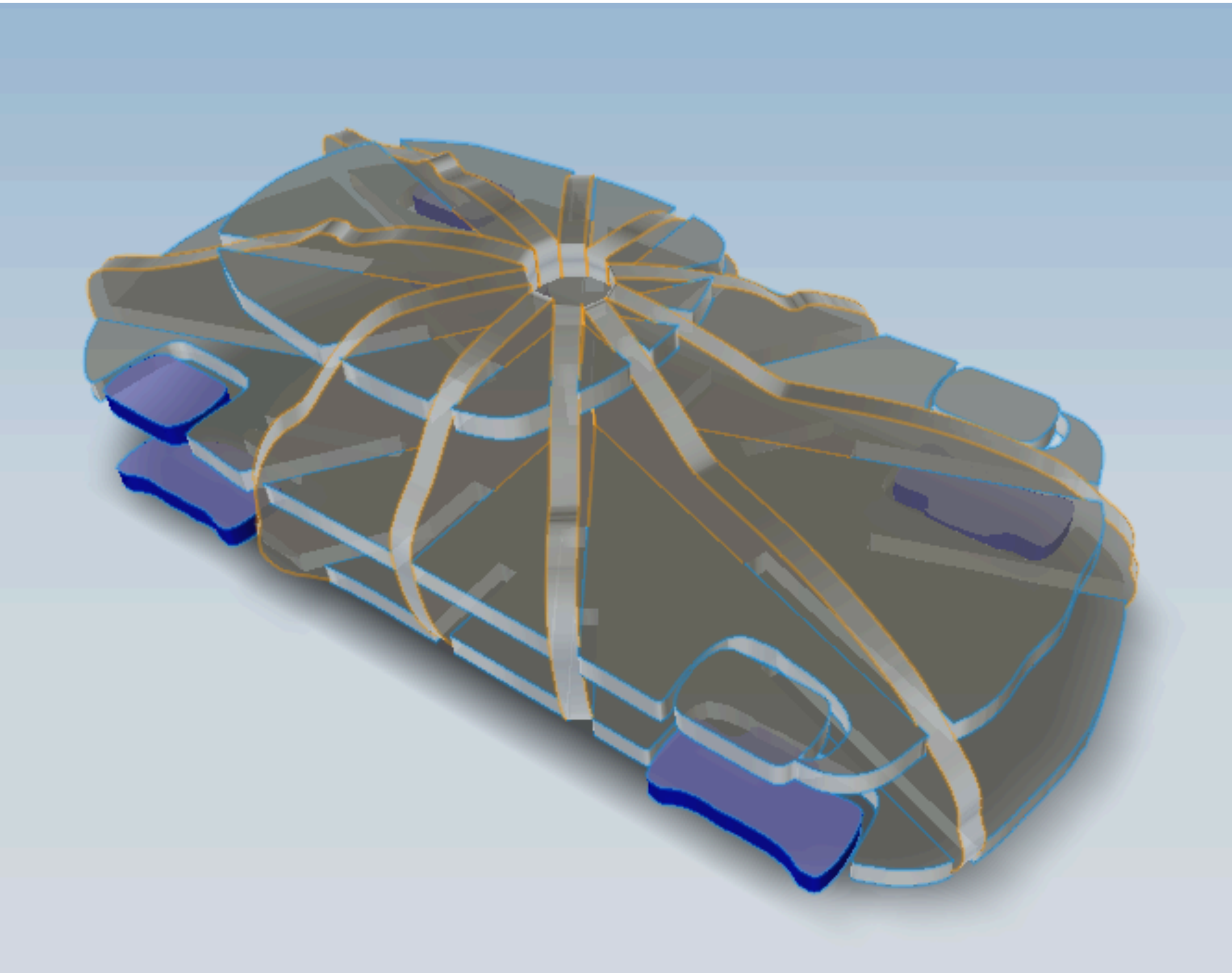


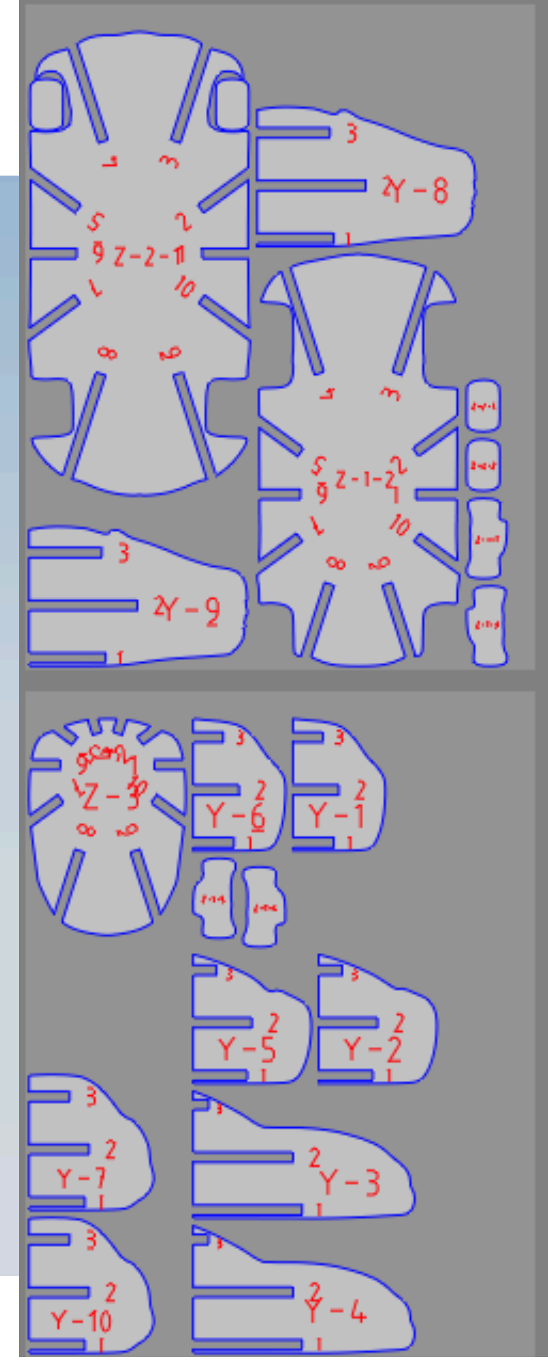


Aus steckbaren Teilen zusammenfügen



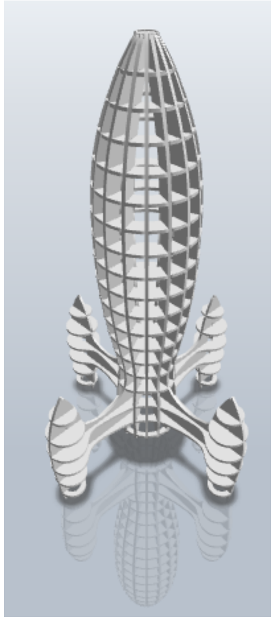




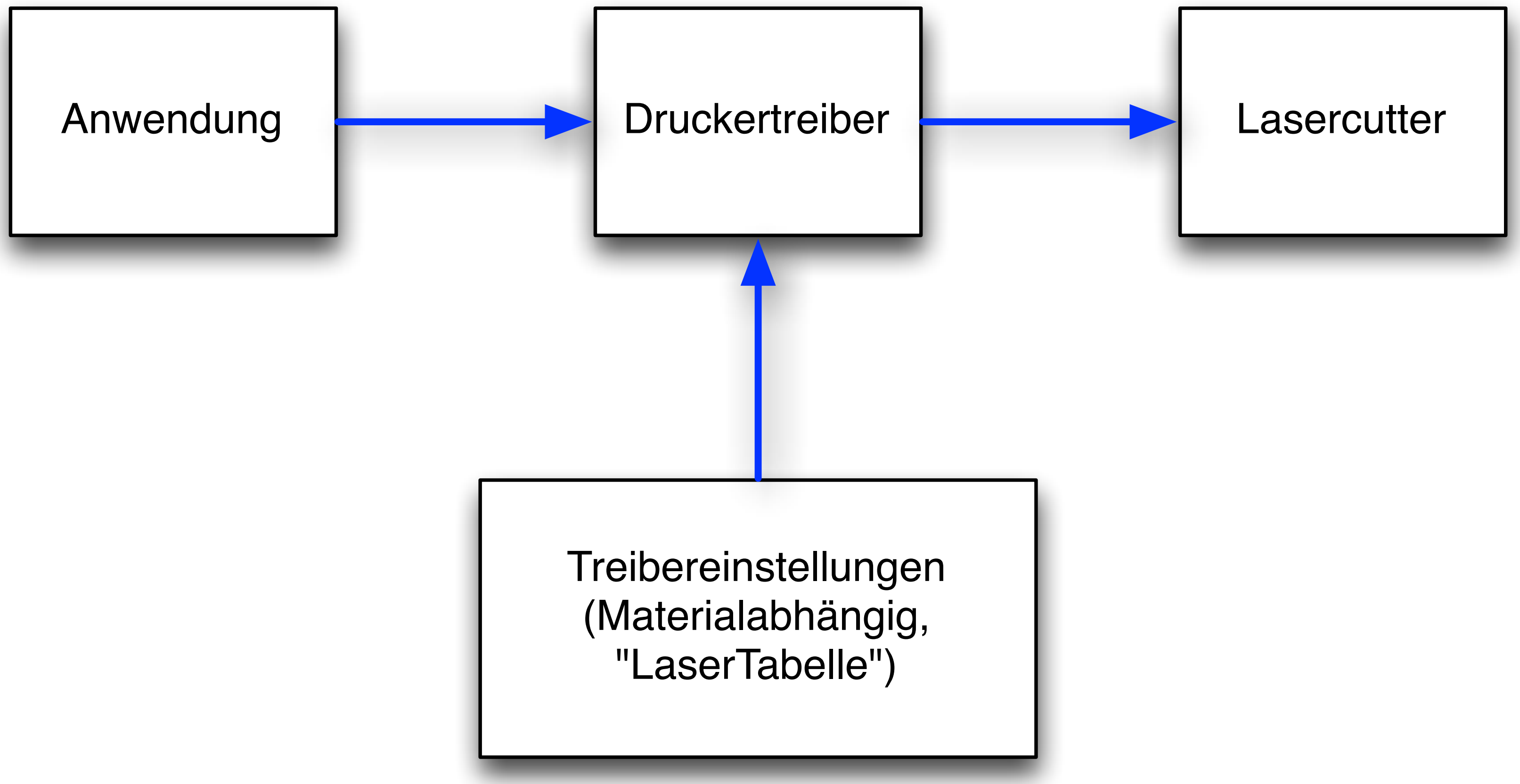

Z-2-11
2Y-8
2Y-9
Z-1-2
Y-6
Y-1
Y-5
Y-2
Y-7
Y-3
Y-10
Y-4

Anwendungen zur Arbeit am Lasercutter

- **2D-Zeichnungen:** Inkscape / Ilustrator
- **Rasterbilder:** Gimp / Photoshop / Illustrator
- **Slicing von 3D Modellen:** 123DMake



Workflow Lasercutter

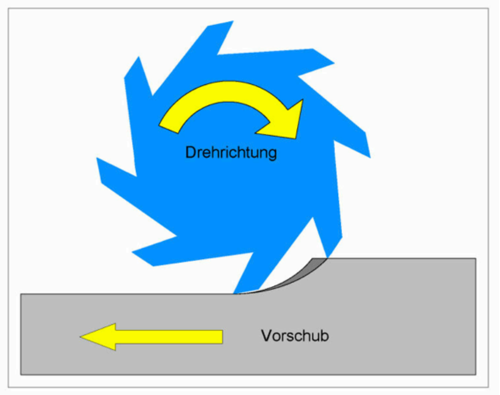


MILLING MACHINE

Modela MDX-20

CNC Fräsen

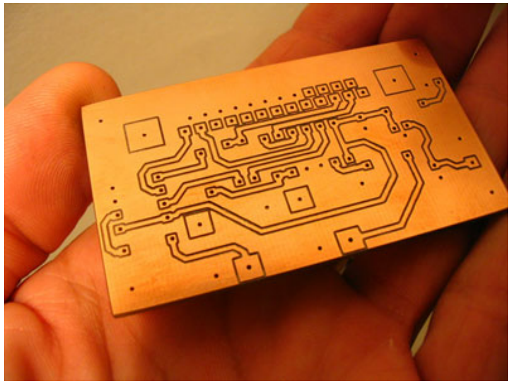
- Subtraktive Herstellungsweise



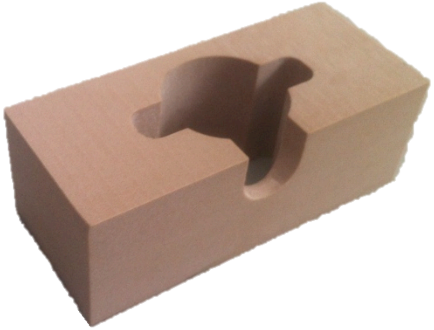
- Rotierendes Werkzeug
  - Flacher Kopf
  - Runder Kopf
  - Gravierstichel
  - Versch. Durchmesser

CNC-Fräsen: Anwendungsbereiche

- Platinenherstellung (Isolationsfräsen)



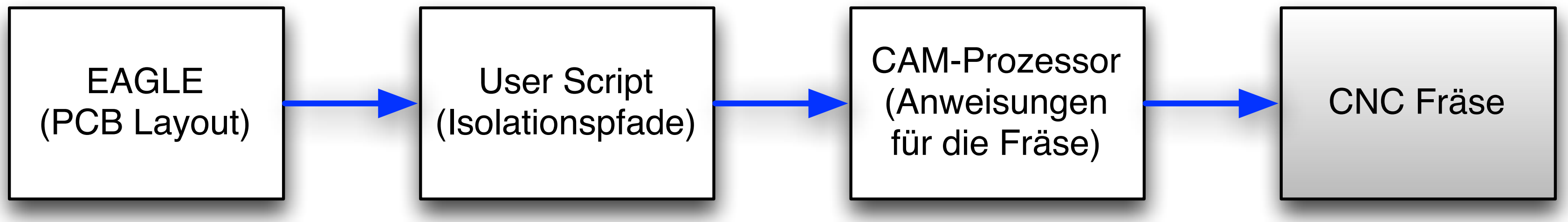
- 2.5D-Objekte



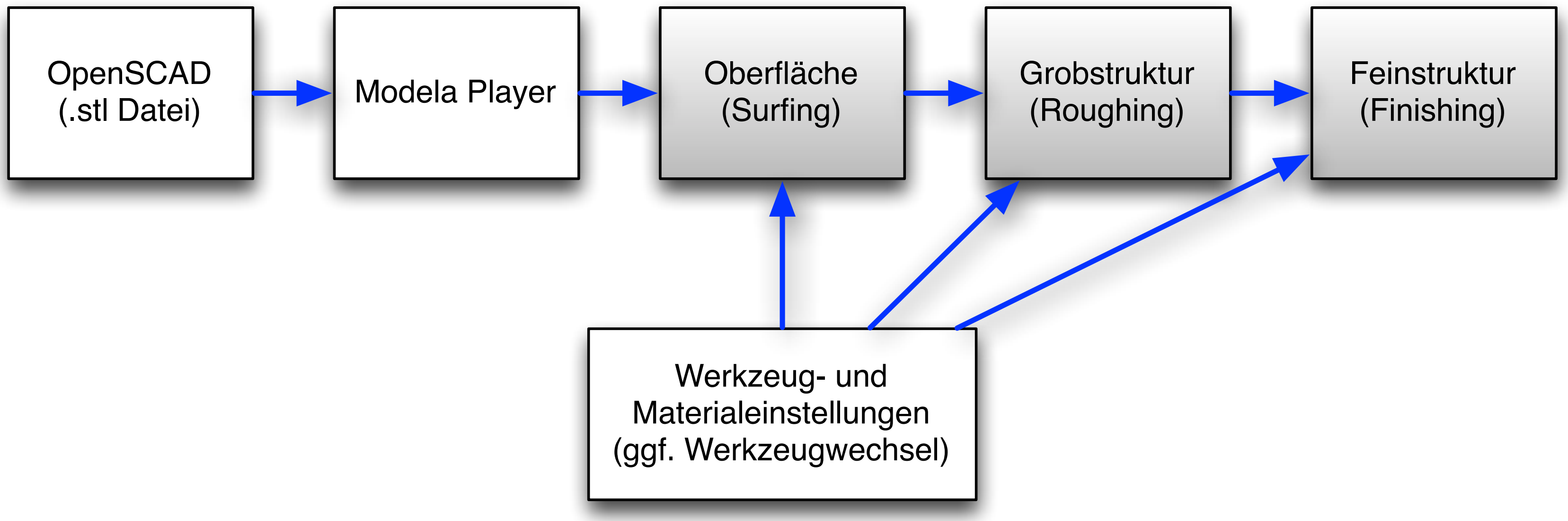
CNC Fräsen

- Vorteile
  - Etabliertes Verfahren
  - Hohe Präzision, “sauberes” Aussehen
  - Große Materialauswahl
  - Möglichkeit zur Fertigung von Gussformen
- Nachteile
  - Langsamer als additive Verfahren (kommt auch auf die Fräse an)
  - Werkzeugverschleiß
  - 2.5D (bei Einsteigermodellen)

Modela Workflow: Platinen



Modela Workflow: Gegenstände



Roving-Modul (3.3V!)