An Internet of Custom-Made Things:

From 3D Printing and Personal Fabrication to Personal Design of Interactive Devices

Prof. Jan Borchers

Media Computing Group

hci.rwth-aachen.de

RWTH AACHEN UNIVERSITY

ICWE'13
Aalborg • July 12, 2013

RWTH AACHEN UNIVERSITY

- Excellence University
- 400 faculty, 30.000 students, tech focus
- #1 DFG ranking

1. **Interactive Surfaces:**
   tangibles on tabletops, actuation, haptic feedback, nonplanar surfaces, hybrid documents, 3D tabletops

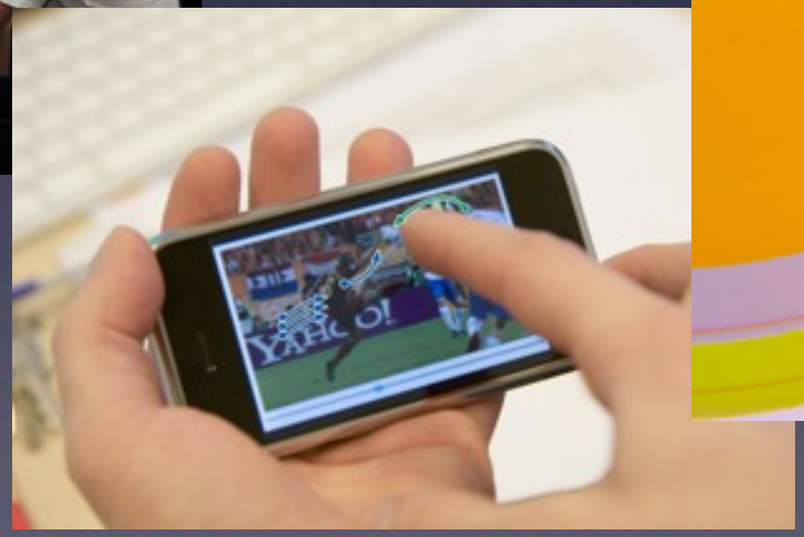
2. **Navigating Media:**
   video navigation, canvas (ZUI) presentations, source code navigation, DJ interfaces

3. **Mobile Interaction:**
   locative gaming, 3D audio VR, nomadic apps, instant user interfaces

4. **Gestural Interaction:**
   conducting music, shadowplay interaction

5. **Hardware/Software UIs & Personal Design:**
   interactive clothing, 3d scanning, fab labs

media computing group



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The 3rd Digital Revolution

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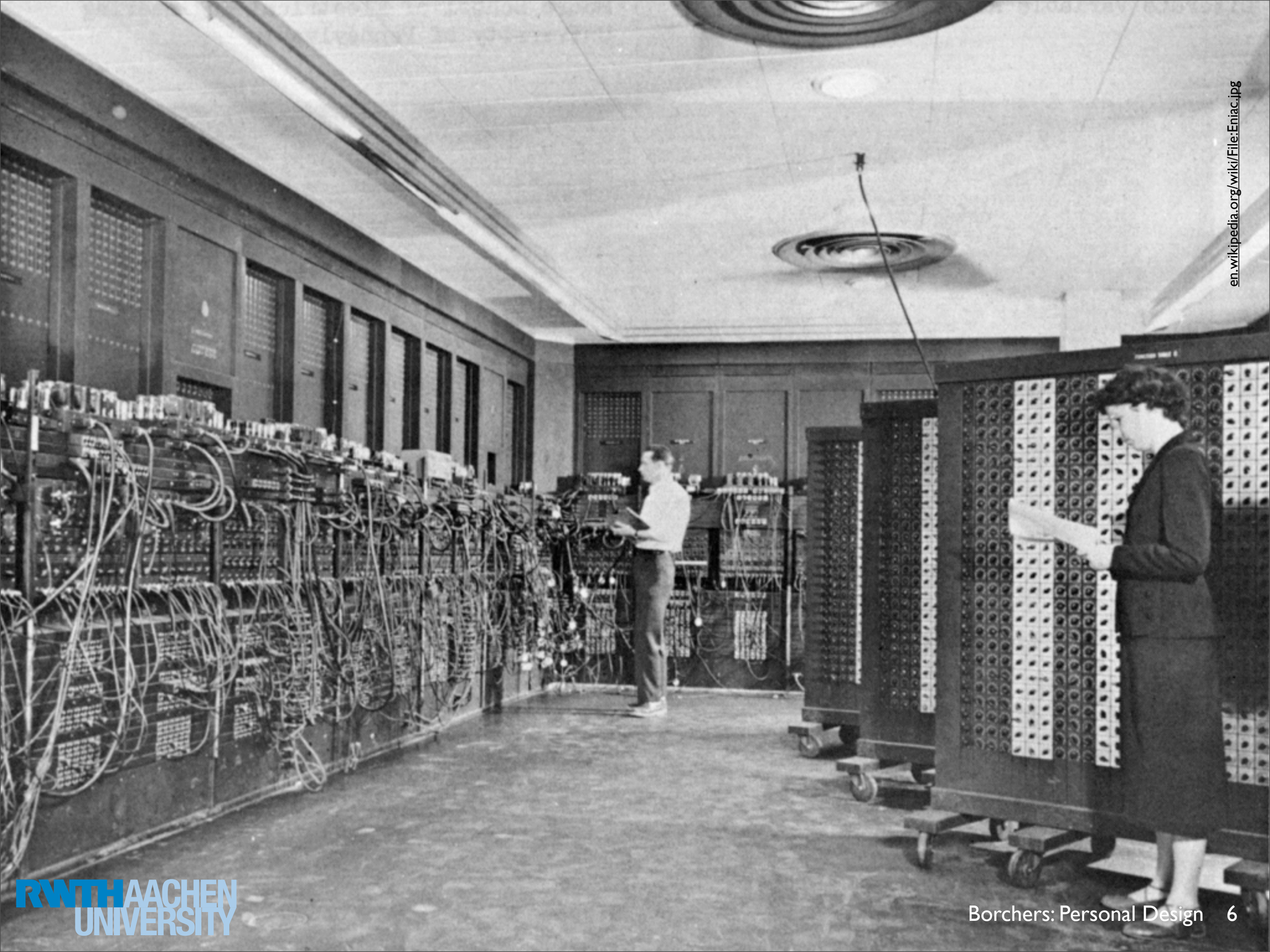

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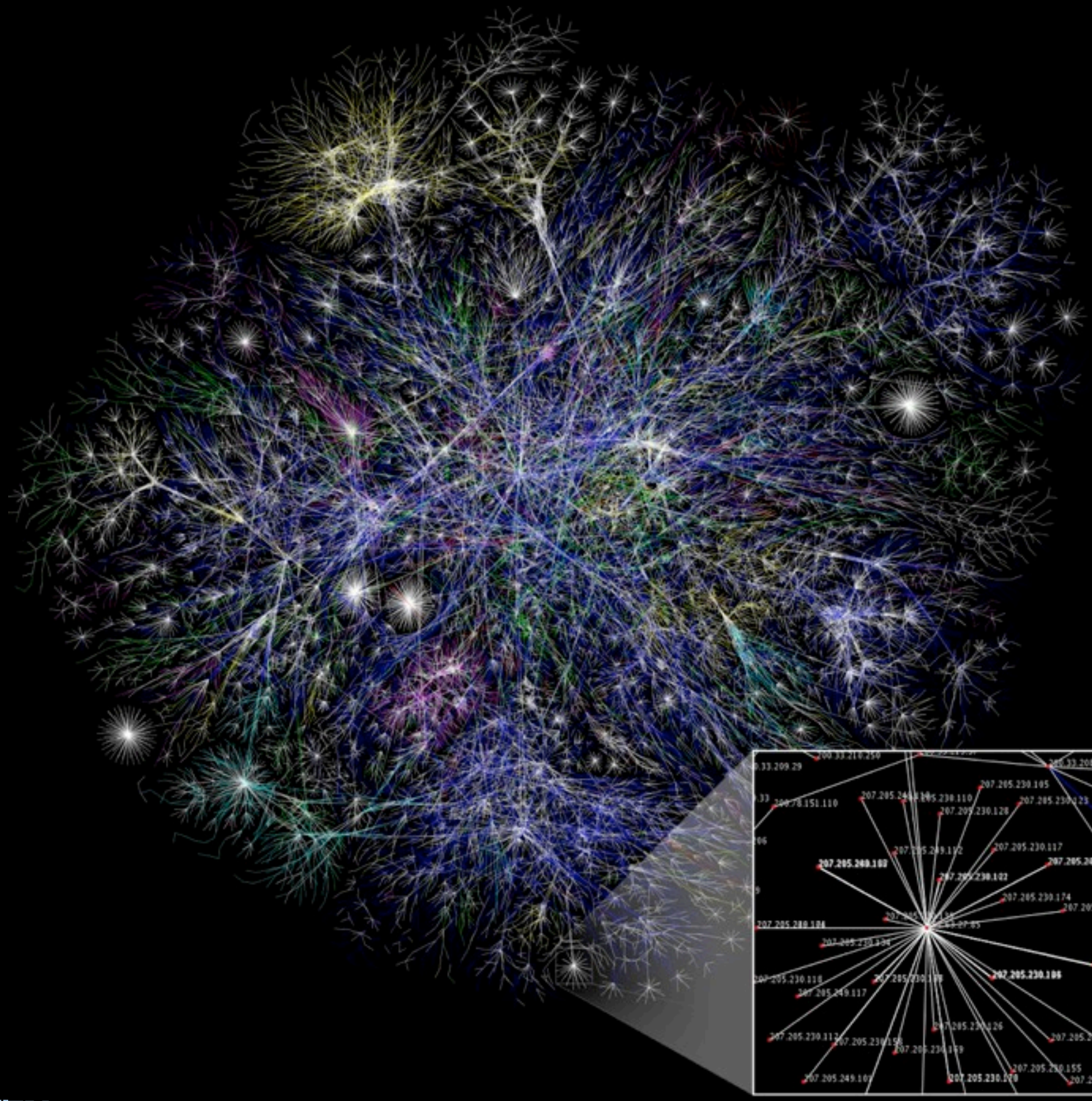

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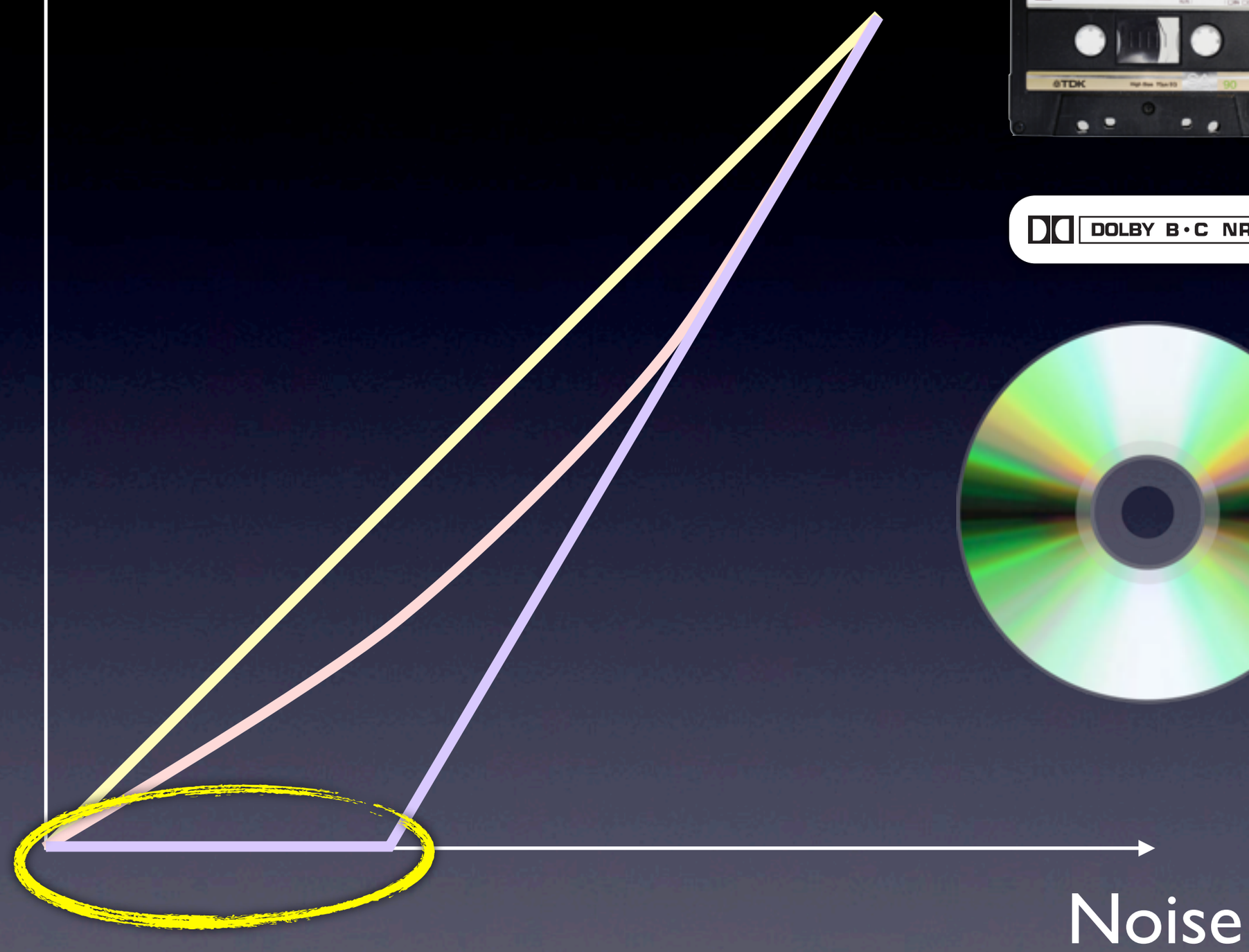


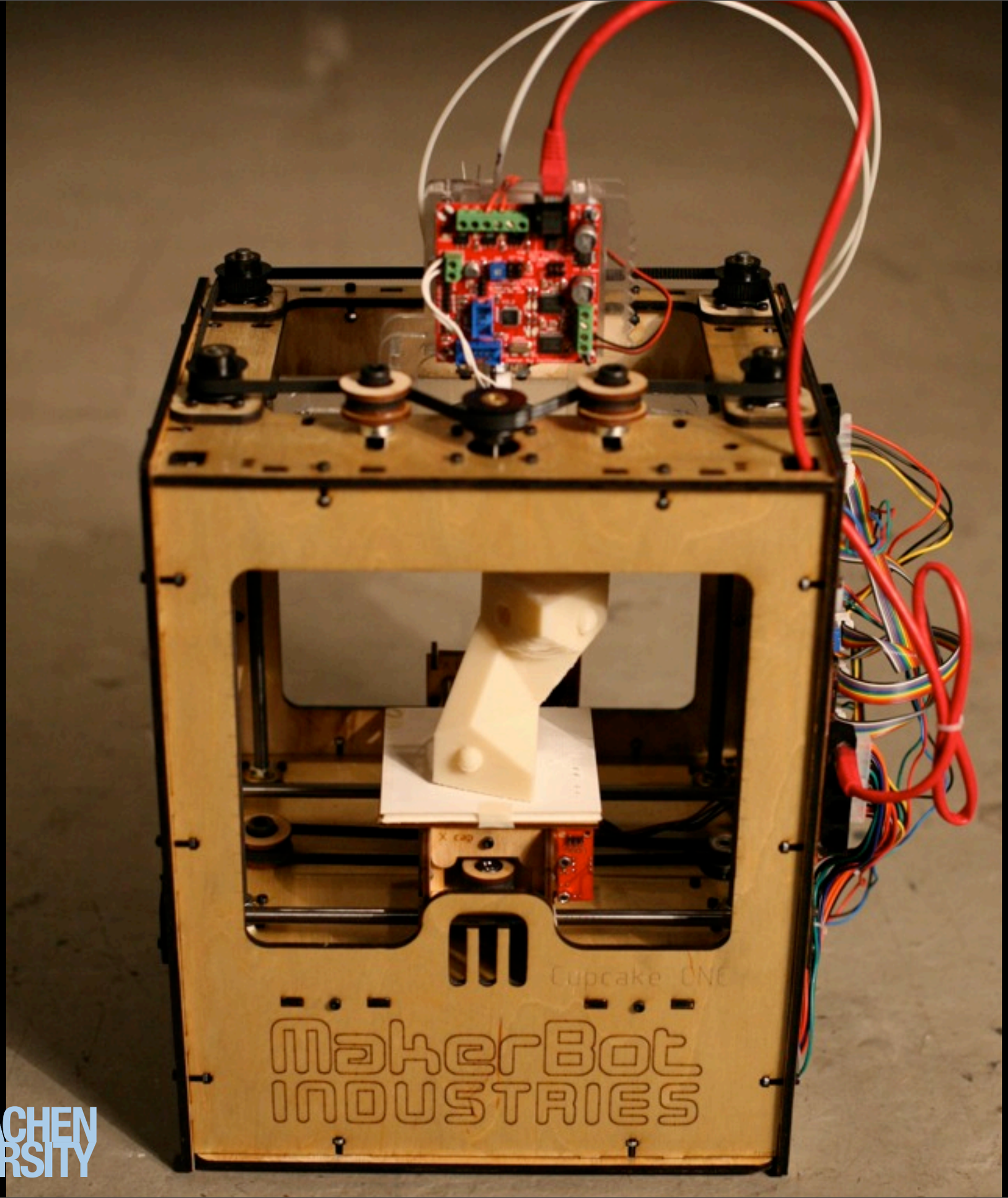
After Gershenfeld 2010 • logotypes101.com • commons.wikimedia.org/wiki/File:Compactcassette.jpg • en.wikipedia.org/wiki/CD

lossless

fast

cheap

en.wikipedia.org/wiki/File:Sinclair_ZX81.jpg

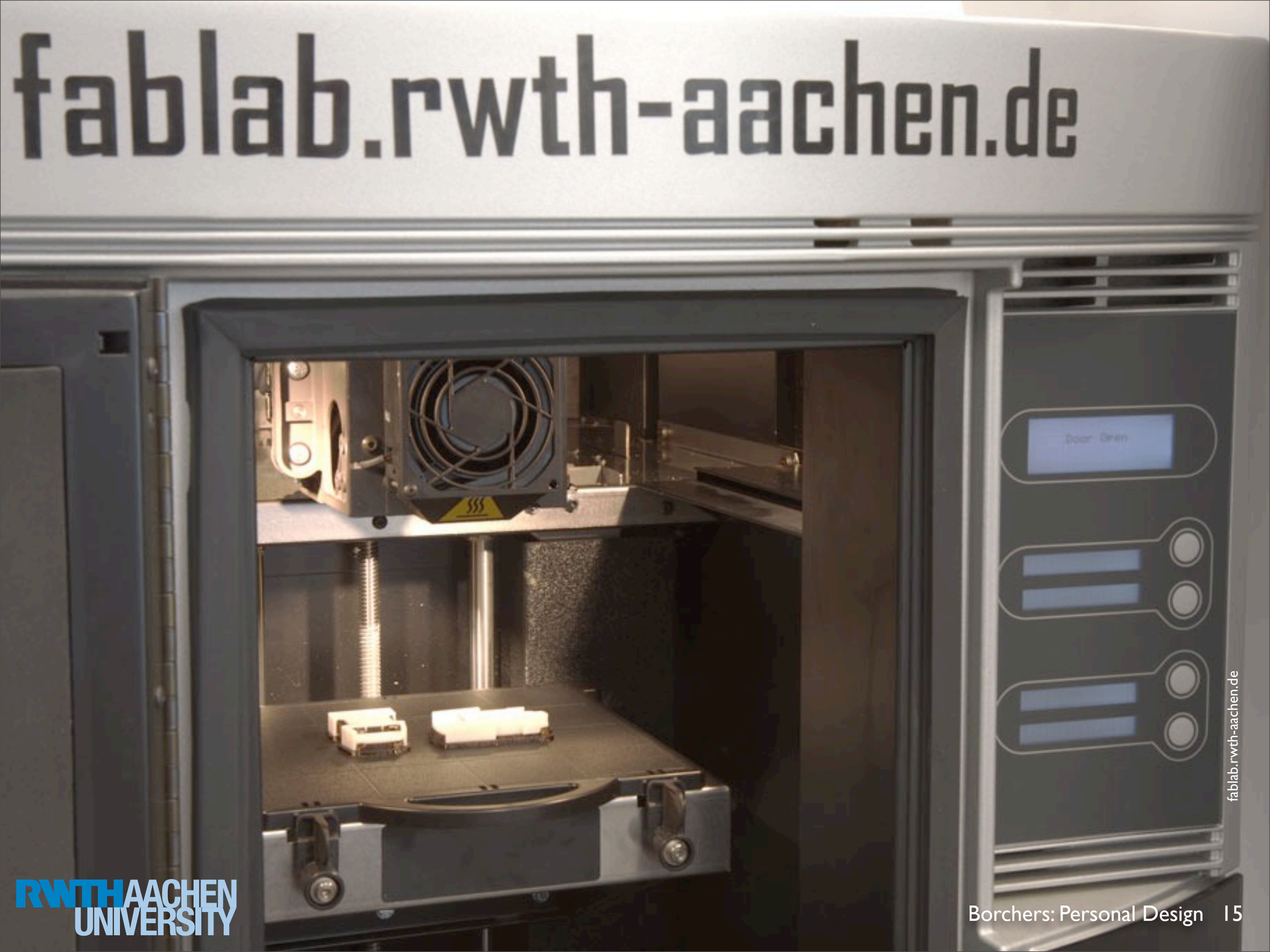


flickr.com/photos/bre/3458247336/

Bre Pettis

flickr.com/photos/bre/5611086130/

Tools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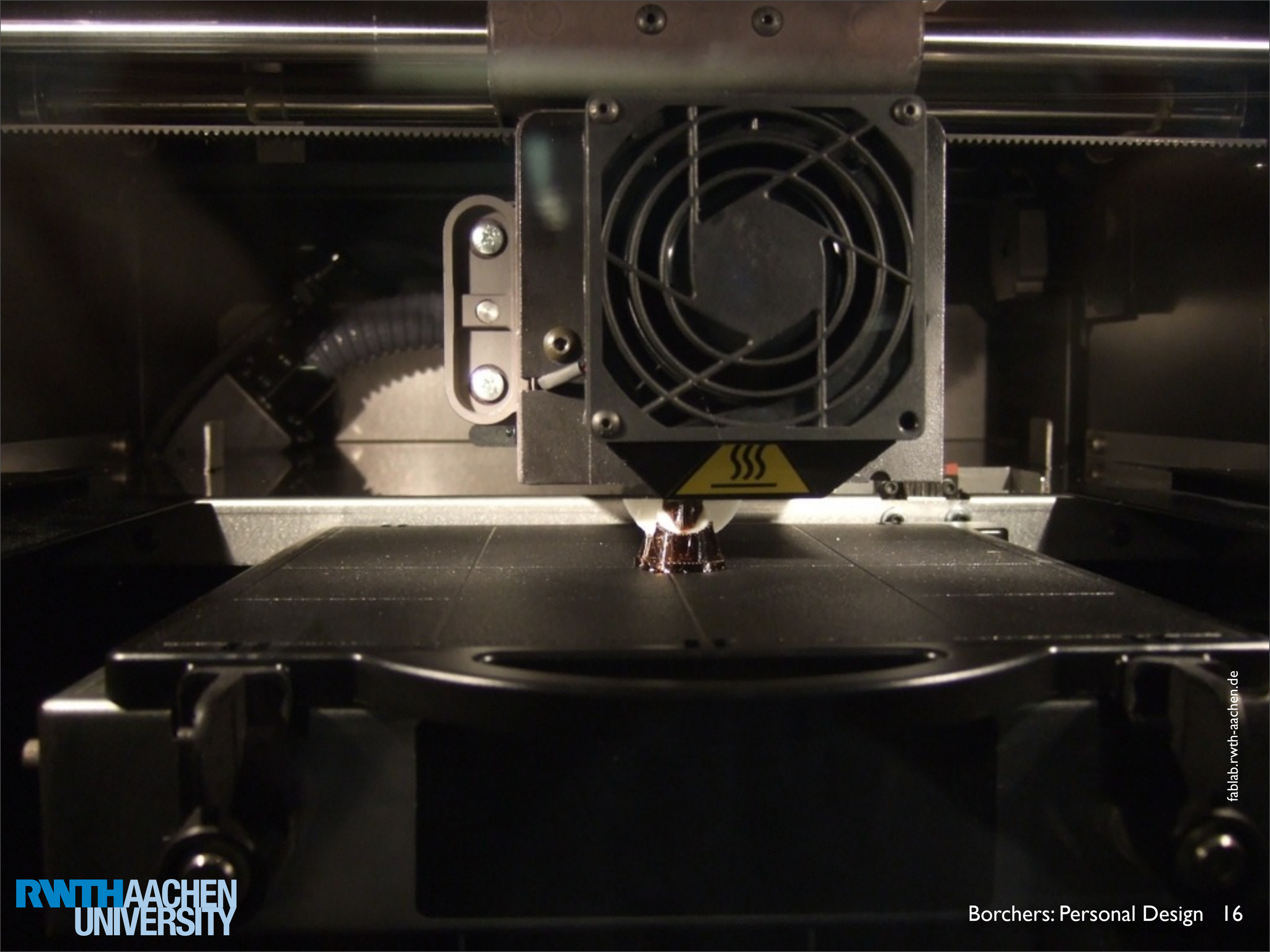
Door: Open
fablab.rwth-aachen.de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Flickr.com / Danny Choo
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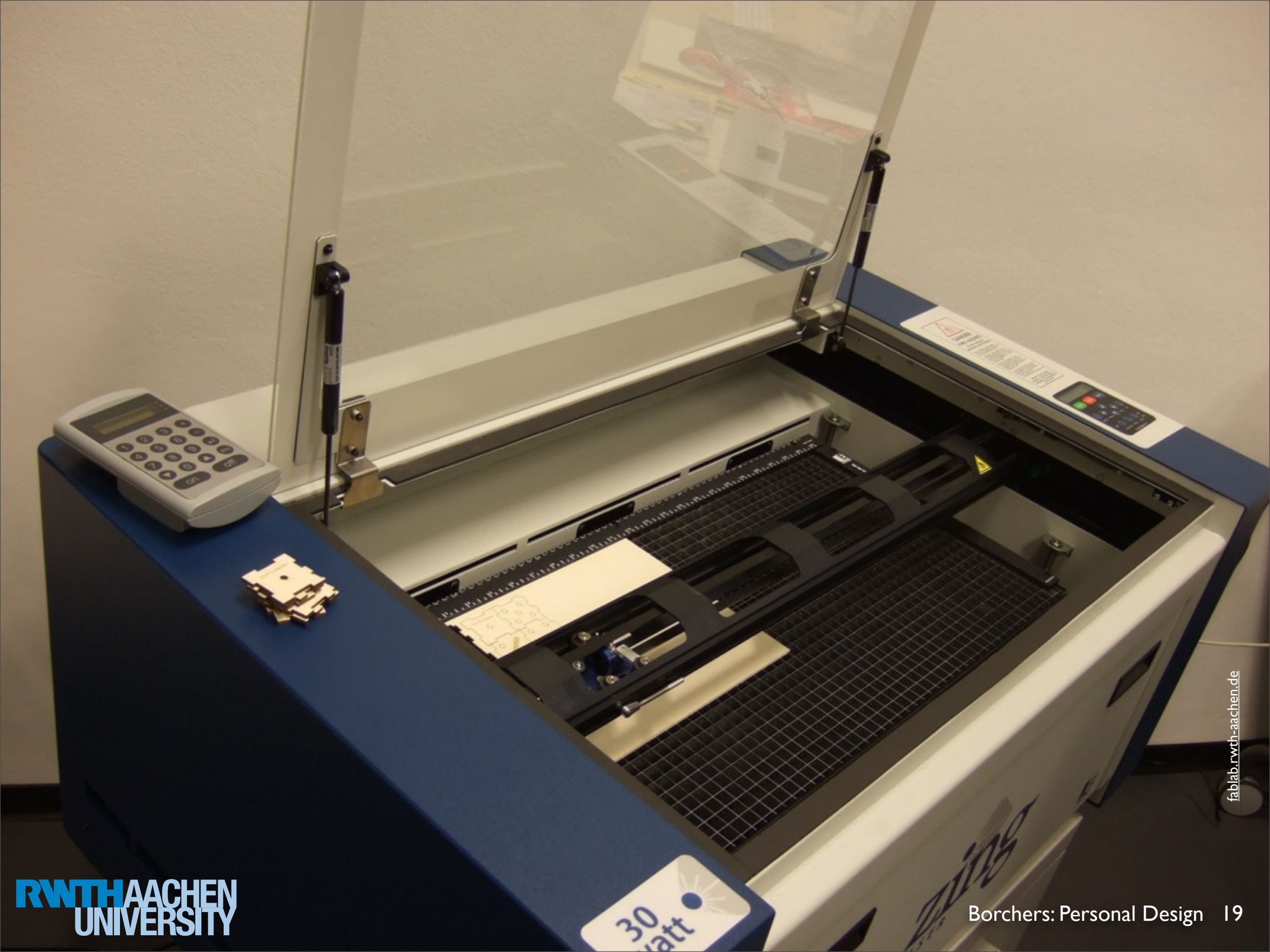
AutoDesk, San Francisco



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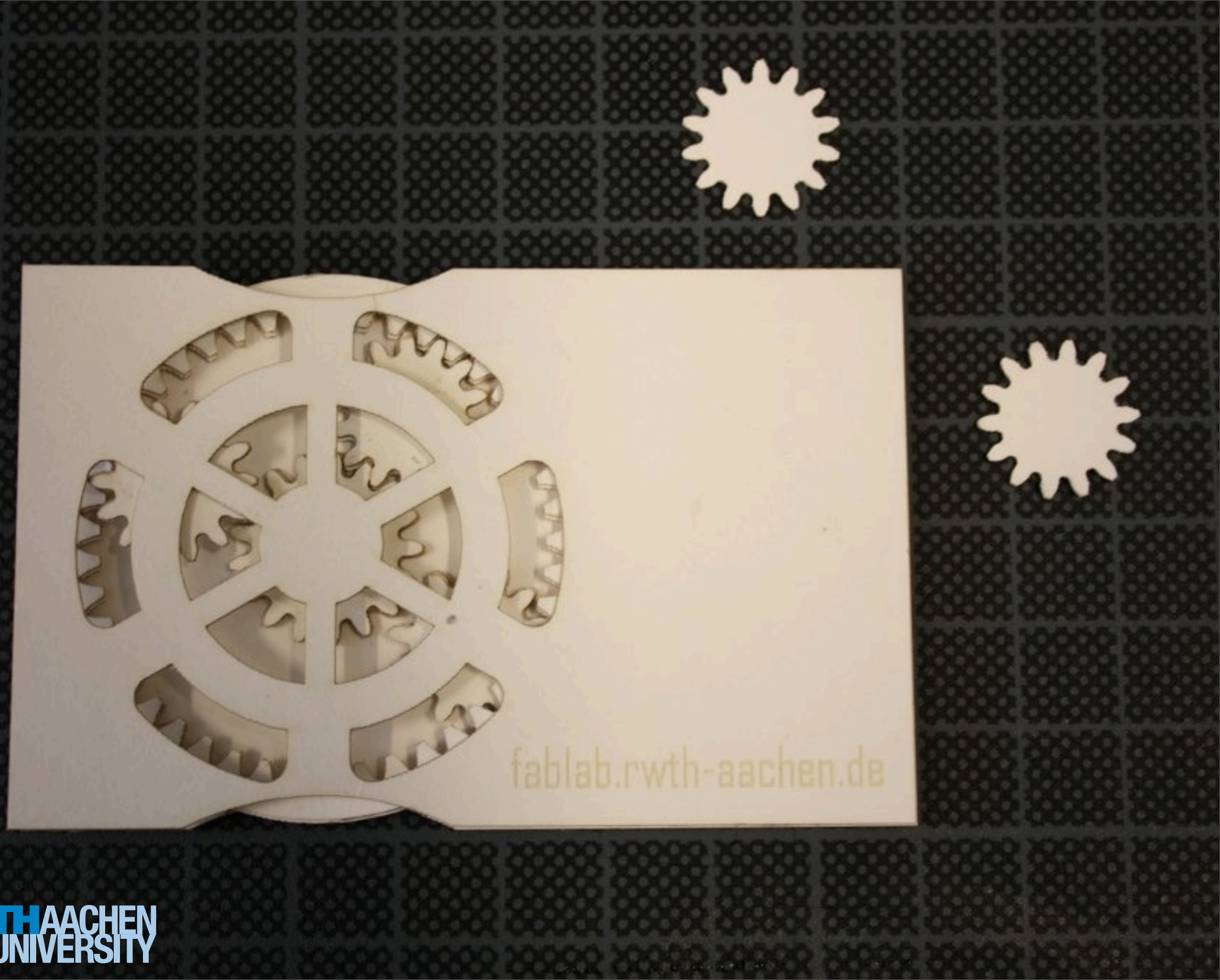

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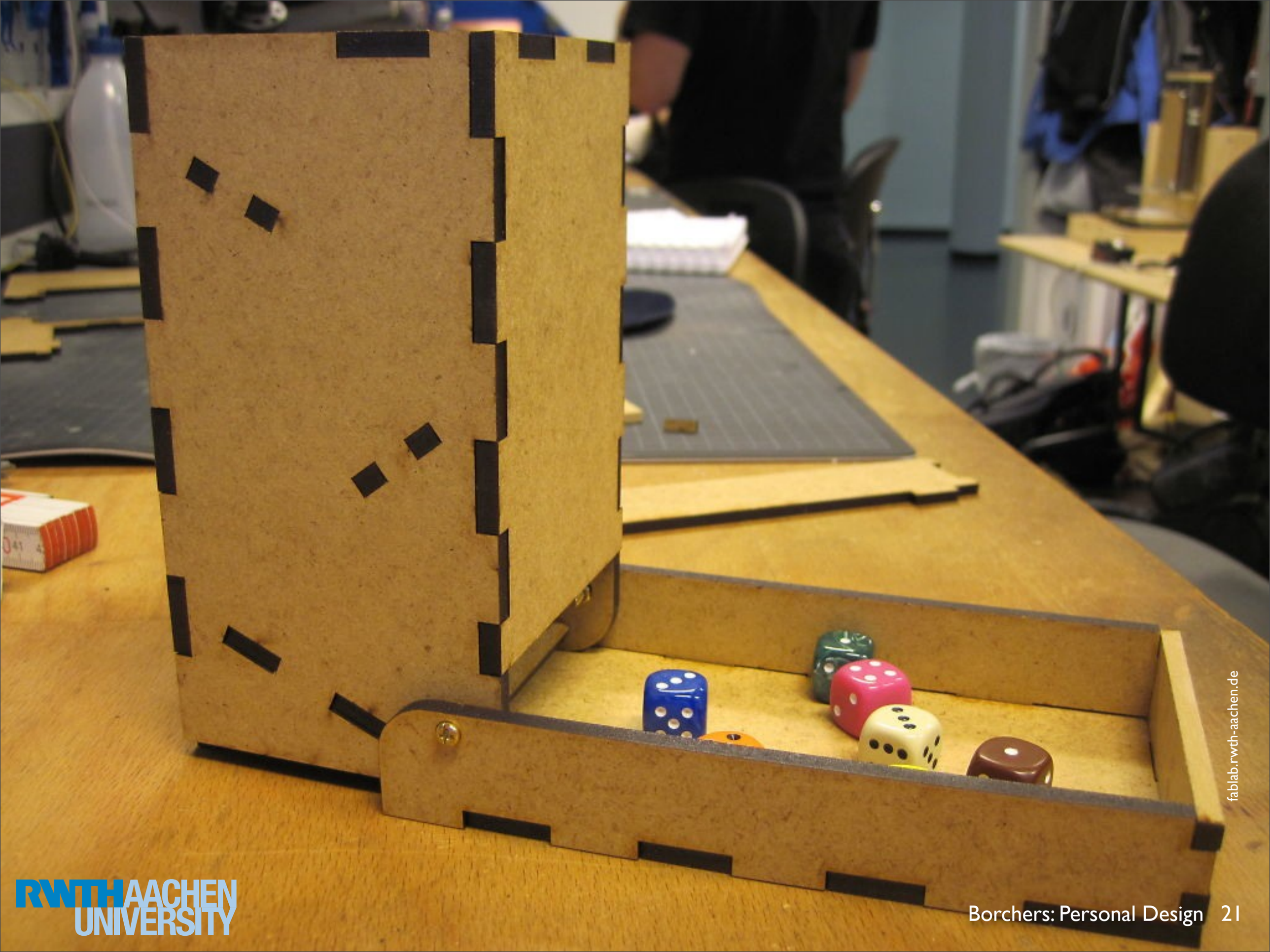
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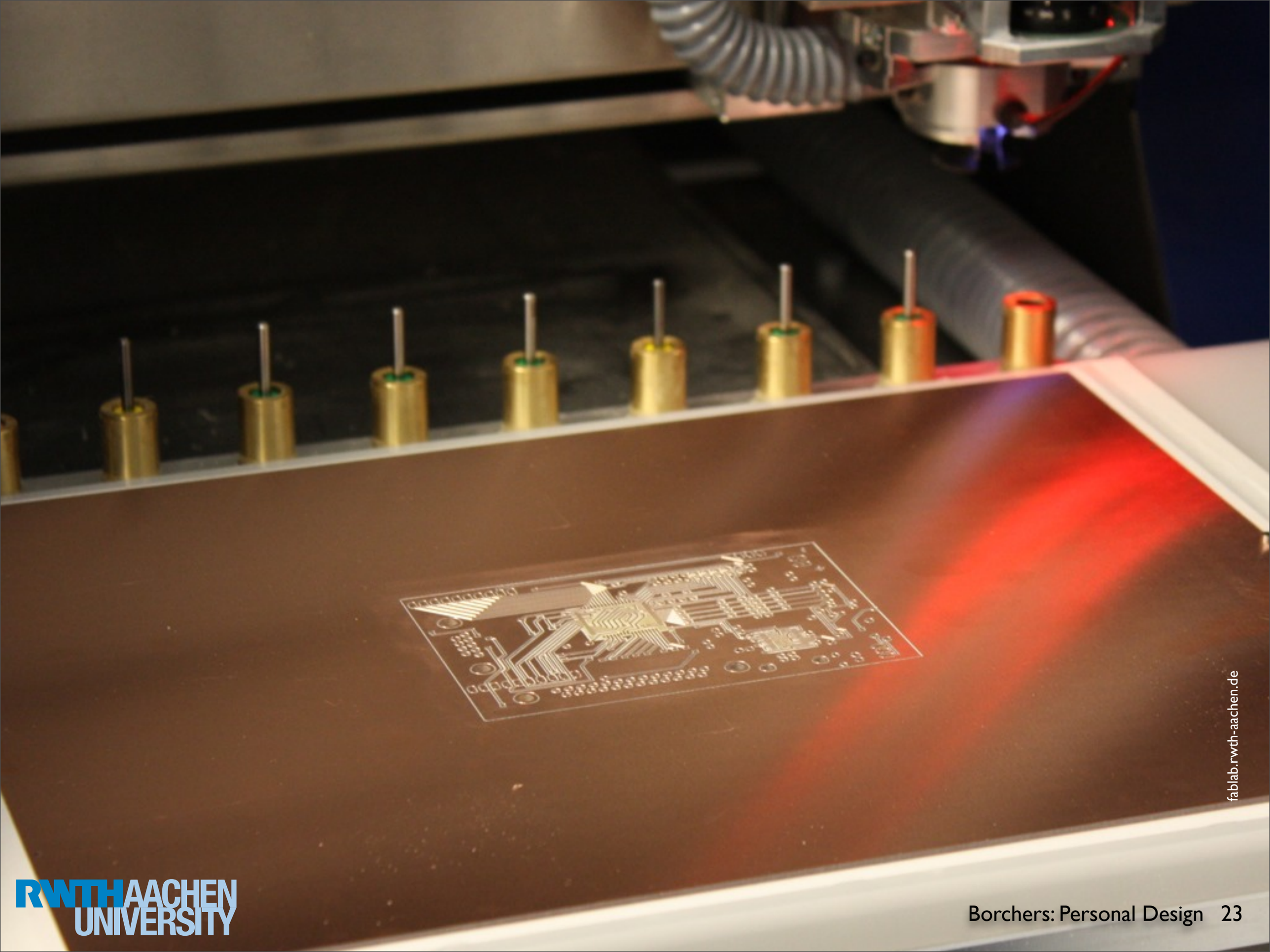
ShopBot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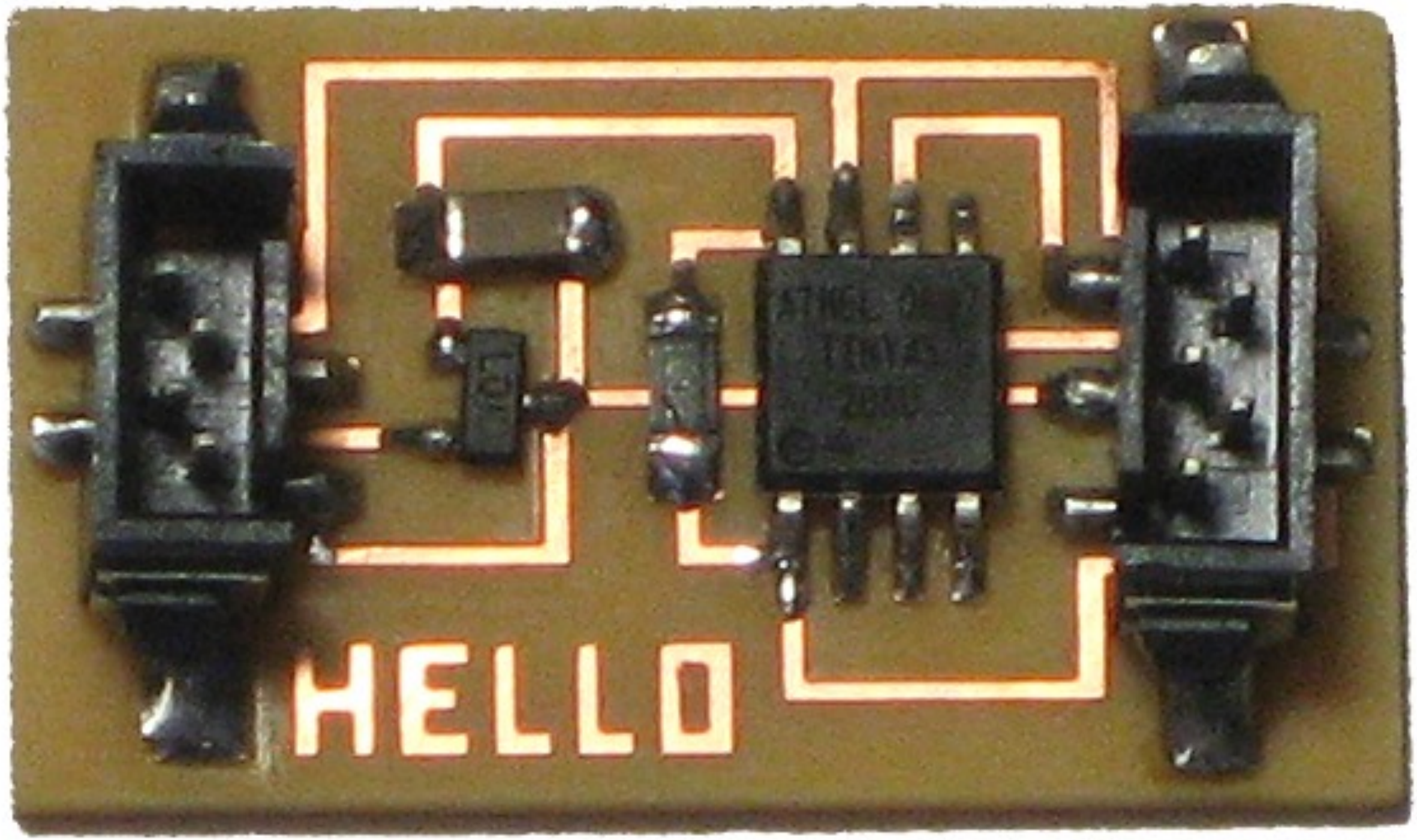
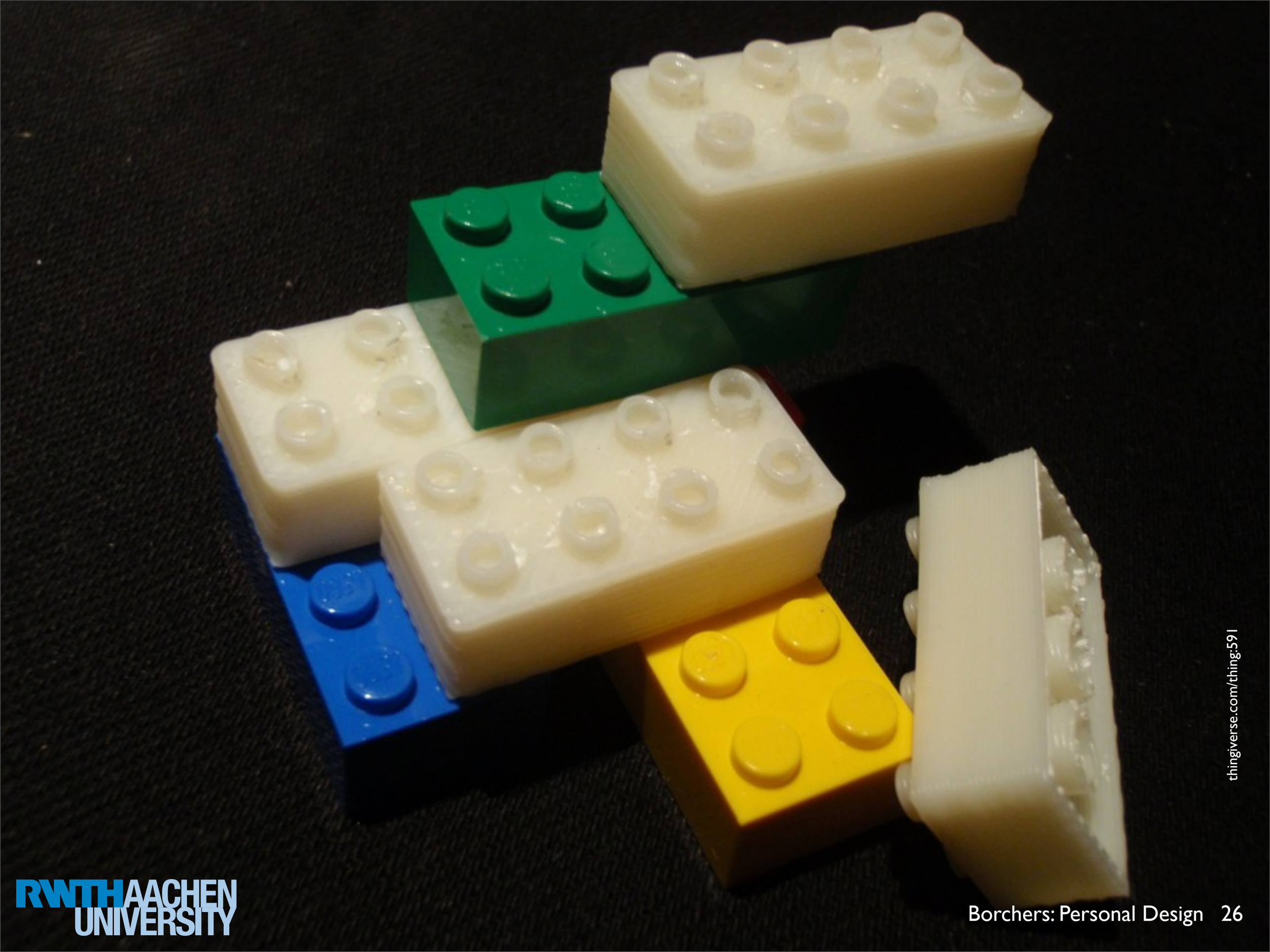
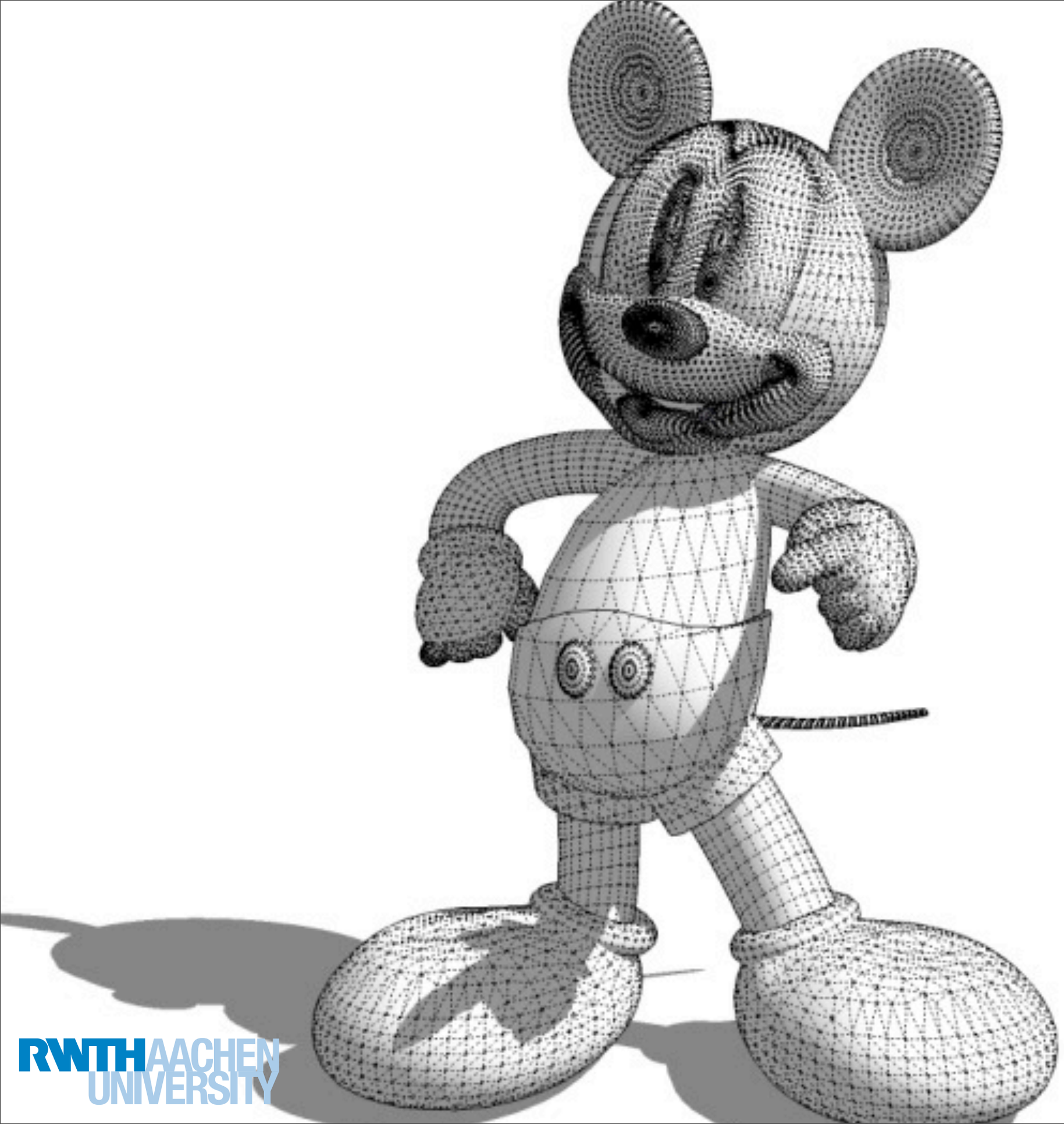

HELLO

Impact


thingiverse.com/thing:591



solosplace.com/images/Mickeyline.jpg

wired.com/design/2012/05/3-d-printing-patent-law

boingboing.net/2009/09/16/working-handcuff-key.html

bbc.co.uk/news/technology-22423883

Fab Labs

- Free access to personal fabrication tools
- Community-based labs
- Educational mission
- Gershenfeld (MIT), 83 worldwide
- Fab Lab Aachen: since 2009, first in Germany
- fablab.rwth-aachen.de

fablab.rwth-aachen.de

Weatherella
RWTH Aachen Universty 2010
hci.rwth-aachen.de/weatherella
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Larisa Katz
Cannes 2011
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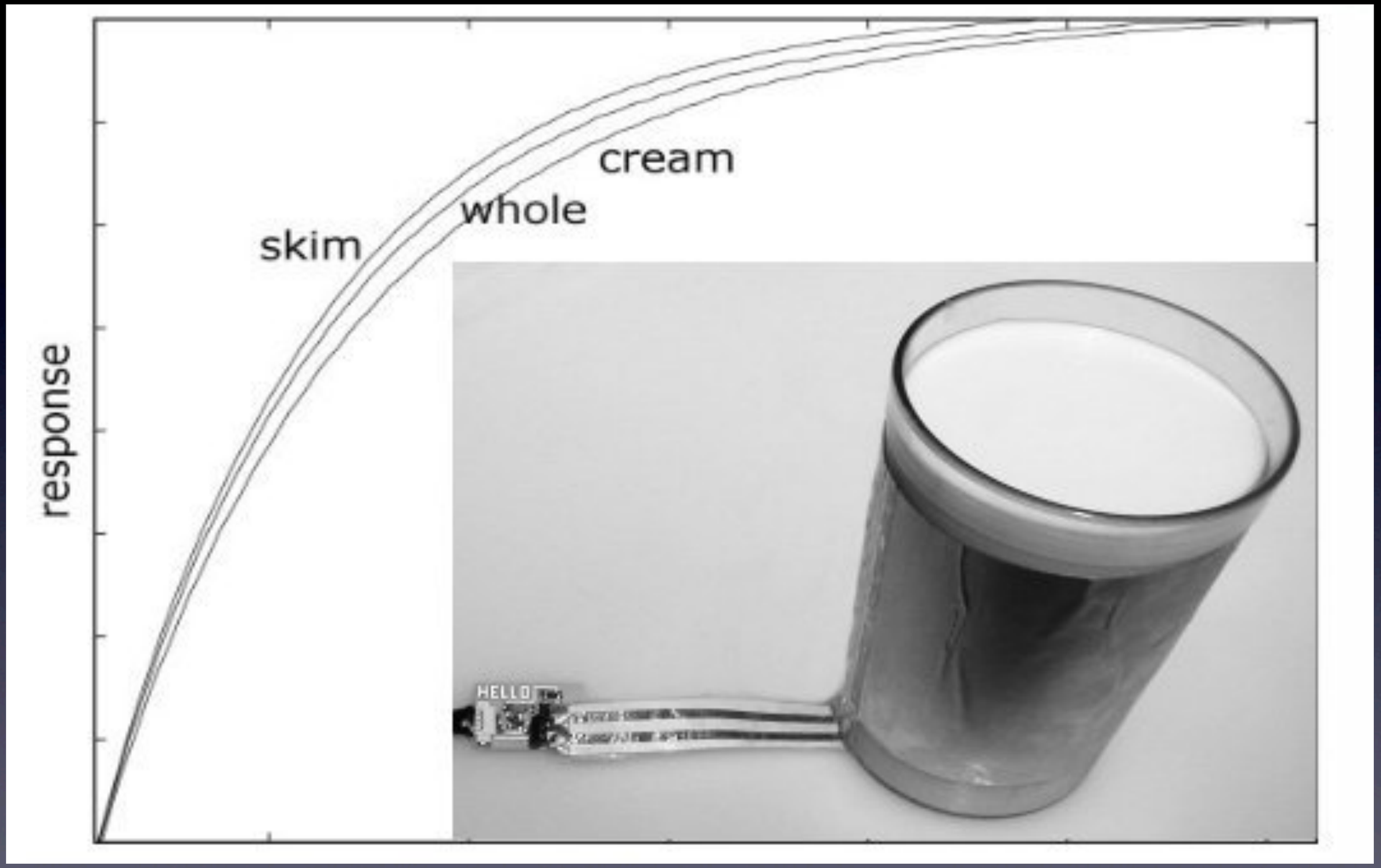
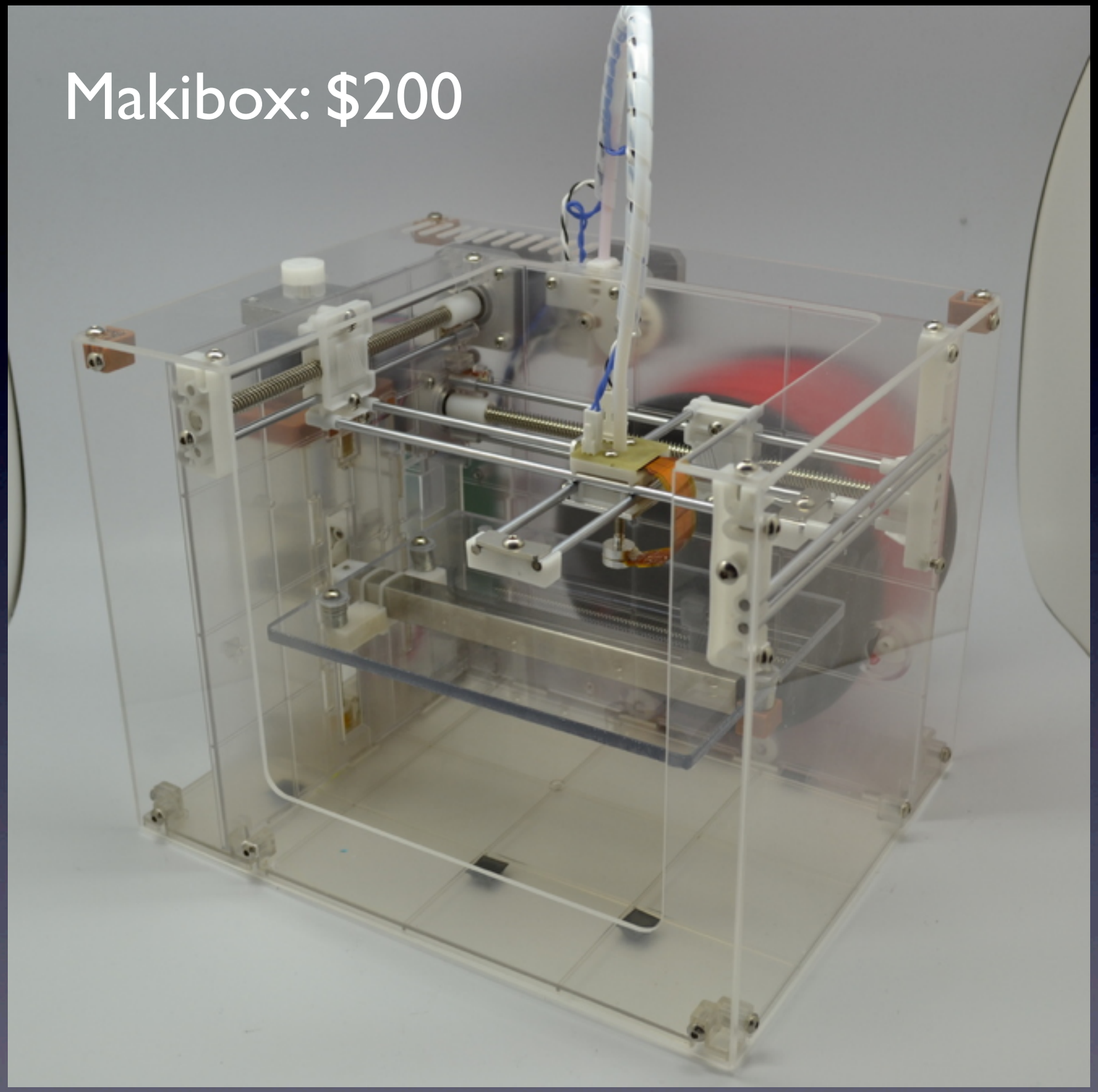
we make things
no war
Fab Lab
Afghanistan



Source: Gershenfeld 2010

Trends

Makibox: $200



RepRap (Bowyer 2008)

RWTH Master Class

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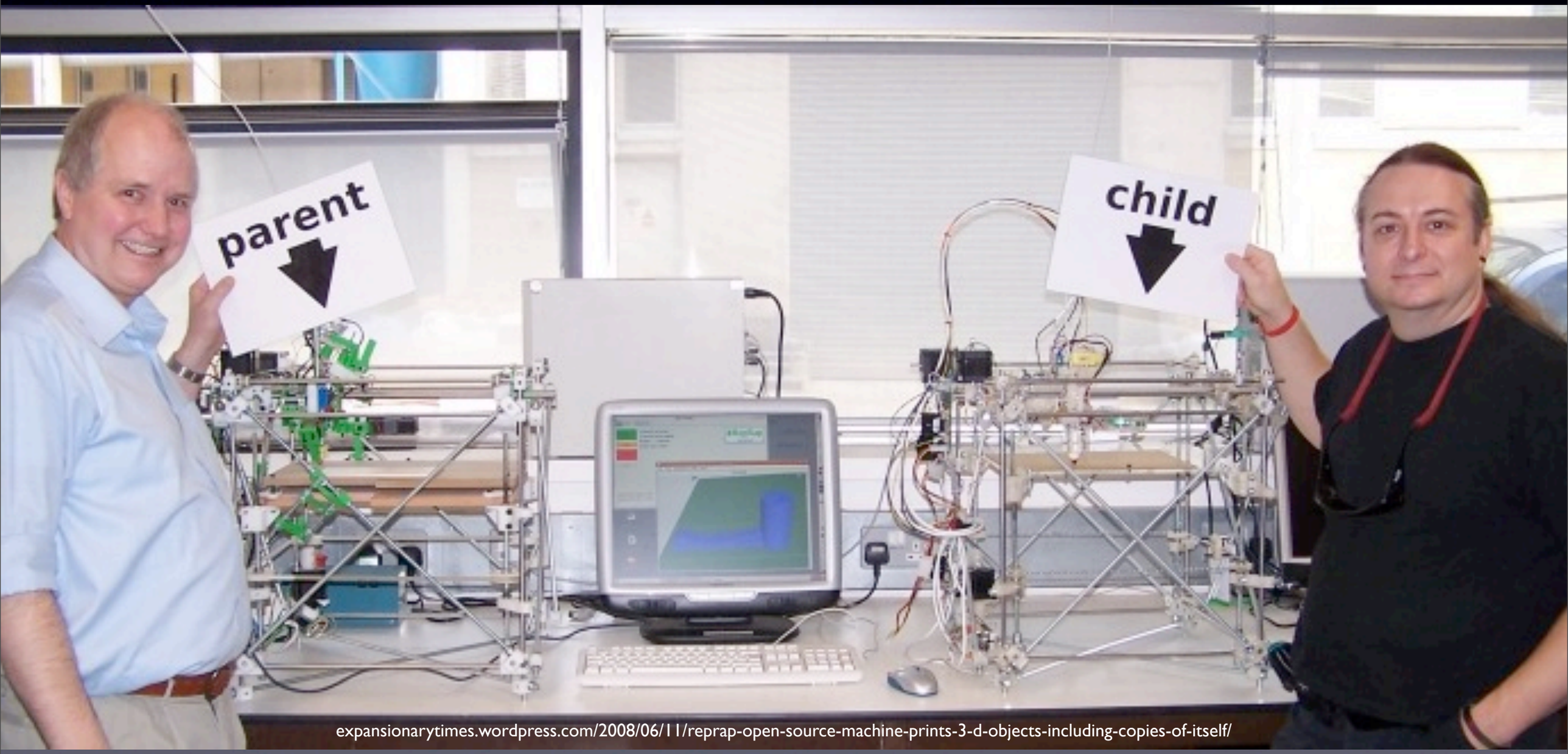
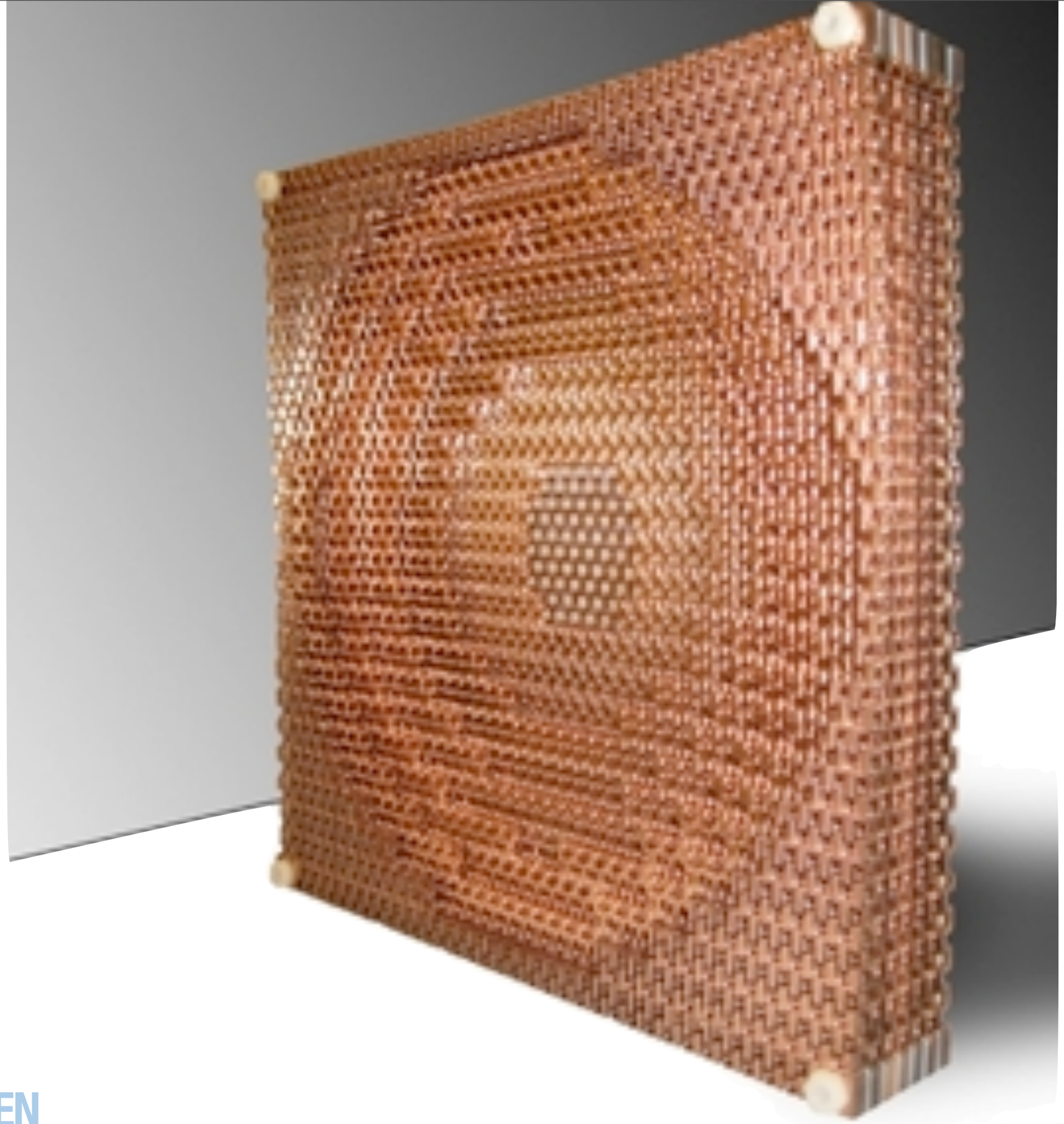
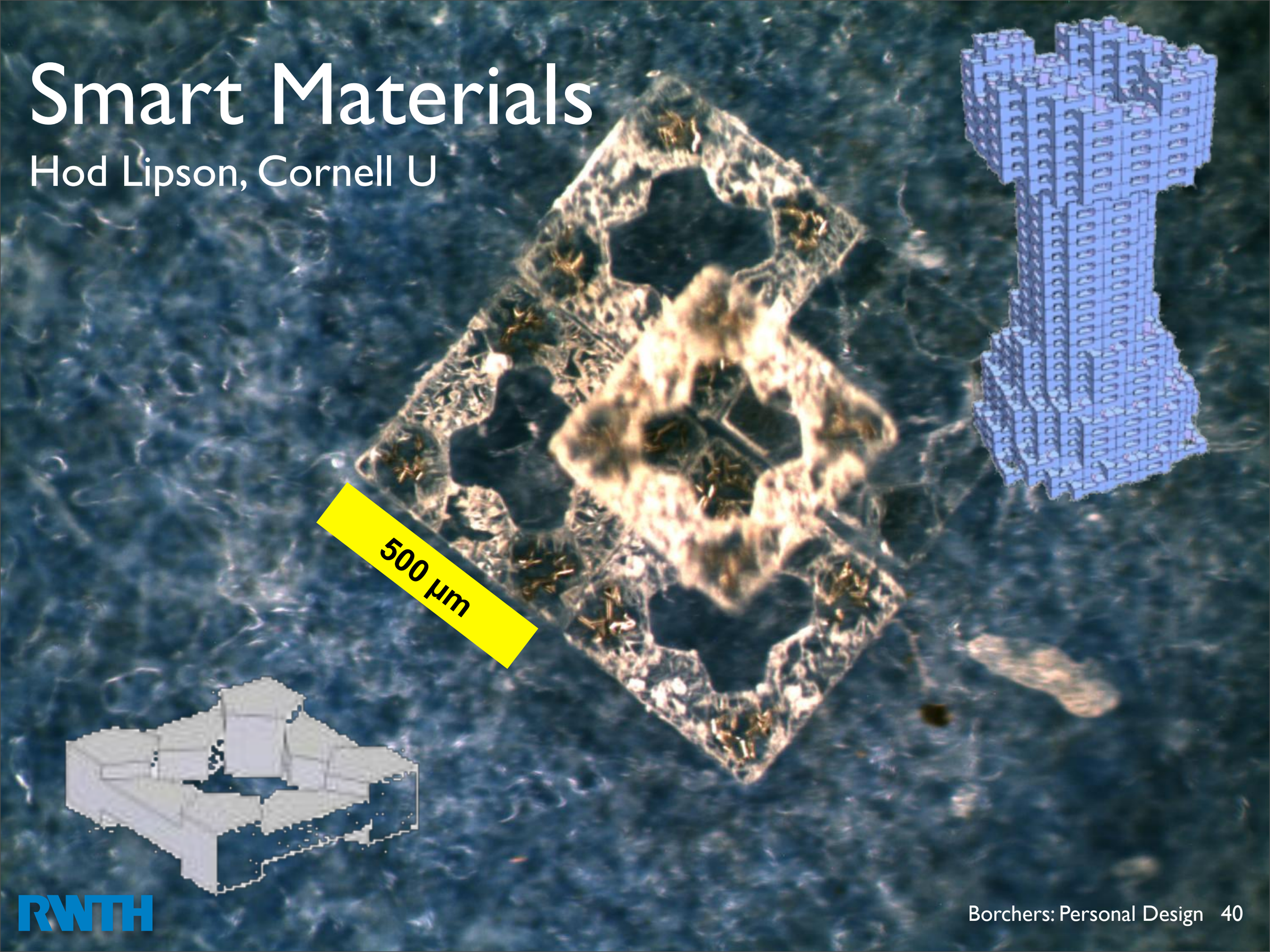


expansionarytimes.wordpress.com/2008/06/11/reprap-open-source-machine-prints-3-d-objects-including-copies-of-itself/



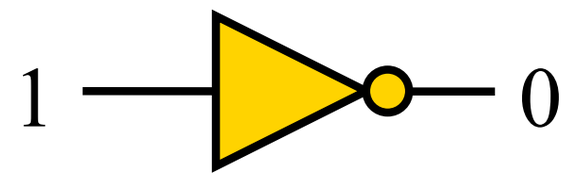
Smart Materials

Hod Lipson, Cornell U

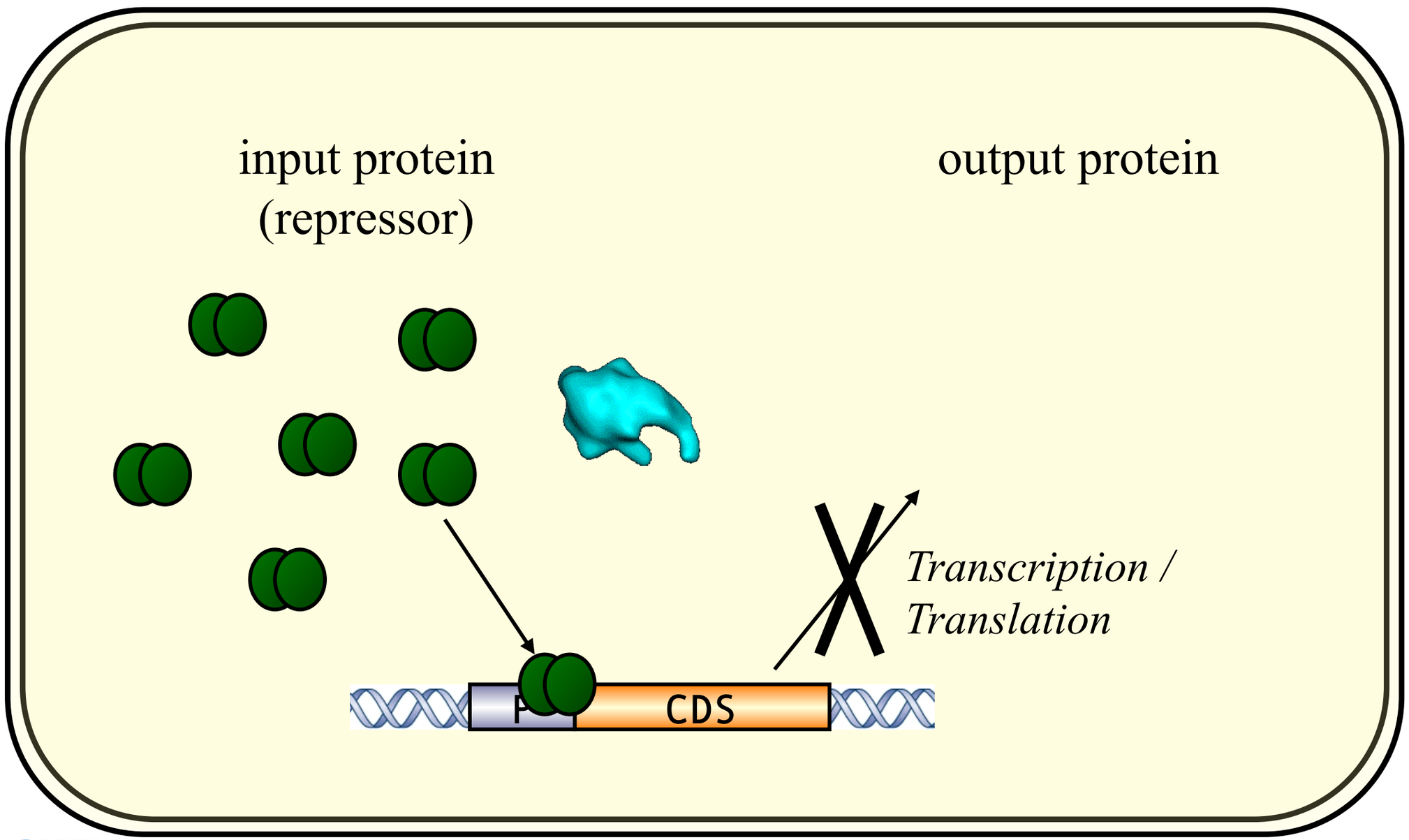


Genetic Building Block – Digital Inverter

Ron Weiss,
BioEng, MIT



Also:
Toggle
MUX
Amp
Osc
...



Printing houses

(D-Shape.com)

Four Stages?

- Fab 1.0: Expensive digital machines on dumb materials
- Fab 2.0: Easily replicated machines that make (MTM)
- Fab 3.0:, 4.0: Smart, self-arranging (replicating?) materials

Personal Design

SolidWorks Robot.SLDASM SolidWorks Search

Edit Component | Insert Components | Mate | Linear Compon... | Smart Fasteners | Move Component | Show Hidden Components | Assembly Features | Reference Geometry | New Motion Study | Bill of Materials | Exploded View | Explode Line Sketch | Instant3D

Assembly | Layout | Sketch | Evaluate | Office Products

- Robot (Default<Display State-1>)
  - Sensors
  - Annotations
  - Front Plane
  - Top Plane
  - Right Plane
  - Origin
  - (f) C 27<1> (Default<<Defau
  - Corner<2> (Default<<Default
  - Corner<3> (Default<<Default
  - Corner<4> (Default<<Default
  - Corner<5> (Default<<Default
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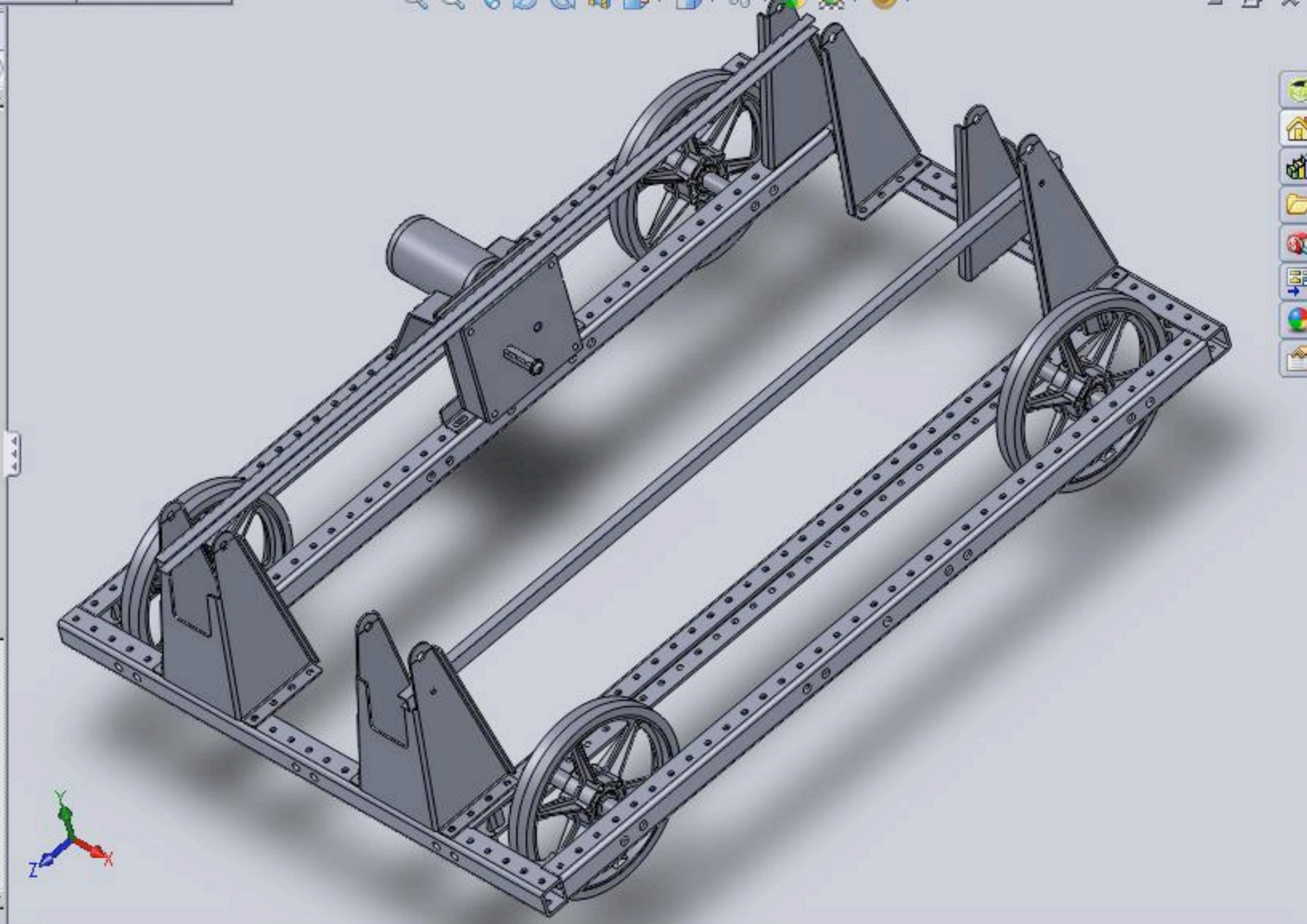


Model | Motion Study 1

SolidWorks Education Edition - Instructional Use Only | Under Defined | Editing Assembly

Start | SolidWorks Educatio... | 5:18 PM

Lego Compatible Disc Buttons by clothbot – Thingiverse

http://www.thingiverse.com/thing:1005

a MakerBot Industries website

THINGIVERSE

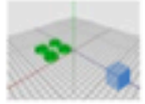
THINGS TOOLS TAGS BLOG

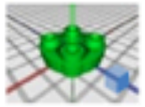
Welcome back, jan.
Thingiverse is awesome because of you.
[LOG OUT]

SEARCH

Thingiverse is a place to share digital designs that can be made into real, physical objects. Let's create a better universe, together!

UPLOAD A THING





Lego Compatible Disc Buttons

Created by
clothbot

Created on Sep 13, 2009

Featured on Sep 14, 2009

How do you make a great idea like Makerbot-printable (clothing) buttons better?

Why, make them Lego Compatible! Naturally.

Update 2009/10/04: In the design files, the knobs are 5mm in diameter. I remeasured my source Lego disc after getting back some Shapeways test prints and the Lego knobs are actually closer to 4.8mm in diameter. I lucked out with my MakerBot-printed buttons; shrinkage brought them down to about 4.9mm in diameter. The Shapeways printed versions are more accurate, 5.00mm diameter, +/- 0.05mm. There's enough give in the plastic materials for them to still fit 'regulation size' lego blocks, but the metal one was simply too wide a diameter.

Update 2009/11/07: I've been playing around with OpenSCAD (http://www.openscad.org/) and came up with the attached DiscButton_20091107 variation. I even added bottom "sockets" to this variation. It's almost too easy when it's all code!

Disclaimer: LEGO is a trademark of the LEGO Group and these explorations are in no way associated with LEGO Group. Heck! The files are CC-licensed; nothing to stop them embracing and extending it themselves if they so chose! ;-)

Tweet 0 | Like 1 | submit | Flattr 0

Sort By | Date | Popular | File Type

DiscButton.stl
2 mb / 361 downloads / 2 years ago

Instructions

0. Download the STL. It prints four buttons.

ADVERTISEMENT
AdChoices
The 3D Printer

File
Edit
Goodies
Font
FontSize
Style
untitled

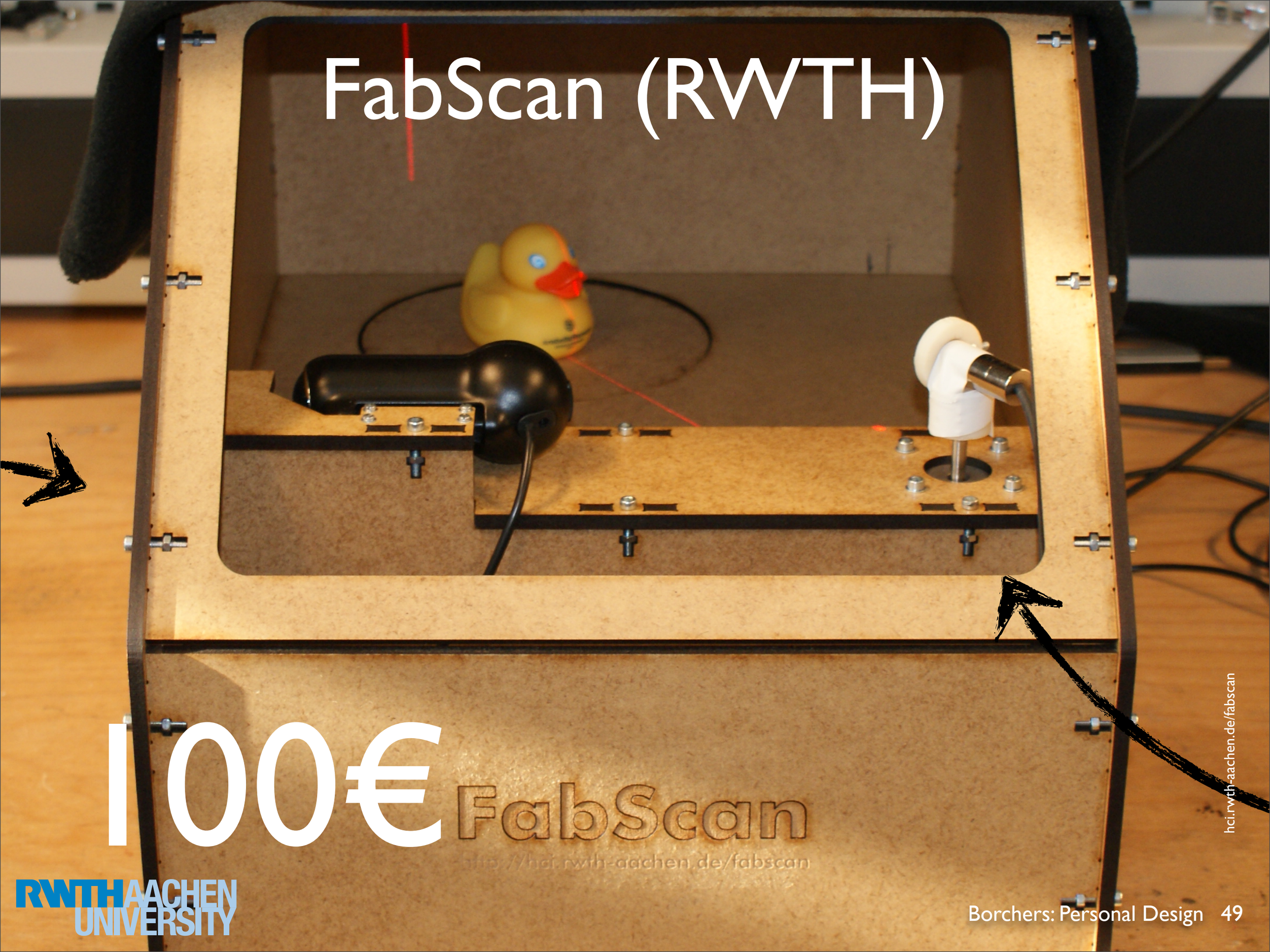
Make awesome stuff.

Flat is boring. Capture your world in 3D with free Autodesk 123D apps.

→ Meet the 123D Apps

123D	123D Catch	123D Sculpt	123D Make
Design stuff you really want to make, send it straight to a 3D printer.	Automatically convert ordinary photos into extraordinary 3D models.	Shape and paint digital clay into amazing 3D sculptures on your iPad.	Transform 3D models into a pattern for assembling real artful creations.

FabScan (RWTH)



100€

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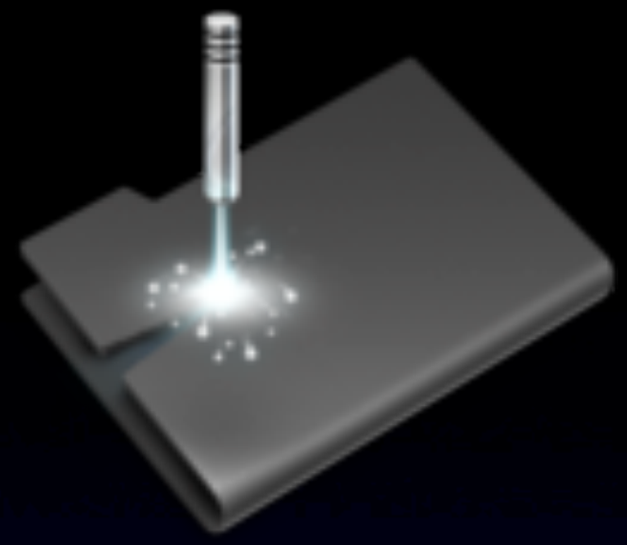

VisiCut

- The VisiCalc of LaserCutting
- Open-source, free
- http://hci.rwth-aachen.de/visicut

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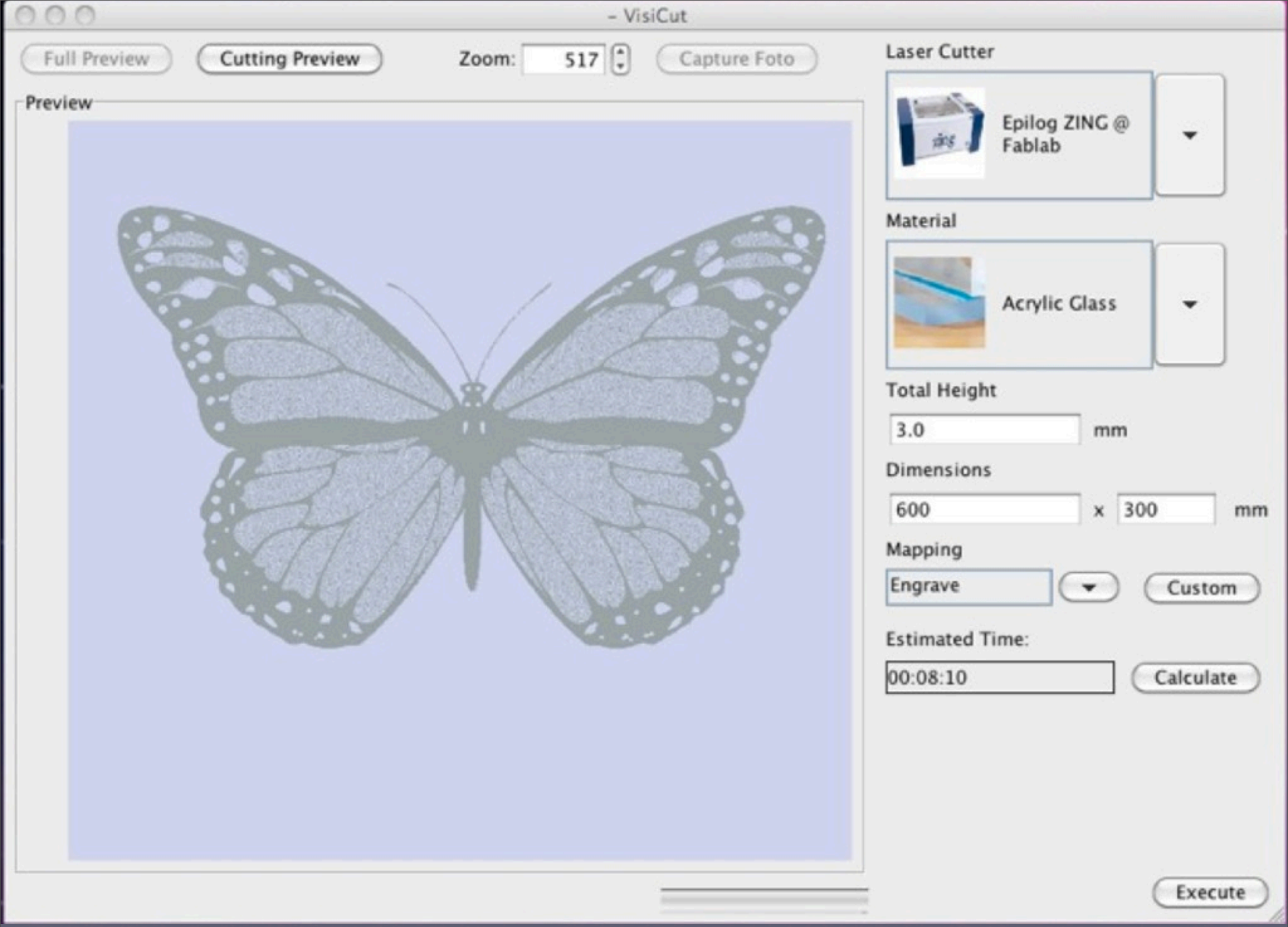
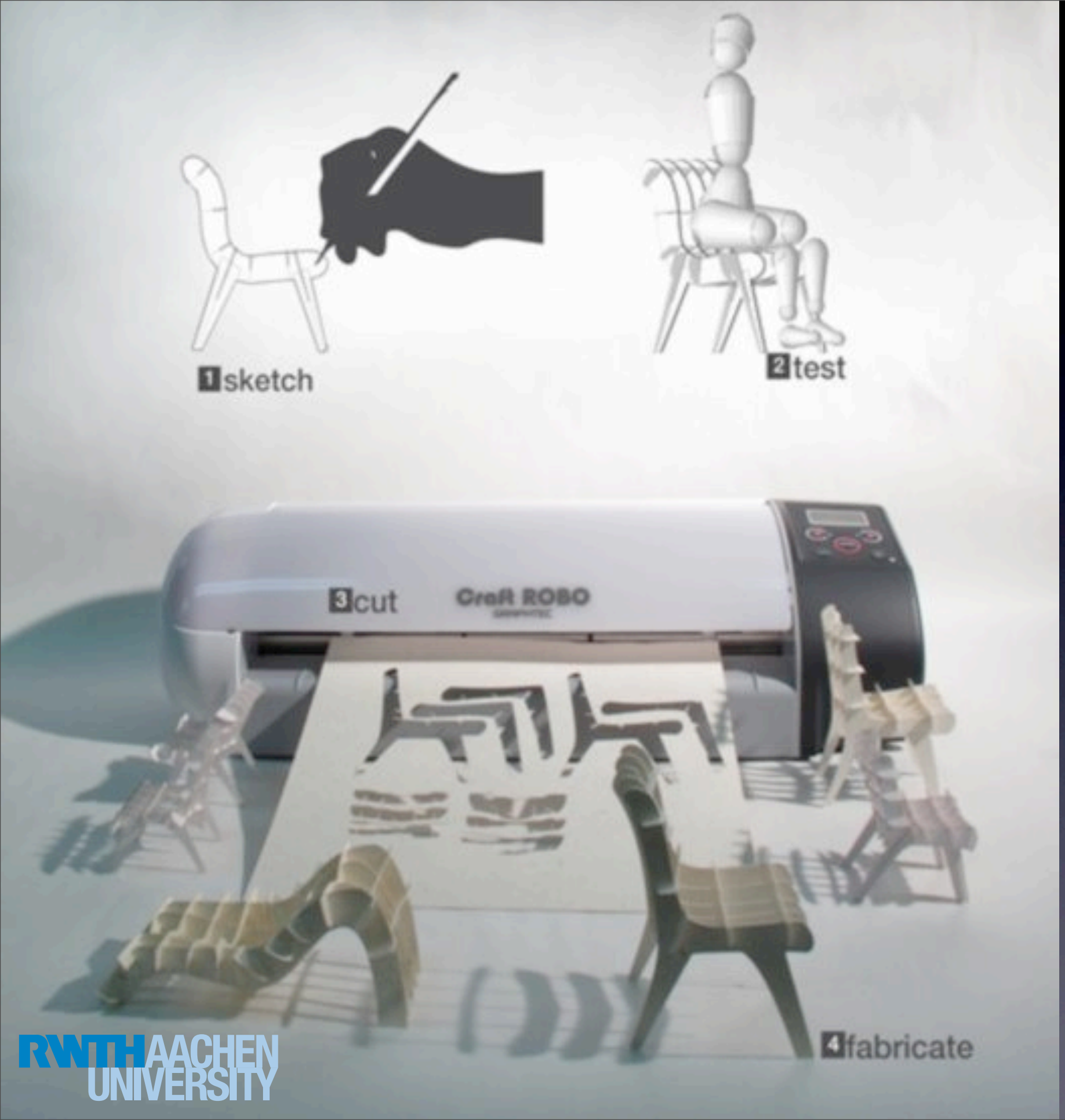

- VisiCut
Full Preview
Cutting Preview
Zoom:
517
Capture Foto
Preview
Laser Cutter
Epilog ZING @ Fablab
Material
Acrylic Glass
Total Height
3.0
mm
Dimensions
600
x
300
mm
Mapping
Engrave
Custom
Estimated Time:
00:08:10
Calculate
Execute

Cassius Lamp (AEC ’09)



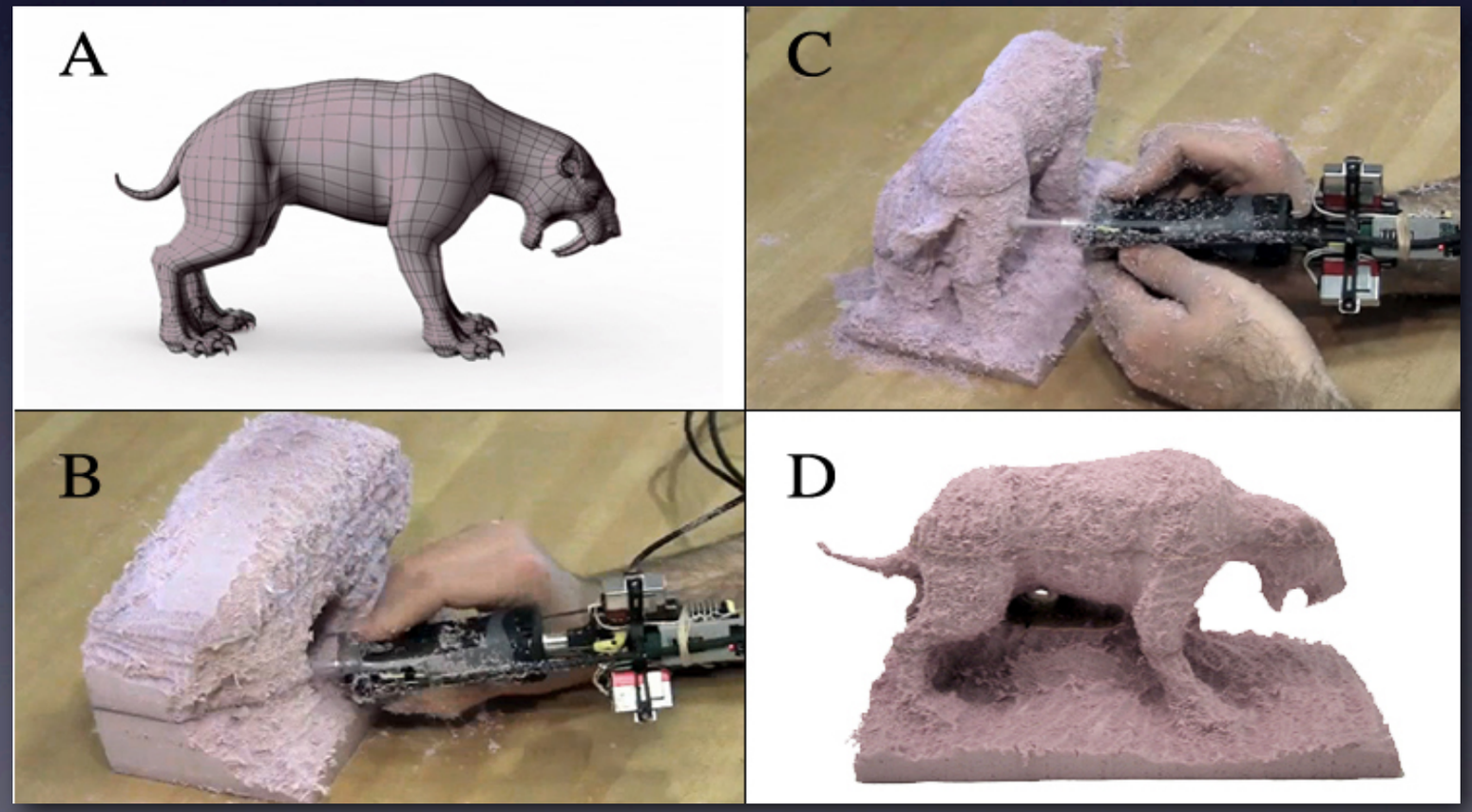
Sketch Chair (Greg Saul, 2010)

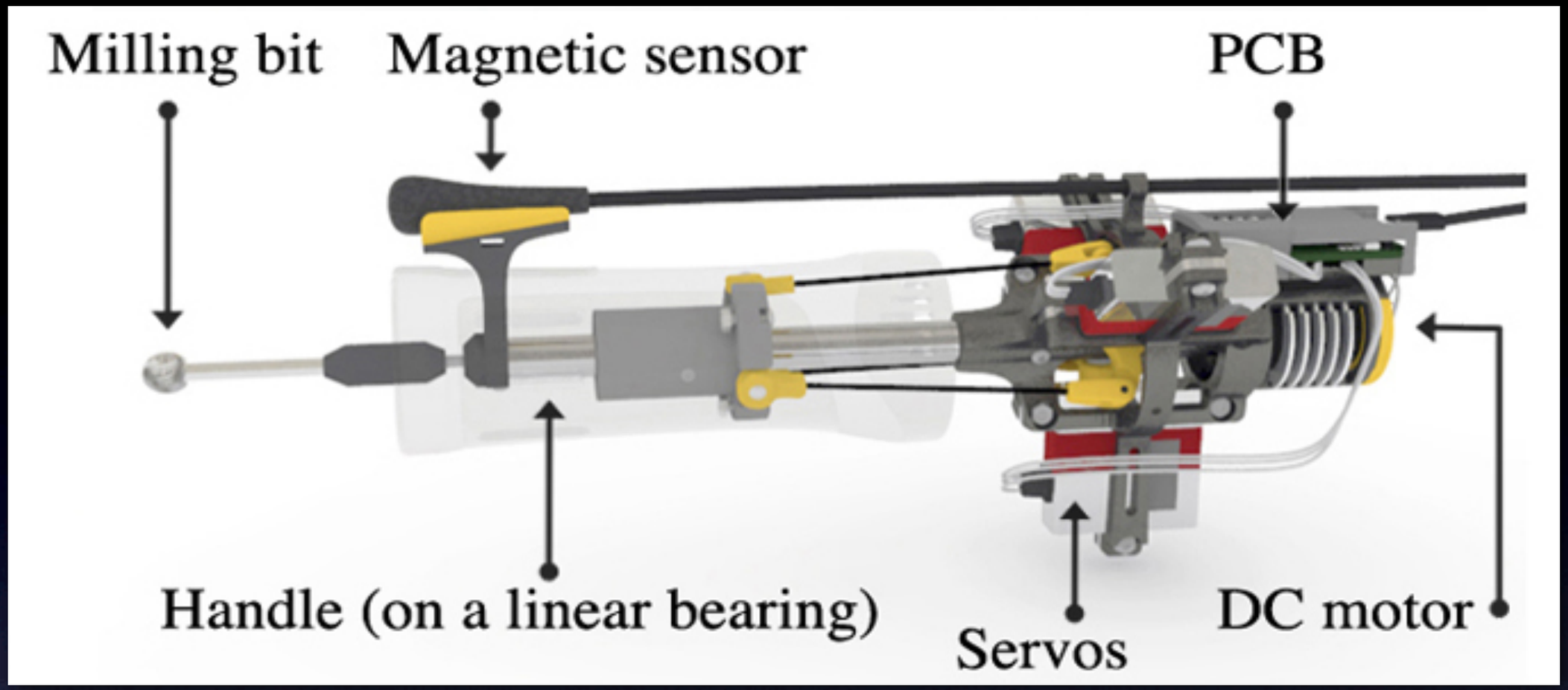
FRONT: Sketching Furniture (2007)

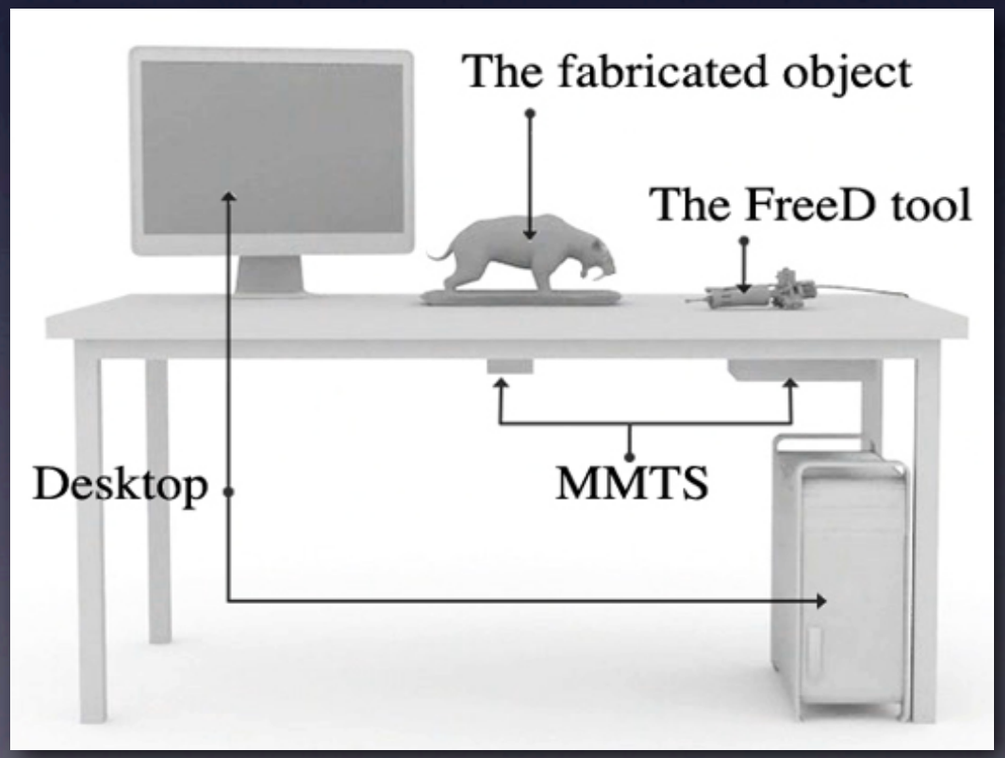
http://youtu.be/8zPlemldg5k

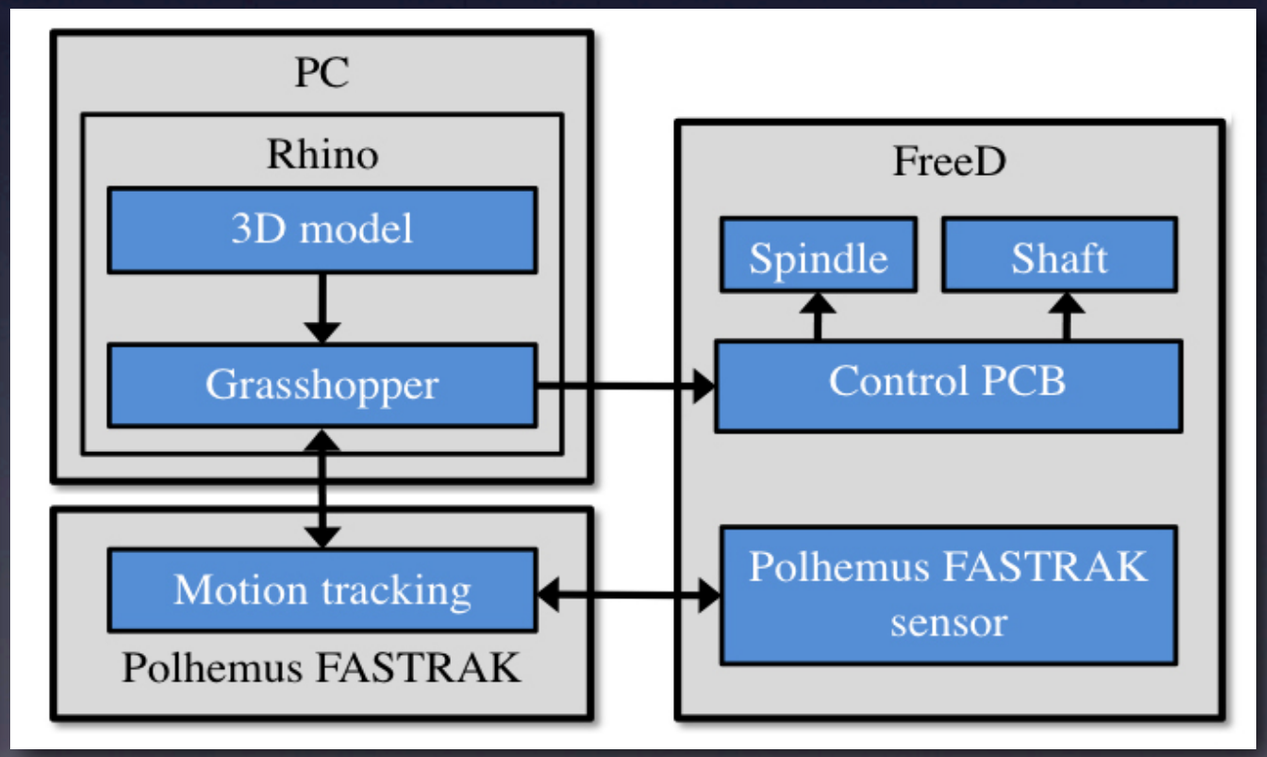
FreeD:
A Freehand Digital Sculpting Tool

- Amit Zoran, Joe Paradiso (MIT), CHI 2013 (vimeo.com/59826043)
- Handheld milling device knows 3D model, constrains sculptor to avoid, e.g., carving too deeply



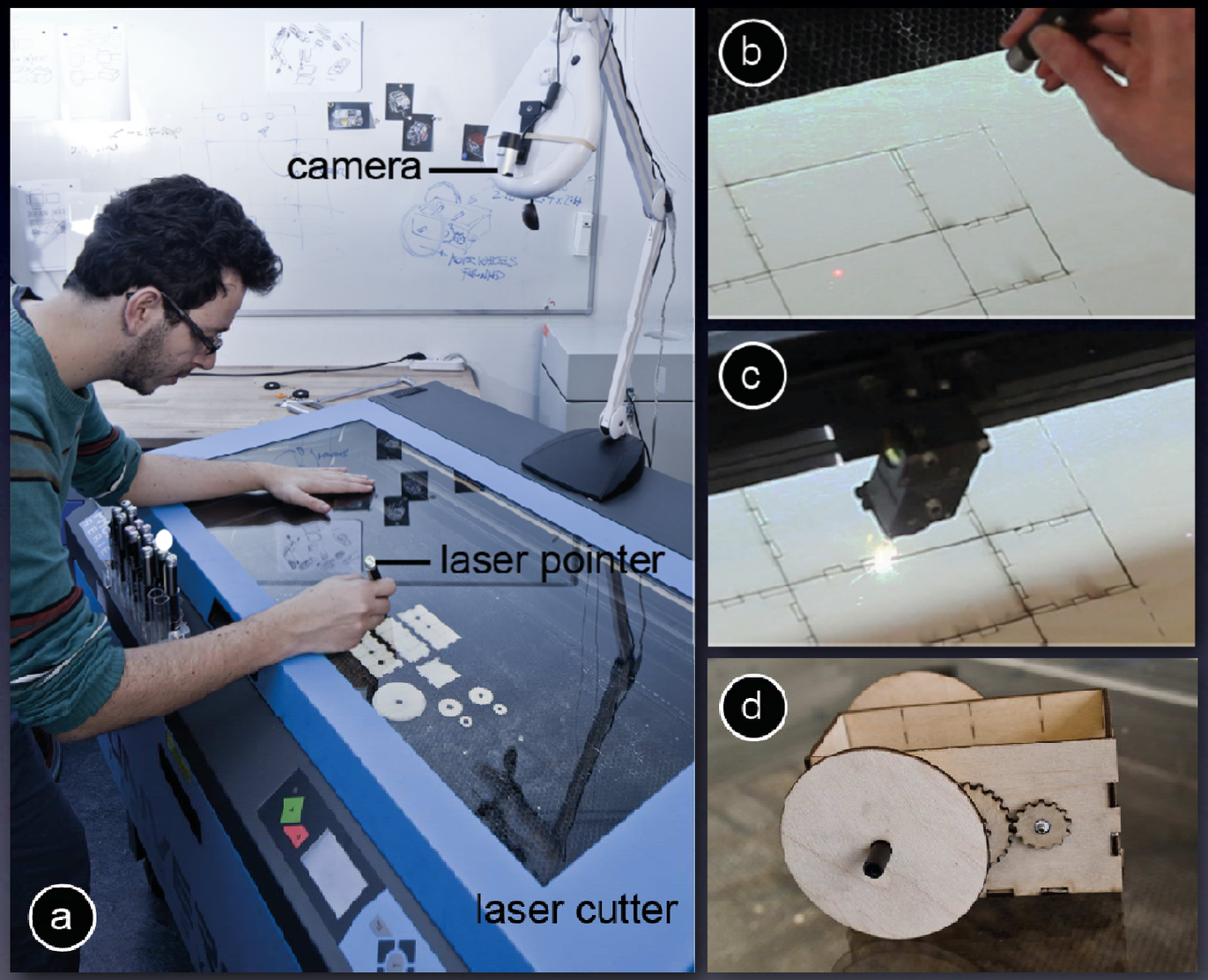

Milling bit
Magnetic sensor
PCB
Handle (on a linear bearing)
Servos
DC motor


The fabricated object
The FreeD tool
Desktop
MMTS


PC
Rhino
3D model
Grasshopper
Motion tracking
Polhemus FASTRAK
FreeD
Spindle
Shaft
Control PCB
Polhemus FASTRAK sensor

Interactive Construction

- Stefanie Mueller et al. (HPI), UIST 2012 (youtu.be/8g3LaF9oVFY)
- Use laser pointers to draw on material, lasercutter cuts interactively



Food

Furniture

Consumer electronics

(Copyrighted) Toys

Weapons

What?

Replacement parts

Prosthetics

Art

Small-market gadgets

3D Scan

AI, Assistants, Templates

CAD

Crowdsourcing

How?

Parameterization

Download/Query

Gesture

Touch&Haptics

Personal Design vs. Personal Fabrication

	Local Design	Outsourced Design
Local Fabrication	AutoCAD +RepRap	Thingiverse
Outsourced Fabrication	Shapeways	Traditional

Research Topics

- Tools for HCI & Ubicomp Research
  - Examples: SLAP, Madgets, Pneumatic Displays (CHI 2009)
- Software for Fabrication
  - 123D Make (Autodesk)
  - SketchChair.cc (Igarashi)
- New Interactions for Fabrication (beyond CAD)
  - FreeD
  - Constructables

maclife.com/article/feature/apple_their_eyes?page=0%2C4

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THAT EVERYONE CAN USE

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Shipping Dec 2013

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ON KICKSTARTER

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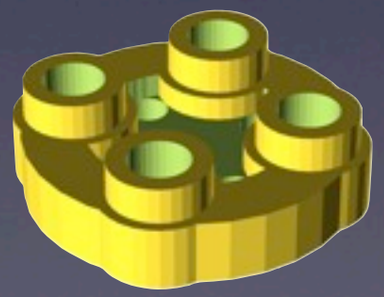
For Permanent Storage

1. Personal Fabrication: the 3rd digital revolution
2. 3D Printer, Lasercutter & Co.: lossless – fast – cheap
3. Personal Fabrication & Copyright, gun control,...
4. Fab Labs: hands-on Personal Fabrication
5. From intelligent molecules, to printing your house
6. Personal Design changes Ubicomp R&D & education
7. Personal Design needs new user interfaces



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