digital fabrication in hci

Anastasia Bezerianos

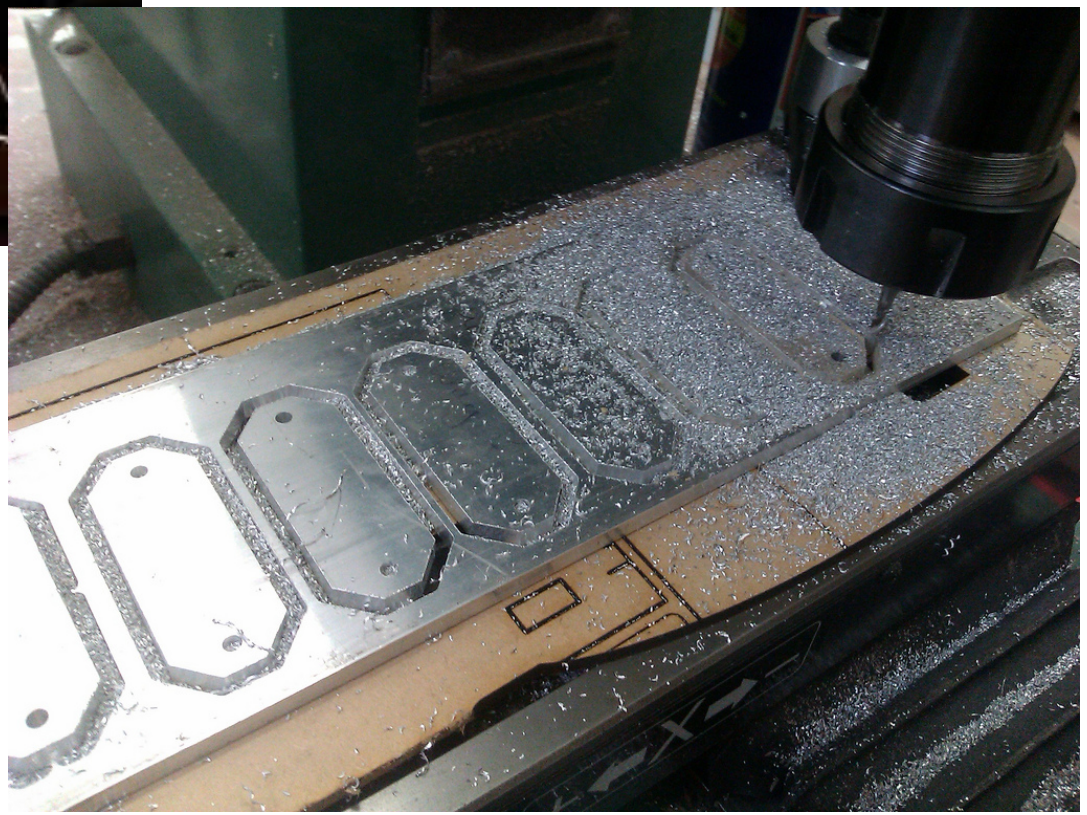
Inspired by: D. Mellis, S. Follmer, B. Hartmann, L. Buechley, and M.D. Gross. (2013). FAB at CHI: digital fabrication tools, design, and community. In CHI '13 Extended Abstracts on Human Factors in Computing Systems (CHI EA '13). Some slides come from Lora Oehlberg

who likes to make stuff?

- Soldering?
- Electronics?
- Cooking?
- Knitting? Crochet?
- Sewing?
- Woodworking?
- Welding?
- Casting?
- Ceramics?
- Glass-blowing?

traditional vs. digital fabrication

http://www.browardtrailer.net/



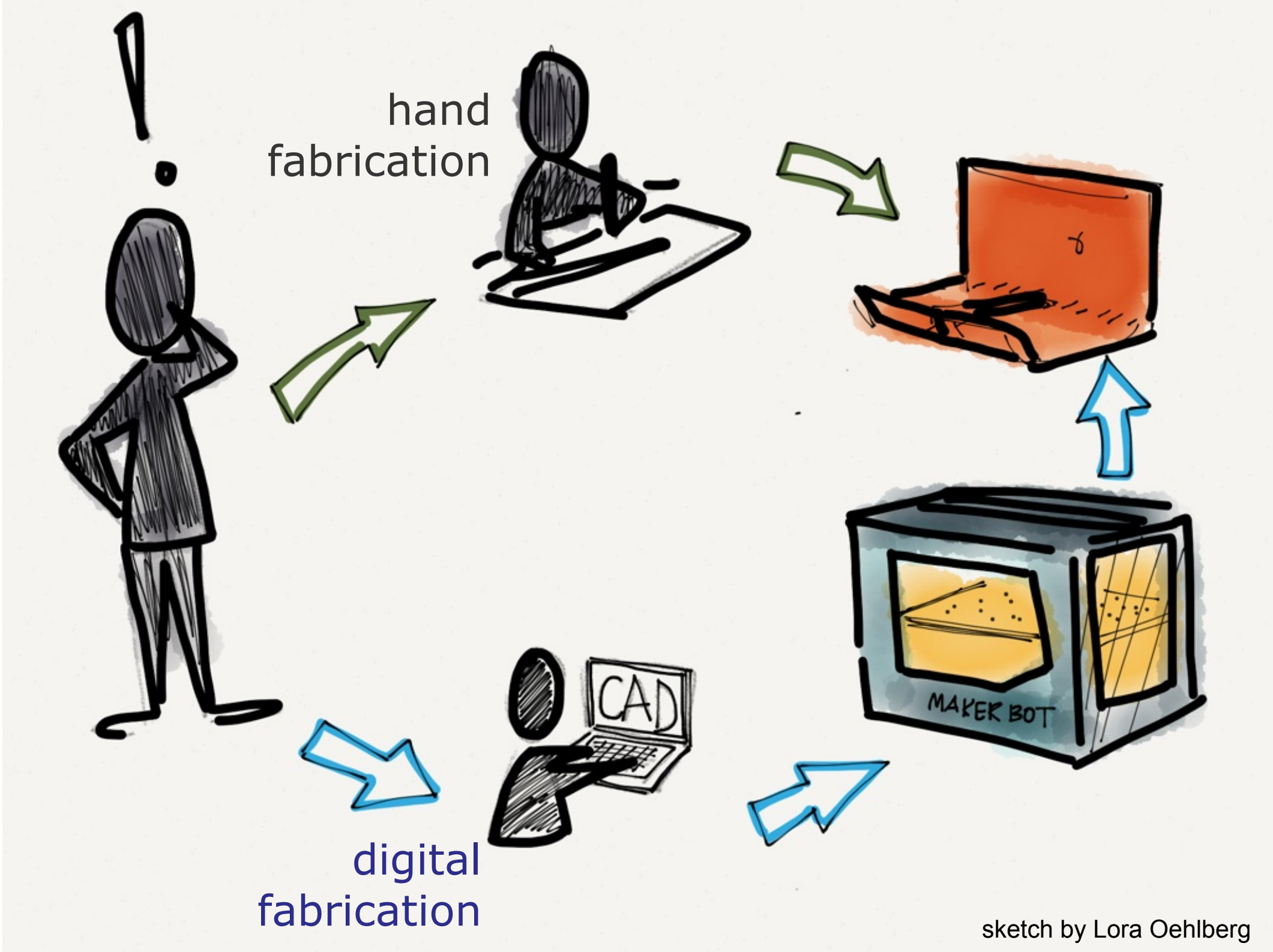
Flickr user matthewvenn

digital fab at different scales

BanQ restaurant

www.creativeapplications.net

TinyDruino



sketch by Lora Oehlberg

When should I use...

... hand fabrication?

- You are more expressive by hand than using computer tools (CAD, Vector Graphics)
- It's a one-off object, not worth bothering with CAD
- It's faster to just make it, and not over-think

... digital fabrication?

- I want to create a data-driven object
- I want to make small batches (4+)
- I will eventually make VERY large batches (1000+)
- I *need* something more precise than I can produce by hand

“fab lab”

Machine shop

fab lab (fabrication laboratory)

small-scale workshop for (personal) digital fabrication, accessible to the public

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fab lab movement history:

2001: Grassroots Invention Group +
Center for Bits and Atoms (CBA) MIT Media Lab
Community outreach initiative
Maker culture (tec DIS movement)

around 2000 of fab-labs world-wide (and many in Paris)

a fabrication lab in our university (open to all of you and the public)

medium-scale fabrication

Lasercutter

Vinylcutter

2D VECTOR DRAWING

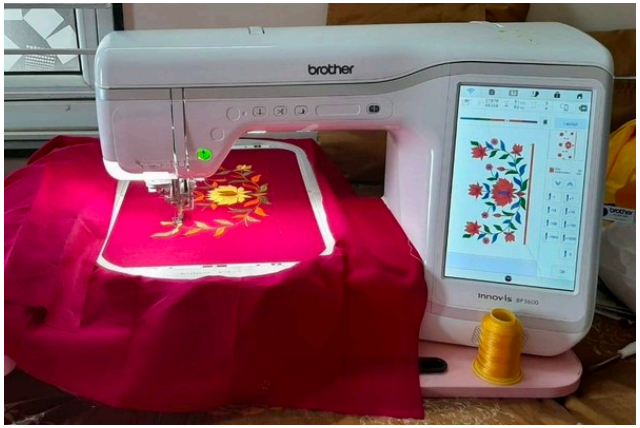
3D printer

CNC Milling

3D CAD MODEL

3D Scanner

and many more …

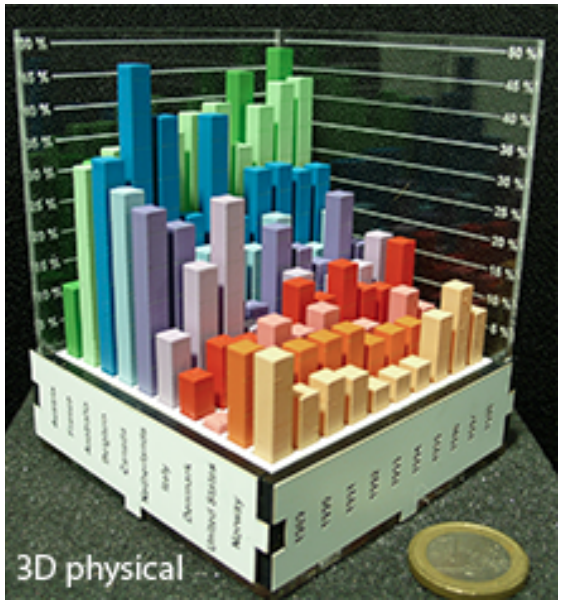


fab + hci

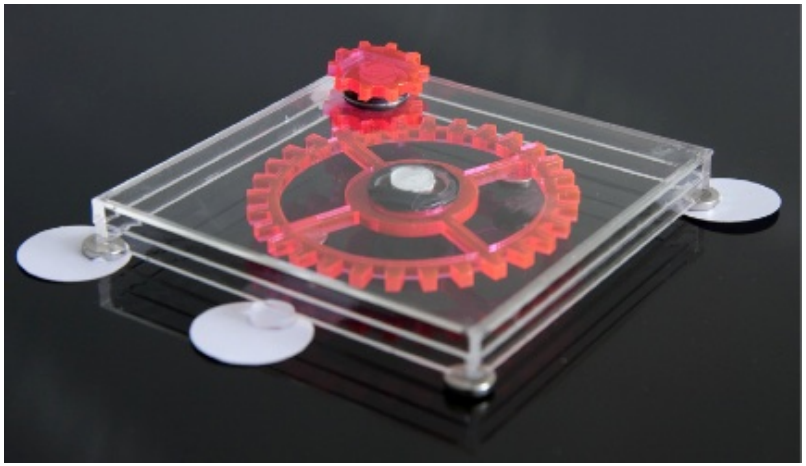
1. Fab for prototyping interaction and tangibles
2. HCI interfaces for design and Fab
3. Online communities and Fab collaboration

fabrication in service of hci ...

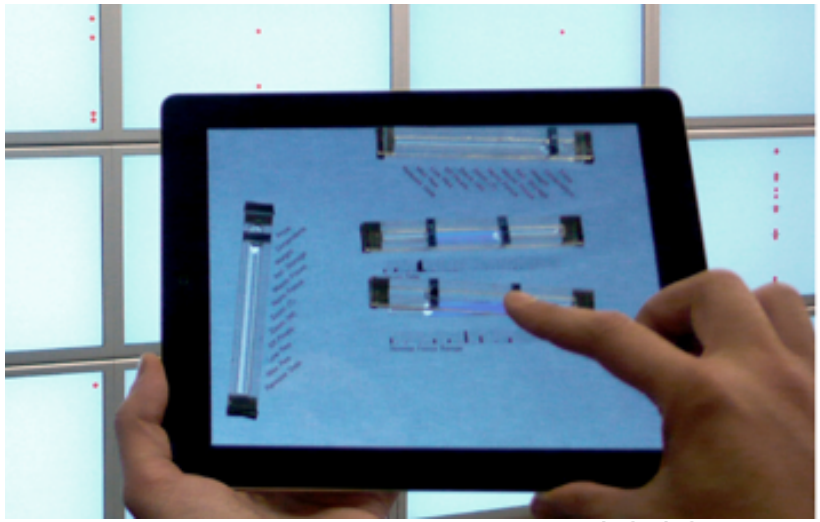
… remember tangibles?



[Jansen et al, 2012]



[Weiss et al., 2010]

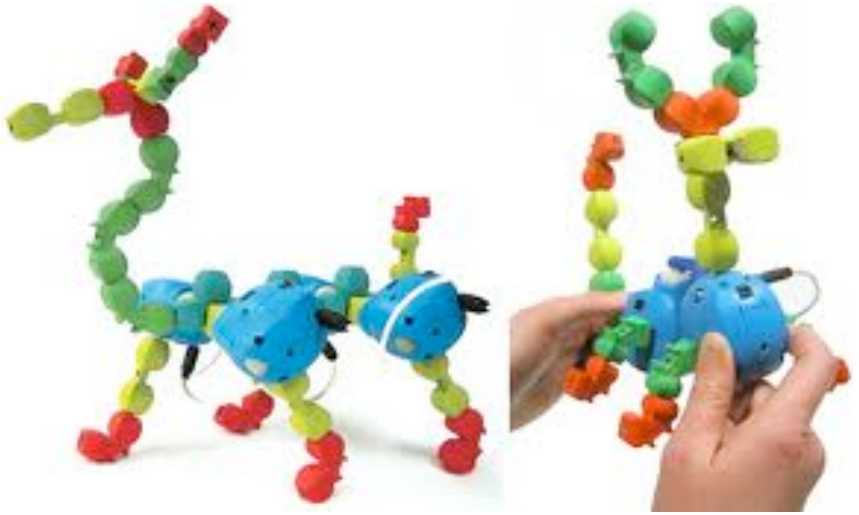


[Jansen et al., 2010]

[Chan et al., 2012]

Topogo [Raffle et al., 2004]

3D constructive assembly kit with « kinetic » memory



stuff.mit.edu
http://youtu.be/50JdK_K2NWk

Midas [Savage et al., 2012]

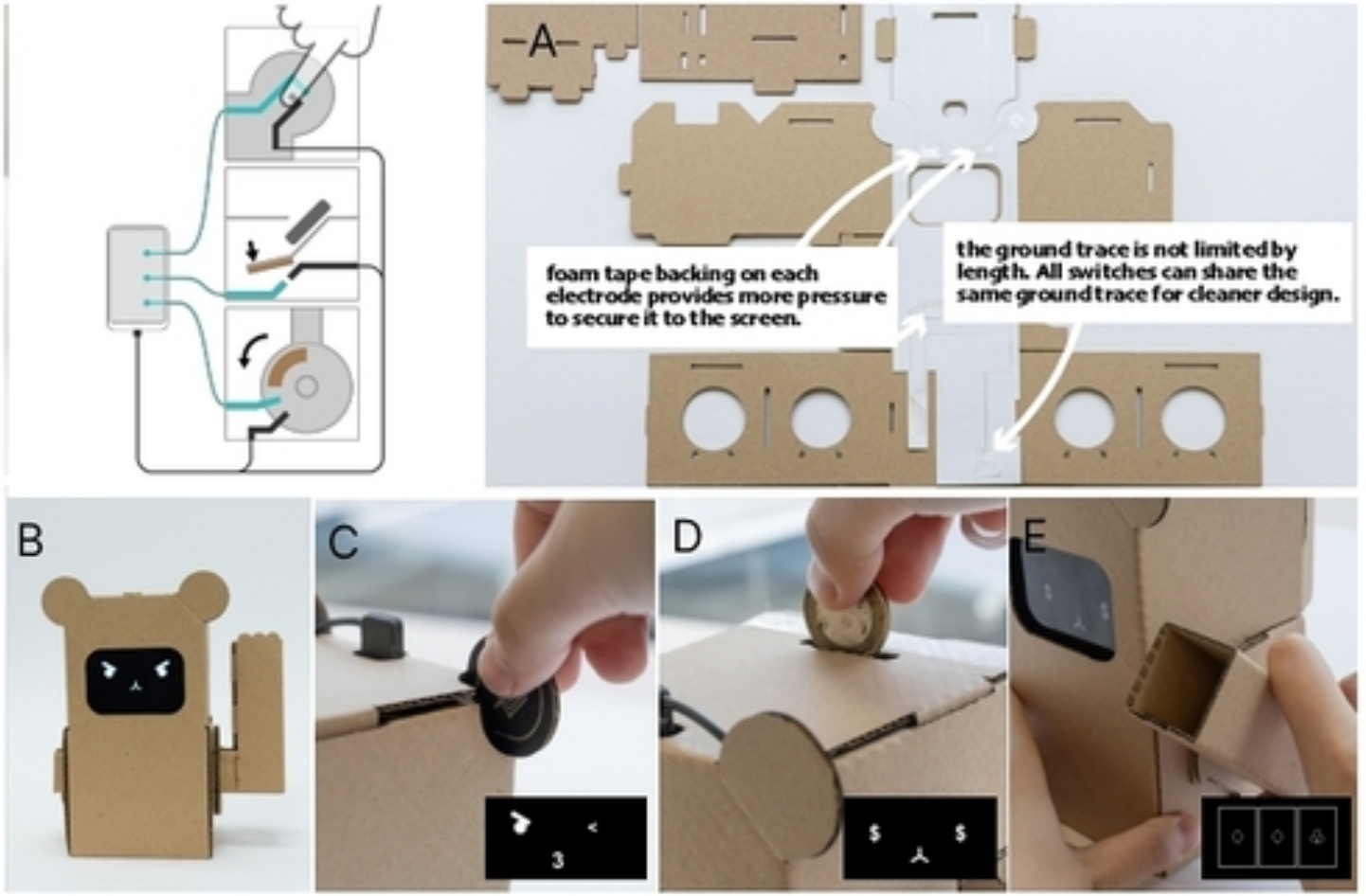
eecs.berkeley.edu
http://youtu.be/WHcQgtjD_zY

Sketch-a-TUI [Wiethoff et al., 2012]

Build low fidelity physical prototype
Draw on it using conductive ink
Recognize ink pattern on touch devices

PaperTouch [Ye et al., 2024]

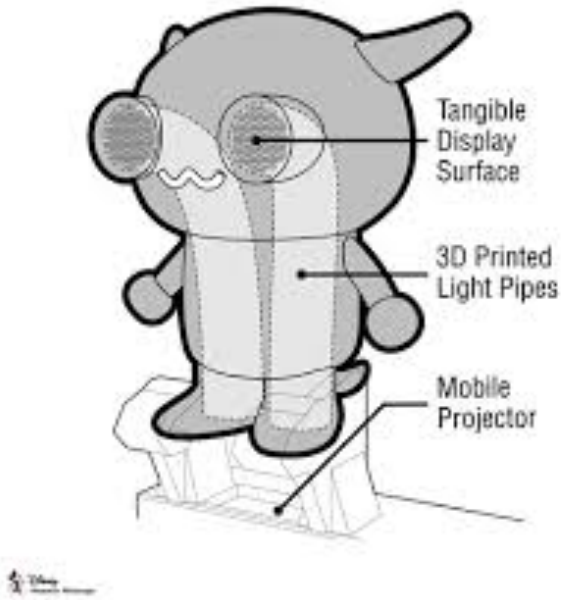
Combines regular paper and capacitive touch technology

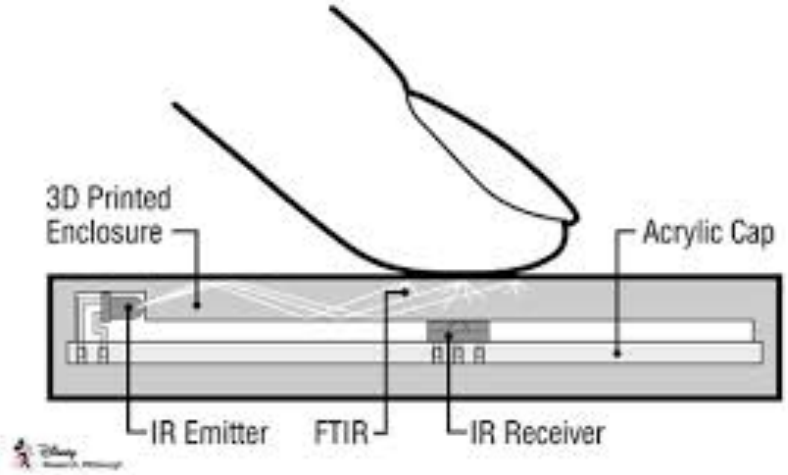


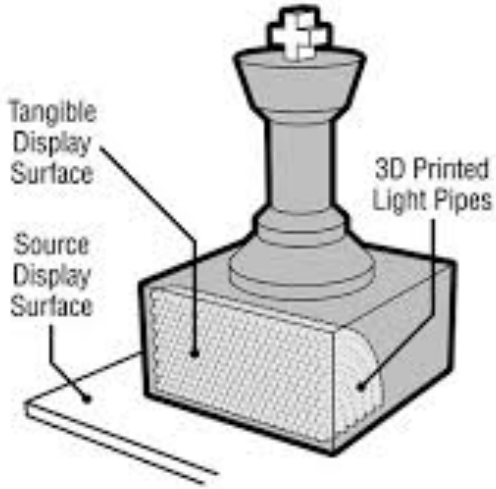
https://dl.acm.org/doi/10.1145/3613904.3642571

Printed Optics [Willis et al., 2012]

Help 3D print items that allow sensing, display and illumination



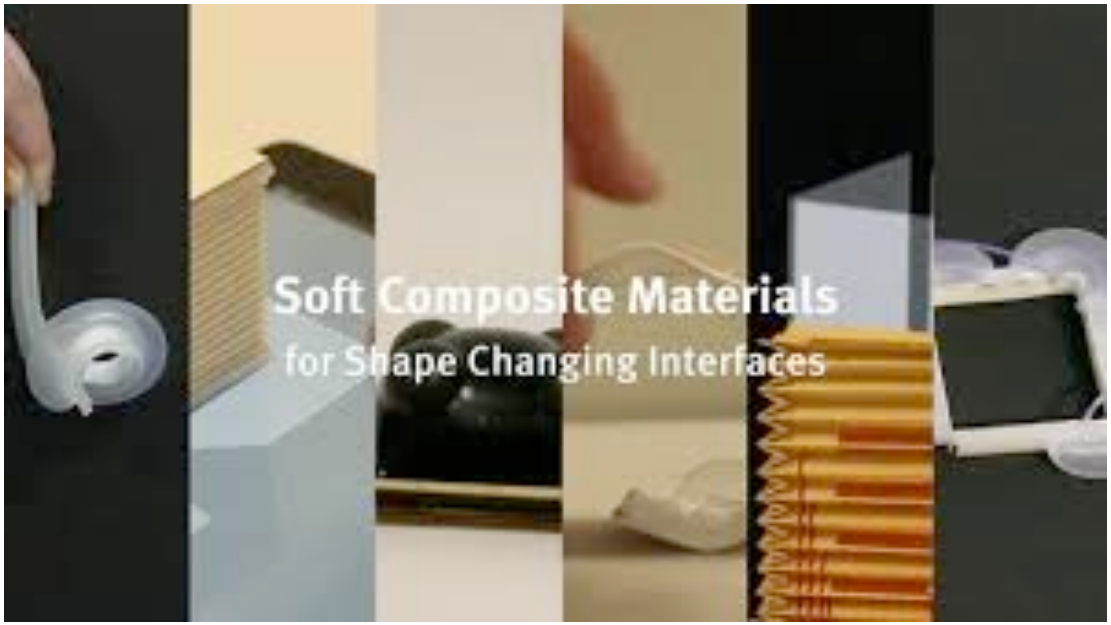




disneyresearch.com
http://youtu.be/eTeXTbXA6-Y
newer versions
http://www.disneyresearch.com/project/papillon/

PneUI [Yao et al., 2013]

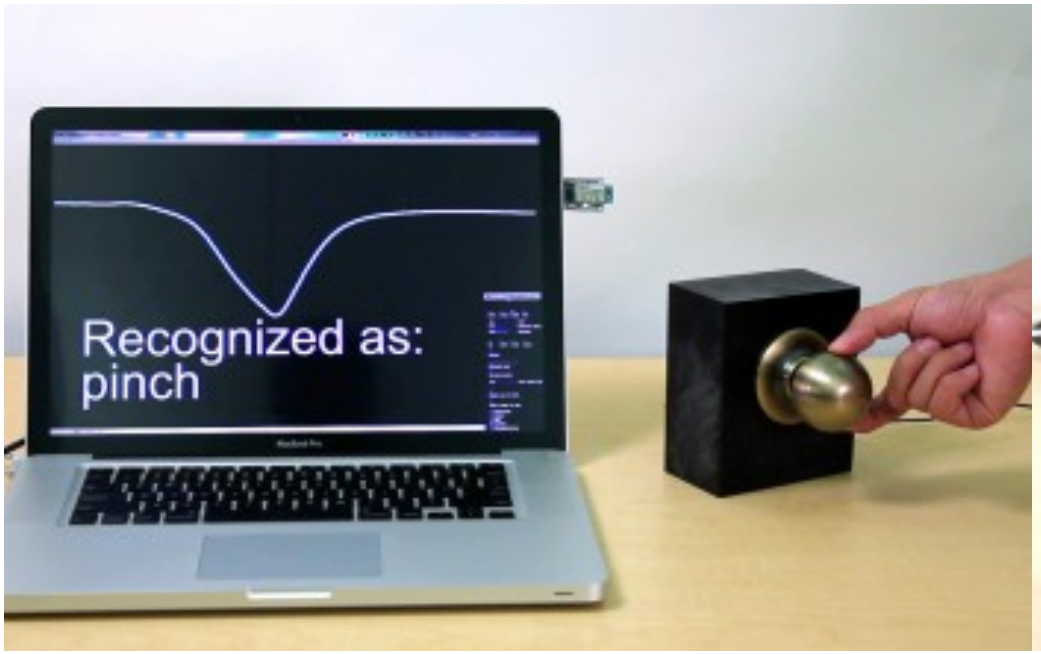
A way to build shape-changing interactive components

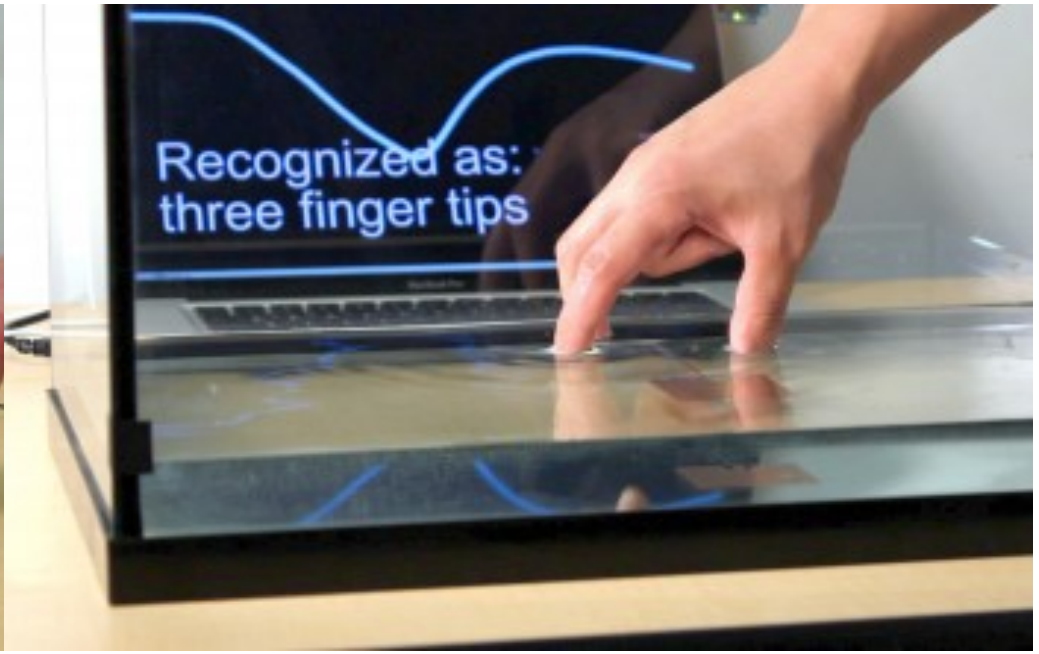


http://tangible.media.mit.edu/project/193/

Touché [Sato et al., 2012]

A way to add capacitive input in many different surfaces

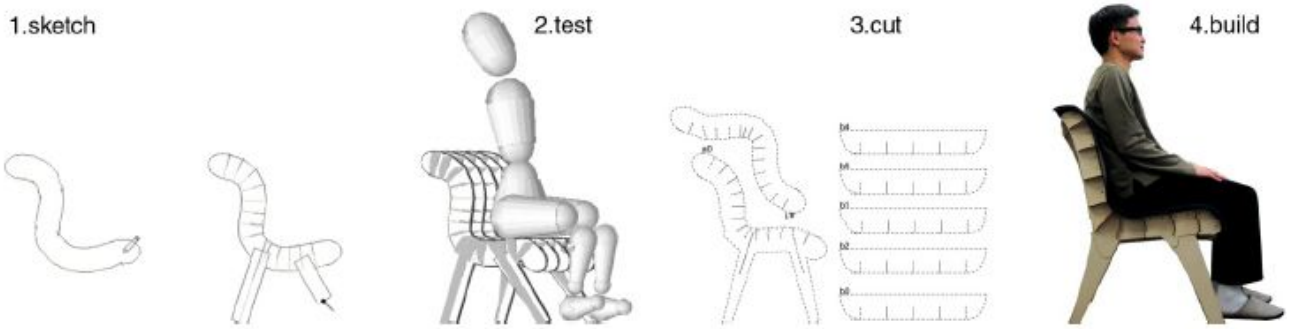




https://satomunehiko.com/works/touche/

hci in service of fabrication ...

Domain specific

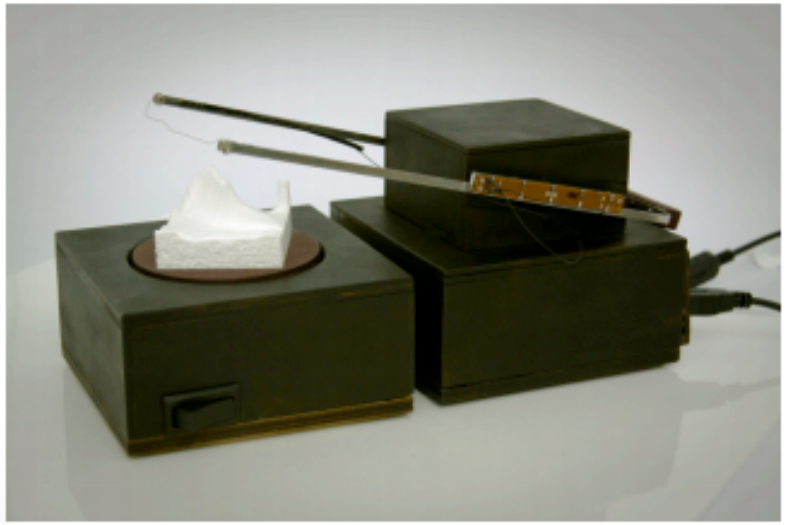


SketchChair [Saul et al., 2011]
http://www.jst.go.jp/erato/igarashi/en/projects/sketchchair/

Plushie [Mori and Igarashi, 2007]
http://www.geocities.jp/igarashi_lab/plushie/index-e.html

Tangible interaction for fab

kidCAD [Follmer and Ishii, 2012]
uses the deFORM surface to capture 2+1/2D



[Willis et al., 2010] Prototype devices
« sense » input to drive fabrication

Midas (again!) [Savage et al., 2012]

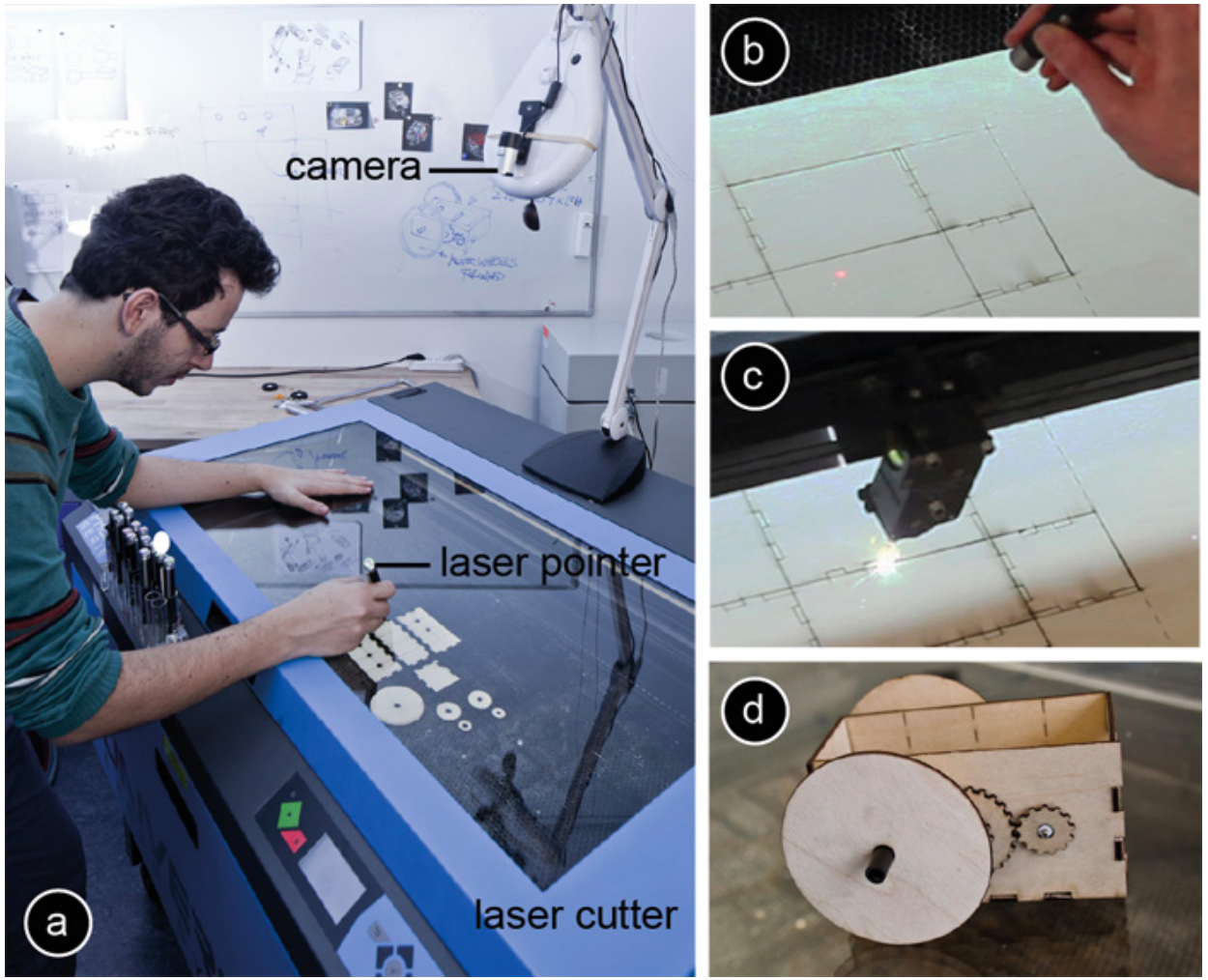
Laser Origami [Mueller et al., 2013]

Using software to design and laser cut (some) 3D shapes

http://stefaniemueller.org/

Constructable [Mueller et al., 2012]

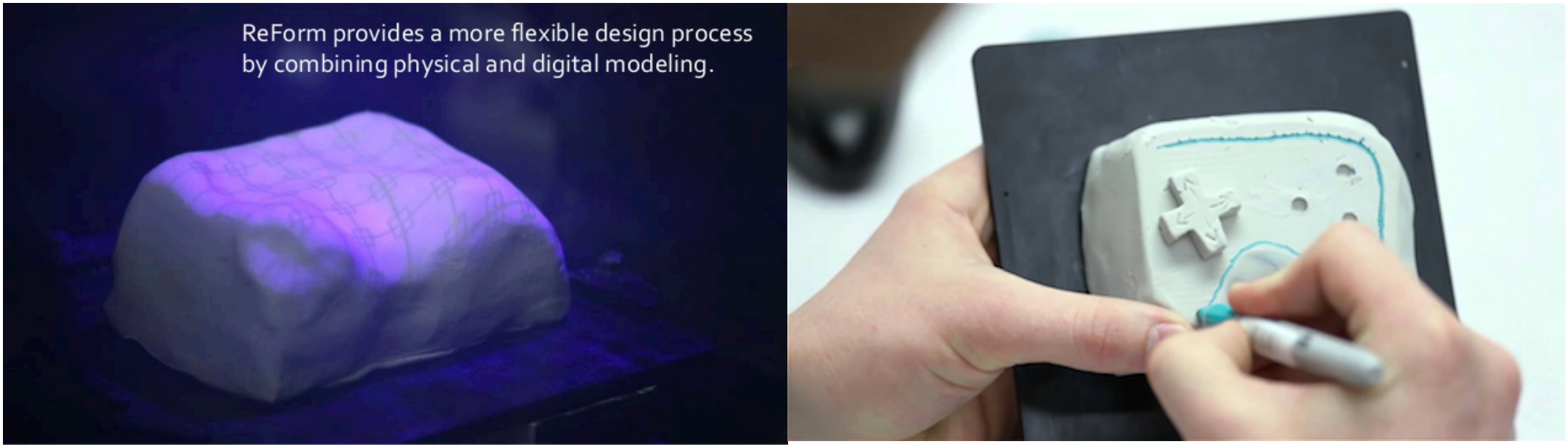
Removing CAD from the design process



http://stefaniemueller.org/

ReForm [Weichel et al., 2015]

Rapid prototyping and iteration …



https://youtu.be/w4Q9JCObLM0

hci and fab
in service of collaboration

FABACADEMY

Opportunity to study and support a new form of CSCW

around shared artefacts,

forming communities,

tracking the origin of designs …

E.g., study of communities

Sharing is Caring: Assistive Technology Designs on Thingiverse

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ABSTRACT
An increasing number of online communities support the open-source sharing of designs that can be built using rapid prototyping to construct physical objects. In this paper, we examine the designs and motivations for assistive technology found on Thingiverse.com, the largest of these communities at the time of this writing. We present results from a survey of all assistive technology that has been posted to Thingiverse since 2008 and a questionnaire distributed to the designers exploring their relationship with assistive technology and the motivation for creating these designs. The majority of these designs are intended to be manufactured on a 3D printer and include assistive devices and modifications for individuals with disabilities, older adults, and medication management. Many of these designs are created by the end-users themselves or on behalf of friends and loved ones. These designers frequently have no formal training or expertise in the creation of assistive technology. This paper discusses trends within this community as well as future opportunities and challenges.

Author Keywords

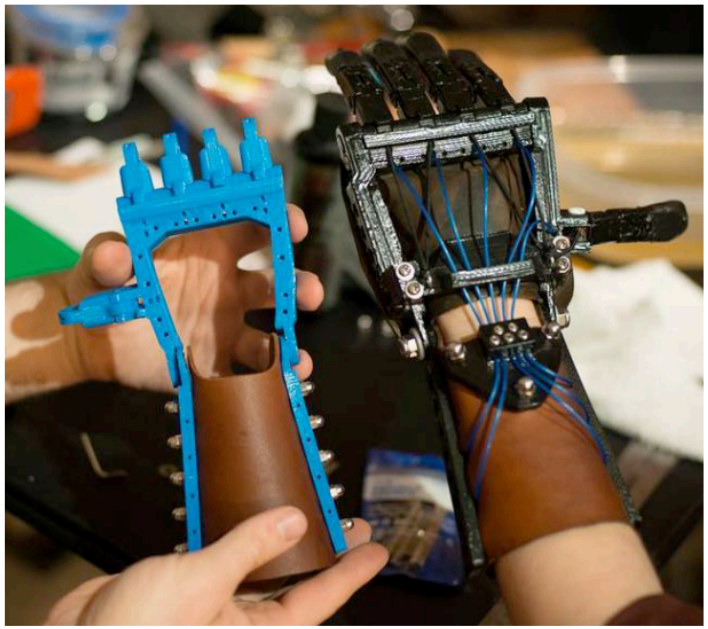


Figure 1. An example of a 3D-printable prosthetic hand, a popular type of assistive technology featured on Thingiverse.com. (Thing # 229620)

E.g., study of communities

“A Lot of Moving Parts”: A Case Study of Open-Source Hardware Design Collaboration in the Thingiverse Community

KATHY CHENG, University of Toronto, Canada
SHURUI ZHOU, University of Toronto, Canada
ALISON OLECHOWSKI, University of Toronto, Canada

Open-source is a decentralized and collaborative method of development that encourages open contribution from an extensive and undefined network of individuals. Although commonly associated with software development (OSS), the open-source model extends to hardware development, forming the basis of open-source hardware development (OSH). Compared to OSS, OSH is relatively nascent, lacking adequate tooling support from existing platforms and best practices for efficient collaboration. Taking a necessary step towards improving OSH collaboration, we conduct a detailed case study of *DrawBot*, a successful OSH project that remarkably fostered a long-term collaboration on Thingiverse – a platform not explicitly intended for complex collaborative design. Through analyzing comment threads and design changes over the course of the project, we found how collaboration occurred, the challenges faced, and how the DrawBot community managed to overcome these obstacles. Beyond offering a detailed account of collaboration practices and challenges, our work contributes best practices, design implications, and practical implications for OSH project maintainers, platform builders, and researchers, respectively. With these insights and our publicly available dataset [20], we aim to foster more effective and efficient collaborative design in OSH projects.

CCS Concepts: • **Human-centered computing** → **Empirical studies in collaborative and social computing**; • **Applied computing** → *Computer-aided design.*

Additional Key Words and Phrases: Collaborative Design; Open-source; 3D Printing; Remixing

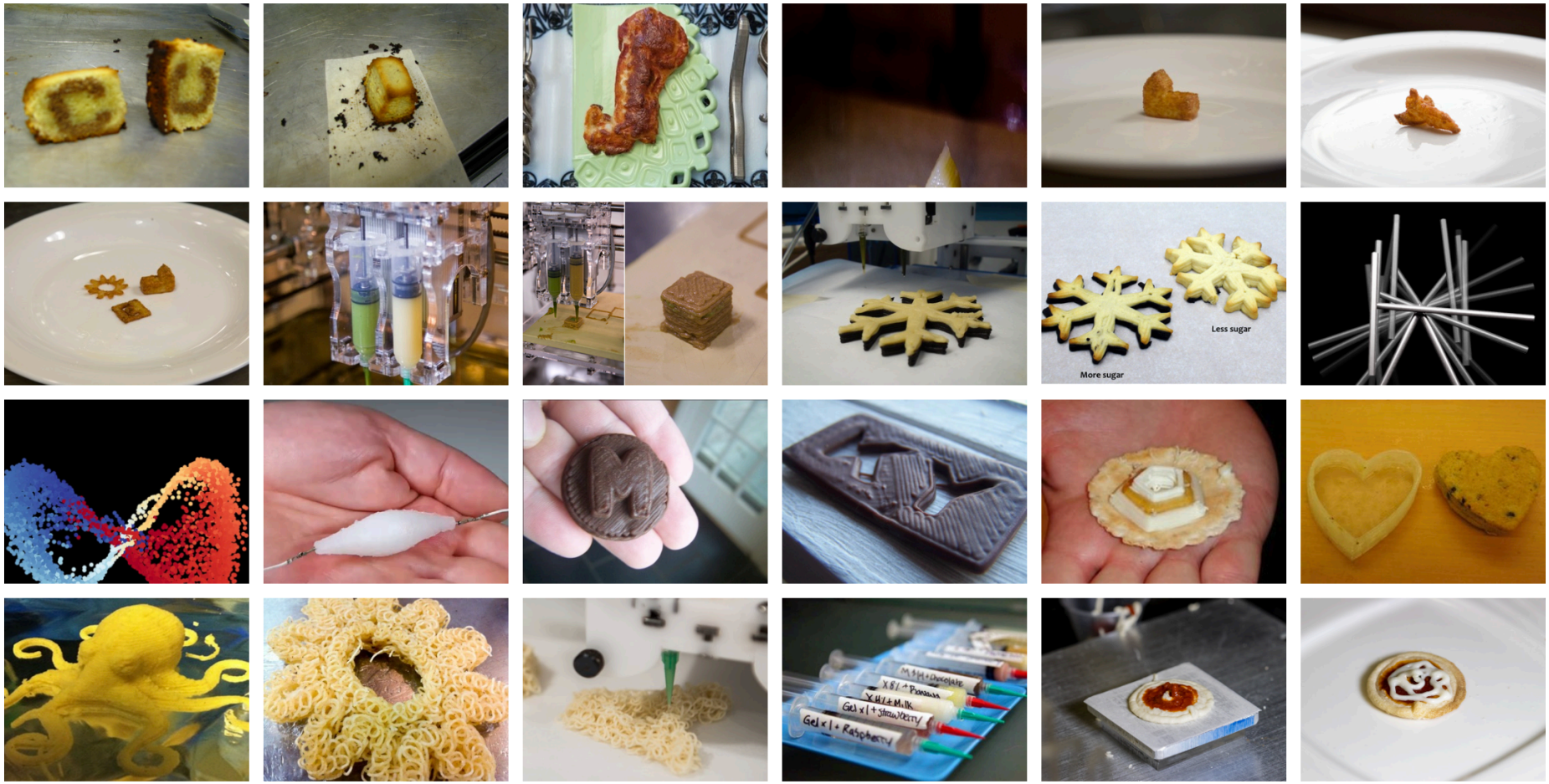
ACM Reference Format:
Kathy Cheng, Shurui Zhou, and Alison Olechowski. 2024. “A Lot of Moving Parts”: A Case Study of Open-Source Hardware Design Collaboration in the Thingiverse Community. *Proc. ACM Hum.-Comput. Interact.* 8, CSCW2, Article 469 (November 2024), 29 pages. https://doi.org/10.1145/3687008

thingiverse.com still exists, but many more communities and sharing sites have emerged, eg.,thangs.com, printables.com

and more …

Digital Food printing

“Food" printers, that 3D print with edible material



https://www.creativemachineslab.com/digital-food.html

Silk Pavilion, MIT media lab

Combine digital fabrication and biological fabrication (?)

polygonal silk structure using a CNC machine (Computer-Numerically Controlled)

+

real silkworms fill in the structure

http://www.creativeapplications.net/environment/silk-pavillion-cnc-deposited-silk-silkworm-construction-at-the-mit-media-lab/


ninapaley.com

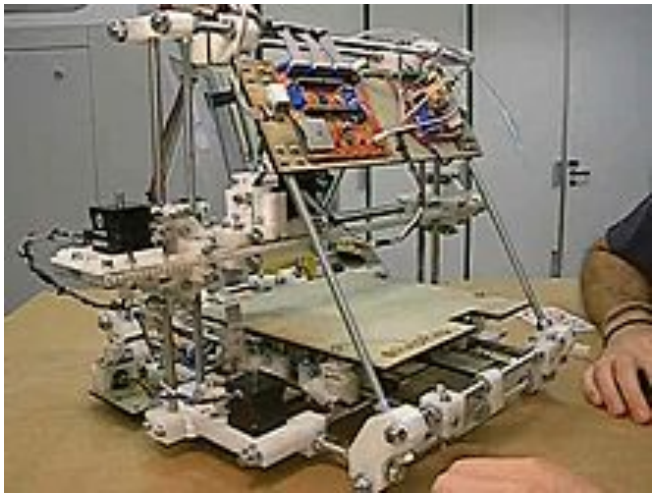

Ninapaley.com

where is it all going?

Some claims:

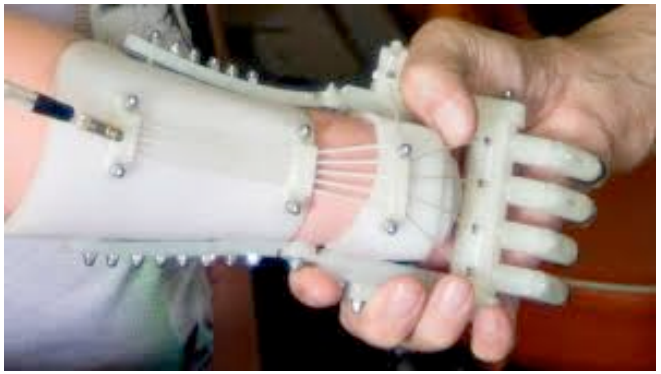
Personal fab will change manufacturing

Download blueprint instead of product



RepRap 3D printer

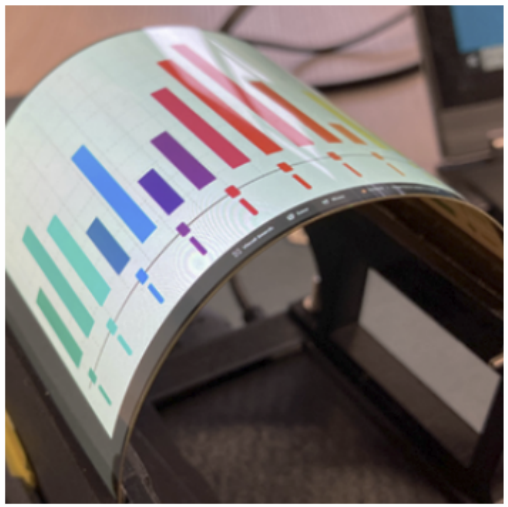
Urbee 3D printed car



3D printed prosthethics robohand

and a more sinister side ...

related internships


Data Visualization on Non-Planar Displays supervised by Petra Isenberg/Raimund Dachselt or Anastasia Bezerianos/Tobias Isenberg (2 positions). www.aviz.fr/Research/Jobs

These internships are part of a project that aims to escape from the “display flatland” that characterizes today’s research. It will establish foundations for how to engage with a future in which physical displays take on several different form factors and become truly embedded in our environments.

Internship 1: non-flat displays for public spaces
Internship 2: non-planar mobile devices