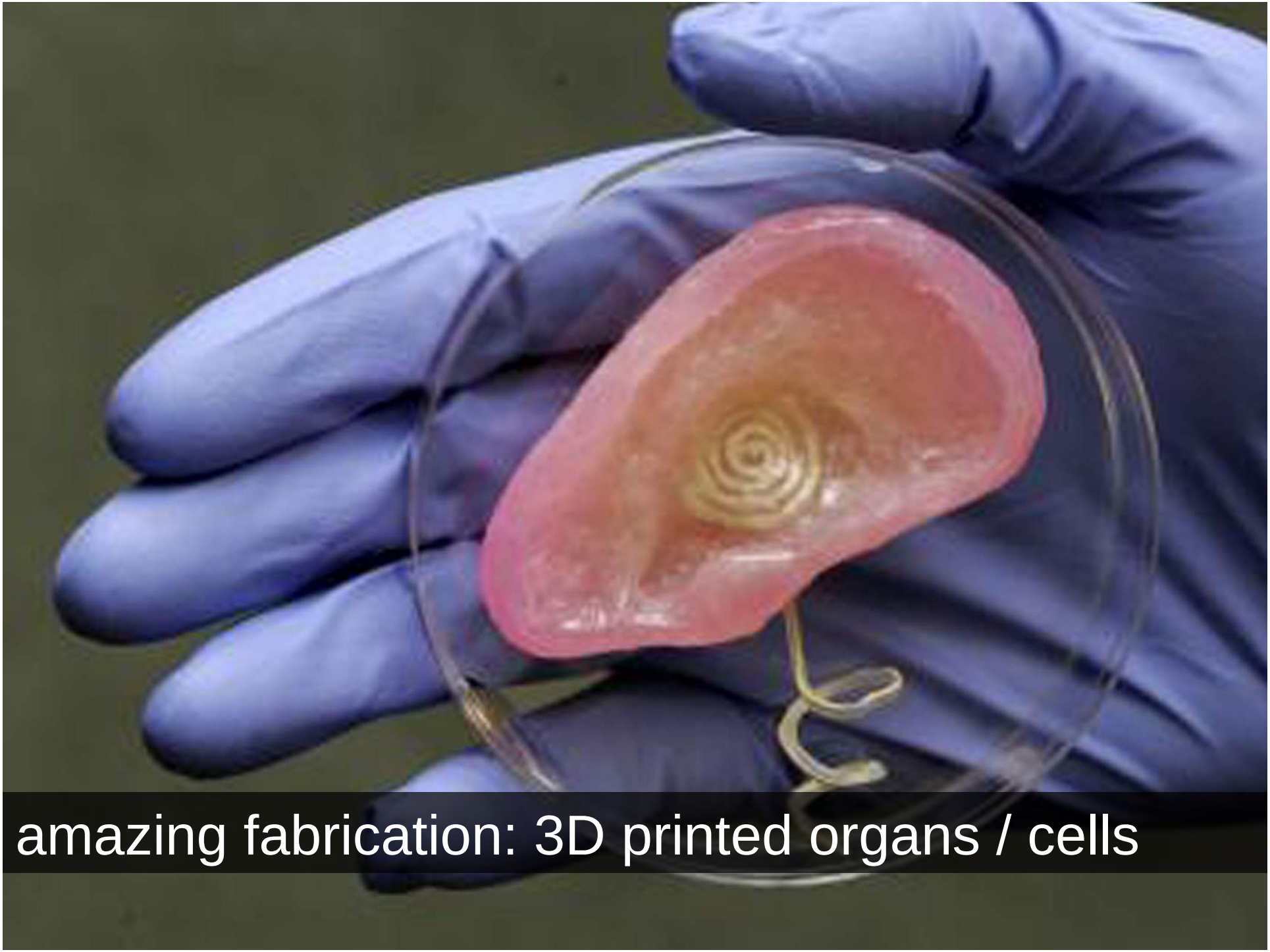
Fabrication Research

# 11

# Human Computer Interaction

COMS21301

Dr. Anne Roudaut
csxar@bristol.ac.uk


amazing fabrication: 3D printed organs / cells


3d printed car

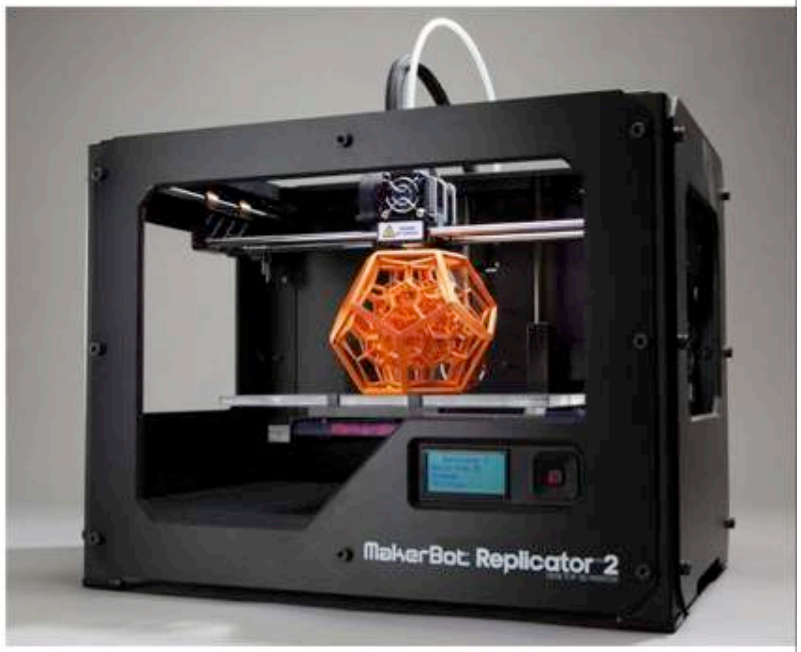

scary …

MANUFACTURER FILES FOR BANKRUPTCY

# 3D PRINTER COMPANY ASKS CLIENTS NOT TO PRINT 3D PRINTERS

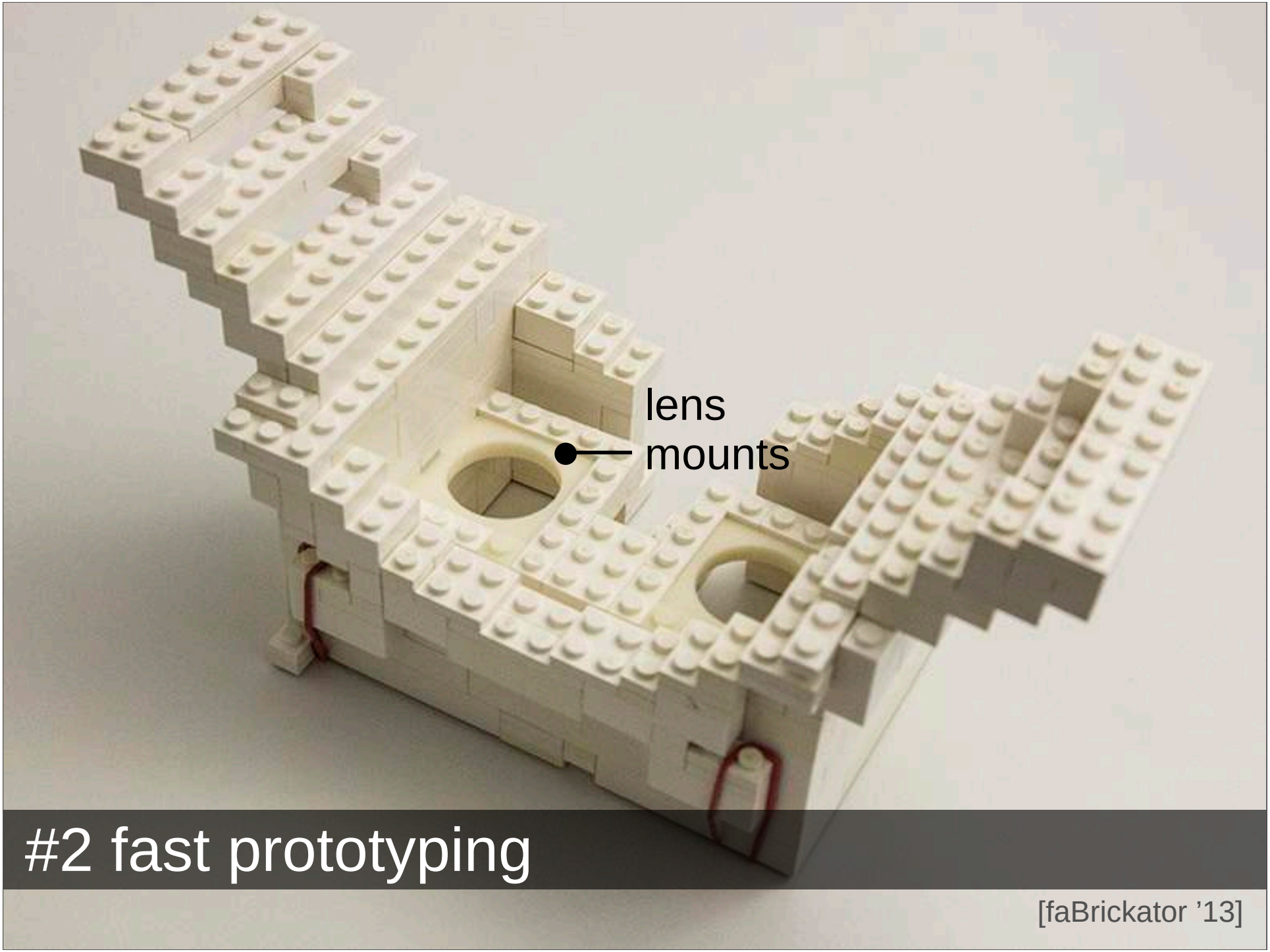
# overview

3D printer



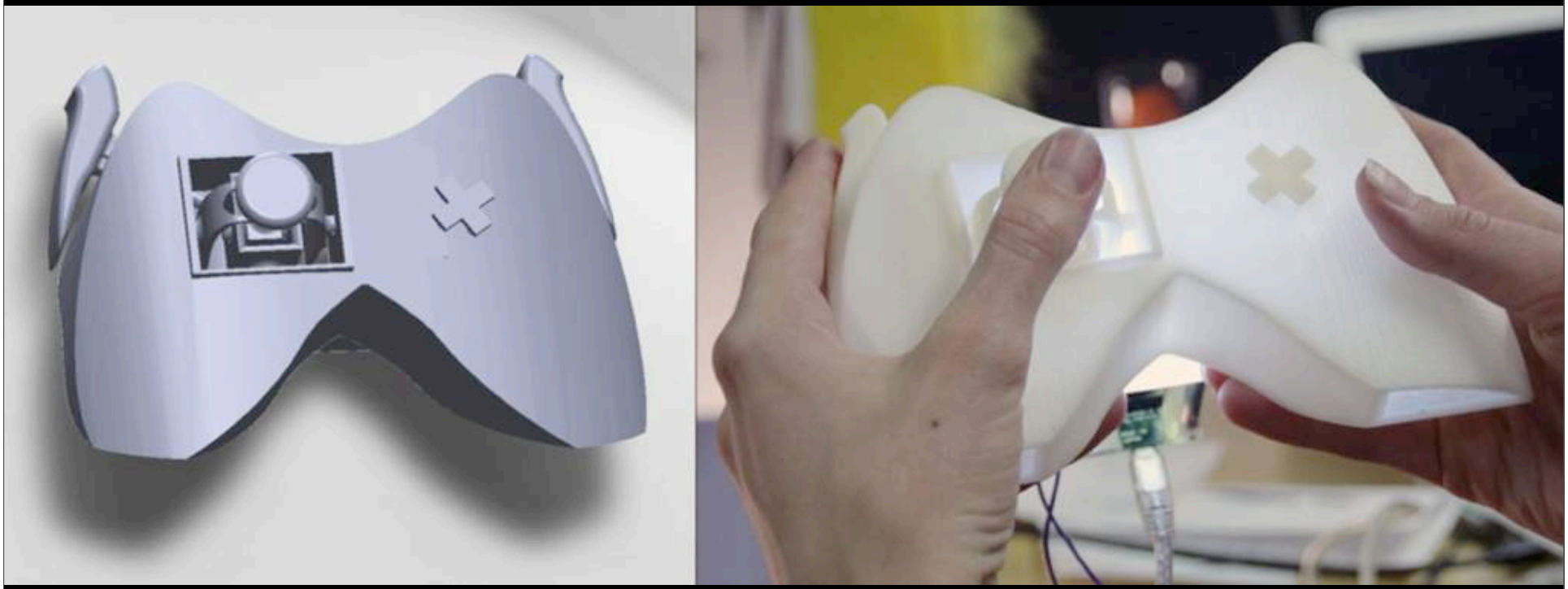

3D scanner


# #1 replication of objects / personal fab



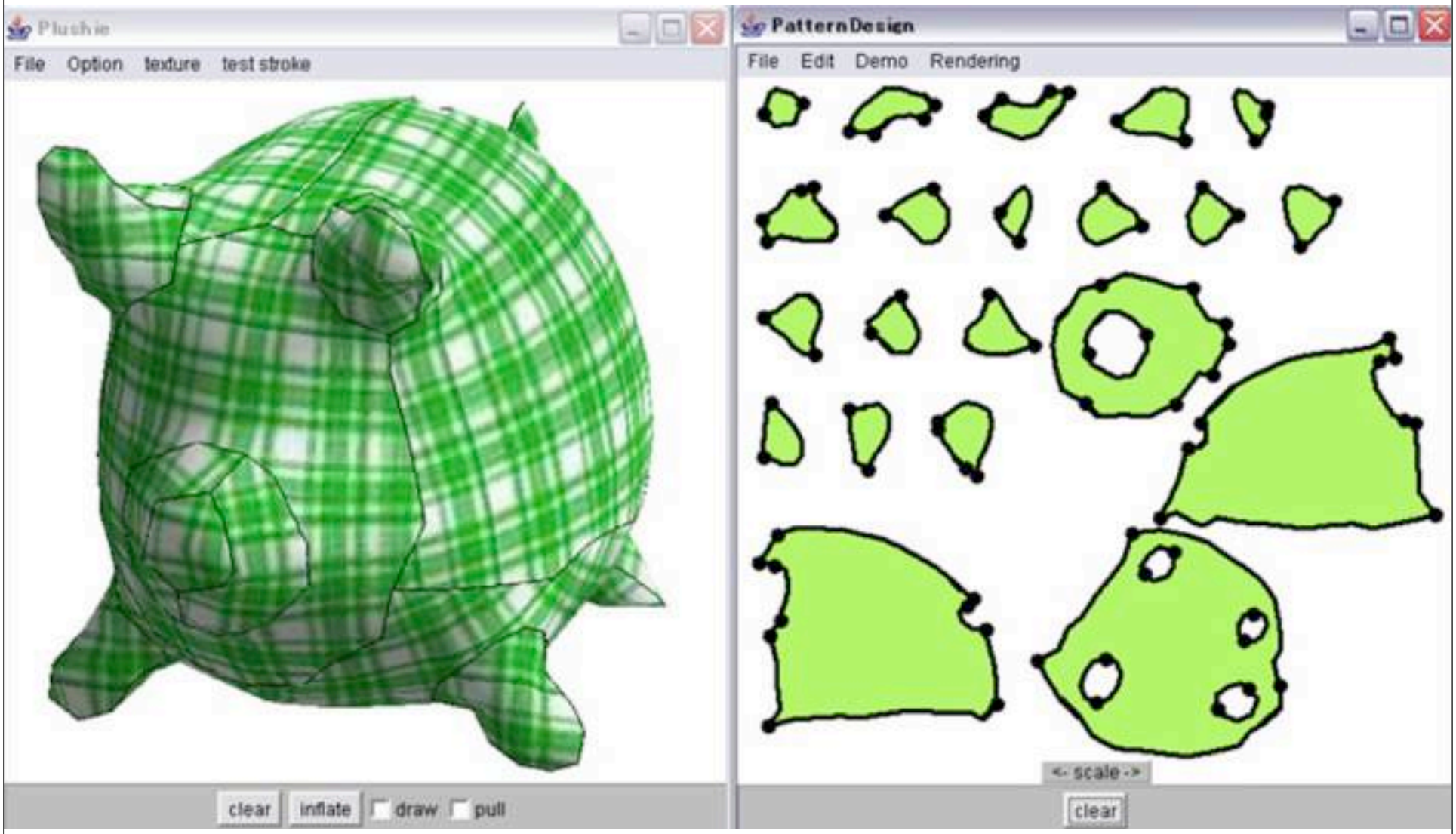

# #2 fast prototyping

[faBrickator ’13]



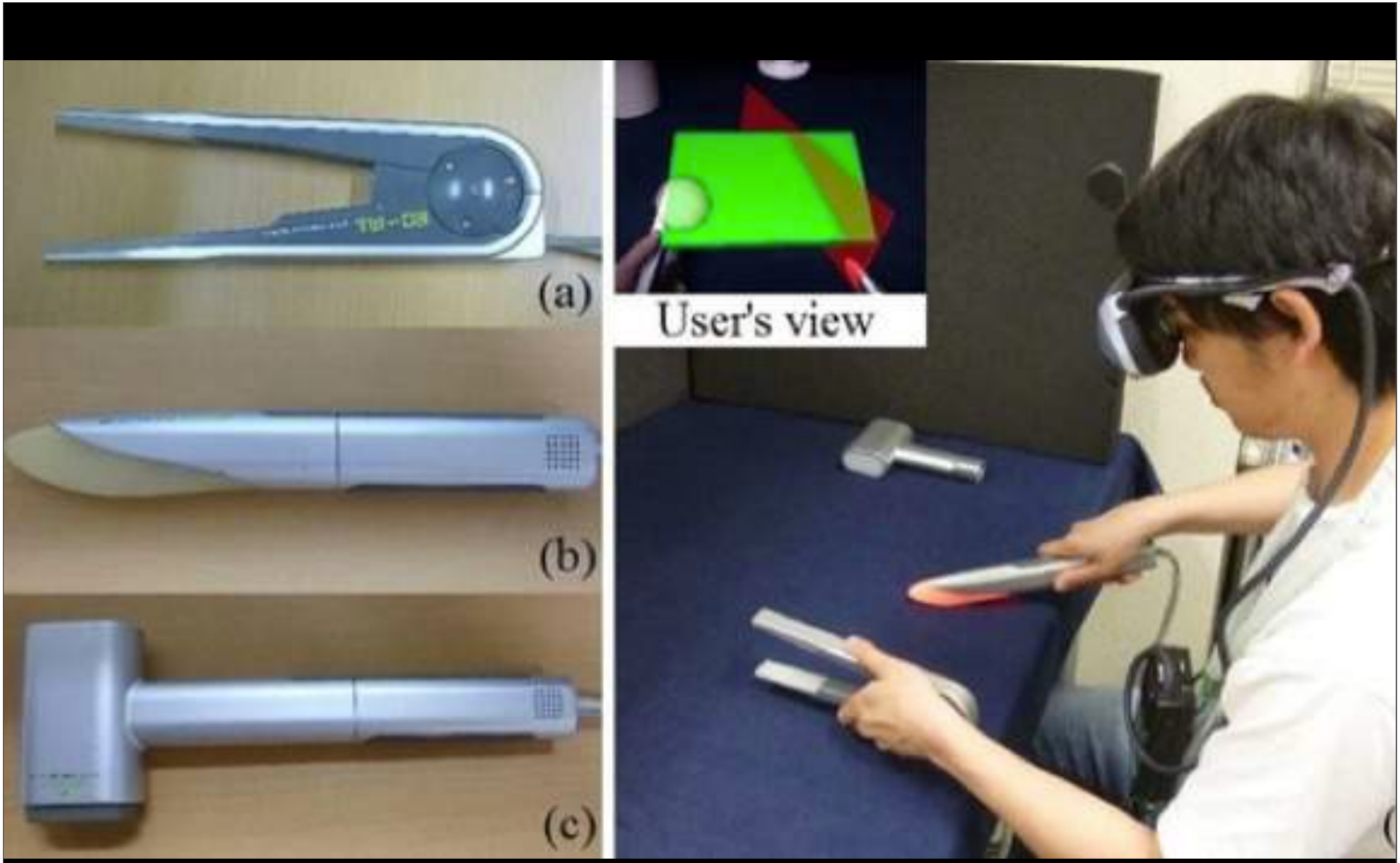
# #3 interactive objects

[Sauron ’13]




# #4 digital editing for the novice user

[Plushie '07]

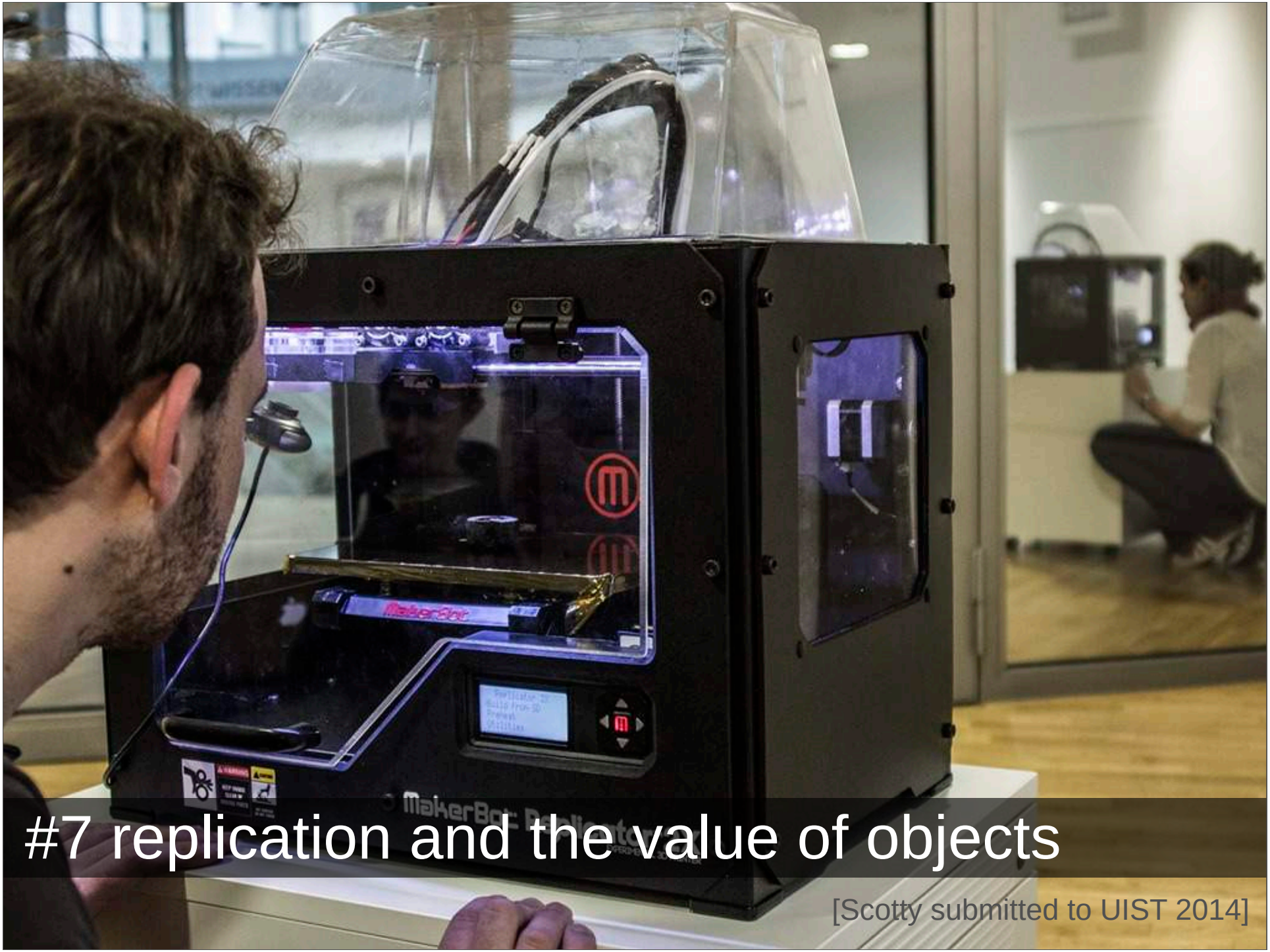



# #5 physical editing (AR, VR, NUI)

[Enjoying virtual handcrafting with ToolDevice ’12]

# #6 interactive fabrication (personal fab + traditional crafting)

[FreeD ’13]



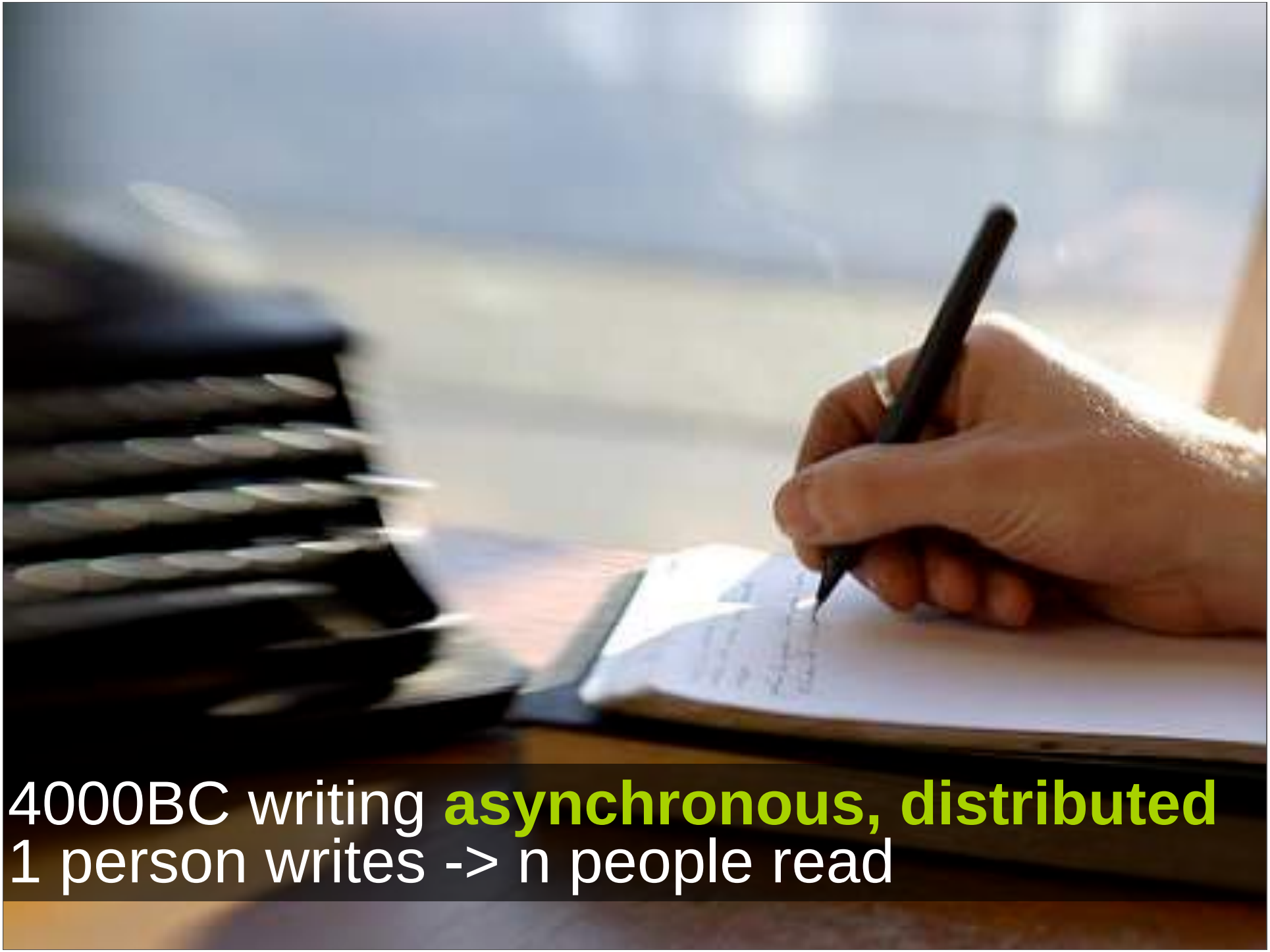

# #7 replication and the value of objects

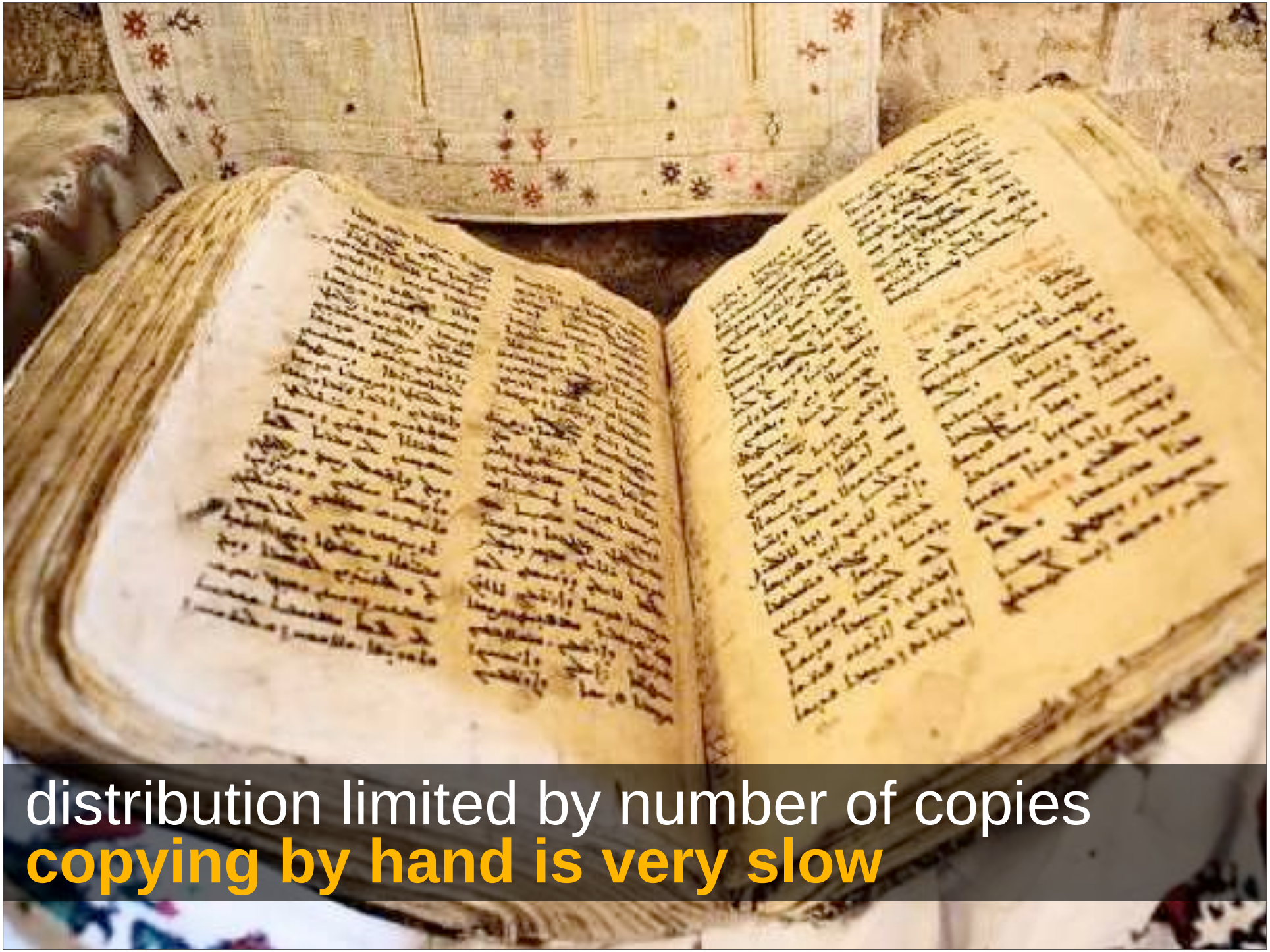
[Scotty submitted to UIST 2014]

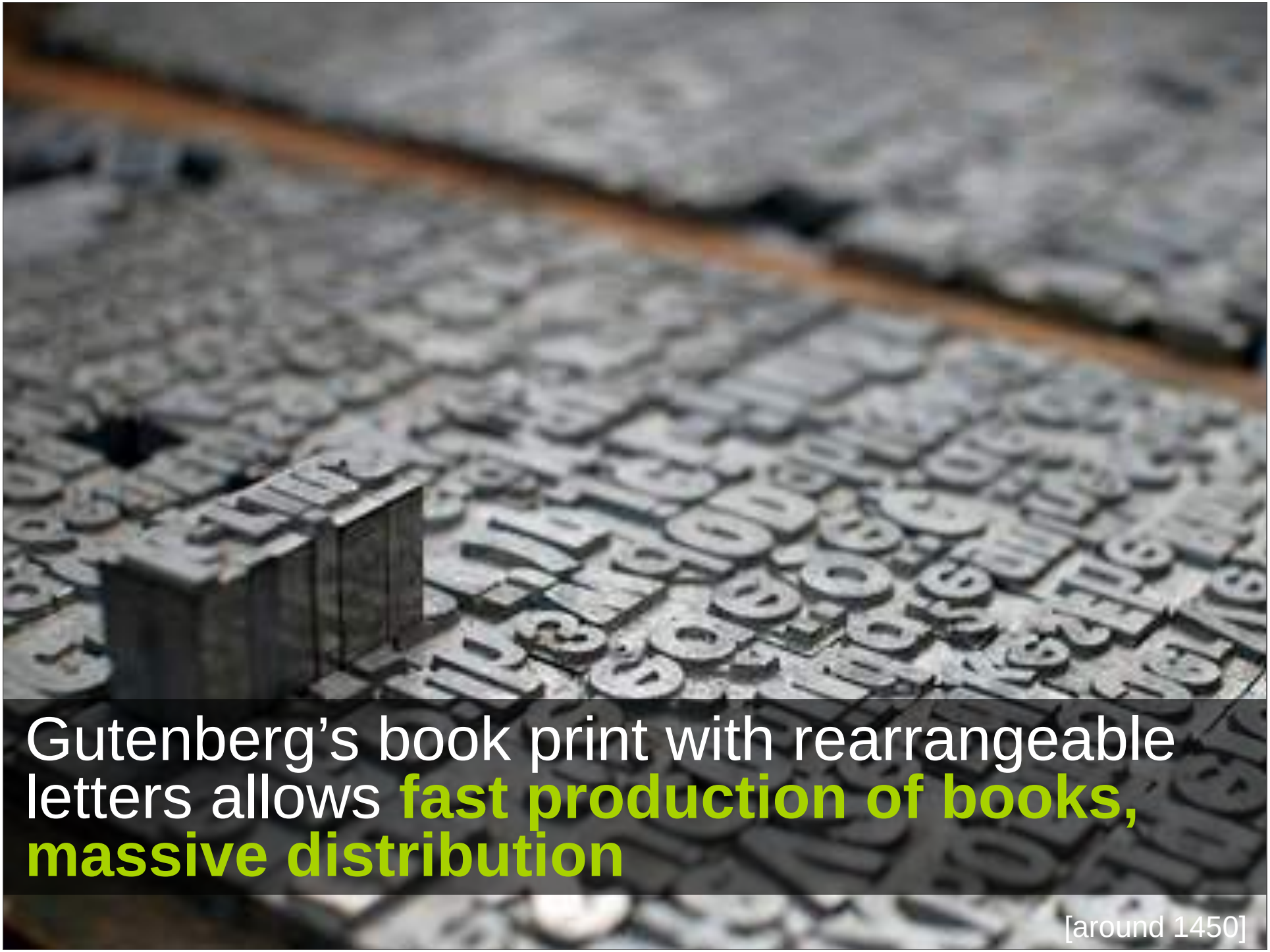
# let’s go back in time

we started **replicating information** using words ...


oral traditions: synchronous, co-located
1 person speaks -> n people listen


4000BC writing asynchronous, distributed
1 person writes -> n people read

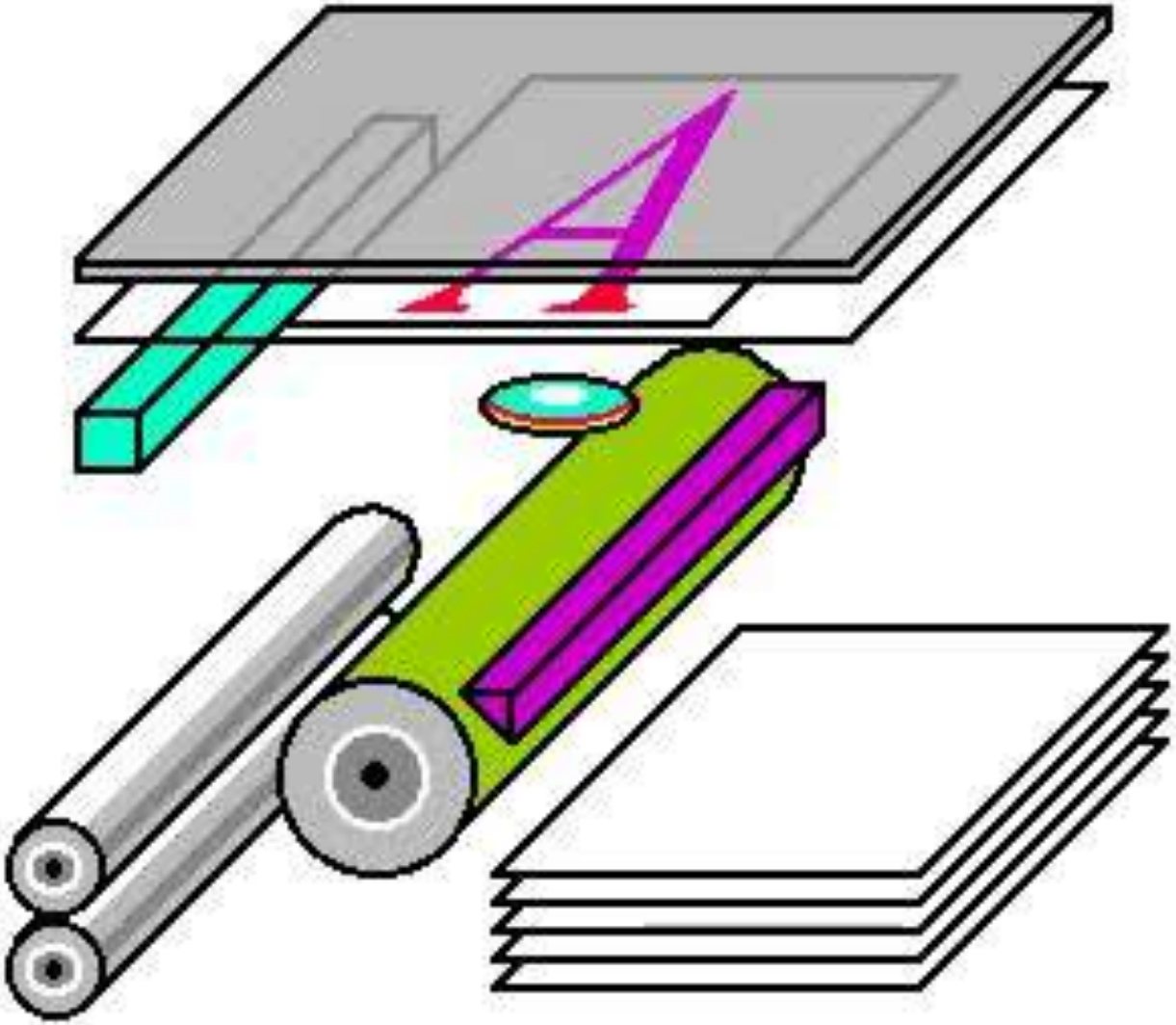

distribution limited by number of copies
copying by hand is very slow



Gutenberg’s book print with rearrangeable letters allows **fast production of books, massive distribution**

[around 1450]


... but **centralized...**
1 person prints -> n people read



1938 xerography: **everyone can replicate**
n person print -> n people read [Carlson 1938]

however, all of those technologies were **analog** ones ...

what are the advantages when you move from analog to **digital?**

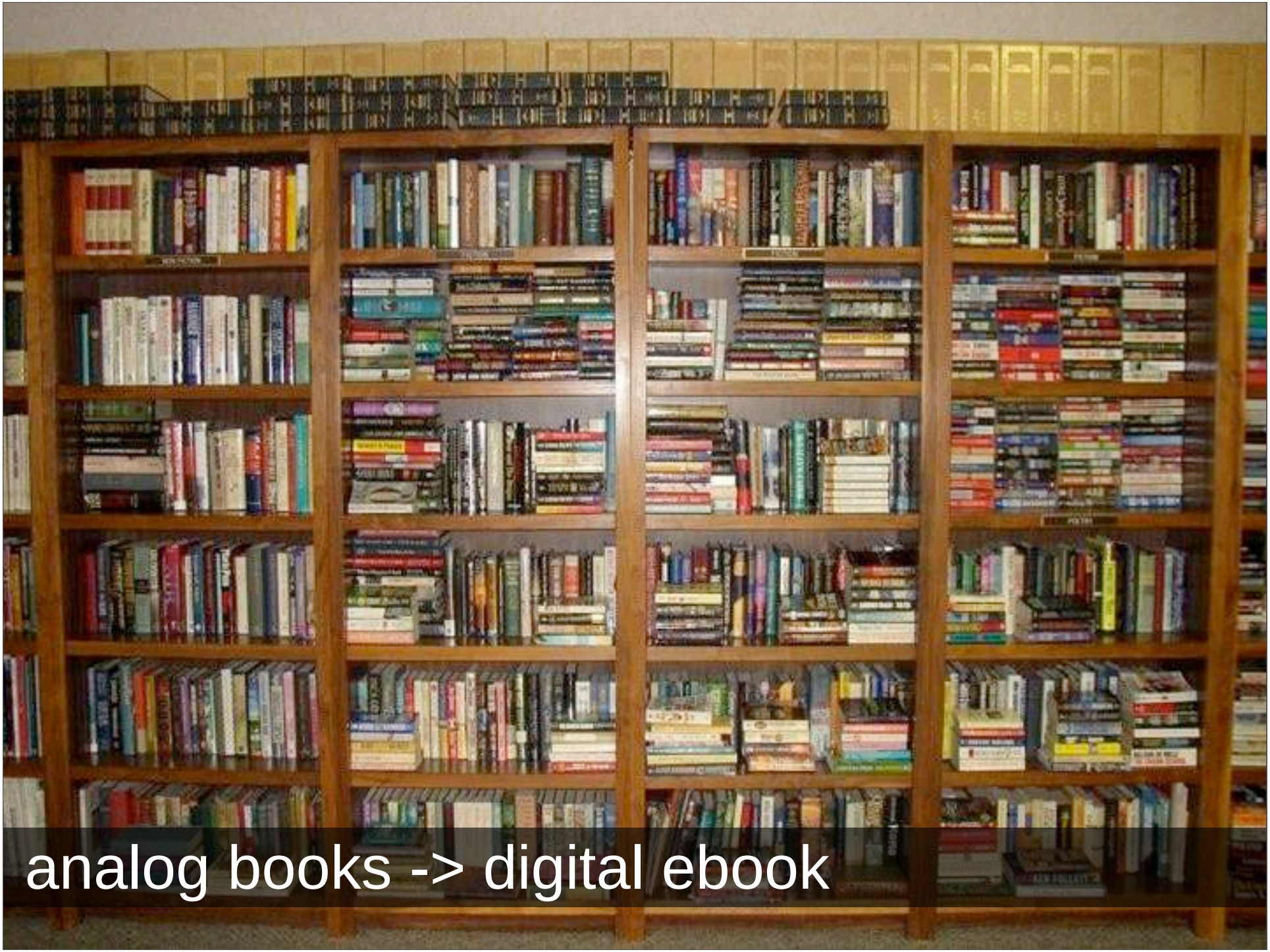
<30s brainstorming with your neighbor>

## digital::

**lossless**: write once, make perfect copies each time
**require no physical space** to be stored
**instant transfer** to remote locations

in combination with the internet,
having everything in digital form allows us to
**share massively...**

today,.. we have **everything in digital form...**


analog books -> digital ebook


# analog books -> digital ebook


vinyl records, tapes, cds -> mp3


iTunes
LIBRARY
Music
Movies
TV Shows
Podcasts
Applications
Radio
STORE
iTunes Store
Purchased
DEVICES
Steve's iPhone
PLAYLISTS
iTunes DJ
Genius
Paper Planes
Viva la Vida
90's Music
Music Videos
My Top Rated
Recently Added
Recently Played
Top 25 Most Played
Albums
Artists
Genres
Composers
Both Sides of the Gun
Ben Harper
Brand New By Tomorrow
Money Mark
Coco
Colbie Caillat
Datarock
Datarock
Eyes – Single
Rogue Wave
Flavors of Entanglement
Alanis Morissette
Fly Between Falls
ALO (Animal Liberation...
Gentlemen
The Afghan Whigs
Last Days
BECK
MODERN GUILT
IRON AND WINE
Sleep Through the Static
Jack Johnson
vinyl records, tapes, cds -> mp3


photos -> jpeg


photos -> jpeg

**text, audio, images, video ....**

once they are digitized they are all the same...

let’s have a look at physical objects...

with physical objects, we are essentially
**still at the stage of Gutenberg:**


injection molding:
**centralized fabrication with large machinery**

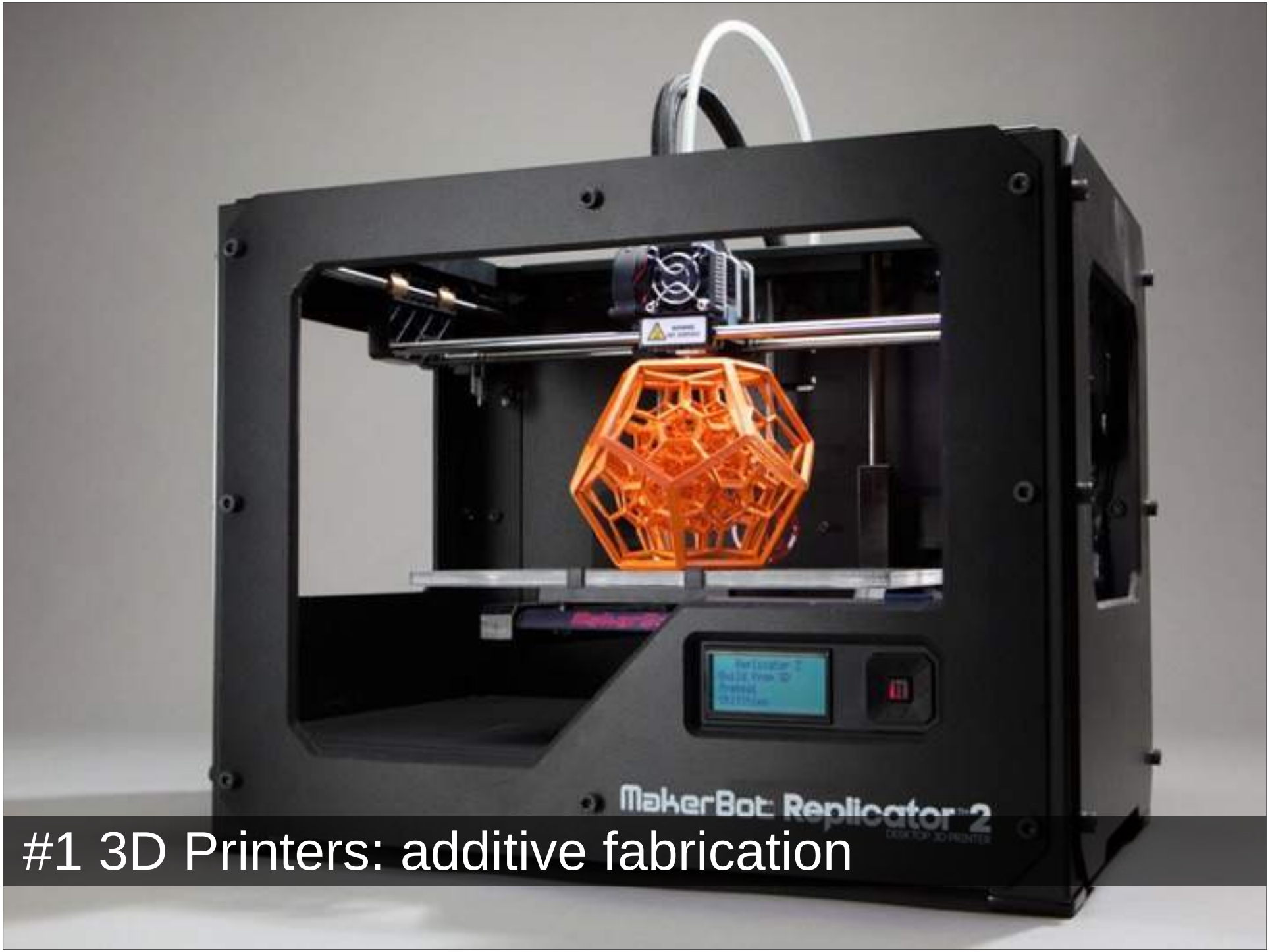

negative forms produce a high number
of units very cheap.


great for standardized objects,
bad for customized, individual objects.

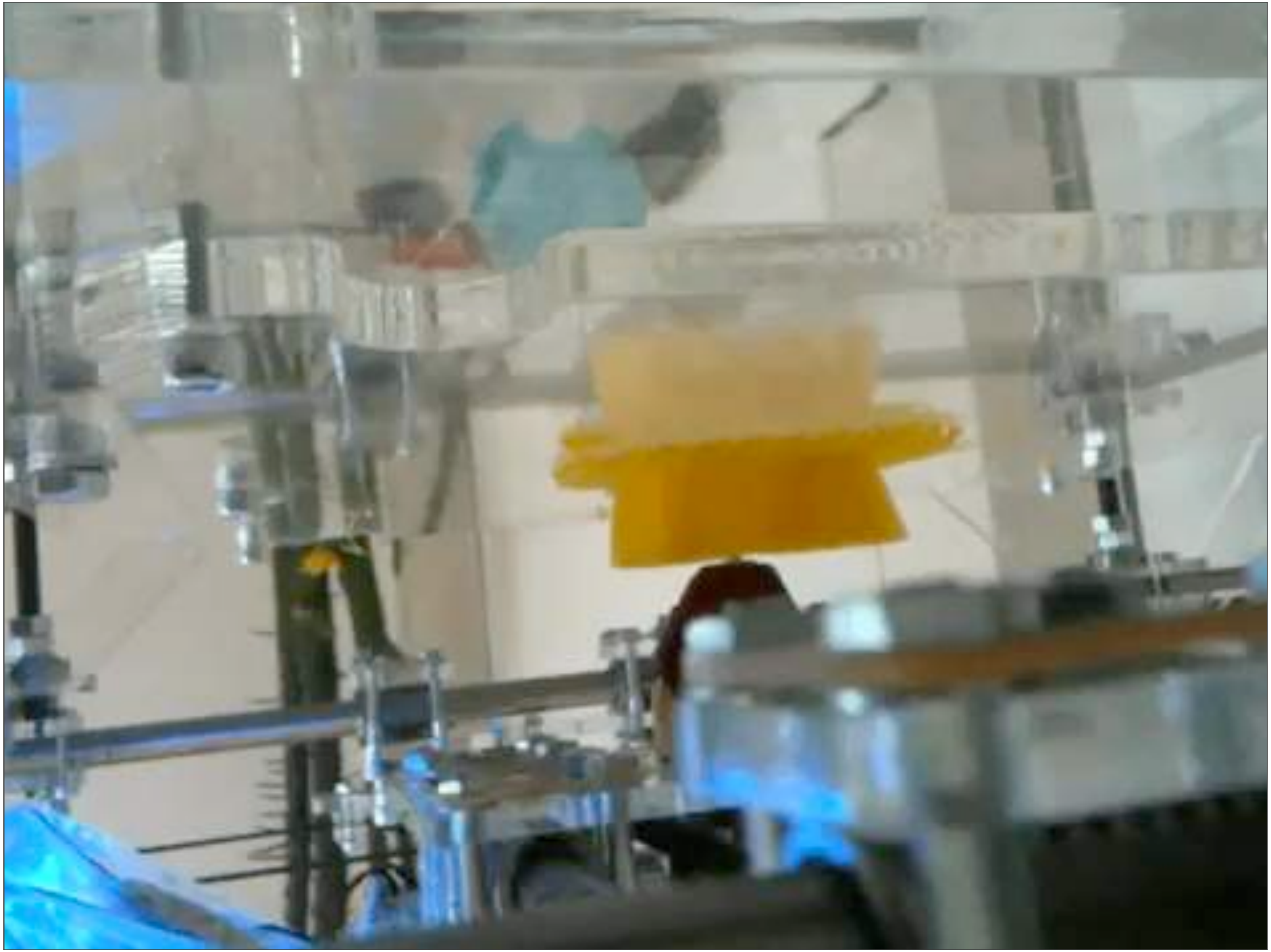
# #1 personal fabrication

personal fab: **low setup costs,** but
**individual objects are more expensive**

let me show you some
**technologies that enable personal fabrication...**



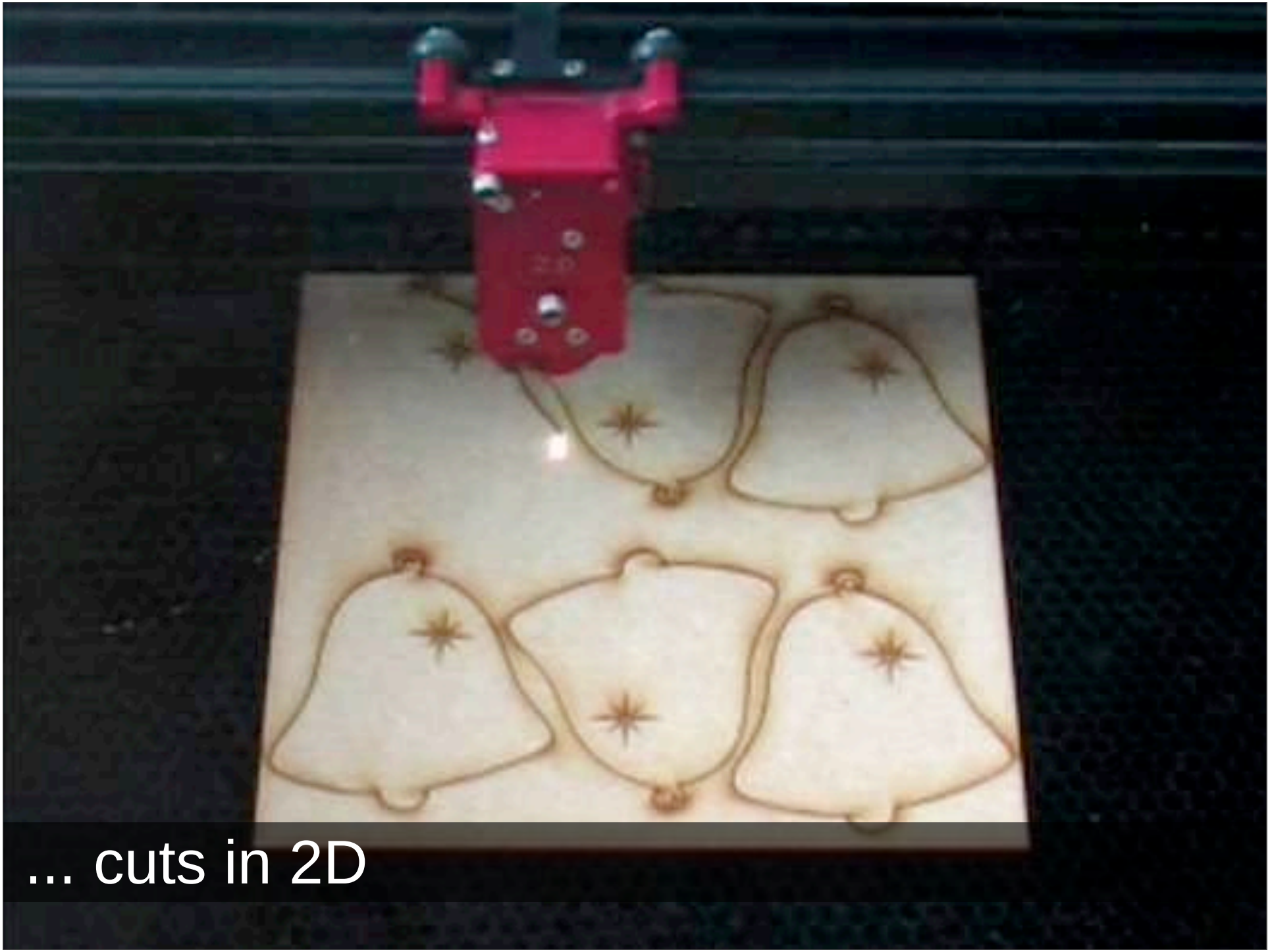

# #1 3D Printers: additive fabrication

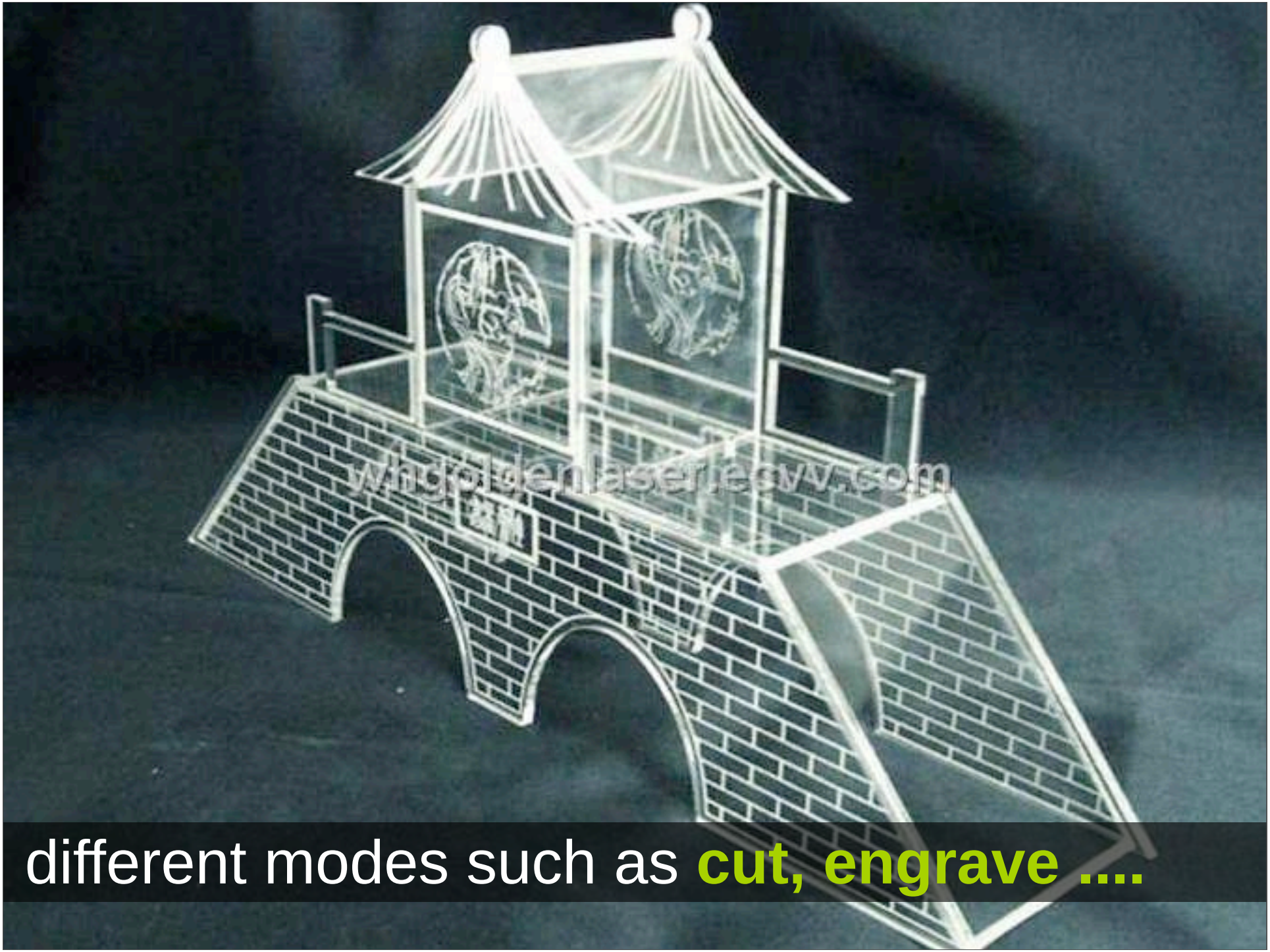


print many **different materials**

Markus Kayser - Solar Sinter Project


# #2 laser cutter: subtractive fabrication


... cuts in 2D




different modes such as **cut, engrave ....**

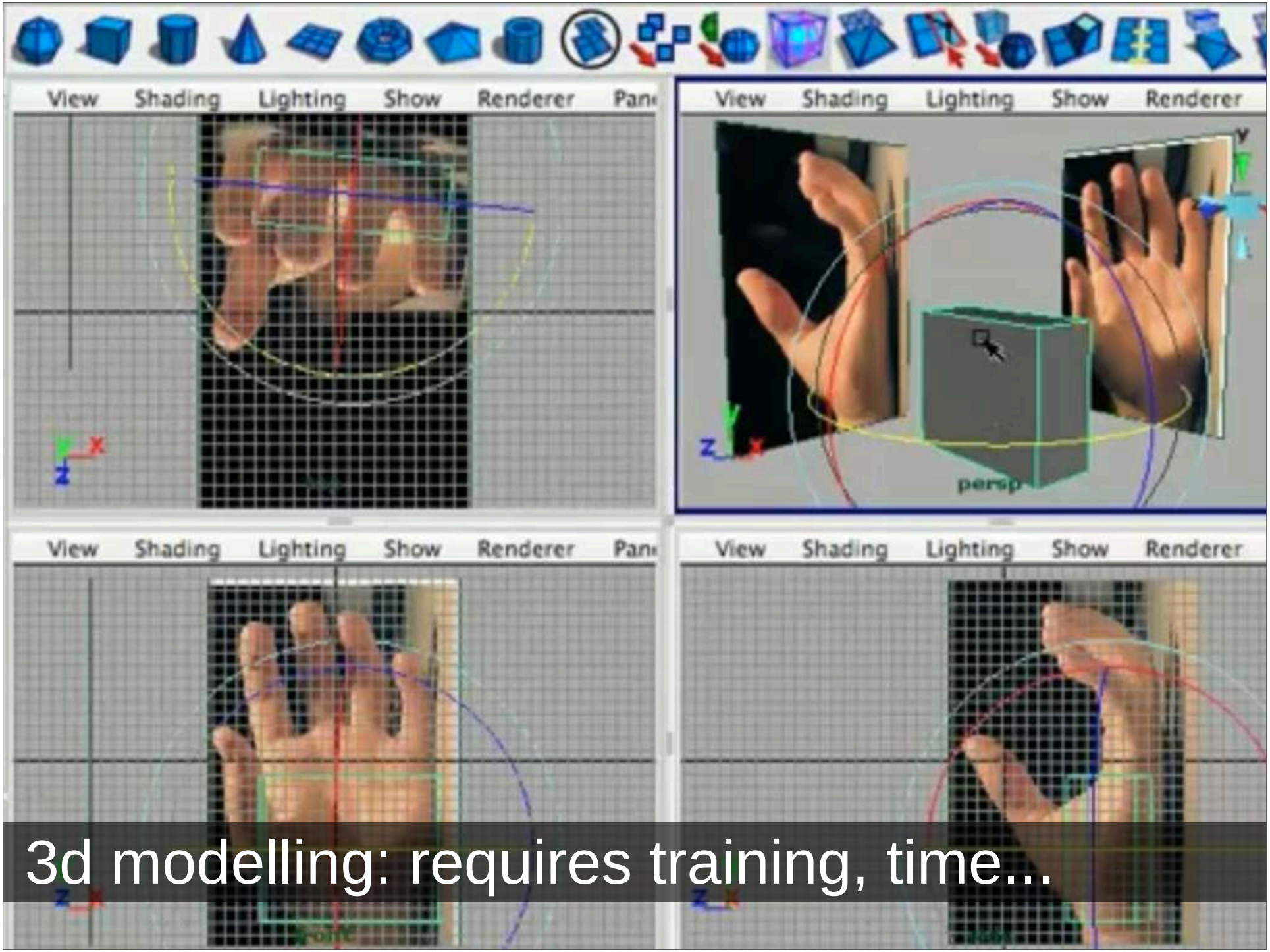

very precise, can create working gears...


#3 milling machine: subtractive fabrication

devices take **digital model** and fabricate

what are different ways how to create a 3D model?

**<30 sec brainstorming>**


View Shading Lighting Show Renderer
persp
3d modelling: requires training, time...

# 3D scanner::

device that analyzes a real-world object to collect data on its **shape** and its **appearance** (i.e. color).

works like a camera,
but **collects distance to each surface point.**

the collected data can then be used to **construct digital, three dimensional models.**

# AUTODESK® 123D® CATCH

AUTODESK.

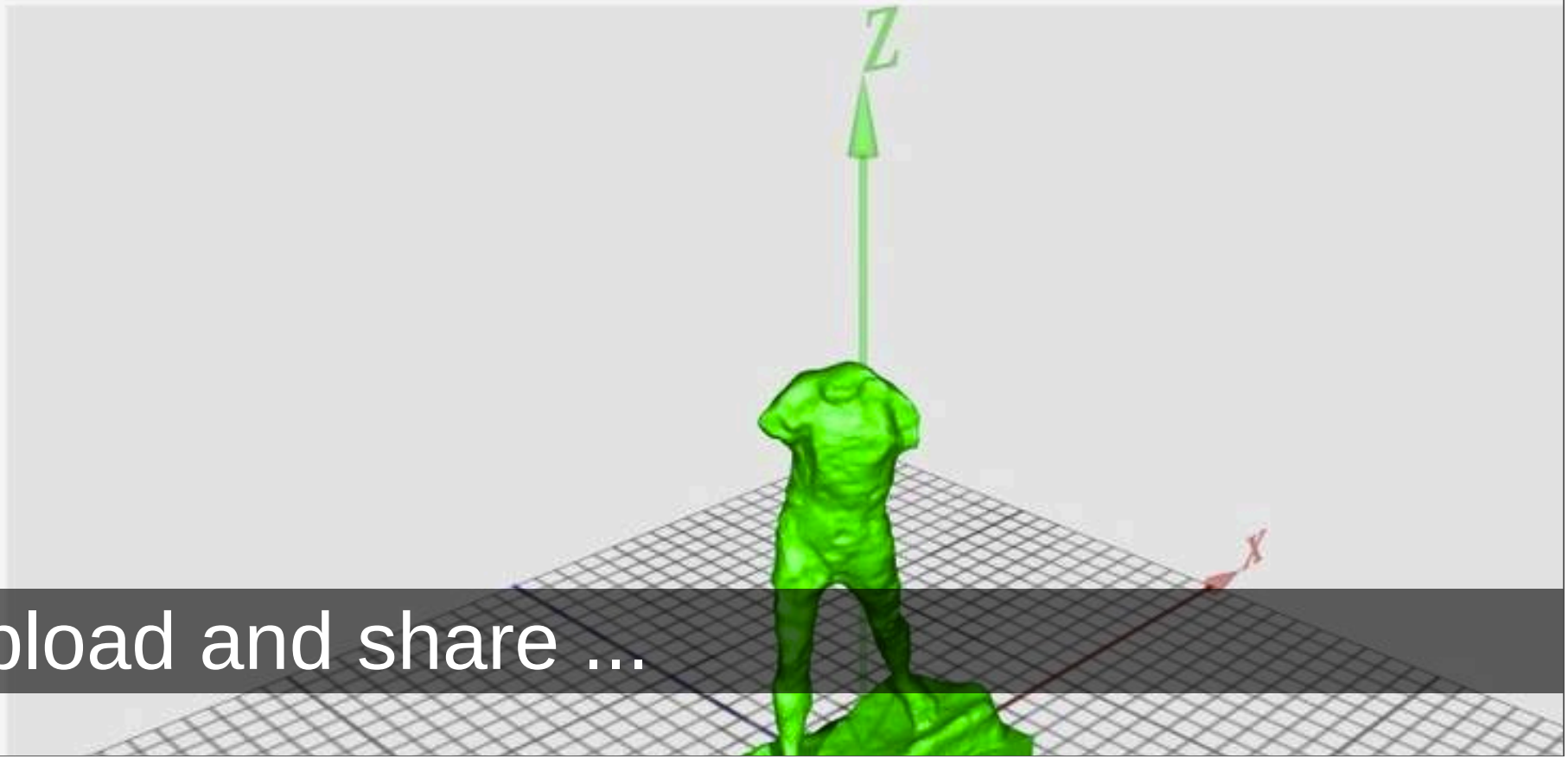
a MakerBot Industries website

# THINGIVERSE

THINGS TOOLS BROWSE BLOG

**Digital designs for real, physical objects. A Universe of Things!**

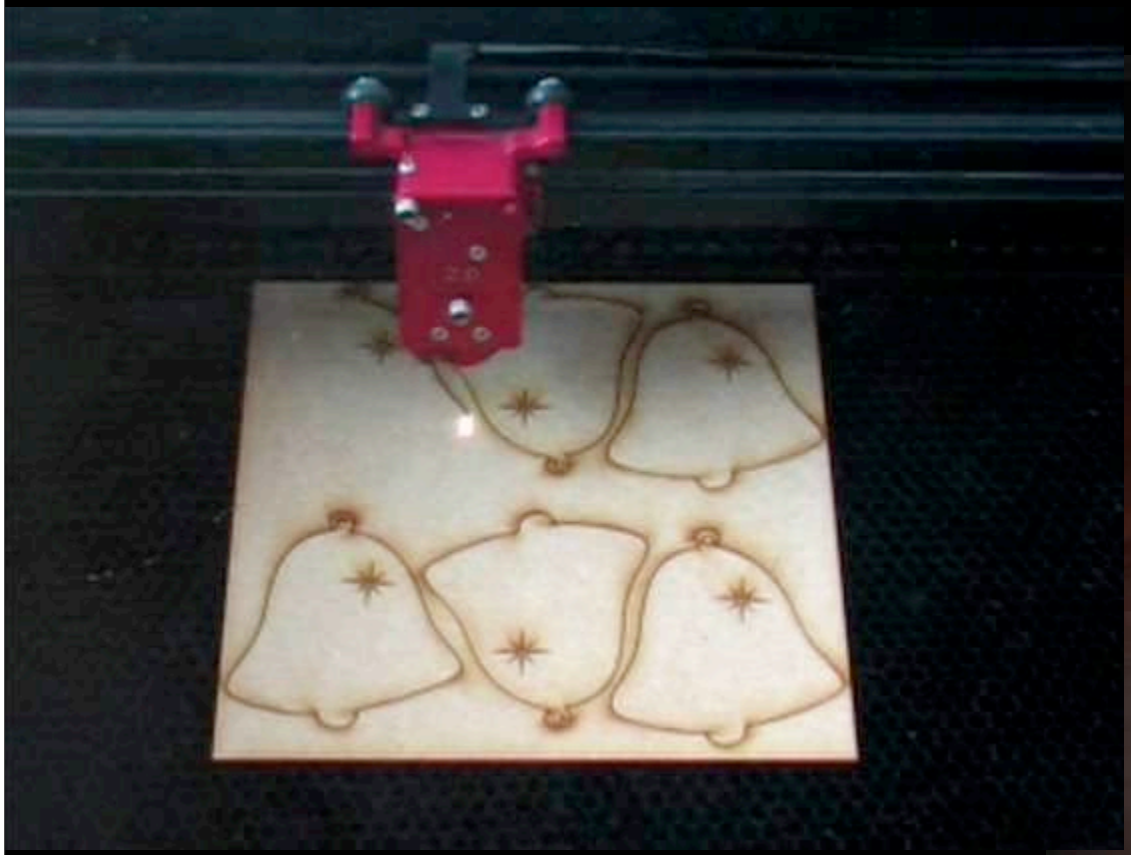
**Image of The Walking Man, by Auguste Rodin**

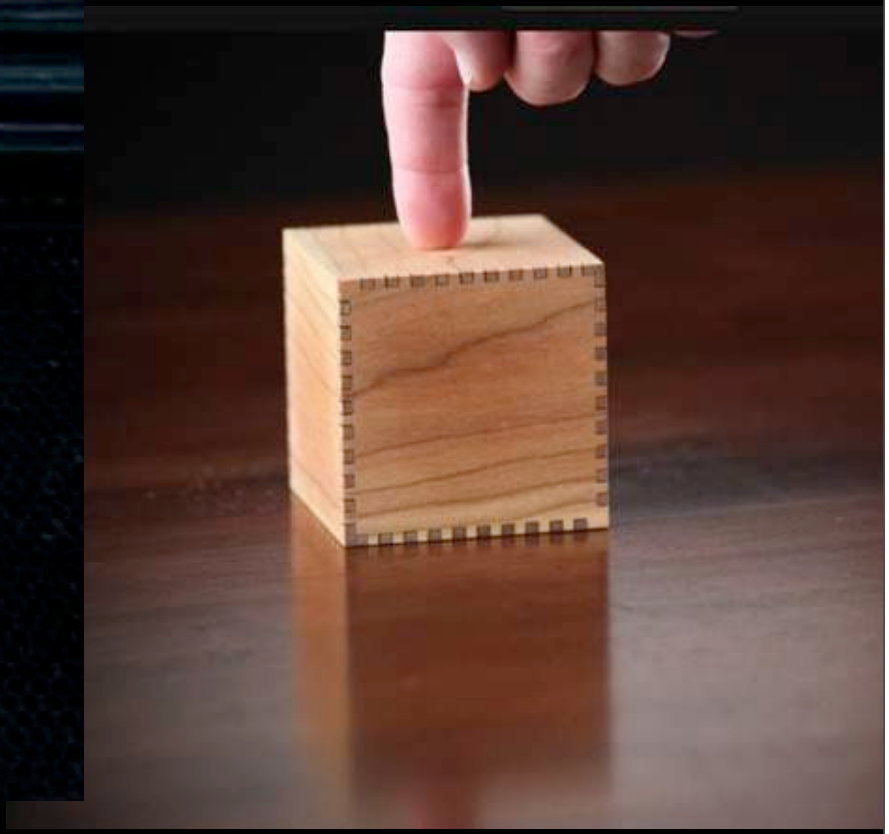



upload and share ...

what we gain from this process are
**millions of objects that we can download**
and fabricate instantly...

# #2
# fast prototyping & design iteration



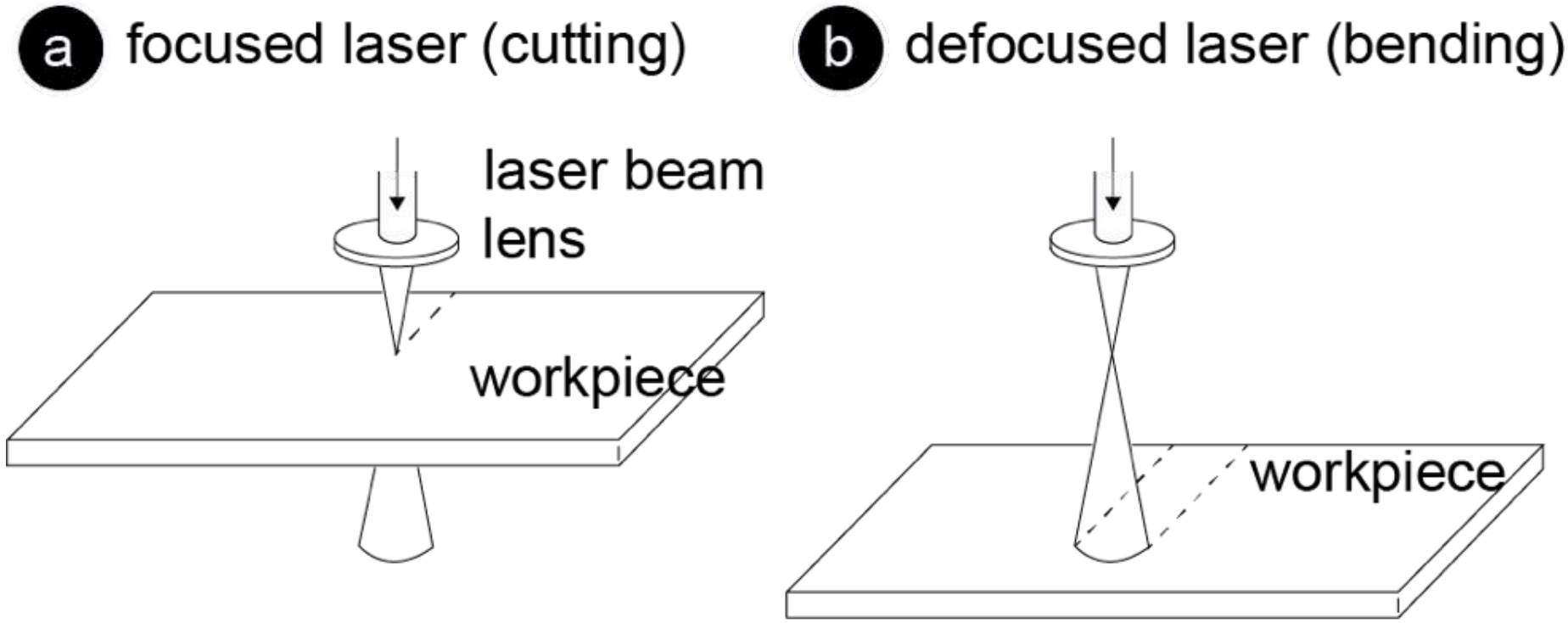


laser cutters: fast, but only 2D (or assembly)

# LaserOrigami: use laser cutter to **cut and fold**

[LaserOrigami ’13]

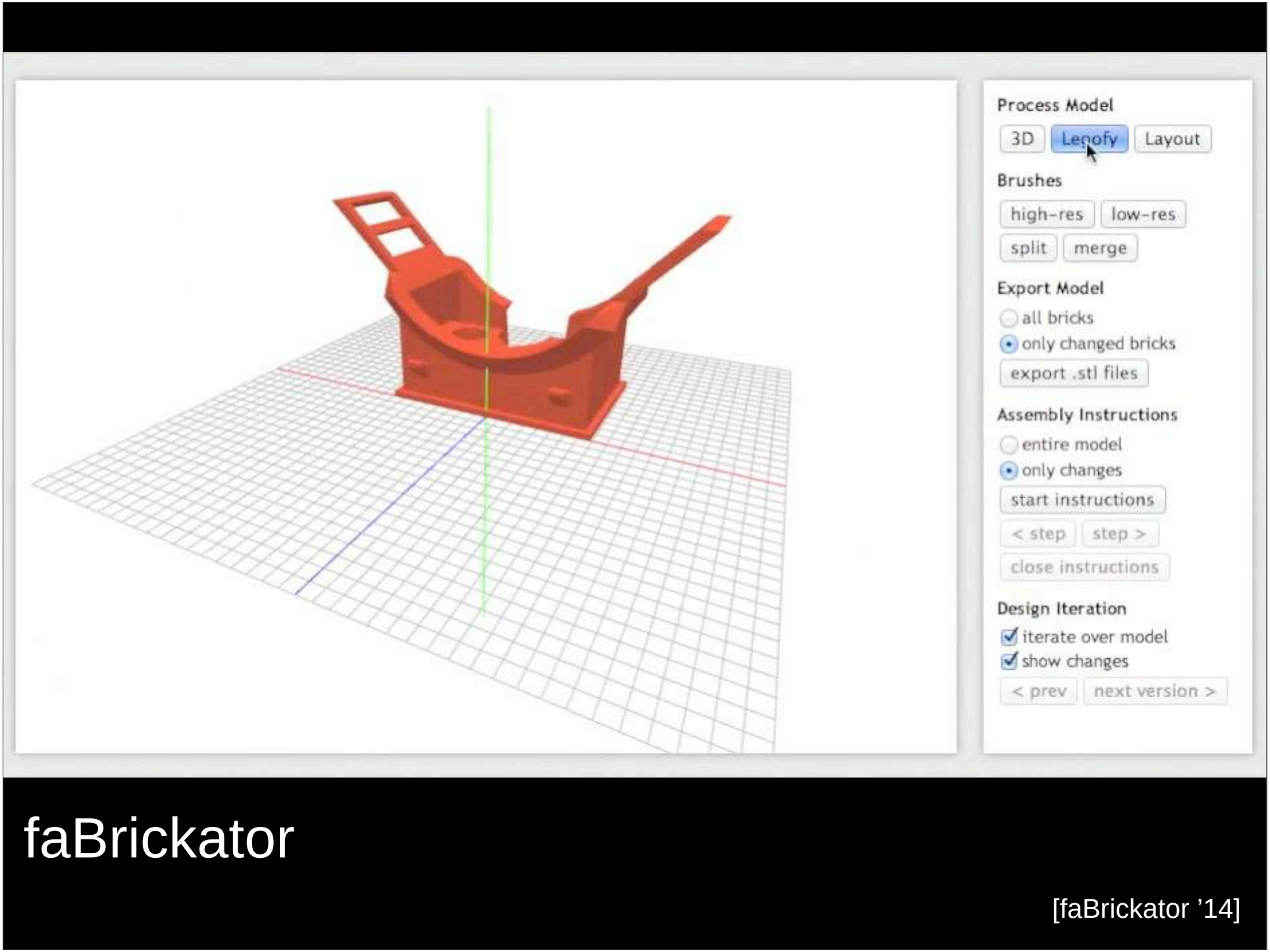

HPI
#3 plant holder




# LaserOrigami: use later cutter to **cut and fold**

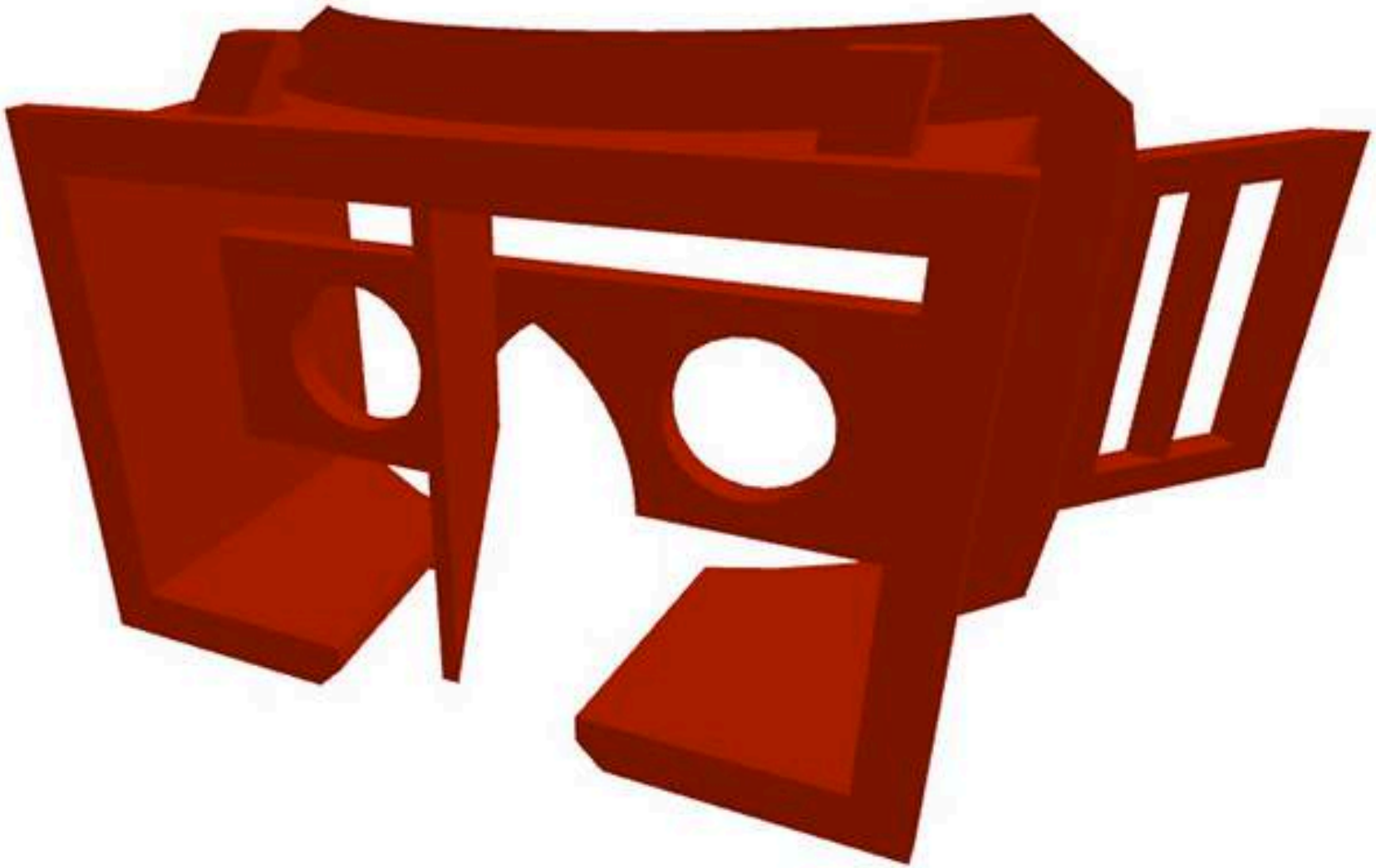
[LaserOrigami ’13]

LaserOrigami is **fast,**
but is limited to **origami-like geometry**

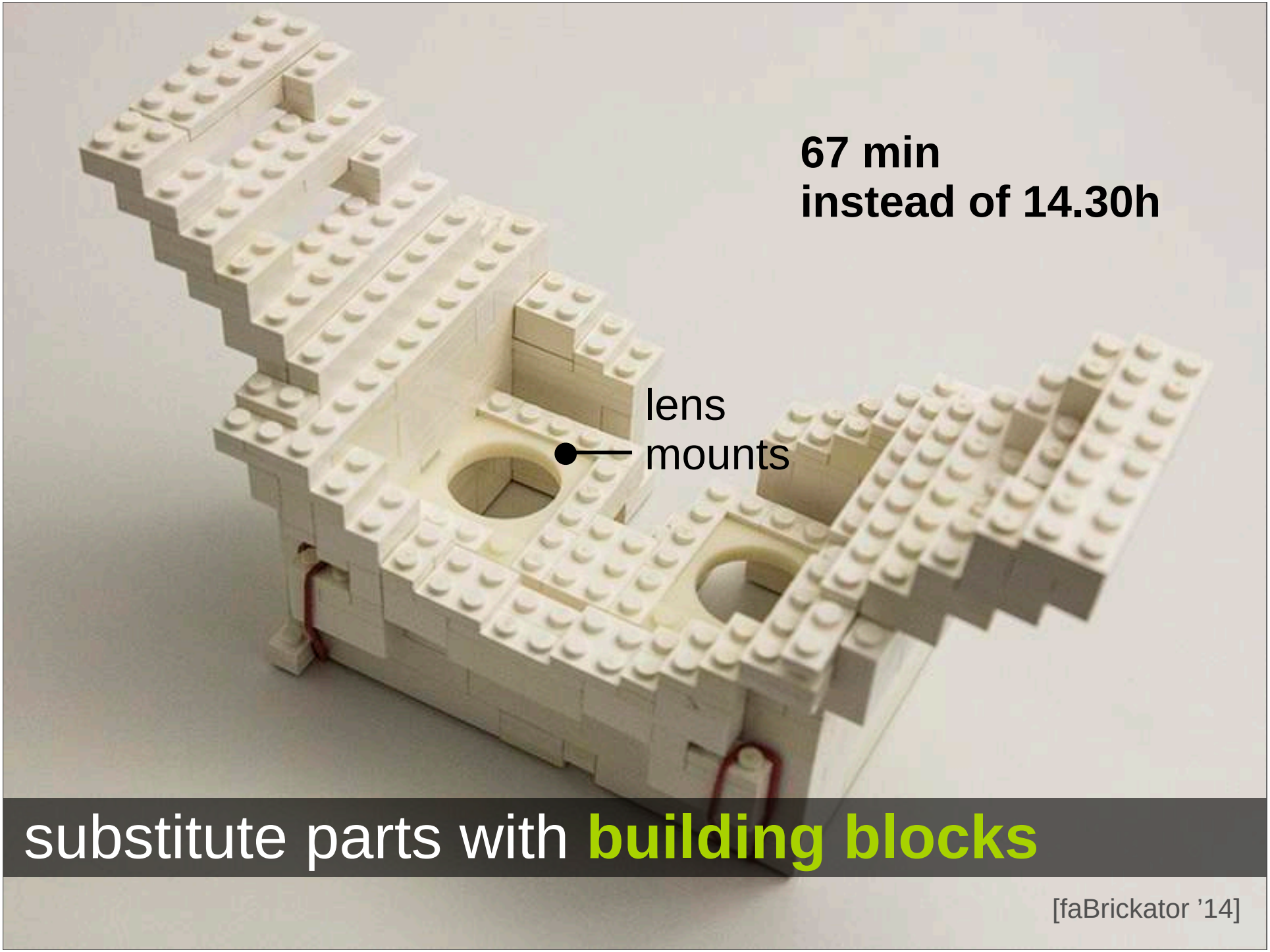



# faBrickator

[faBrickator ’14]



idea: use 3D printing only where necessary

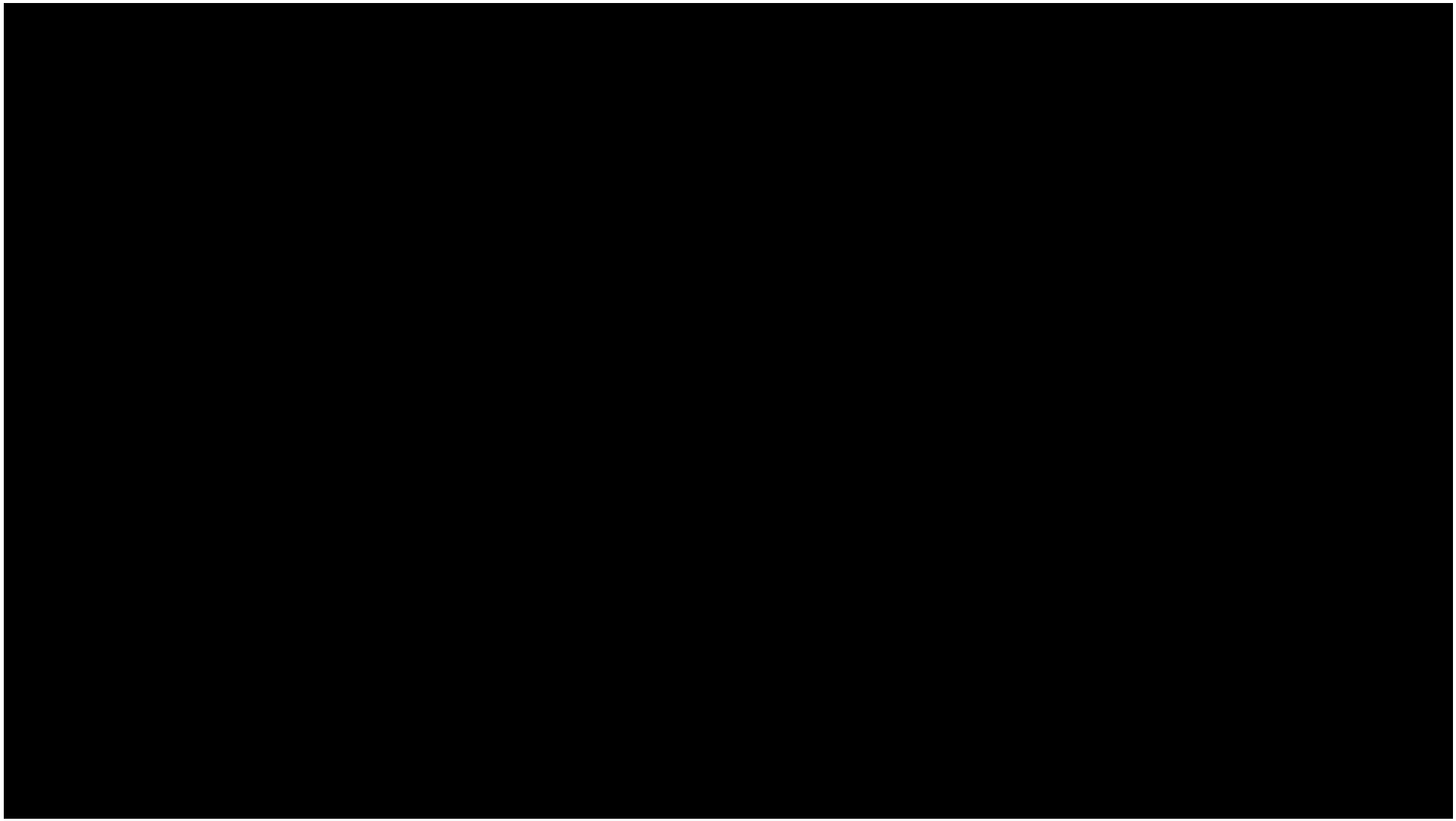



# substitute parts with **building blocks**

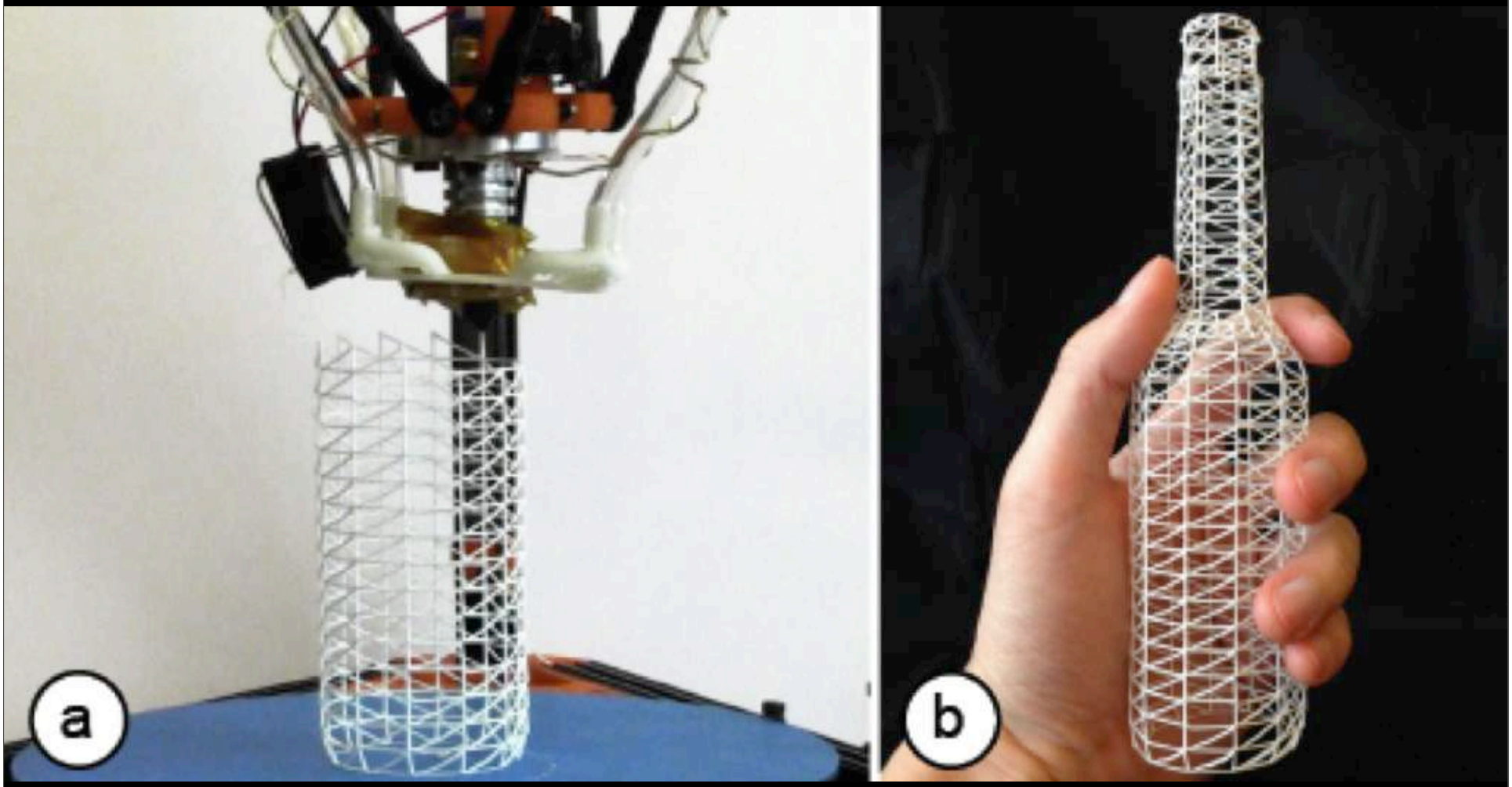
[faBrickator '14]


HPI
faBrickation
Stefanie Mueller, Tobias Mohr, Kerstin Guenther,
Johannes Frohnhofen, Patrick Baudisch


3D printers: wait overnight....

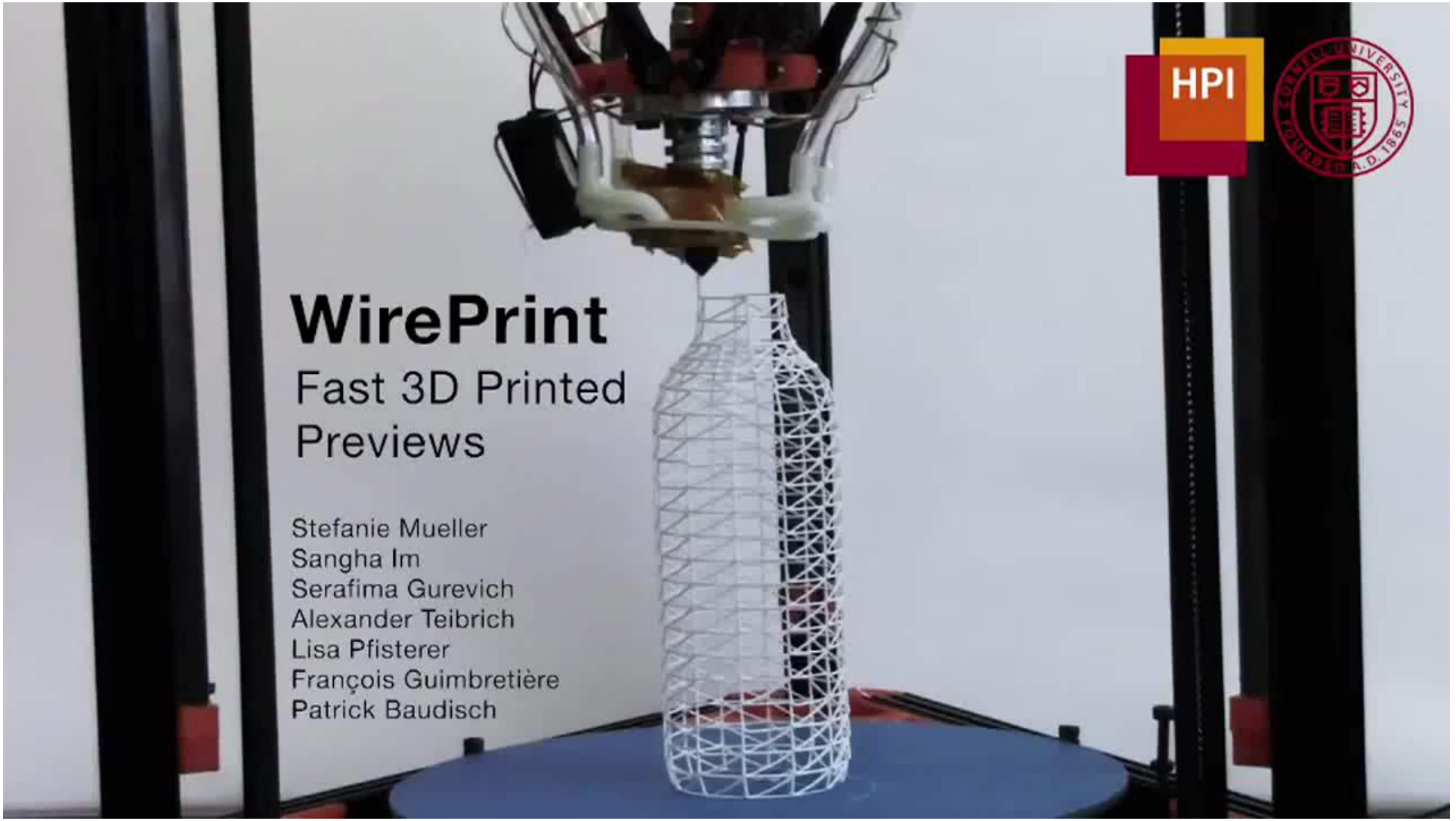


Carbon3D




# WirePrint: automated printing of wireframes

[WirePrint submitted to UIST 2014]


HPI
WirePrint
Fast 3D Printed Previews
Stefanie Mueller
Sangha Im
Serafima Gurevich
Alexander Teibrich
Lisa Pfisterer
François Guimbretière
Patrick Baudisch

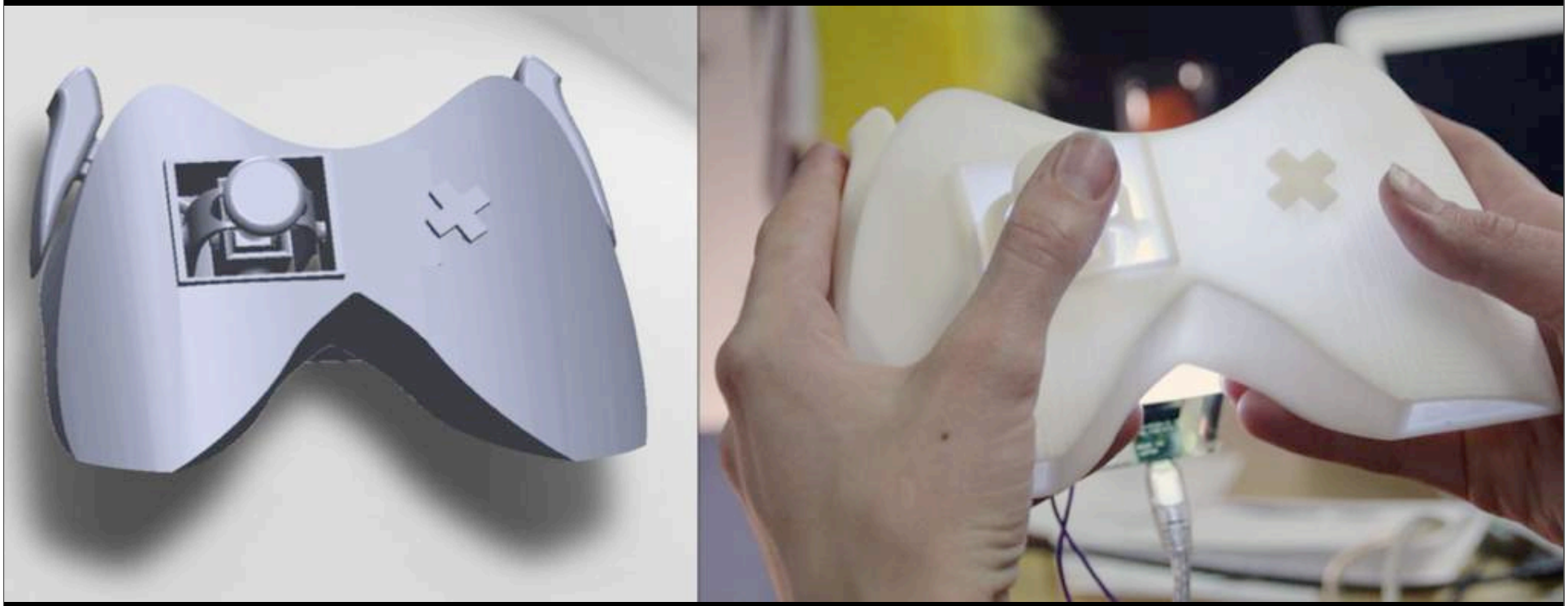
inspired by **3Doodler (manual, analog)**
(ABS plastic is heated at the nozzle, then cools)
[3Doodler]


HPI
Protopiper
physically sketching room-sized objects at actual scale
H. Agrawal, U. Umapathi, R. Kovacs, J. Frohnhofen, H.T. Chen, S. Mueller, P. Baudisch

# #3
# interactive objects

3D printers currently can mostly
**print passive objects** from one material...

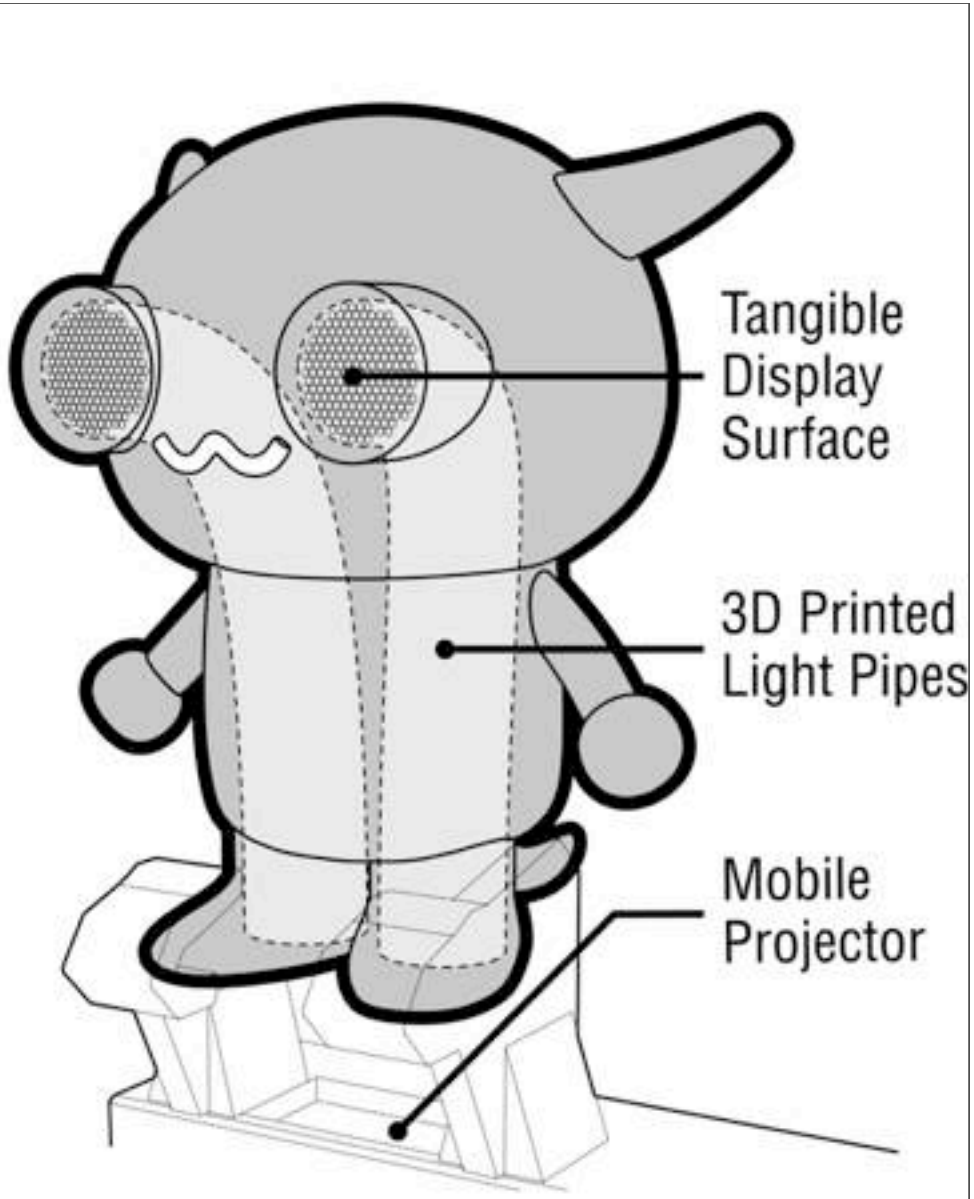
researchers try to find ways to quickly
prototype **interactive objects**



Sauron: marker tracking with **camera** [Sauron ’13]


# PrintedOptics: print **glass-fibers** inside

[PrintedOptics ’12]



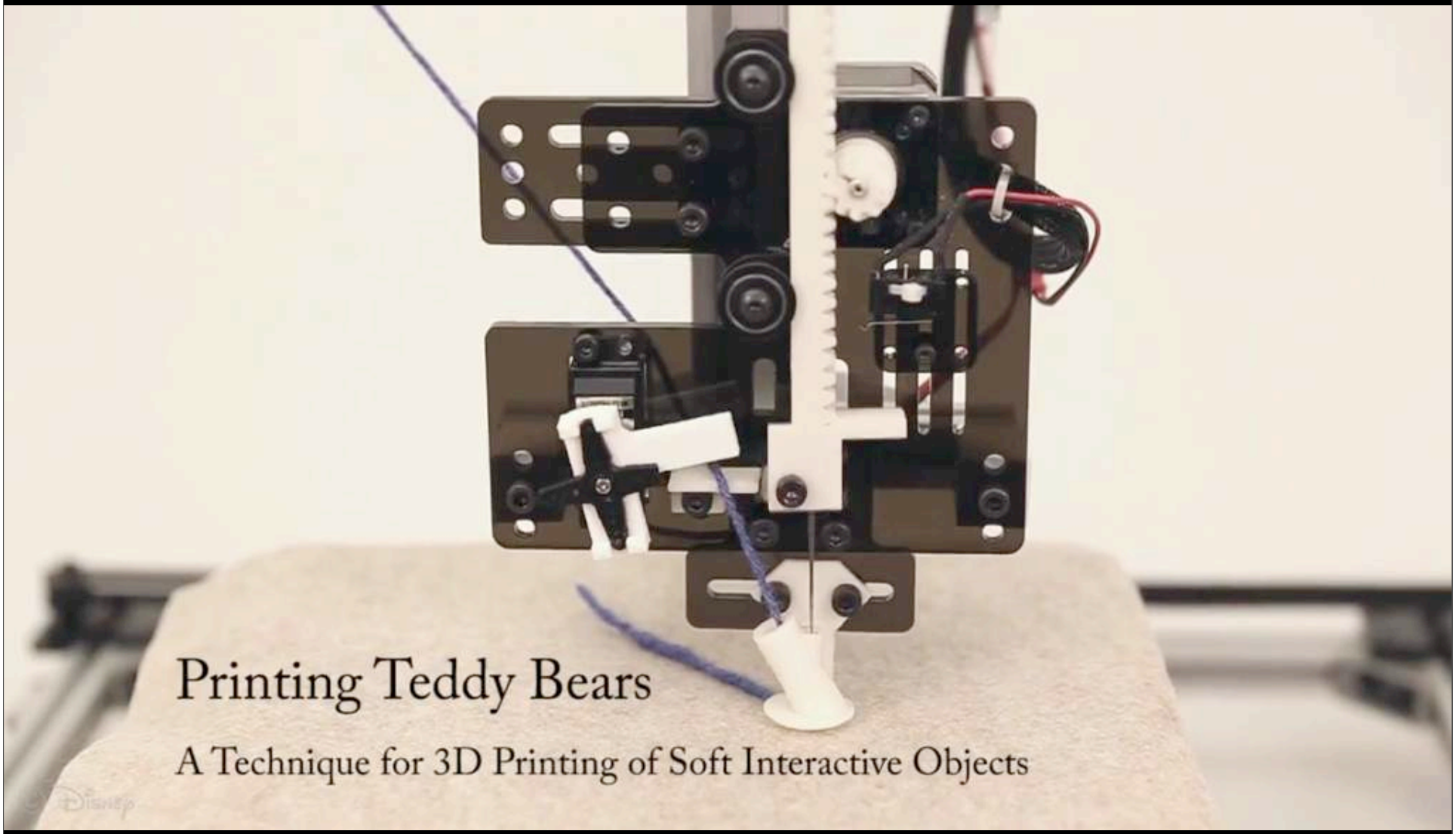

# PrintedOptics: print **glass-fibers** inside

[PrintedOptics ’12]


Disney
Research, Pittsburgh

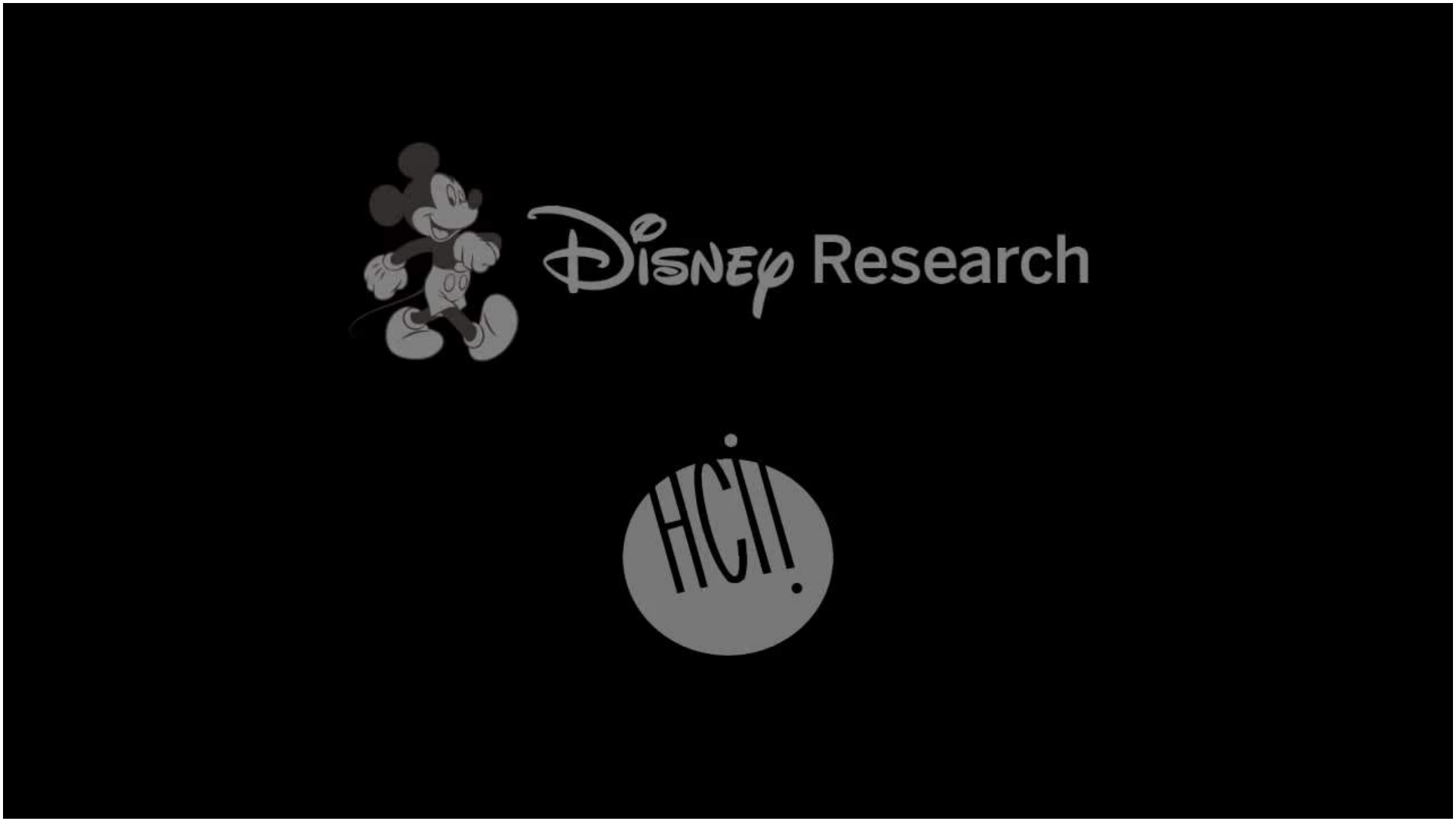
printing **soft** objects (for wearables?)

[Printing Teddybears ’14]




printing **soft** objects (for wearables?)

[Printing Teddybears ’14]


Disney Research
HCII

# interactive **speakers:**
# custom shapes and sound distribution

[Interactive Speakers ’14]

# Capricate: A Fabrication Pipeline to Design and 3D Print Capacitive Touch Sensors for Interactive Objects

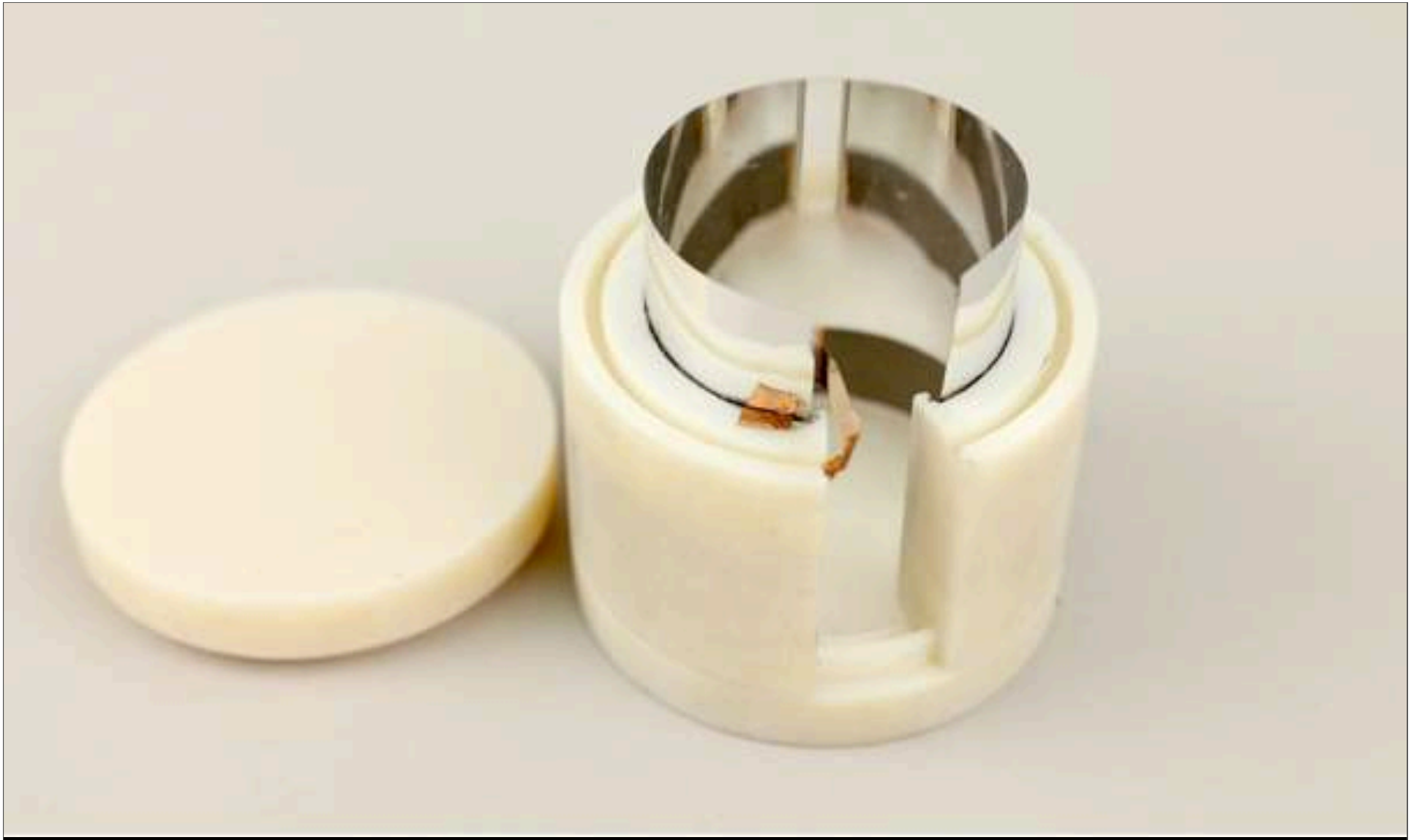
Martin Schmitz, Mohammadreza Khalilbeigi, Matthias Balwierz,
Roman Lissermann, Max Mühlhäuser, Jürgen Steimle

mschmitz@tk.informatik.tu-darmstadt.de



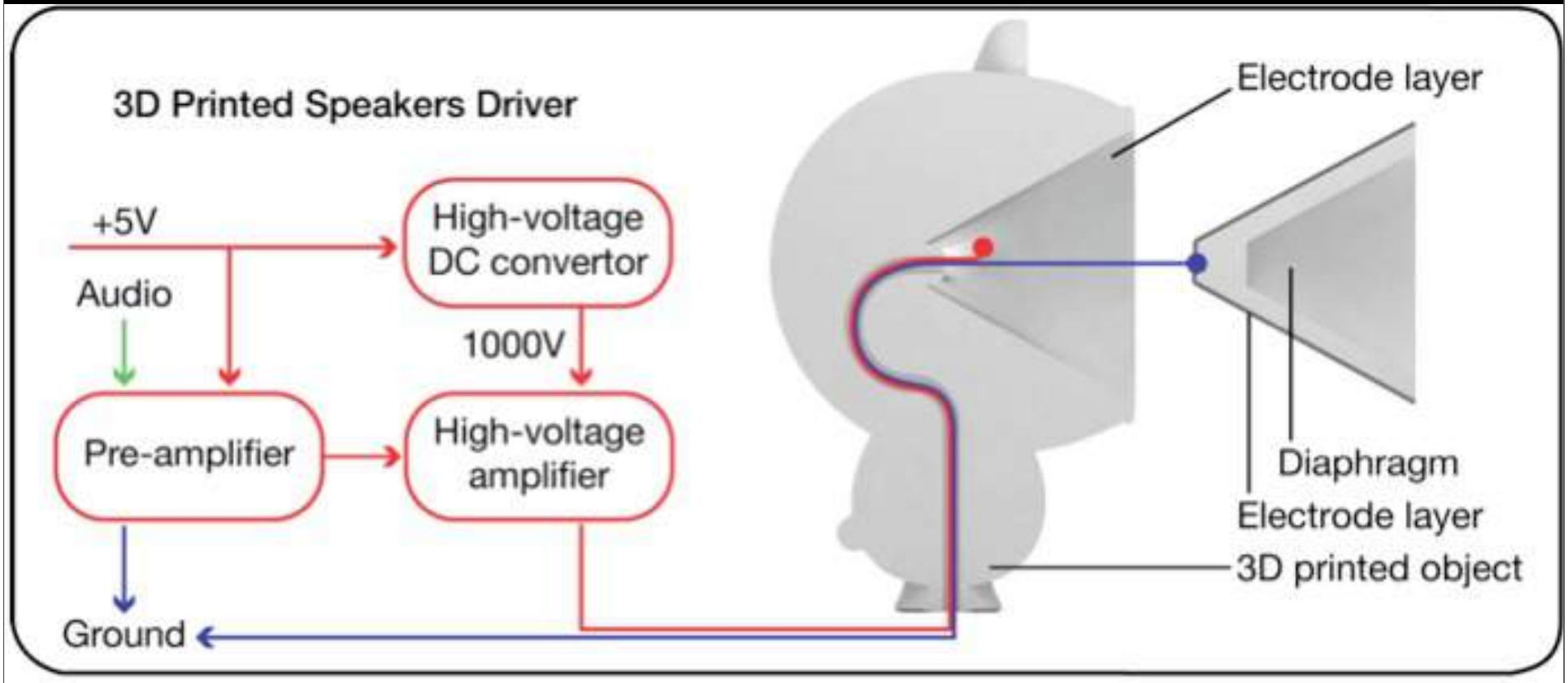


Voxel 8



here conductive paint is used,
but future 3D printers can print **conductive ink**

[Interactive Speakers ’14]




**electrostatic attraction** between the electrode layer and the diaphragm => vibration

[Interactive Speakers ’14]

more and more things become possible
with personal fabrication tools...

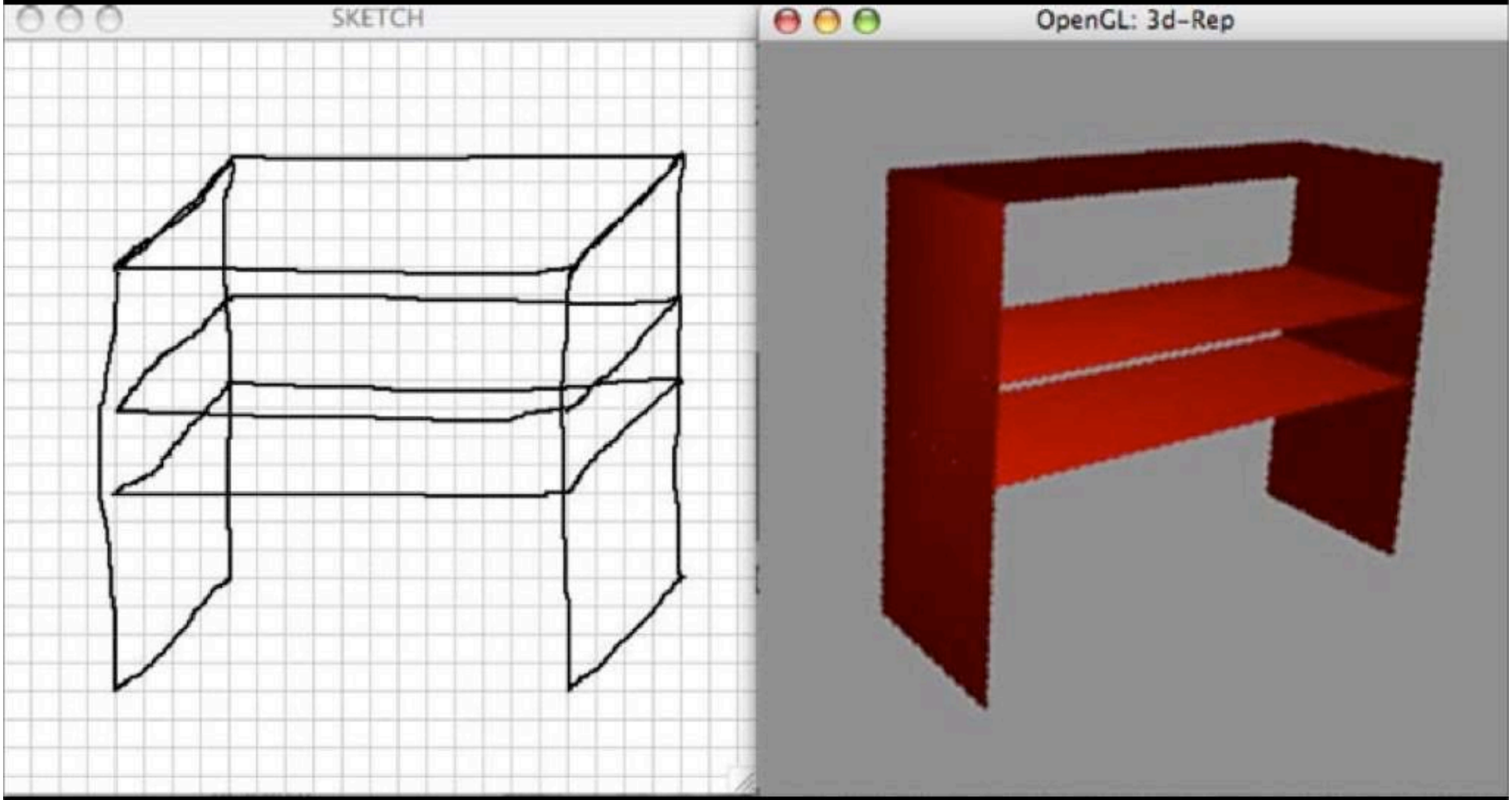
however, it is still **difficult for the average user to create** a custom design for their use case...

(often needs **expert knowledge:**
... 3D modeling skills ...
... knowledge of the mechanics behind the technique...)

# #4
# digital editing for the novice

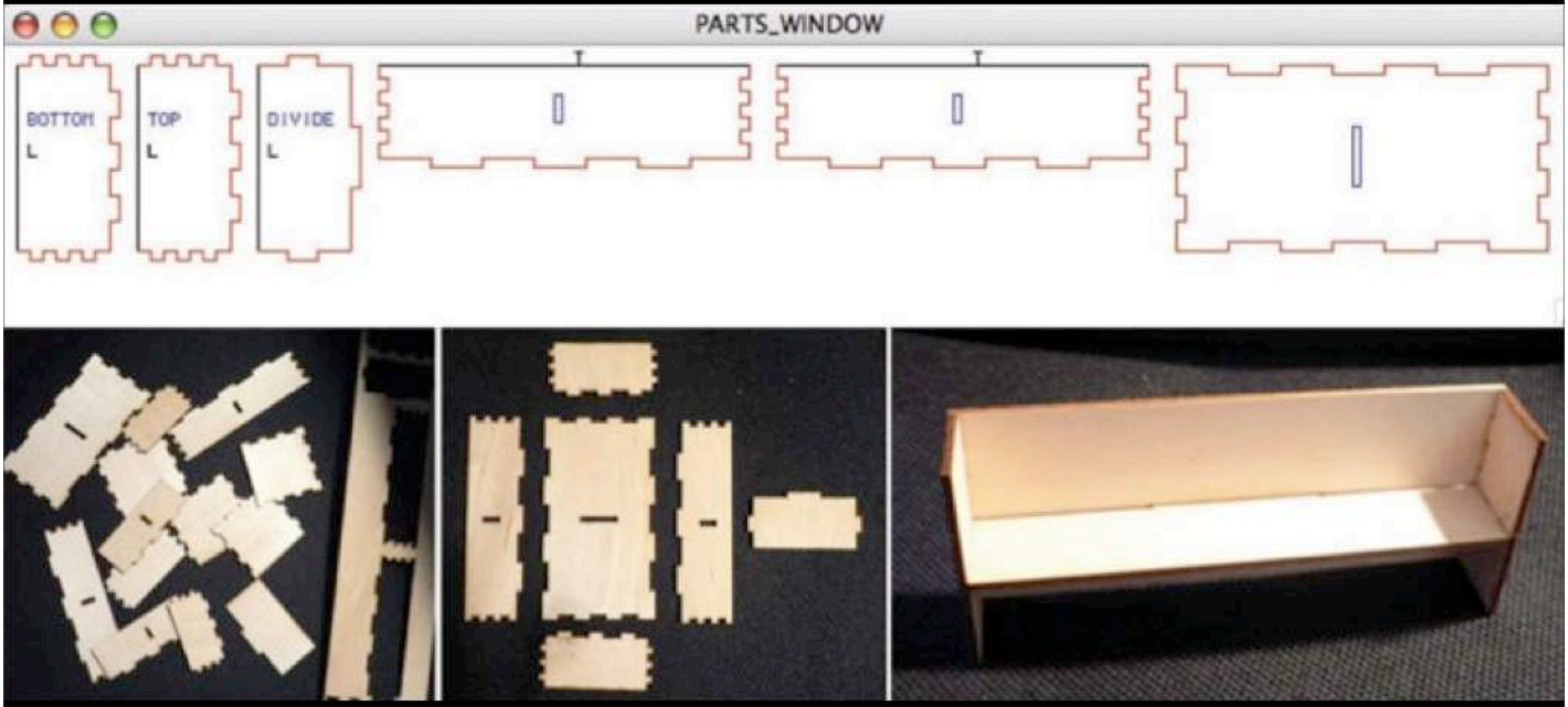
3D modeling is a complex task...

many researchers try to develop concepts to **lower the entry barrier** for producing personal objects ....



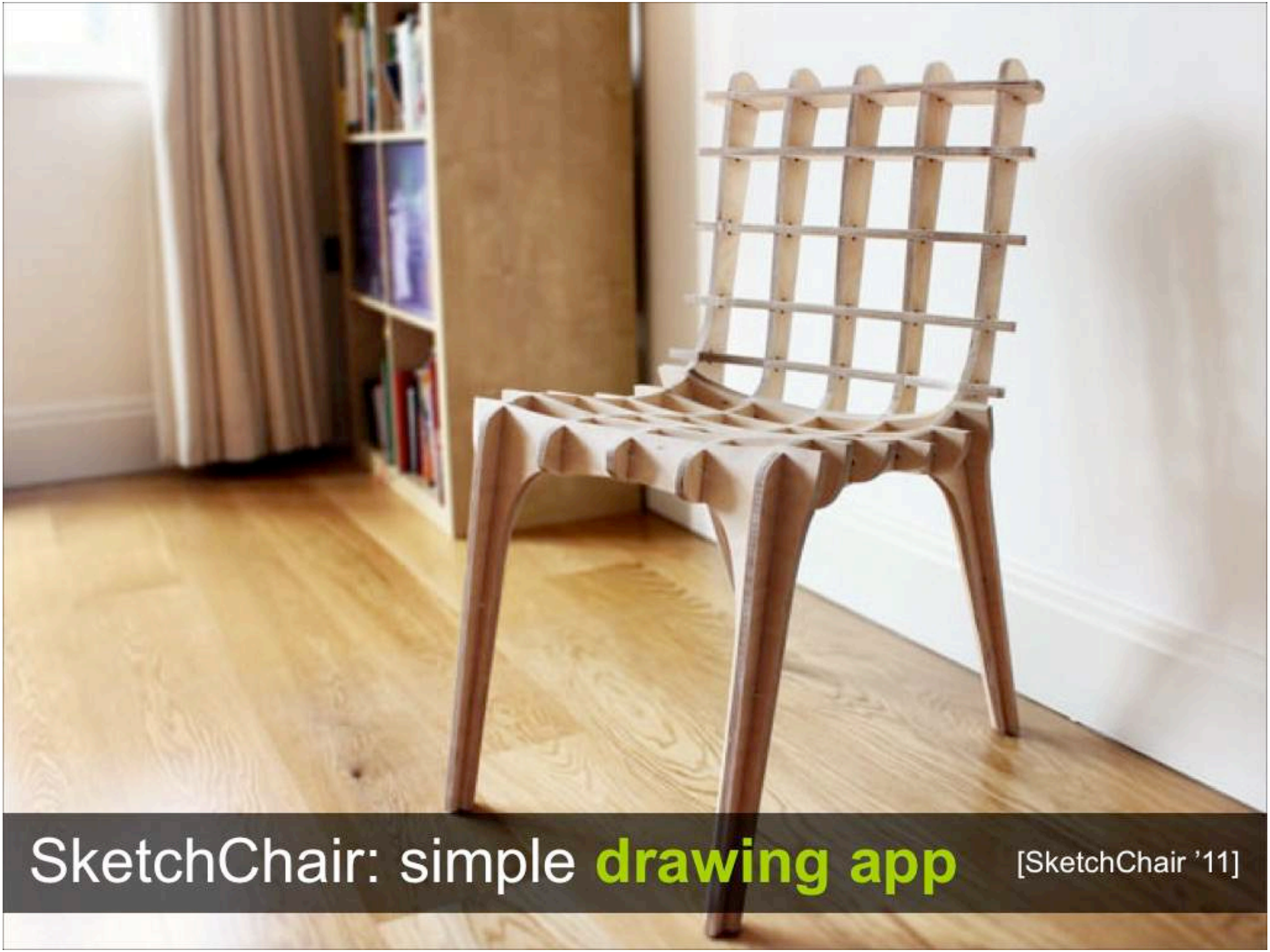

isometric **hand drawings** -> 3D model

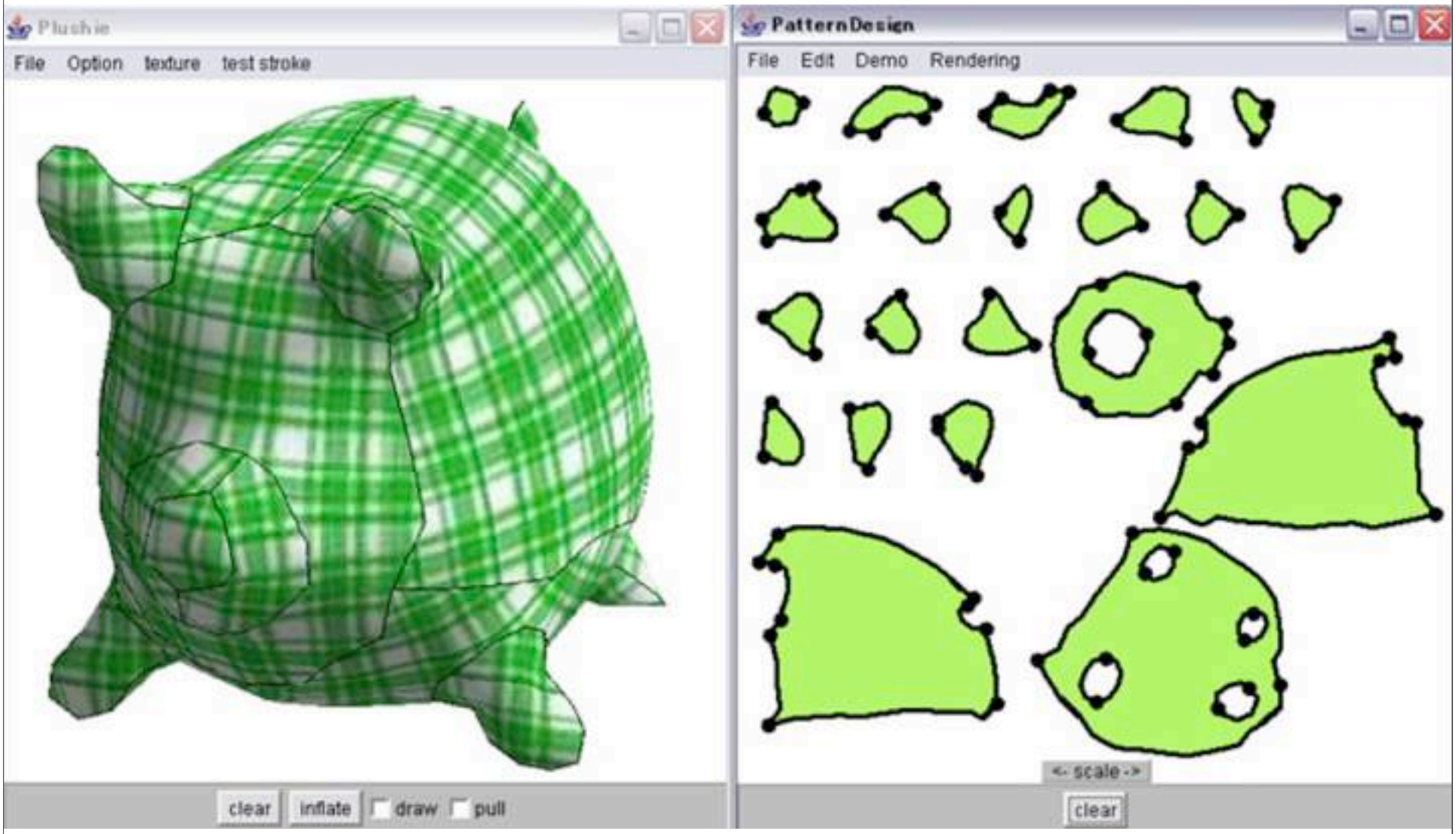
[FurnitureFactory '06]




**automatic generation** of laser cuttable parts

[FurnitureFactory '06]


SketchChair: simple drawing app
[SketchChair '11]

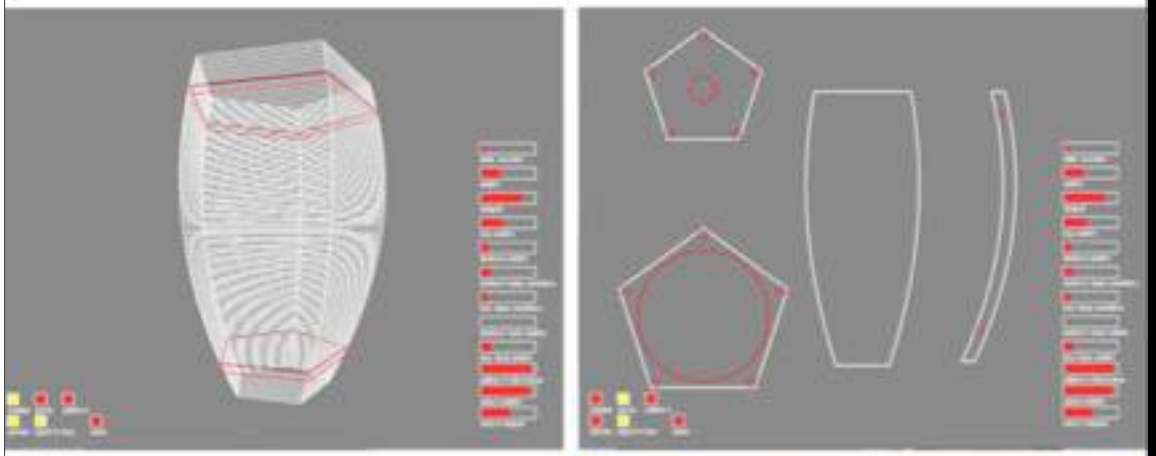



# 3D modeling based on **2D sketches** [Plushie '07]


create objects via code
[Codable Objects ’12]

```
//////////////////////////////////////
// ==========GENERATE SPIRAL================ //

int centerLimit = 150; // variable to control the maximum diamete
float rad = 80; //like the radius of your circle, but increases
//this will draw one spiral
for (int i=0;i<centerLimit;i+=1) {
  rad +=0.5; //change to alter the tightness of your spiral
  pointController.addPolarPoint(width/2, height/2, rad, rad);//
}
```

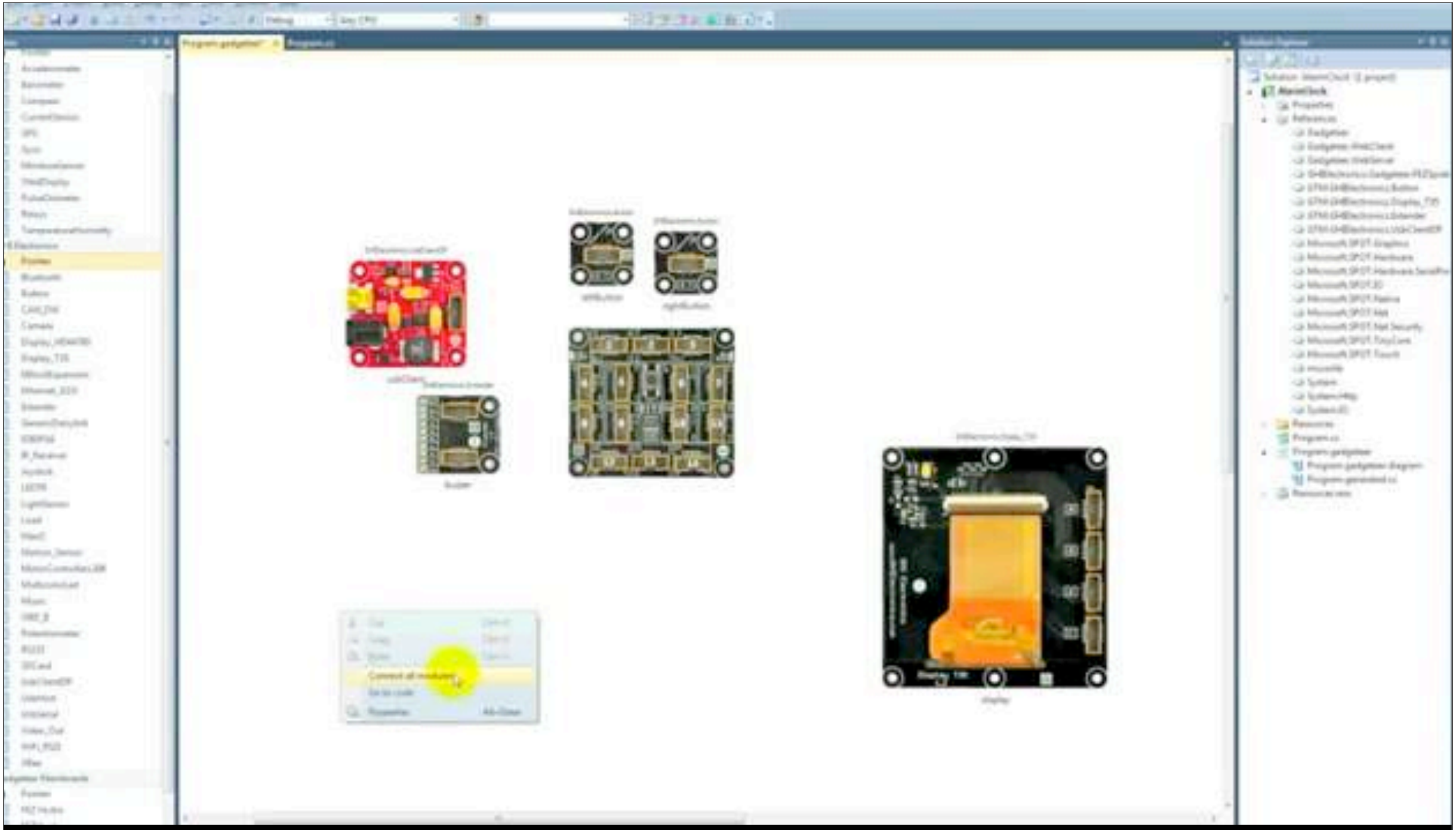






mainly **parametric** patterns

[Codable Objects ’12]



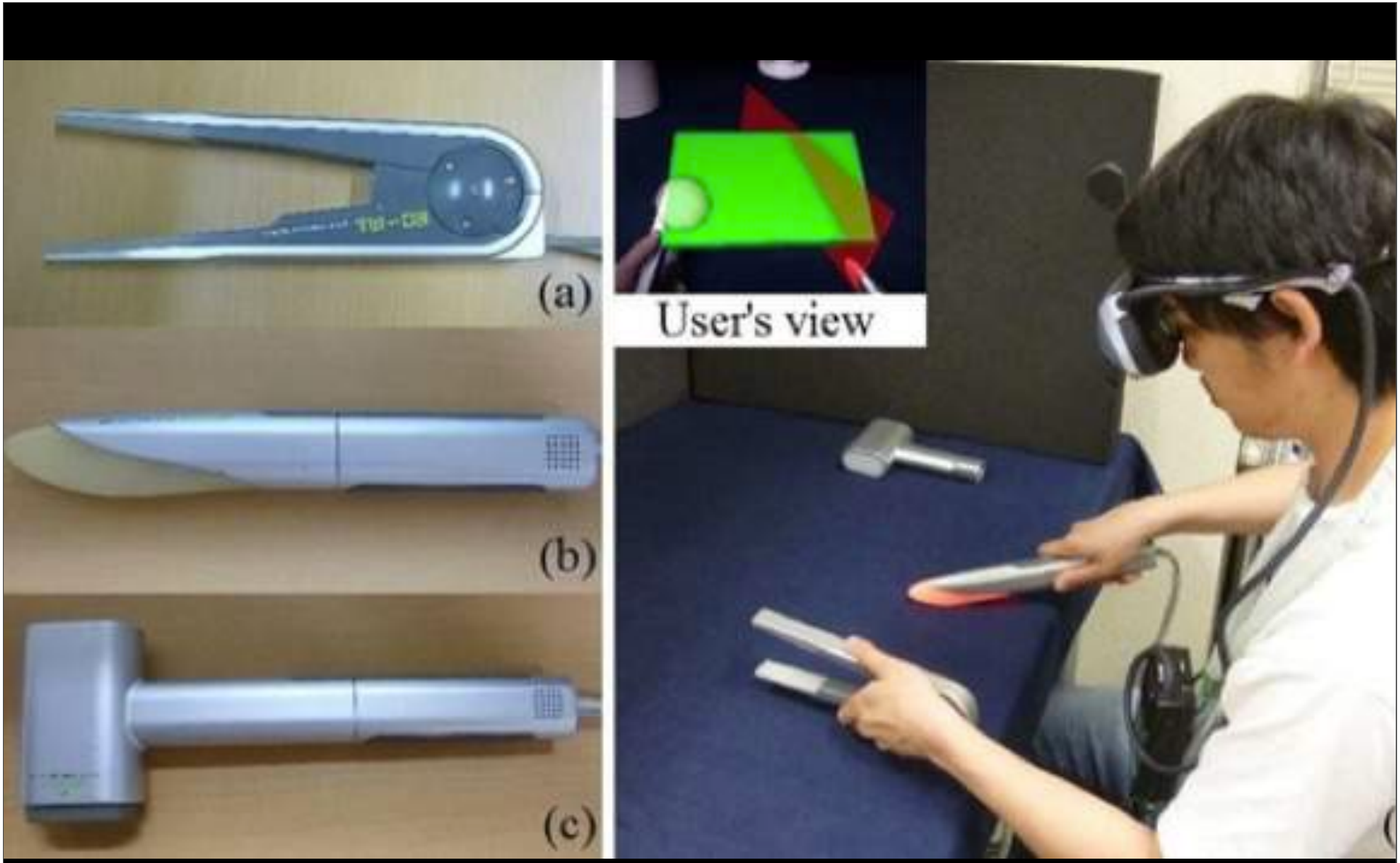
casings that **match** electronic components

[Enclosed ’13]

all these interfaces are digital...

users sit at a computer and
use a **digital 3D editor** to design a **physical object**

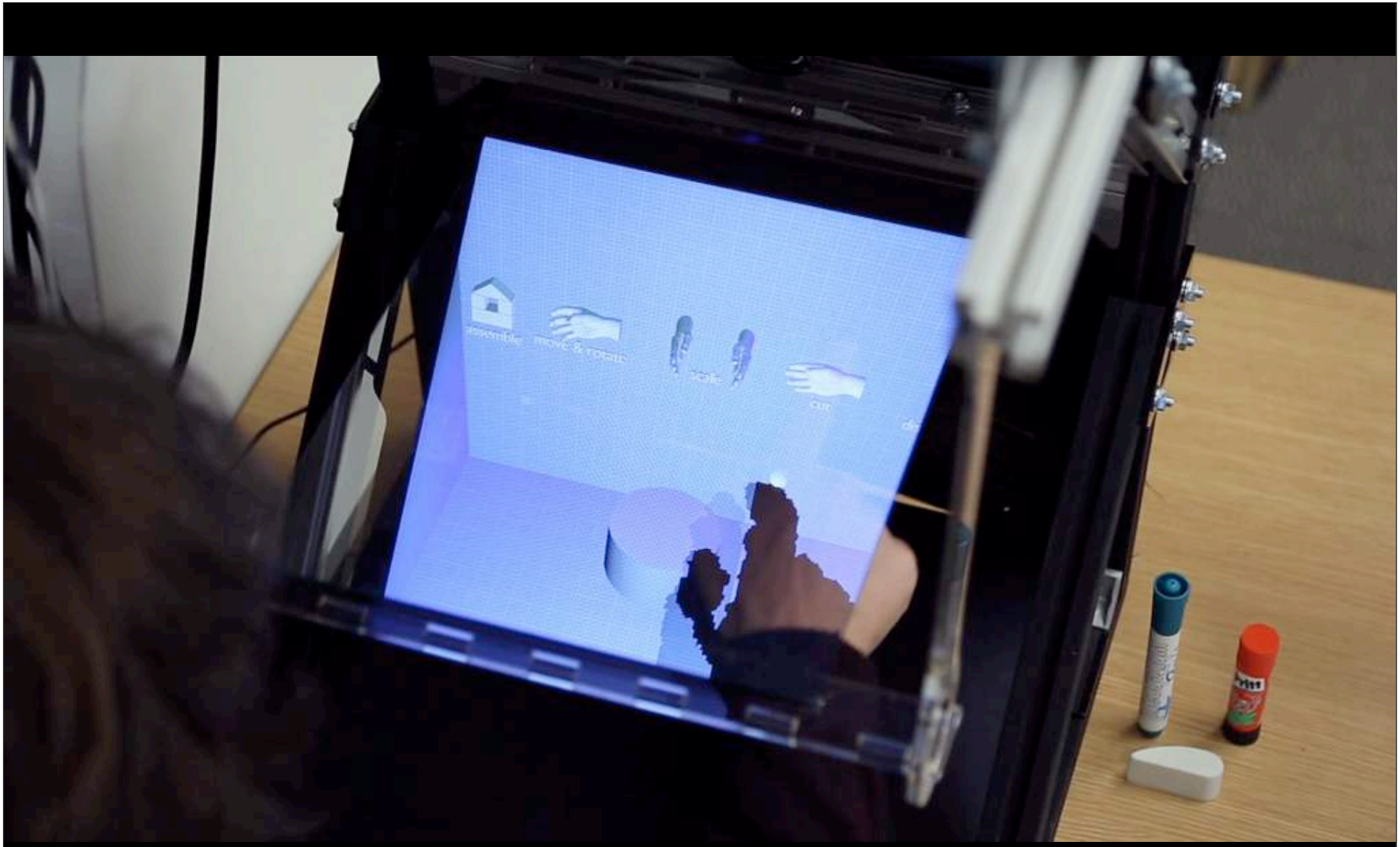
# #5
# physical editing (VR, AR, NUI)




# mixed-reality: **physical tools** + virtual objects

[Enjoying virtual handcrafting with ToolDevice ’12]


mixed-reality: physical tools + virtual objects
[Enjoying virtual handcrafting with ToolDevice ’12]



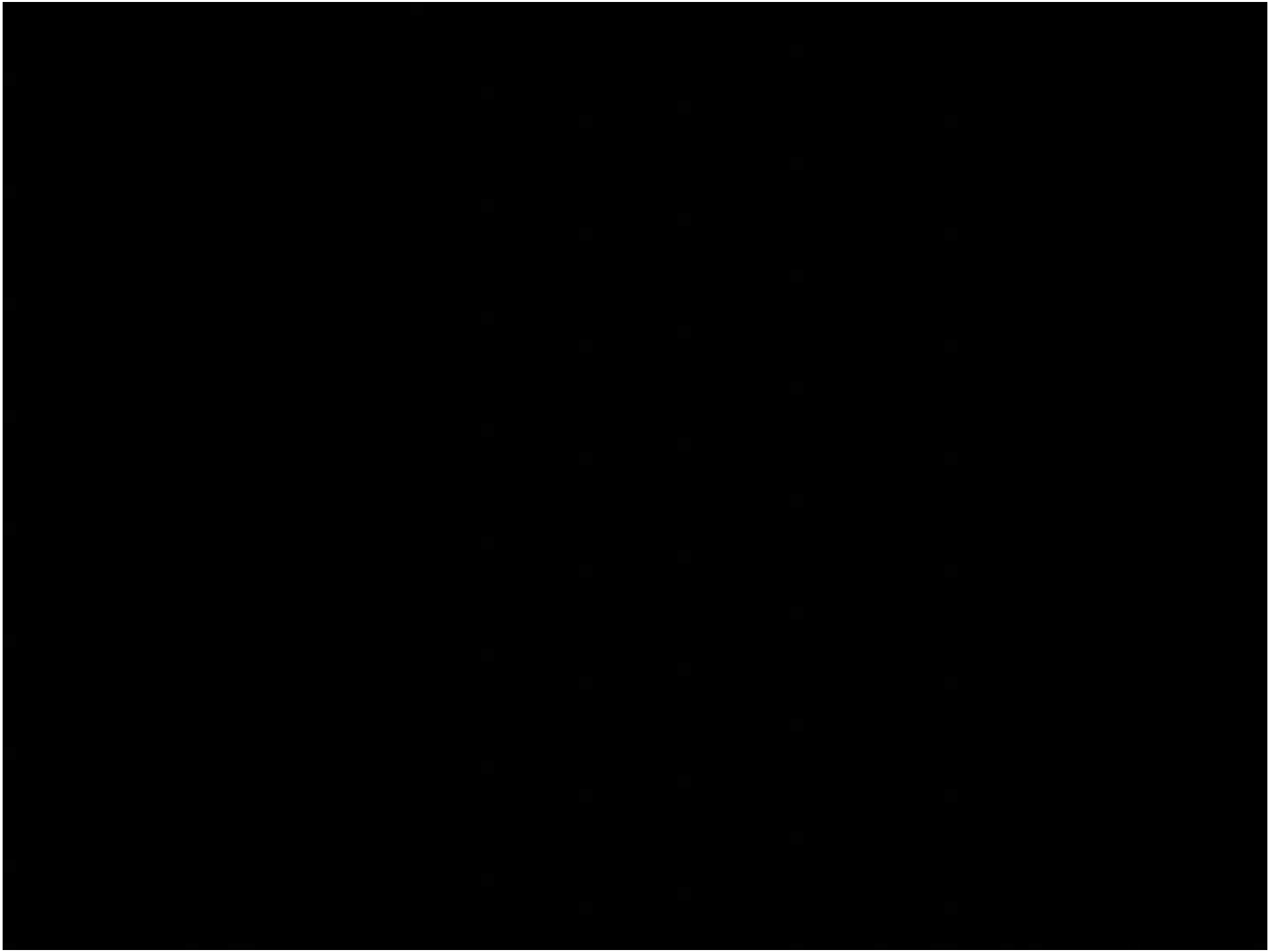

# MixFab: mixed-reality based on Holodesk

[MixFab ’14]


MixFab
a mixed-reality environment
for personal fabrication

mannequin as **physical shape reference**

[DressUp ’12]



do you think this is an good interface for the user?
if yes why?
if no, how can this be made better?

**<30 sec brainstorming>**

input is in the “real” world, 3D spatial...

but **no immediate physical output.**
physical object is only fabricated at the end.


**traditional crafting:**
work directly on the workpiece
+ see physical change after every step

# #6
# interactive fabrication

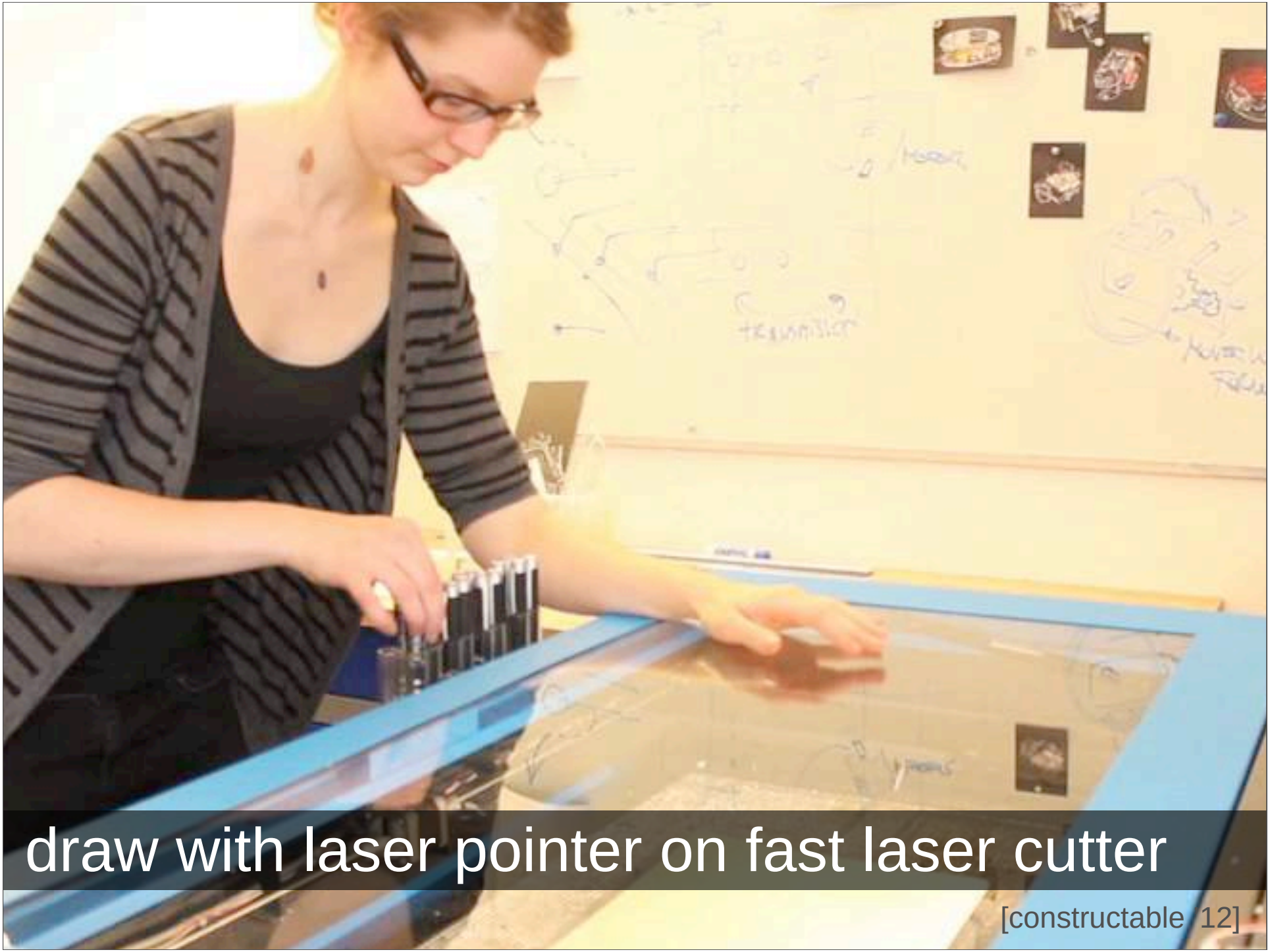

Shaper: foam printer drops new material after user indicated position, still slow
[Interactive Fabrication ’11]

# Shaper

A prototype device that uses a 3 axis CNC machine to interactively dispense expanding polyurethane foam.

**traditional craft:** **user is the bottleneck.**
if the user can operate the tool faster, he can create faster

**interactive fab:** **machine is the bottleneck.**
machine needs time to move the print head and produce the material, users have to wait after each interaction



draw with laser pointer on fast laser cutter

[constructable 12]


HPI
constructable
interactive lasercutting

what do you think are the **advantages** of interactive fabrication, what are the **disadvantages** compared to digital 3D editing + fabrication?

# <30 sec brainstorming>

what do you think are the **advantages** of interactive fabrication, what are the **disadvantages?**

**WYSIWYG, test objects incrementally...**

**no real undo, precision, zooming...**

**interactive fab:**
most **freedom** for experts,
but users can make **mistakes (no undo)**

# #7
# fab guided by a virtual model

# hot glue gun + phantom force feedback arm

[HapticIntelligentsia' 12]

# THE MACHINE

Designing a New Industrial Revolution
Designing a New Industrial Revolution
Designing a New Industrial Revolution
Designing a New Industrial Revolution
Designing a New Industrial Revolution
Designing a New Industrial Revolution
Designing a New Industrial Revolution

JOONG HAN LEE (STUDIO HOMUNCULUS)
HAPTIC INTELLIGENTSIA

router stops when you leave the path

[Position-Correcting Tools for 2D Digital Fabrication' 12]

(a) Target 3D model

(b) Guidance projected onto material

(c) Sculpted physical replica

sculpting: **3D scan** matched against 3D model (green = add material, red = remove material)

[Sculpting by Numbers' 12]

FreeD: hand-held mill
(tracking + shaft actuation)

[FreeD' 13]

scissors that prevent you from mistakes

[Enchanted Scissors' 13]

Enchanted scissor

how does is this implemented?
(how does it work)

how does is this implemented?
(how does it work)

**<30 sec brainstorming>**


conductive ink + servo motor that pushes scissors apart when the circuit is not closed

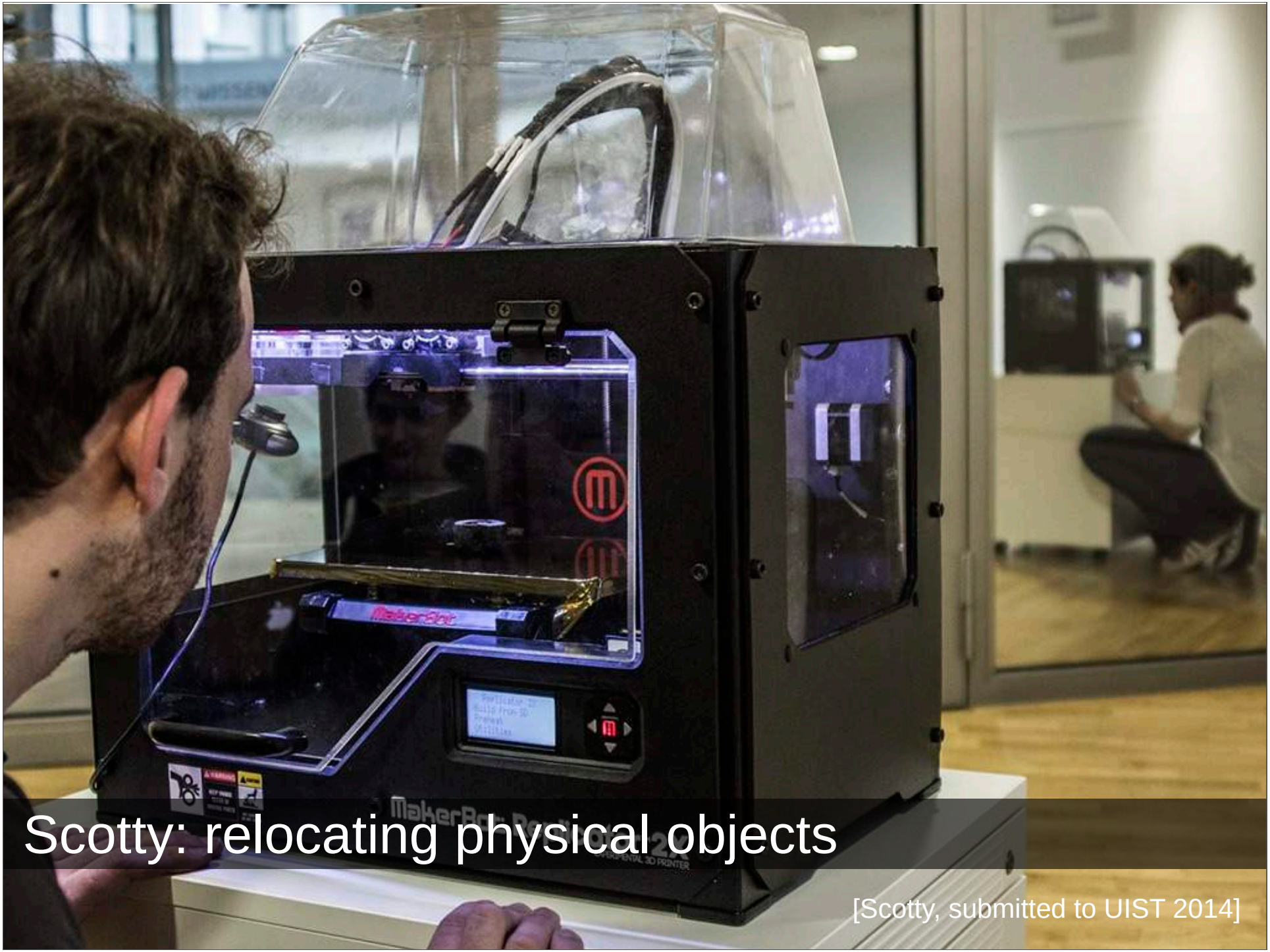
[Enchanted Scissors' 13]

**prevents errors** (great for beginners)
**workflow is mostly predefined**

# #8
# replication
# & value

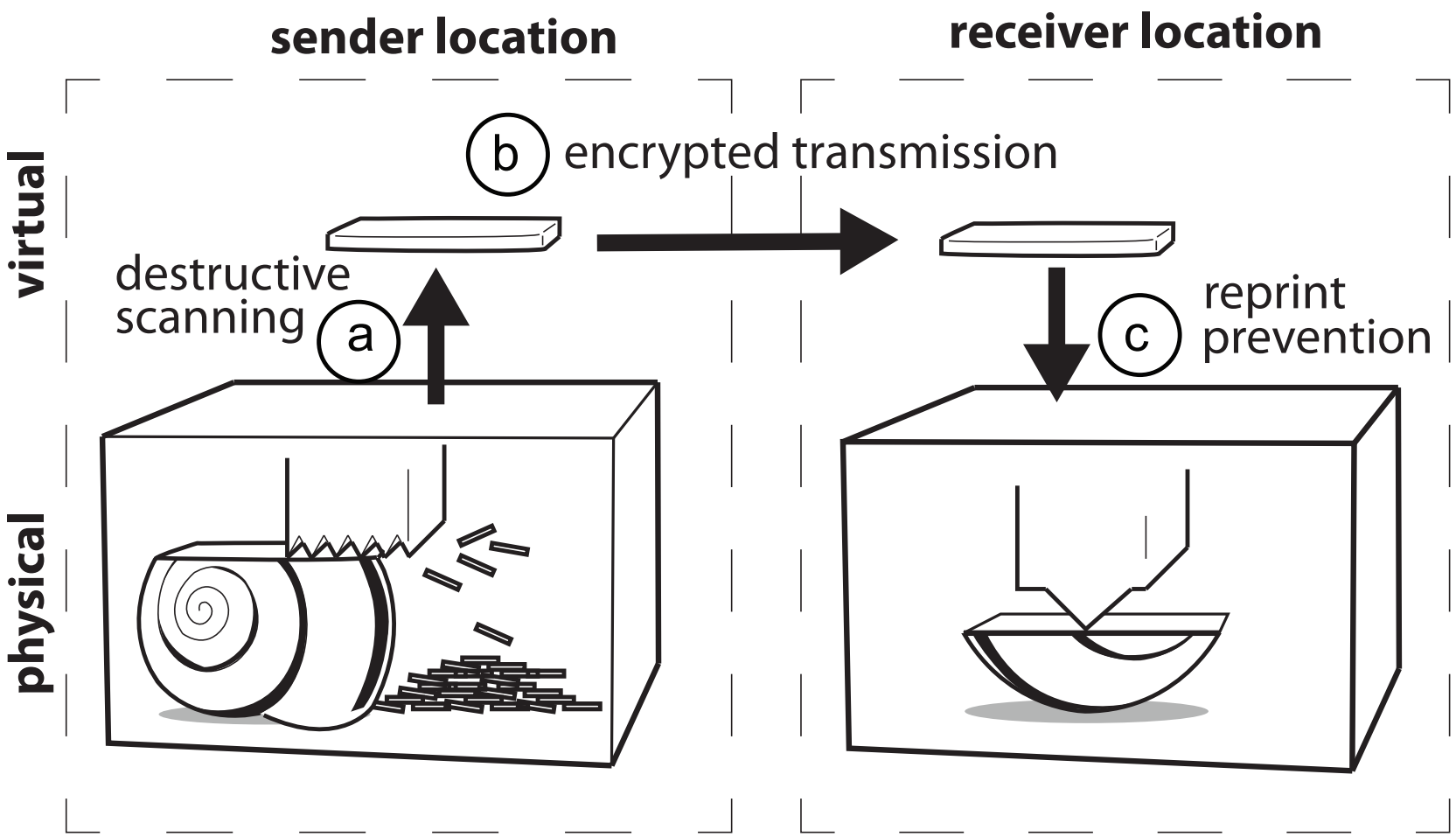
personal fabrication devices allow us to create **more and more** things.

**scan, upload, reprint...**



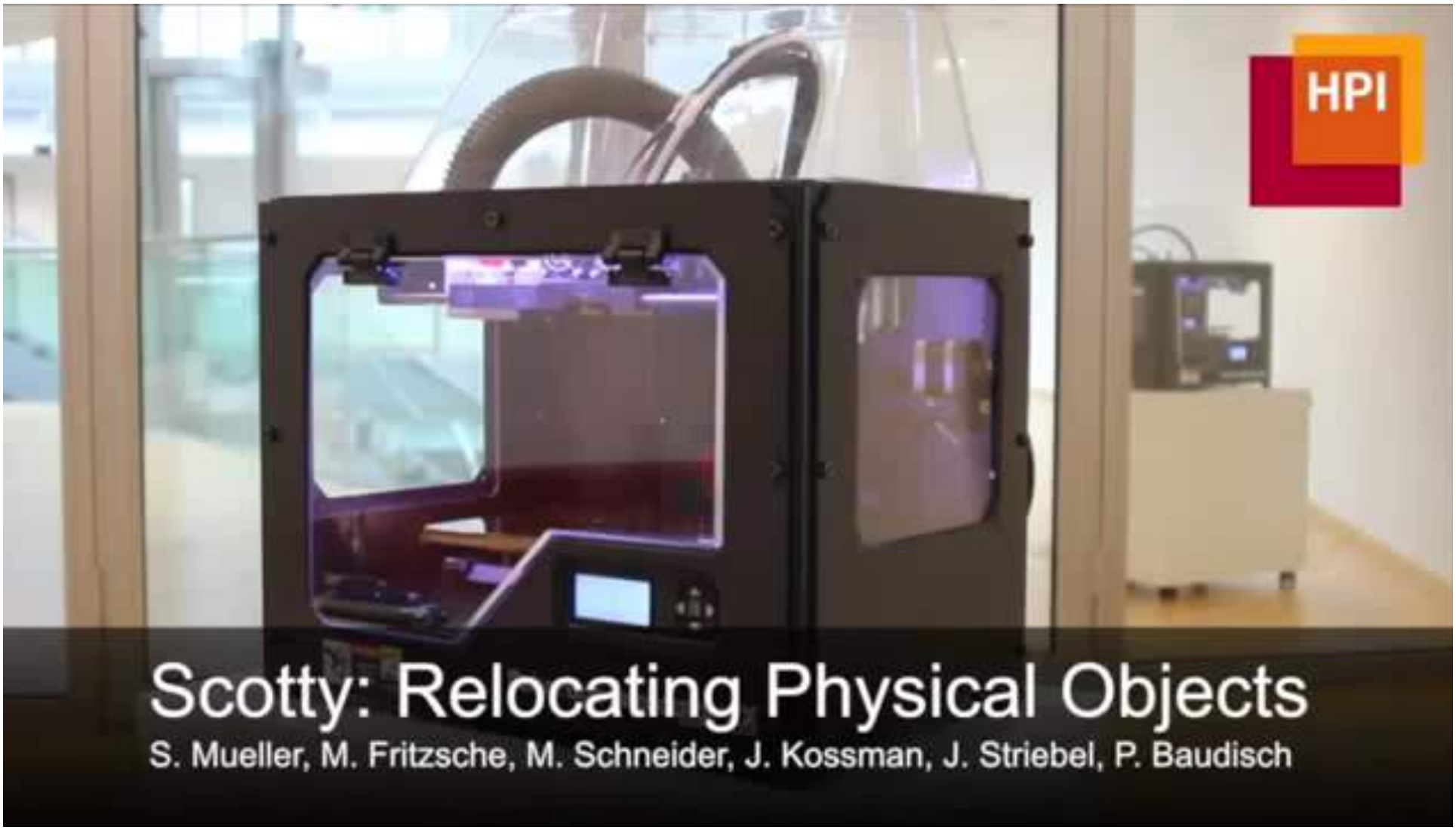

# Scotty: relocating physical objects

[Scotty, submitted to UIST 2014]




**= unique object**

[Scotty, submitted to UIST 2014]




# Scotty: Relocating Physical Objects

S. Mueller, M. Fritzsche, M. Schneider, J. Kossman, J. Striebel, P. Baudisch

next week get your study ready

**Where** MVB atrium

**When** same time as lecture

**Who** Monday: Spoons / kappa / hci-cicles / dendermonde / HC no I in team

Wednesday: Team One / sezen /fivetastic /team won / codeashians

**Everybody here! to both days!**

end