Announcement

Final Exam –

Date: Dec 16th 1:30pm - 3:30pm

Location: IRB IRB2207

Open book: yes you can bring your laptop

Final Milestone Presentation –

Date: Dec 12th 3:30pm - 5:00pm

Location: Sandbox

Live Demo! Bring your setup to Sandbox early, and prepare to give a live demonstration (feel free to use slides)

Vote for best 3 projects!

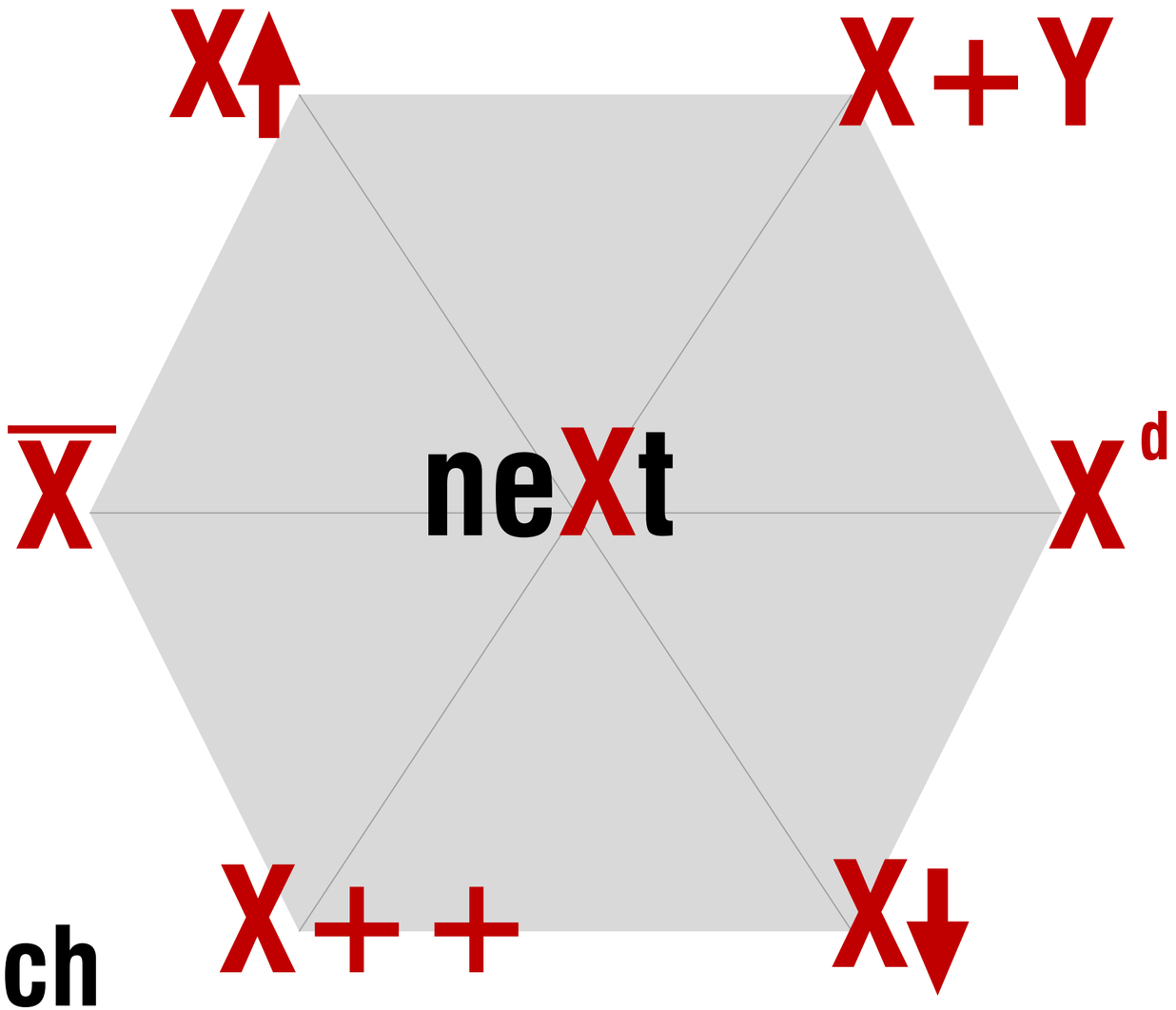
Final Milestone Submission –

Date: Dec 18th EOD

Format: Double-Column ACM format.

Documentation + simple video.

More details on ELMS.



Future Interactive Tech

CMSC730 | UMD CS

A quick recap

Learn

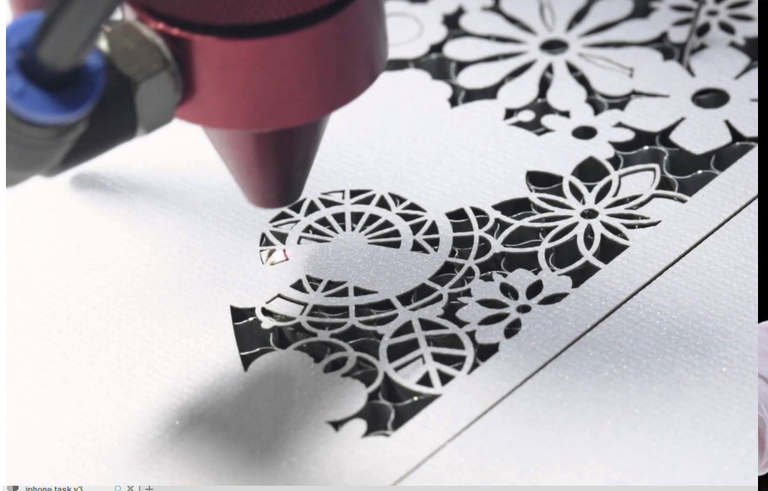
Varies interactive technologies

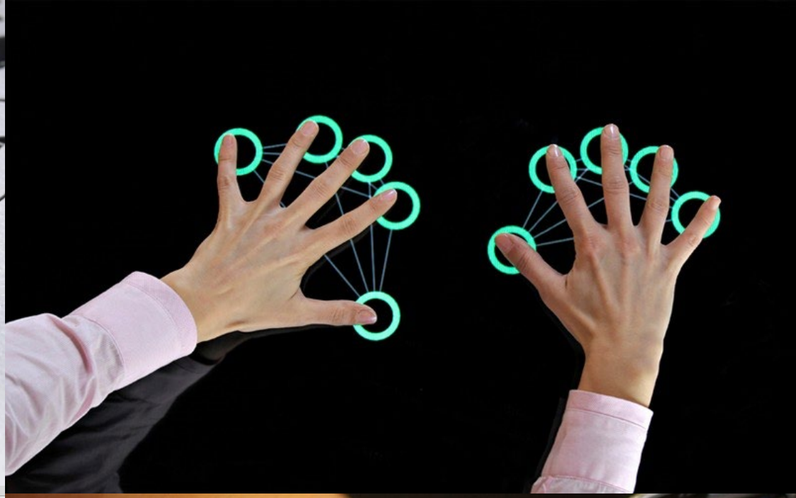
Technologies behind the scene

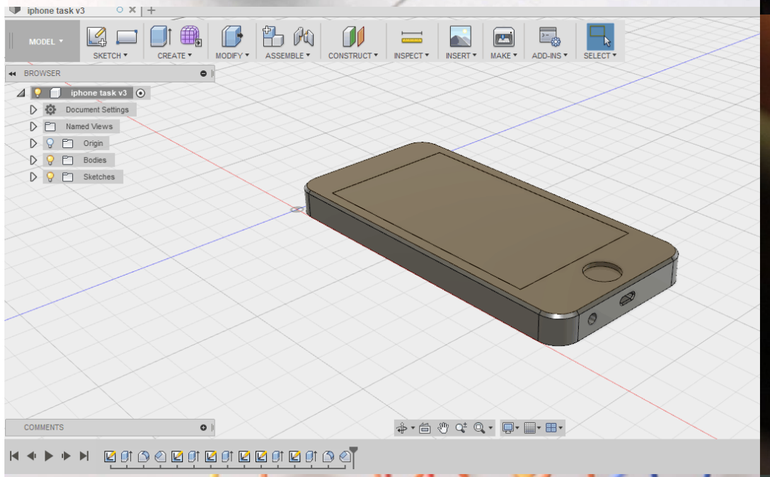
Do

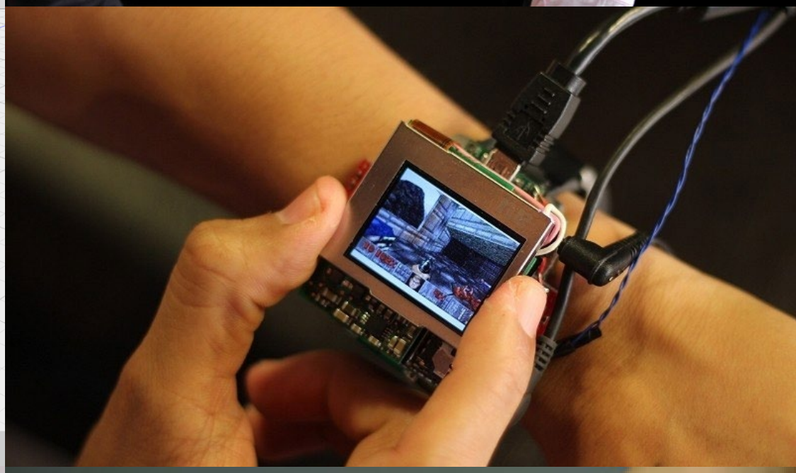
Hands-on building skills

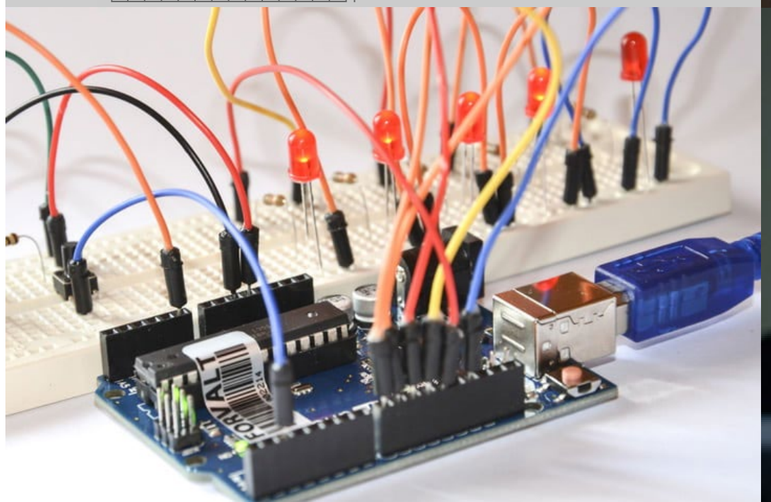
Build interactive gadgets

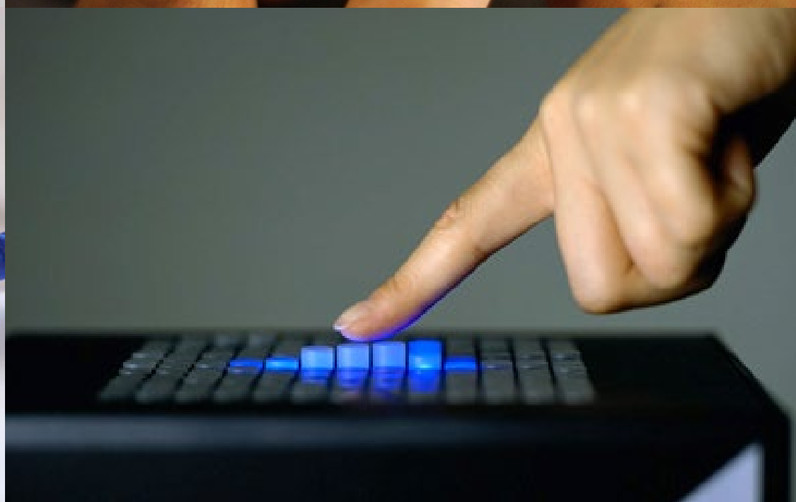








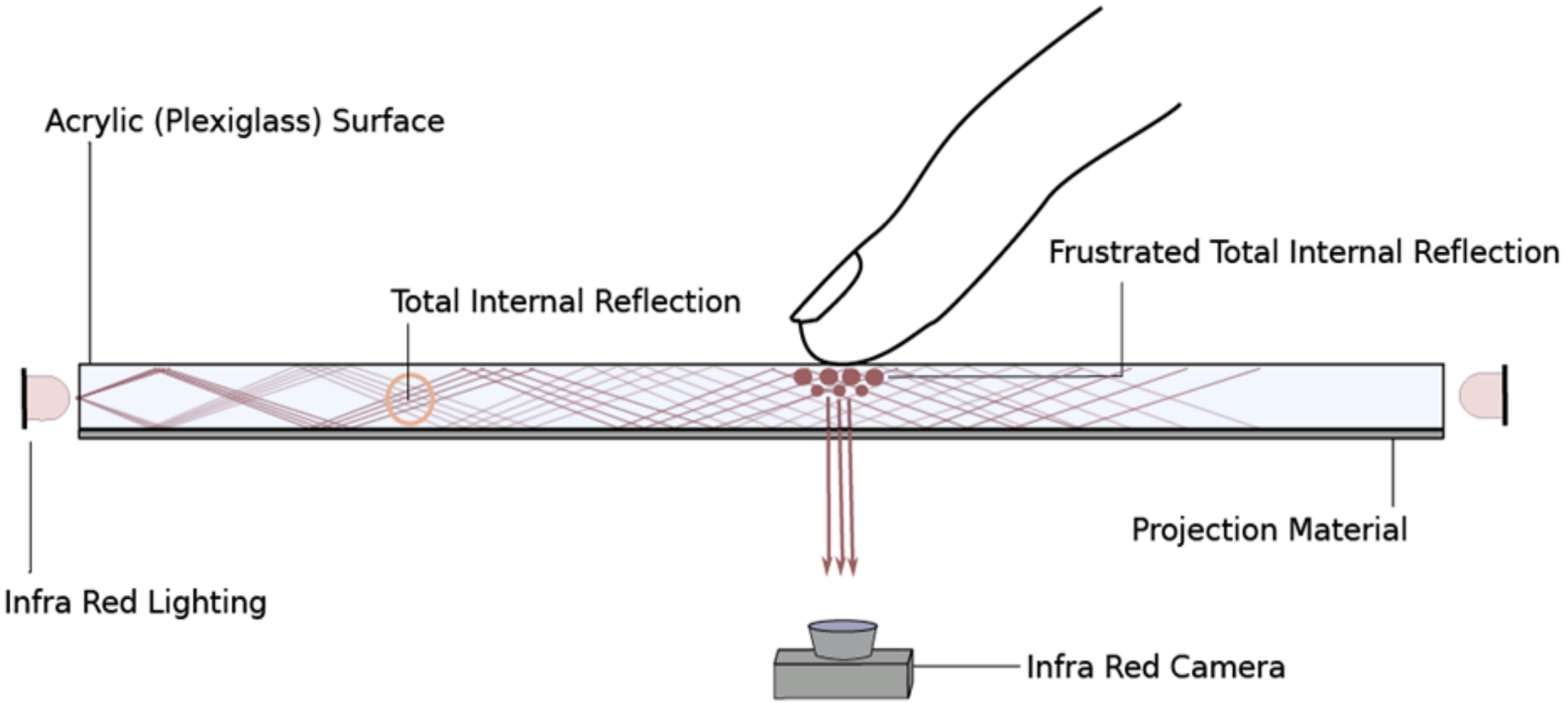




Varies interactive technologies

Multi-touch

FTIR - Frustrated Total Internal Reflection

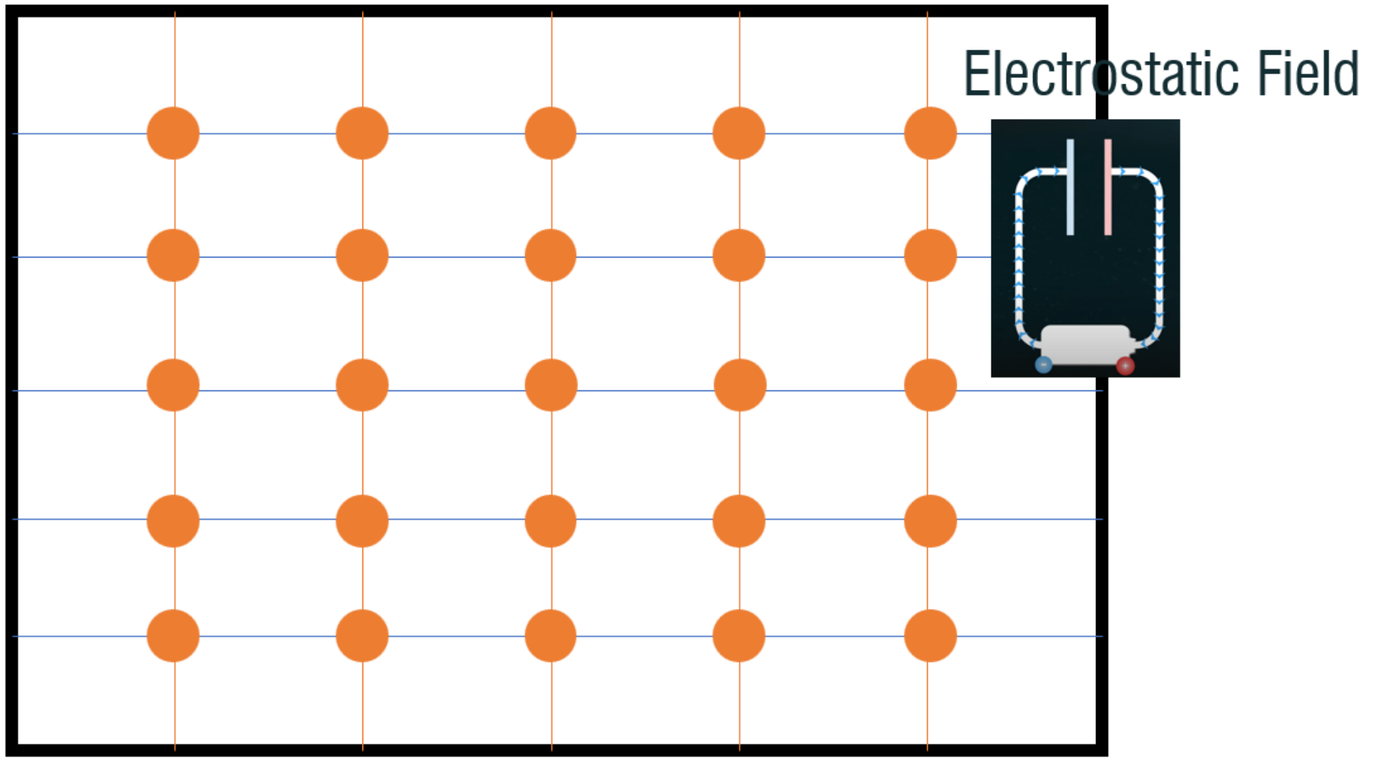


Varies interactive technologies

Multi-touch

Sensing lines
to detect
electric current

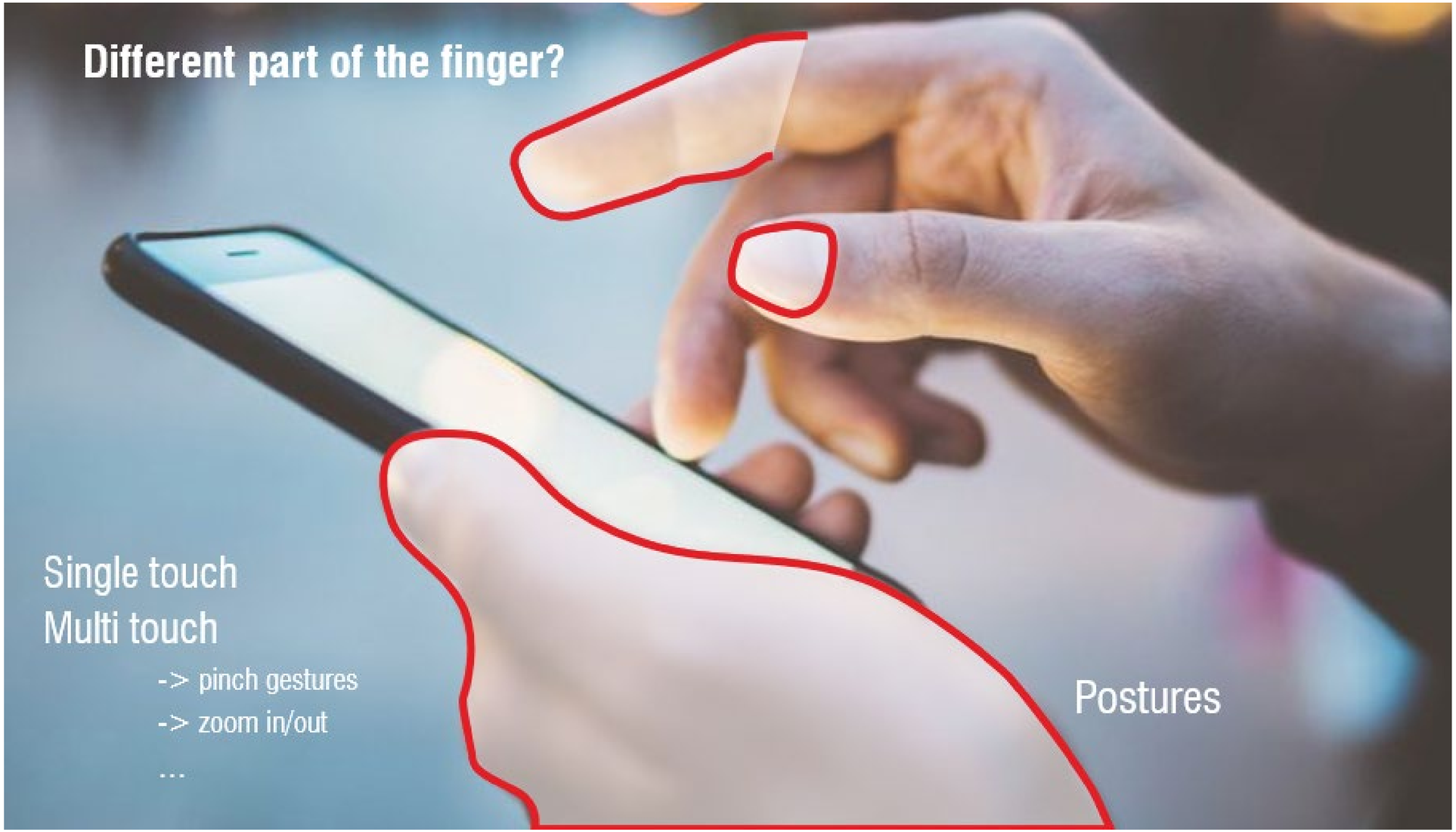
Electrostatic Field



Driving lines
with constant
electric current

Varies interactive technologies

Mobile interaction



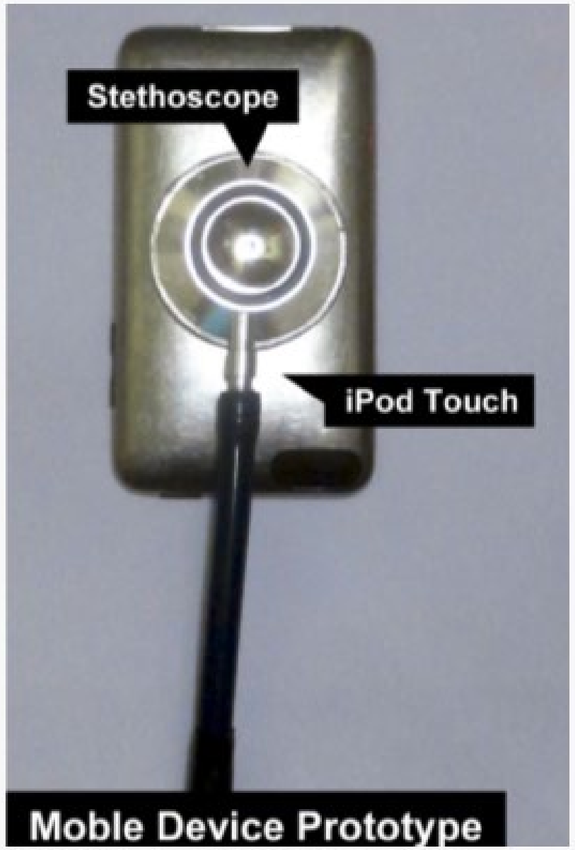
Varies interactive technologies

Mobile interaction

TapSense: Enhancing Finger Interaction on Touch Surfaces

Acoustic sensing: Sensing vibration –> Microphone; IMU, etc

For prototyping?



Benefit?
fast and less noise

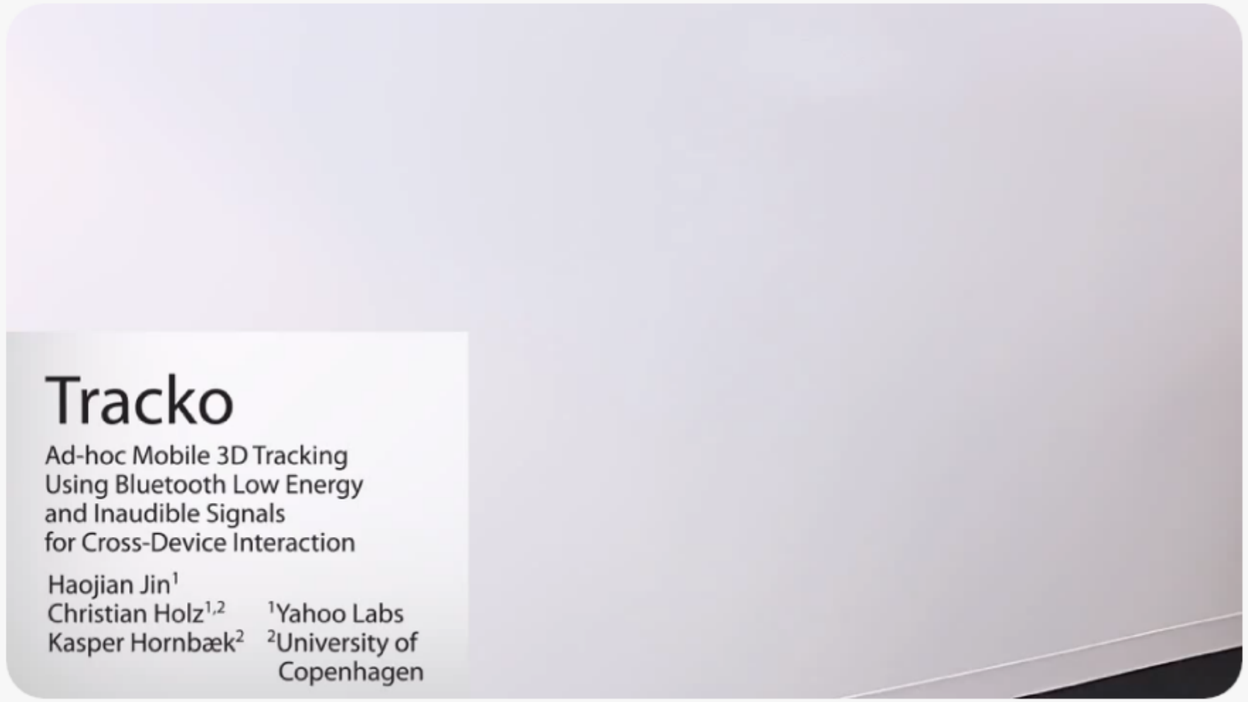
Varies interactive technologies

Mobile interaction

Tracko: Ad-hoc Mobile 3D Tracking Using Bluetooth Low Energy and Inaudible Signals for Cross-Device Interaction

BLE (only) knows the **presence** of a neighbor device

Tracko knows the **actual locations**

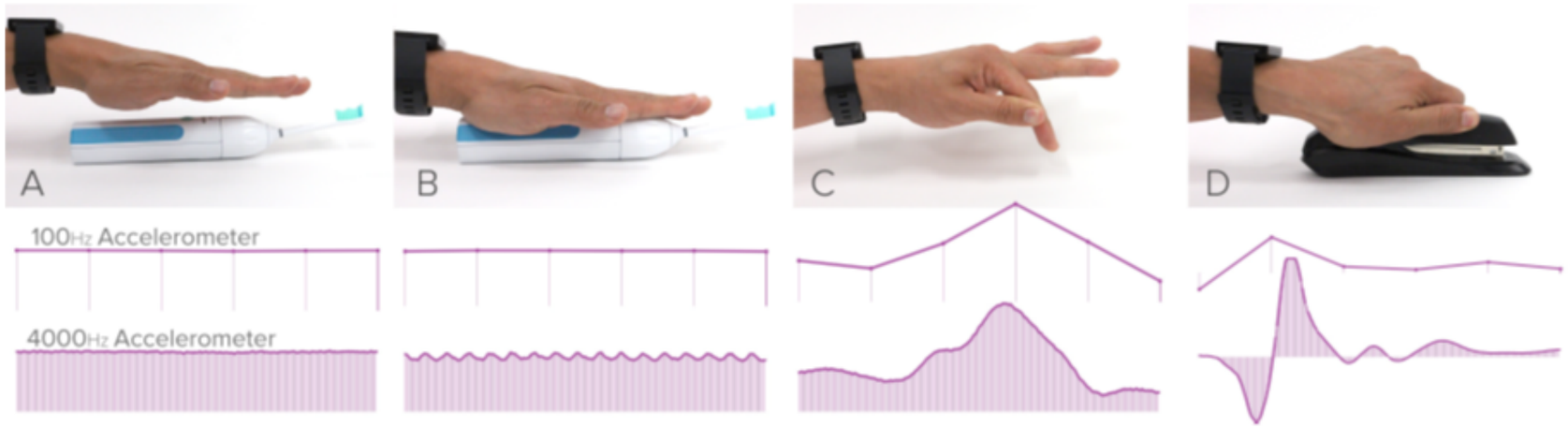


Varies interactive technologies

Smart watch interactions

ViBand: High-Fidelity Bio-Acoustic Sensing Using Commodity Smartwatch Accelerometers

Sensing principle



Use the high-speed mode of existing accelerometer

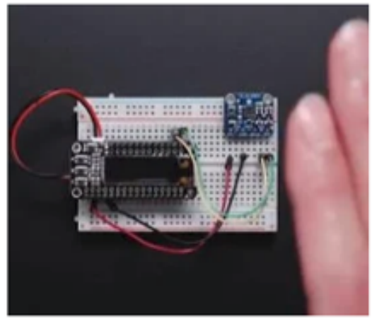
Only need to modify it's kernel – pure software solution!

Varies interactive technologies

Smart watch interactions

LumiWatch: On-Arm Projected Graphics and Touch Input

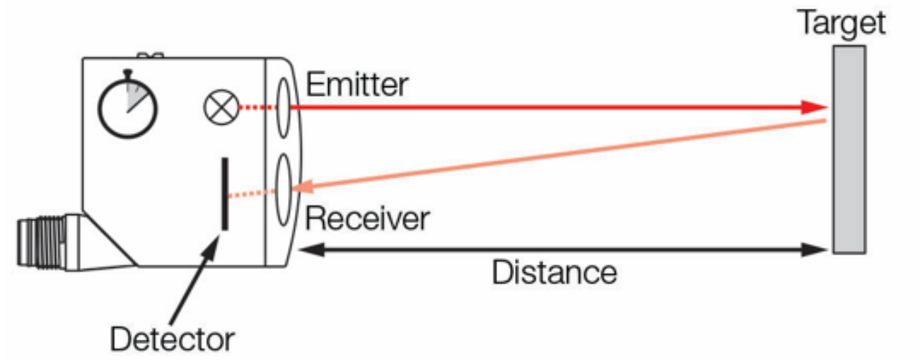
System overview



Adafruit VL6180X Time of Flight Distance Ranging Sensor (VL6180)

$13.95 from Adafruit Industries **89%** positive (4,446)

The **VL6180X** (sometimes called the VL6180) is a Time of Flight distance sensor like no other you've used! The sensor contains a ...



$$d = \frac{c \times \Delta t}{2}$$

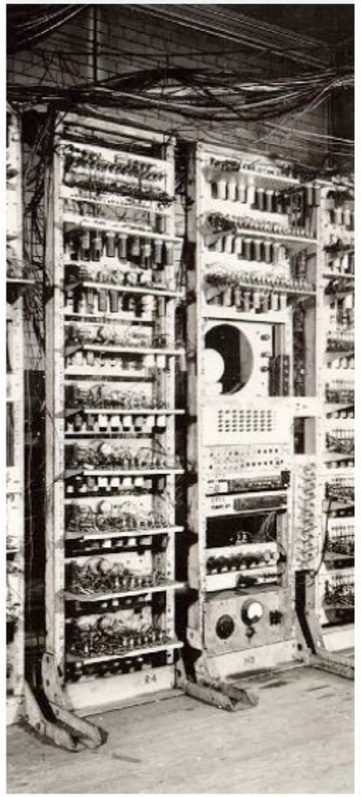
Time of Flight Principle (simplified)

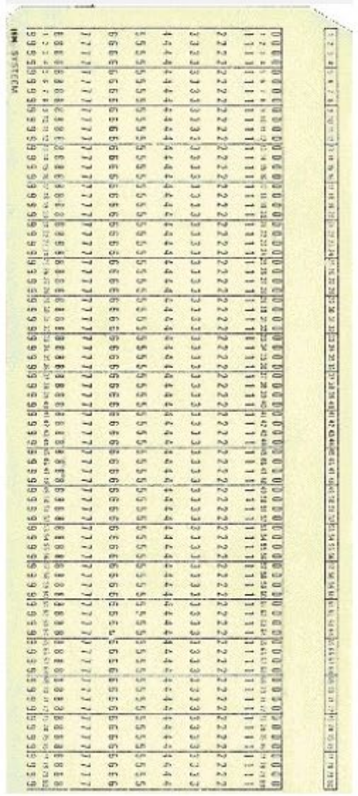
Varies interactive technologies

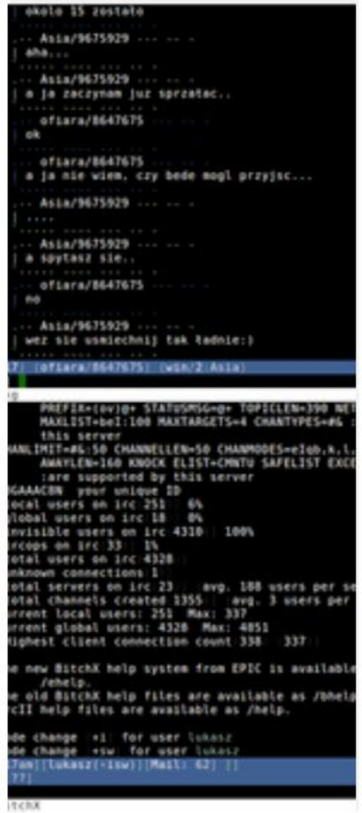
Tangible interaction

Historical Development of UI

Electrical → Symbolic → Textual → Graphical → Embodied →





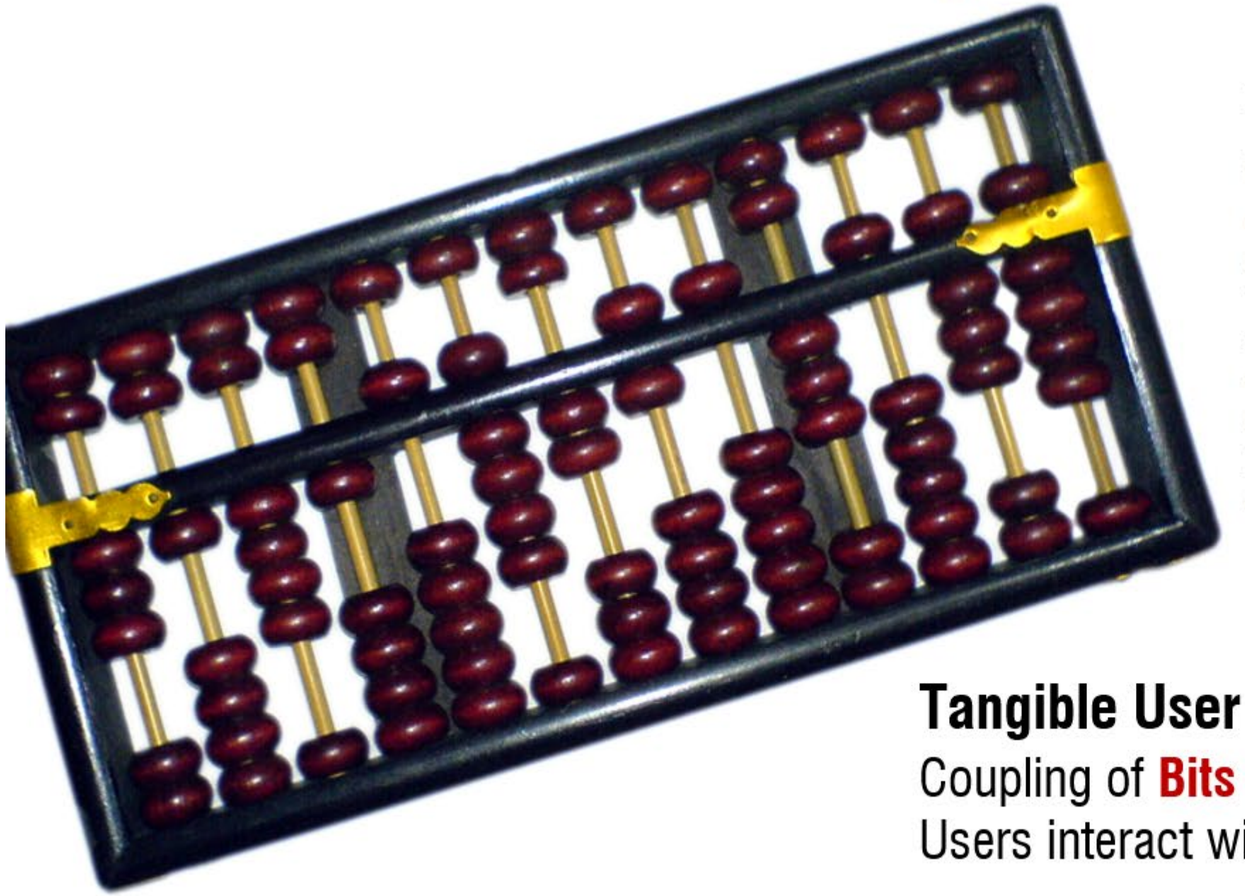


Varies interactive technologies

Tangible interaction

Is the abacus a tangible UI?

no, it's analog, there's no coupling to **digital** information



Ishii met a highly successful PDA (Personal Digital Assistant) called the "abacus" when he was 2 years old. This simple abacus-PDA was not merely a computational device, but also a musical instrument, imaginary toy train, and a back scratcher. He was captivated by the sound and tactile interaction with this simple artifact. When his mother kept household accounts, he was aware of her activities by the sound of her abacus, knowing he could not ask for her to play with him while her abacus made its music. We strongly believe this abacus is suggesting to us a direction for the next generation of HCI.

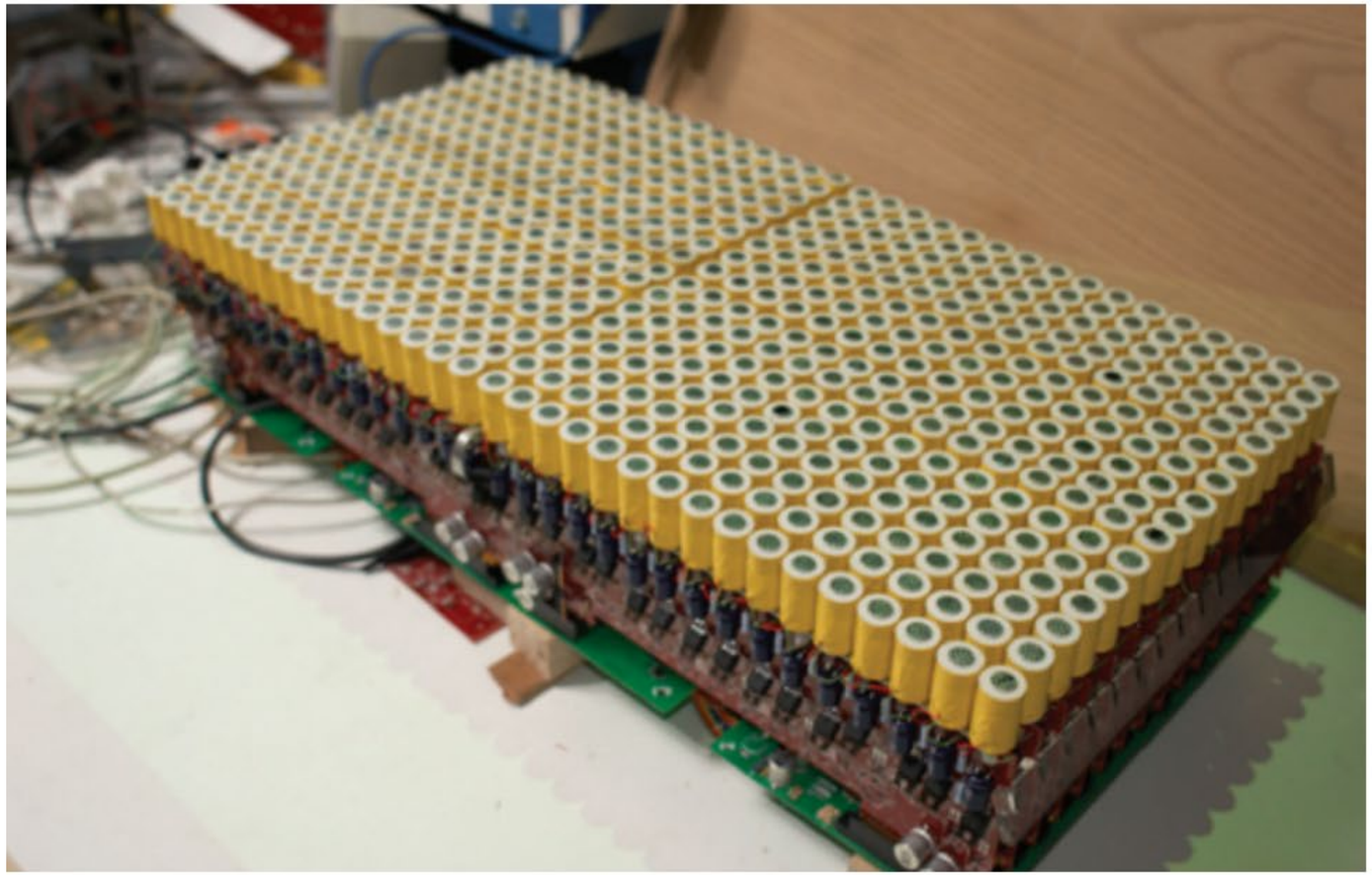
Tangible User Interface

Coupling of **Bits** and **Atoms**

Users interact with digital information **through a physical form**

Varies interactive technologies

Tangible interaction



Mechanical Constraints as Computational Constraints in Tabletop Tangible Interfaces

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ABSTRACT
This paper presents a new type of human-computer interface called Pico (Physical Intervention in Computational Optimization) based on mechanical constraints that combines some of the tactile feedback and affordances of mechanical systems with the abstract computational power of modern computers. The interface is based on a tabletop interaction surface that can sense and move small objects on top of it. The positions of these physical objects represent and control parameters inside a software application, such as a system for optimizing the configuration of radio towers in a cellular telephone network. The computer autonomously attempts to optimize the network, moving the objects on the table as it changes their corresponding parameters in software. As these objects move, the user can constrain their motion with his or her hands, or many other kinds of physical objects. The interface provides ample opportunities for improvisation by allowing the user to employ a rich variety of everyday physical objects as mechanical constraints. This approach leverages the user's mechanical intuition for how objects respond to physical forces. As well, it allows the user to balance the numerical optimization performed by the computer with other goals that are difficult to quantify. Subjects in an evaluation were more effective at solving a complex spatial layout problem using this system than with either of two alternative interfaces that did not feature actuation.

Author Keywords
tangible interfaces, physical interaction, interactive surface, improvisation, actuation.

ACM Classification Keywords

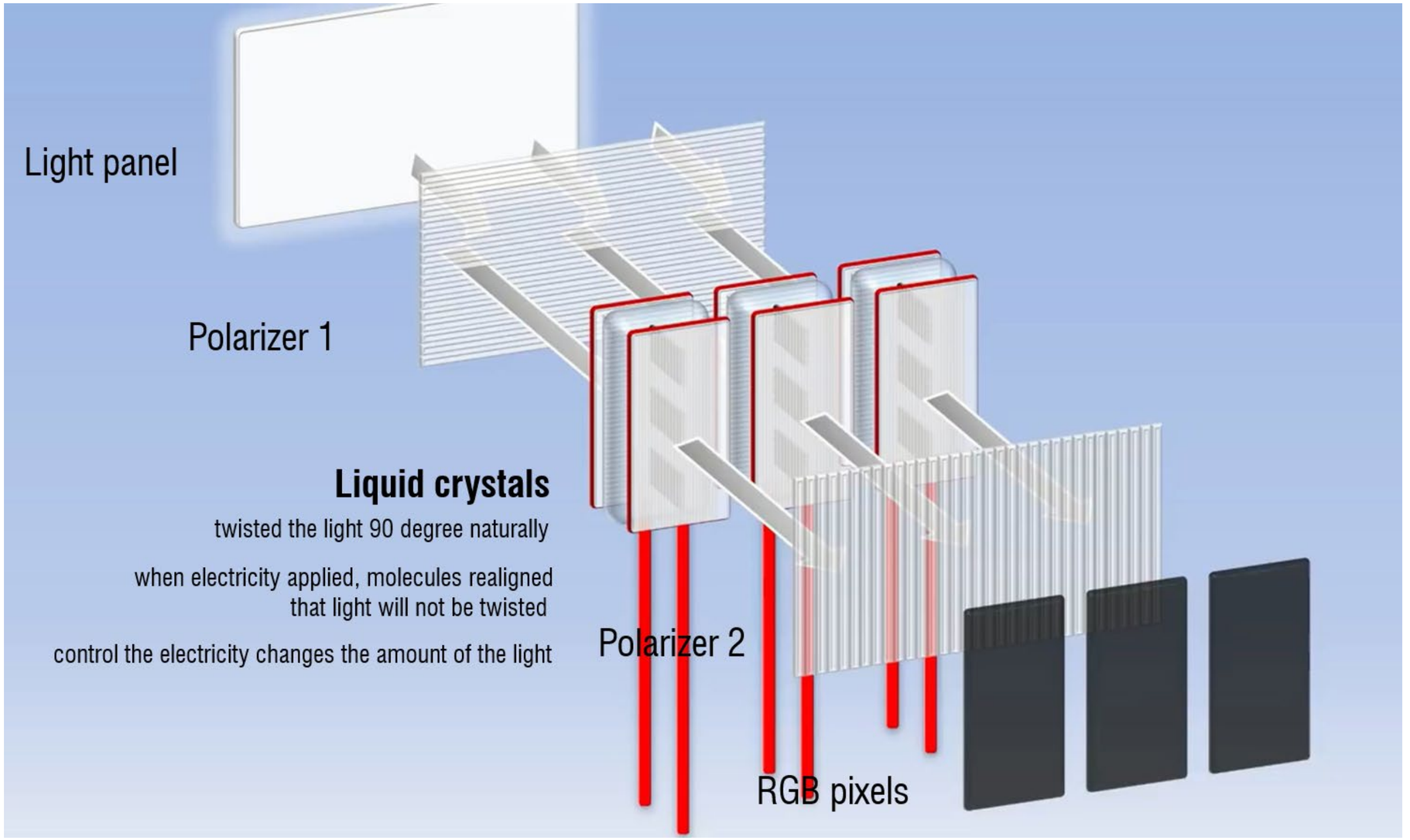
Figure 1: A flexible "artist's curve" constraining the motion of a cellphone tower in the Pico system.

ical process. The user can leverage his or her mechanical intuition about the way physical objects respond to forces and interact with each other to understand how common objects, such as a rubber band or coffee cup, might be used to constrain the underlying software process.

Objects on the Pico table are moved not only under software control using electromagnets but also by users standing around the table. The combination of these interactions, all governed by the friction and mass of the objects themselves directly affects the result of the task being performed. Additional information is graphically projected onto the table from above. In this paper we will show how this technique

Varies interactive technologies

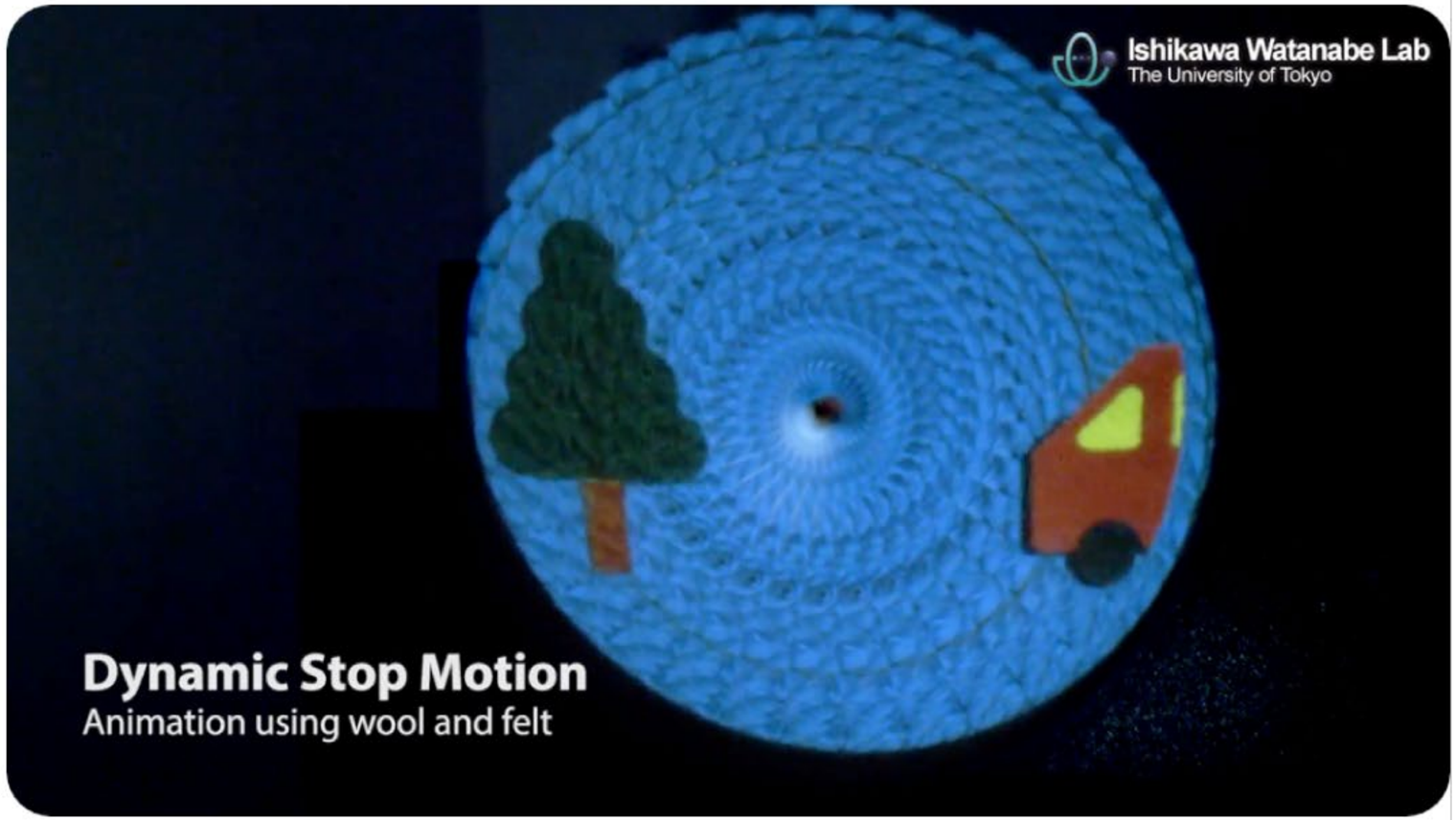
Display



Varies interactive technologies

Display

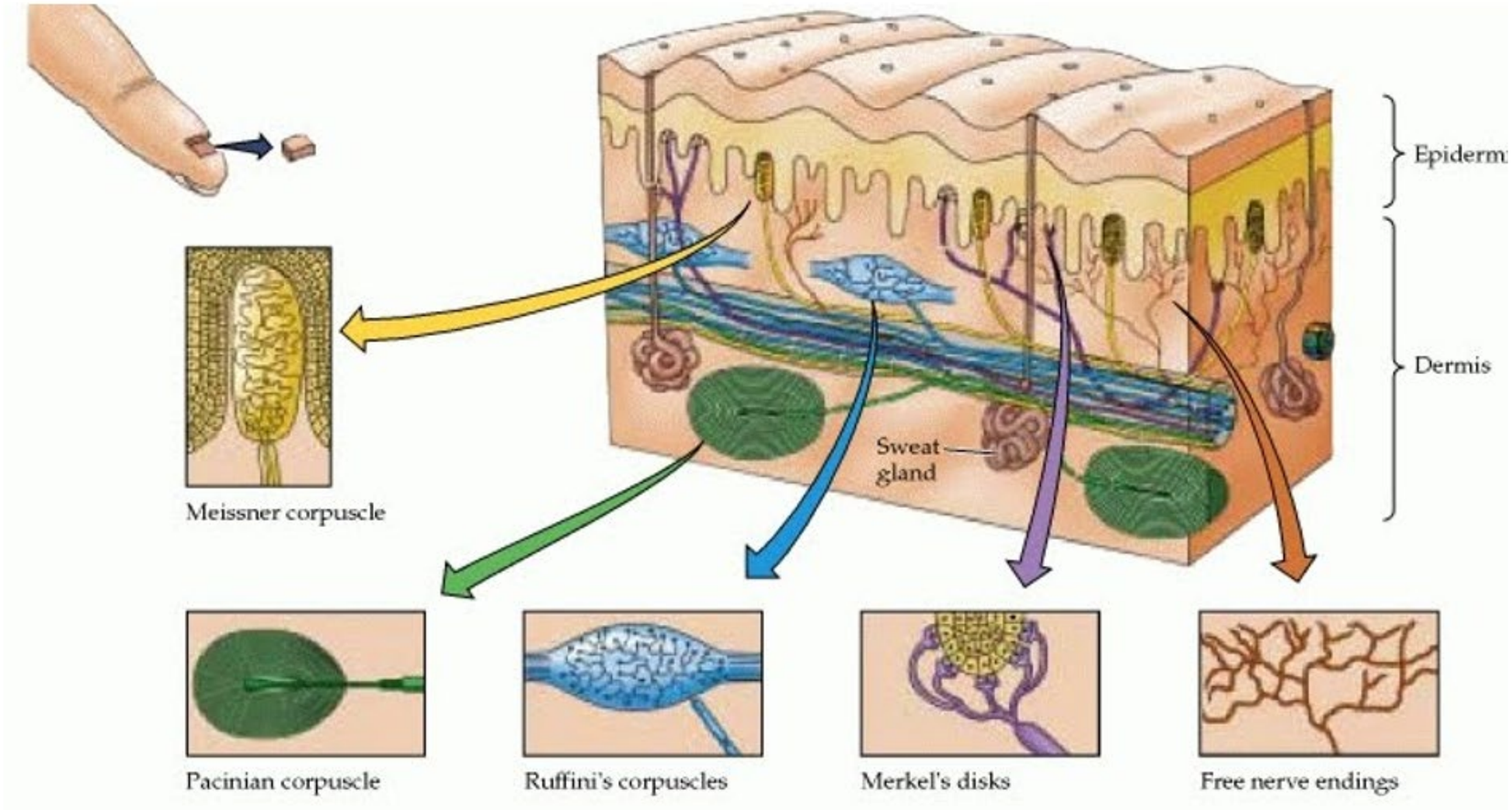
yes this is real wool and real felt.
any idea how this works?



Varies interactive technologies

Haptic

Mechanoreception



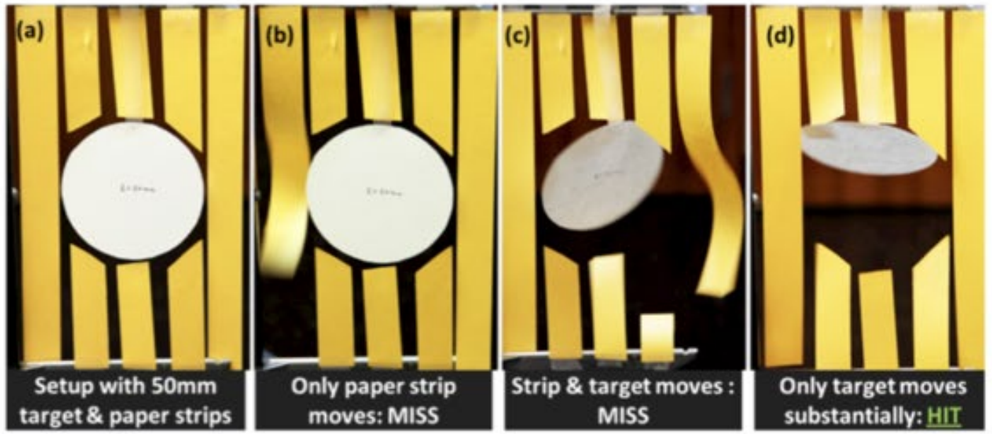
Varies interactive technologies

Haptic

Mid-air haptics

Vortex haptics

Figure 2: (left) Volume of air moved by speaker equals the volume of the slug used to model the vortex formation. (right) Vortex ring is a toroid where air flows around the circular axis as the entire toroid travels along its perpendicular axis.



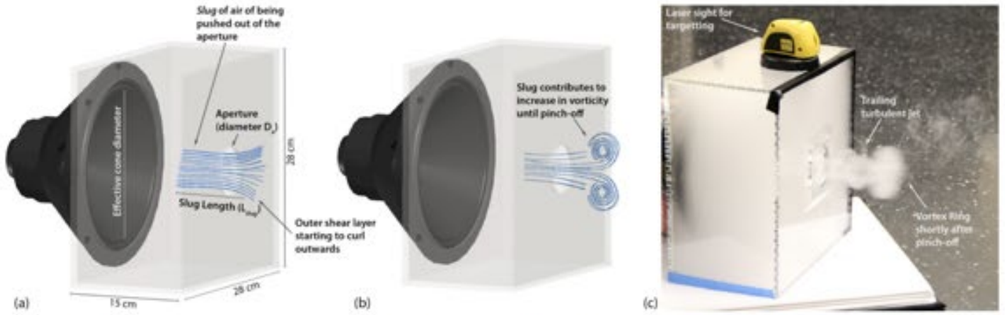
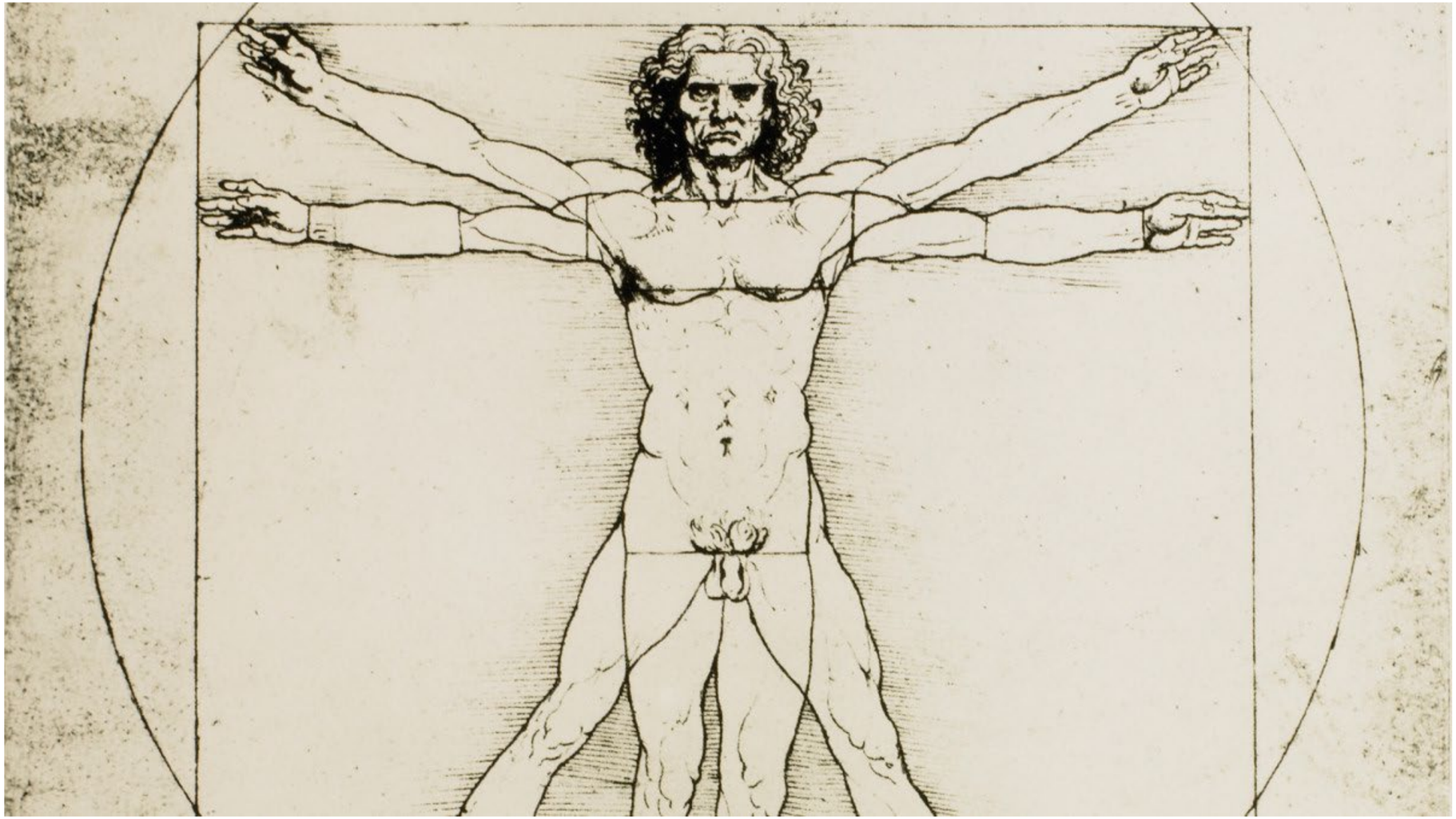


Figure 3: Vortex generator prototype and vortex ring formation process. (a) As the slug of air is pushed out of the aperture, the boundary layer starts to curl outwards as it exits, then (b) vorticity increases until pinch-off, causing the vortex to detach. (c) AirWave prototype filled with fog to visualize a vortex ring shortly after pinch-off.

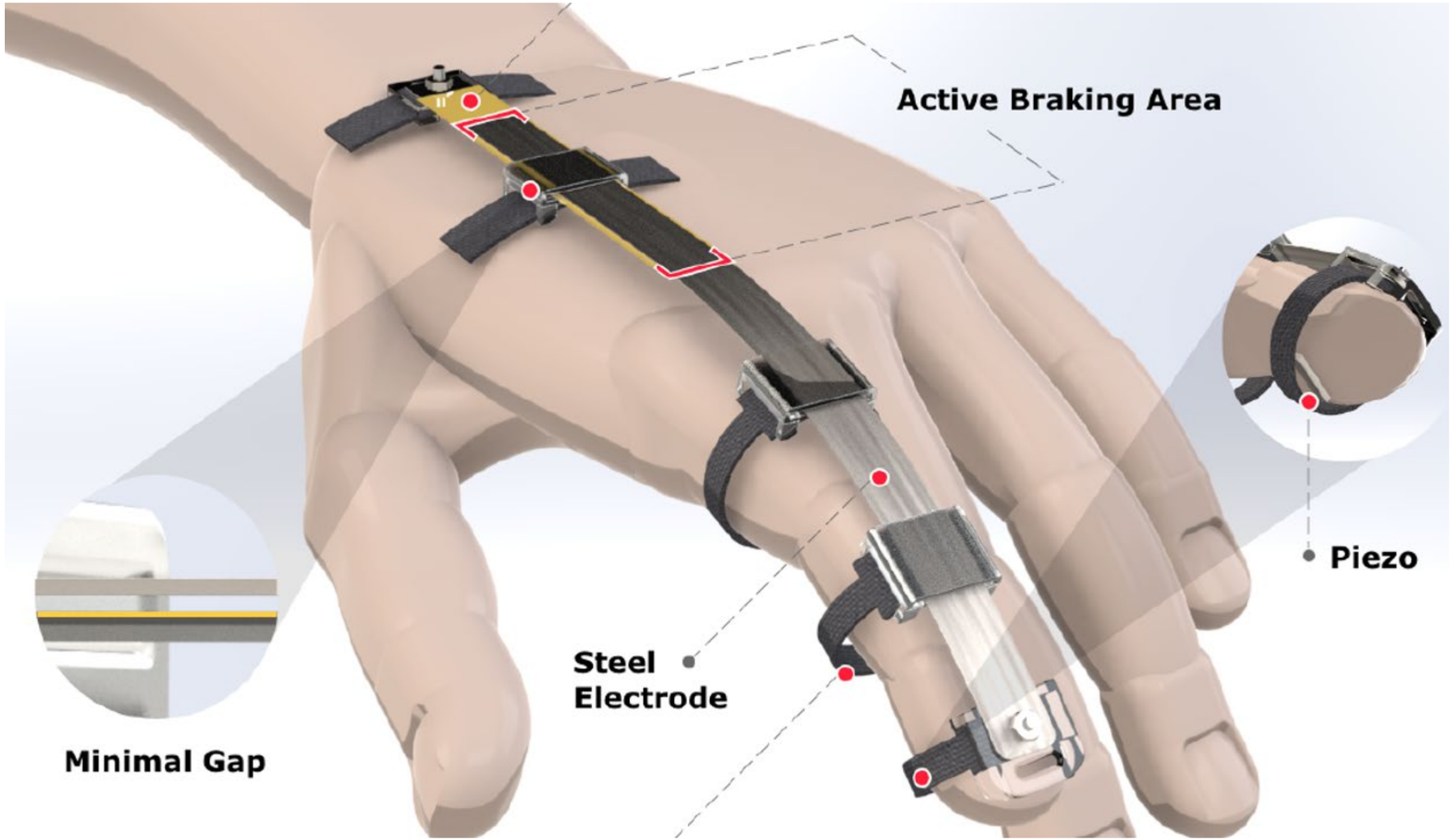
Varies interactive technologies

Haptic + VR



Varies interactive technologies

Haptic + VR



Varies interactive technologies

Haptic + VR

Based on hand's trajectory and VR content
Robotic arm will pose the corresponding surface at the right location

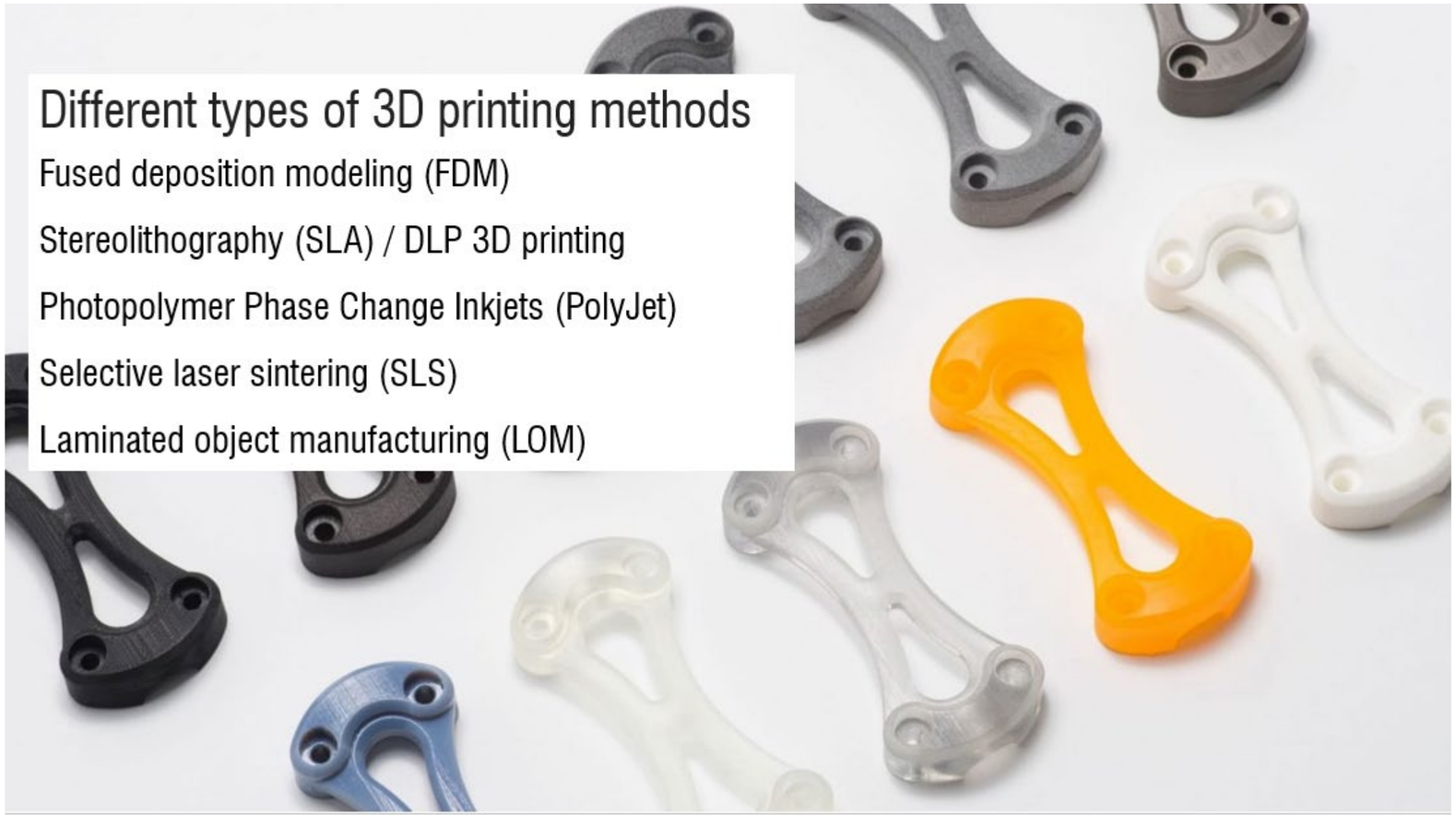
Varies interactive technologies

Haptic + VR

Human actuators!

Varies interactive technologies

Fabrication



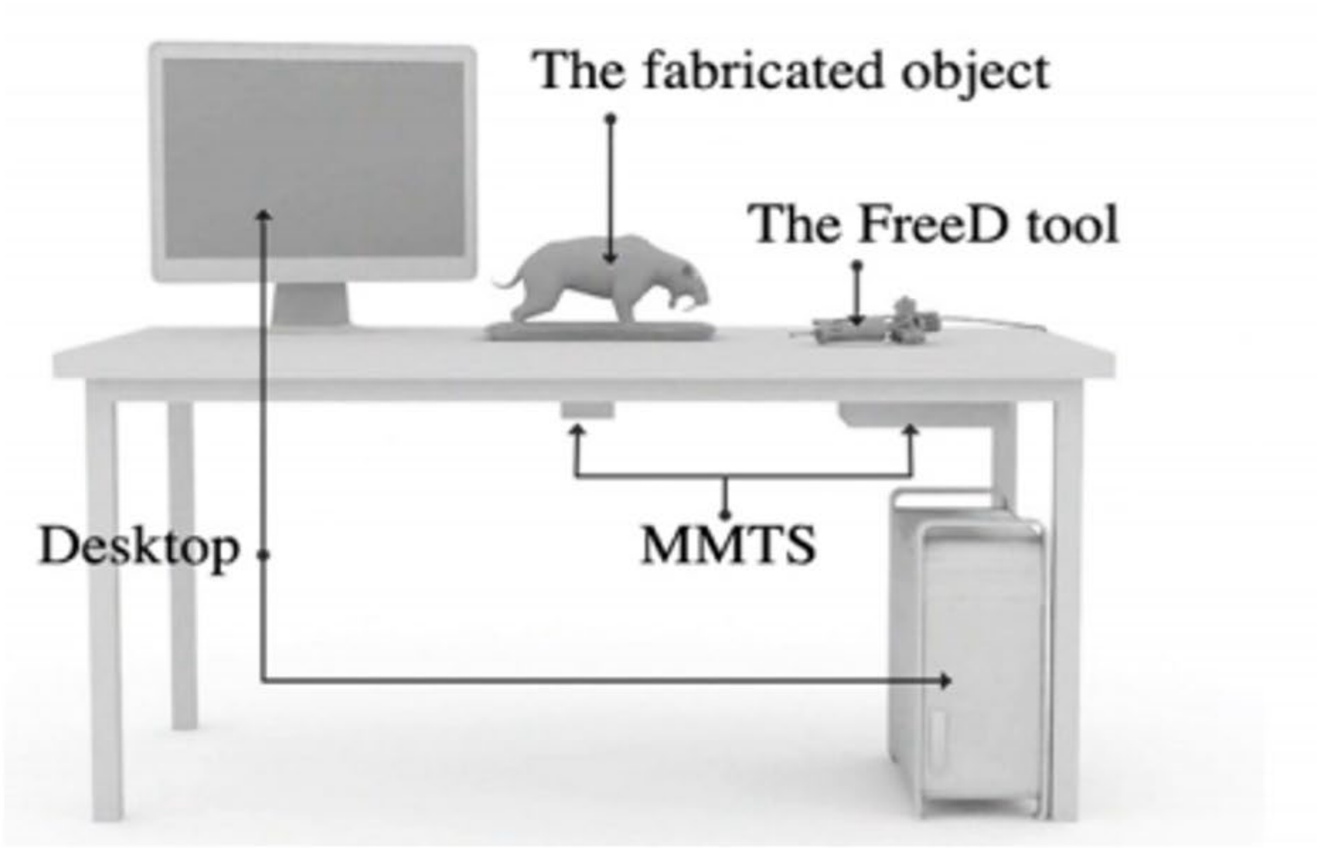
Varies interactive technologies

Fabrication

Tracking: 6DOF Magnetic tracking

Control: stop milling at the edge of the digital model

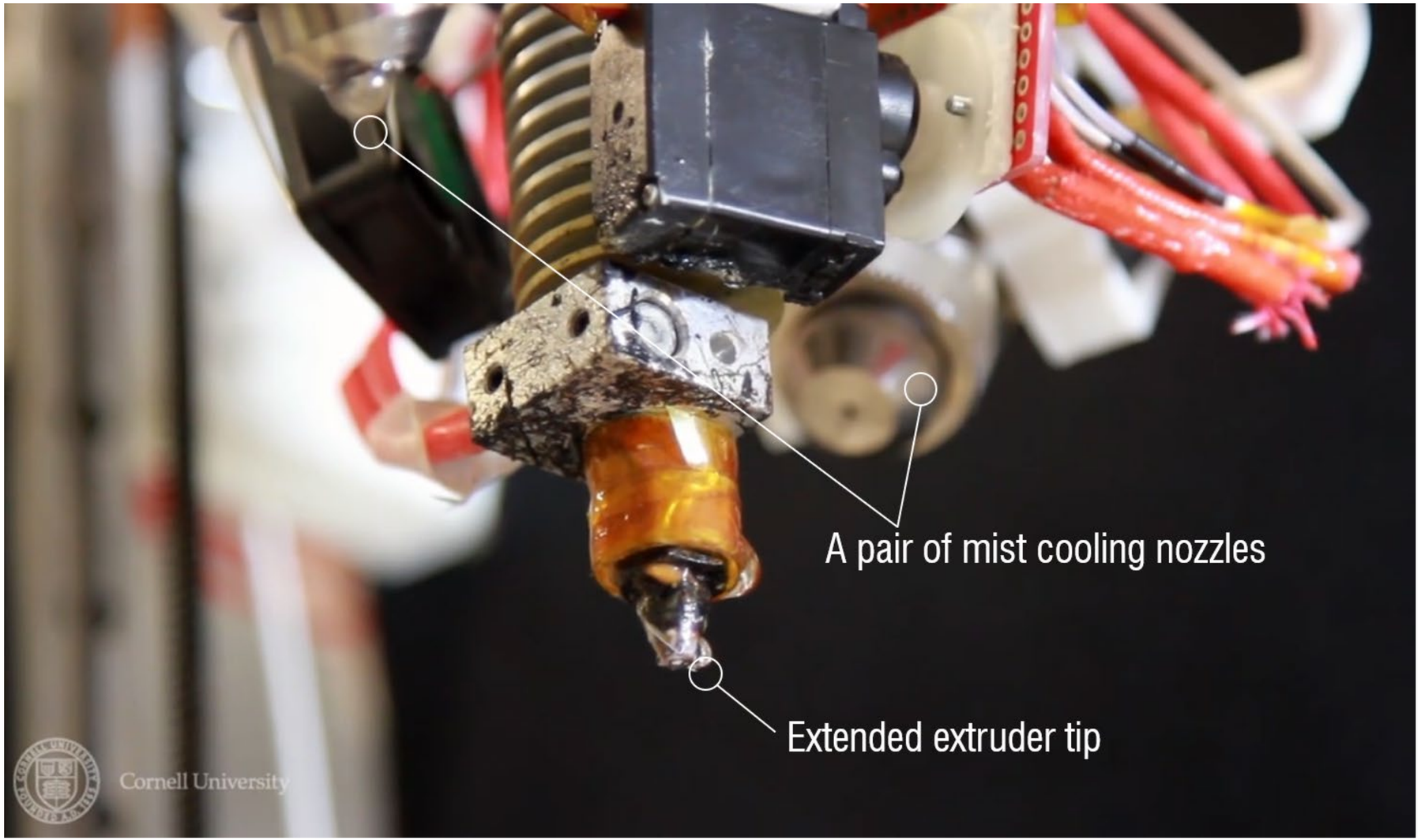
Control can be overridden with manual control



What can this do that the previous project cannot?

Varies interactive technologies

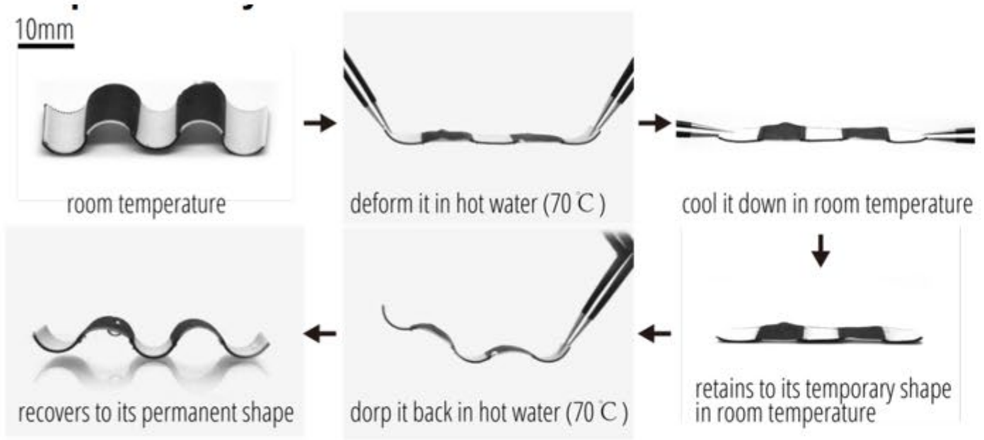
Fabrication

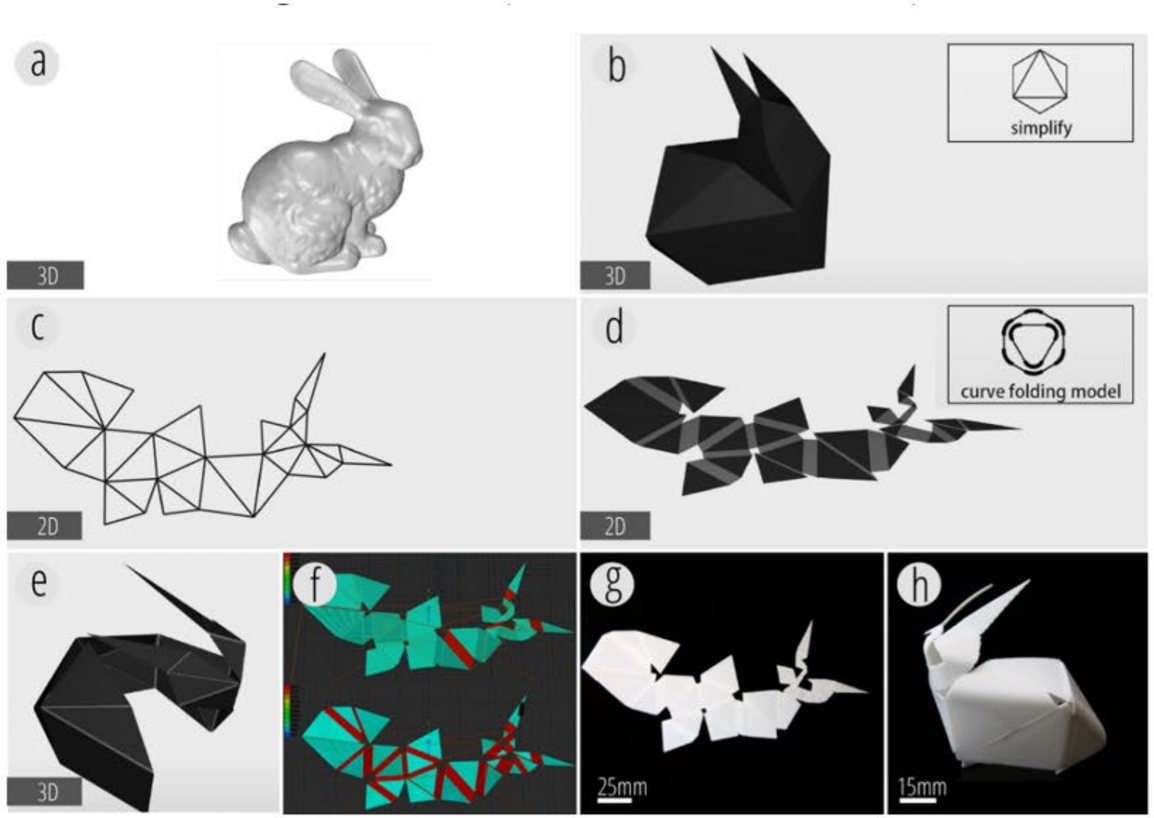


Varies interactive technologies

Fabrication

Shape memory of thermoplastic





Varies interactive technologies

Fabrication

laser features #1

Raster engraving

laser features #2

Vector engraving/cutting

laser features #3

Joints - creating 3D objects

laser features #4

bending

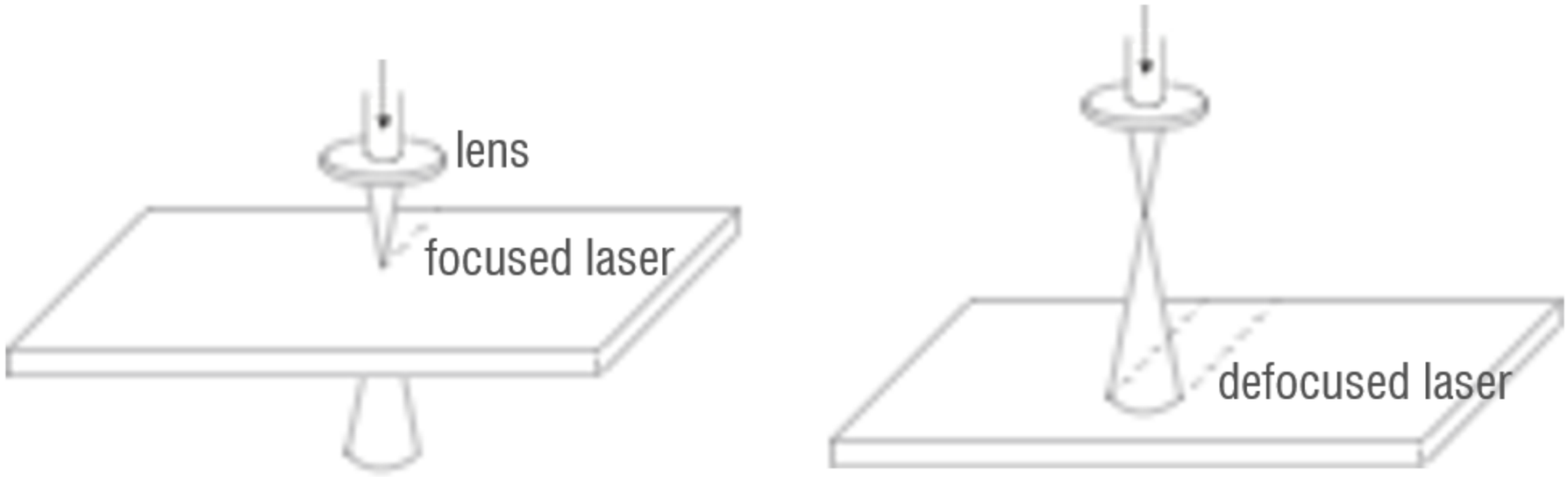
laser features #5

moving parts

Based on Stefanie Mueller’s slides

Varies interactive technologies

Fabrication

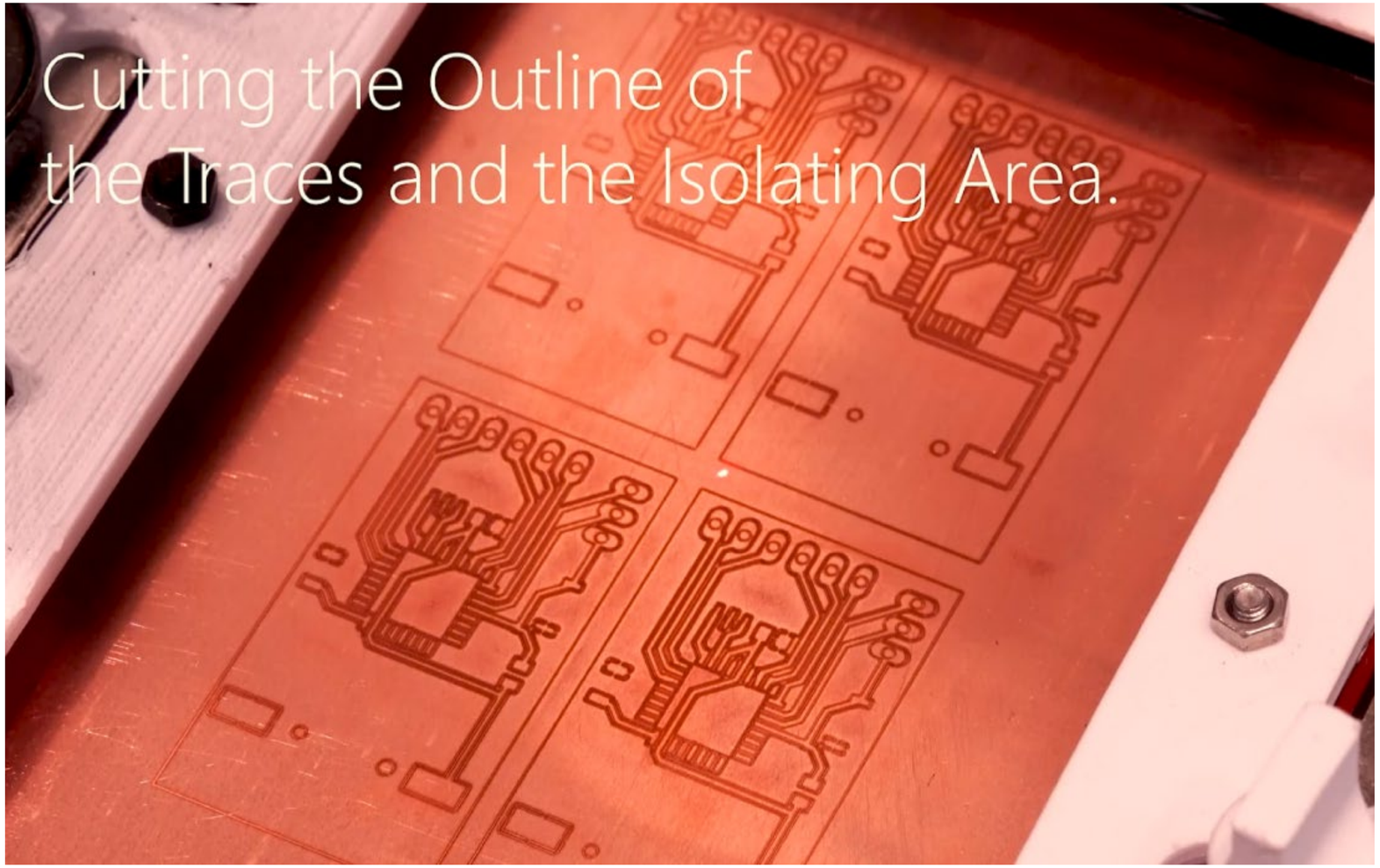


To cut-through we need to have the laser focused to the top surface of the material

Any benefit of defocusing a laser?

Varies interactive technologies

Fabrication



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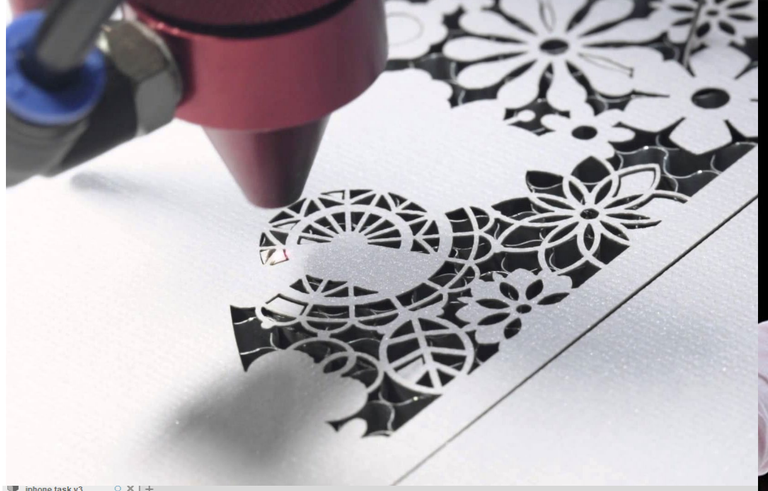
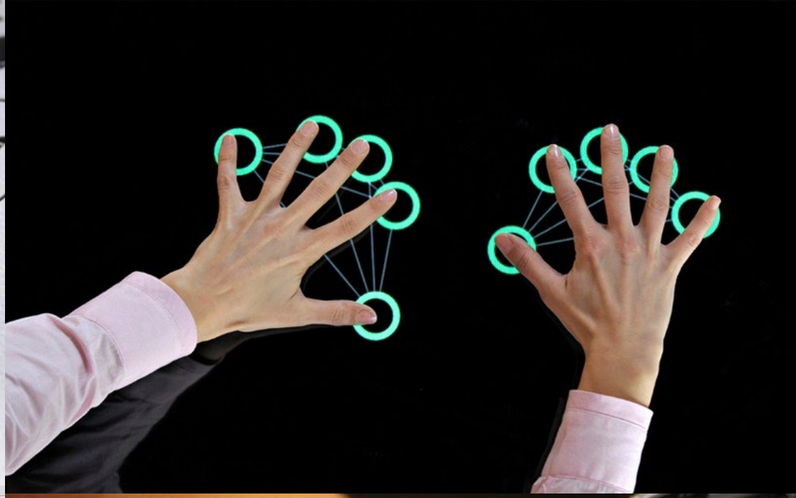
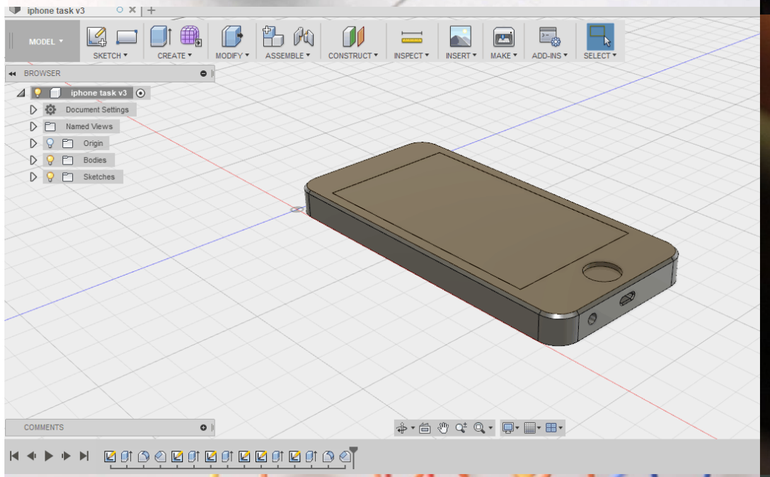
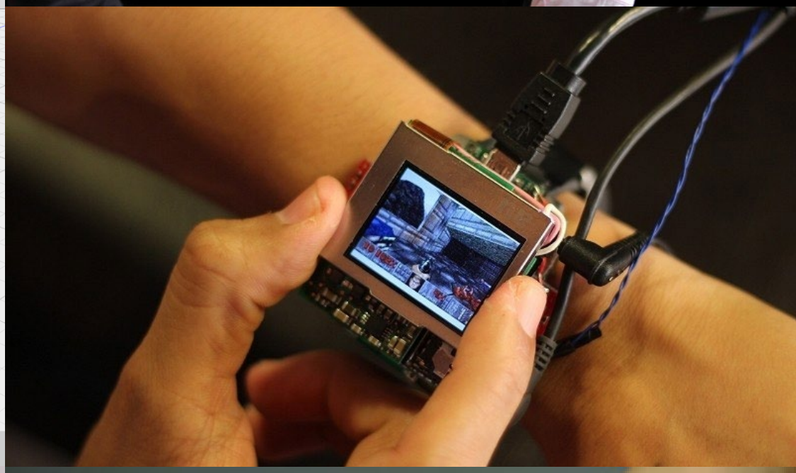
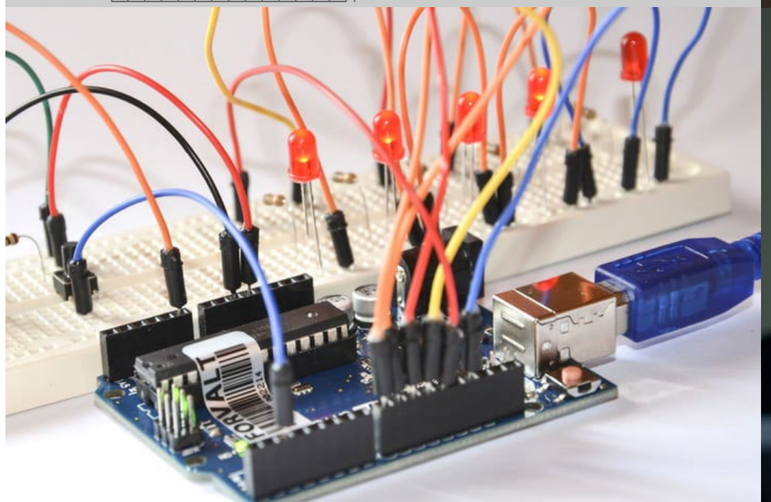
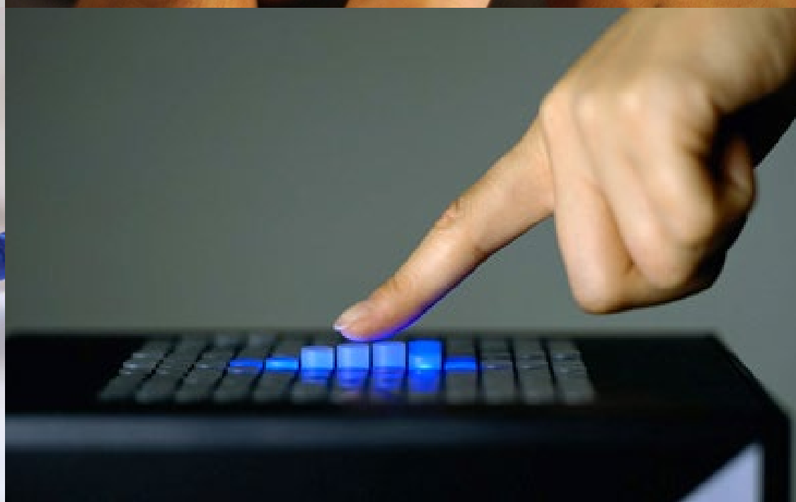








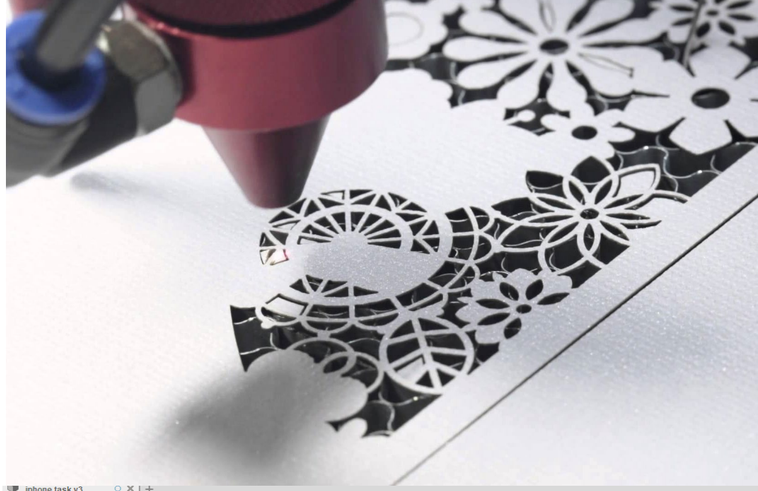


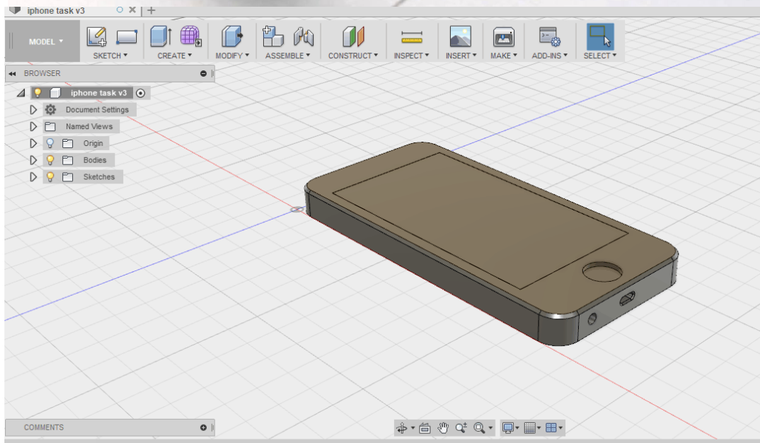


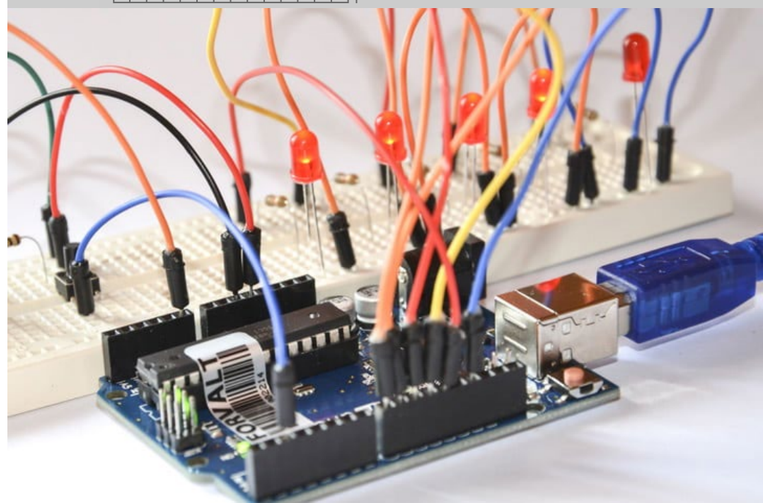
Varies interactive technologies

Hands-on building skills

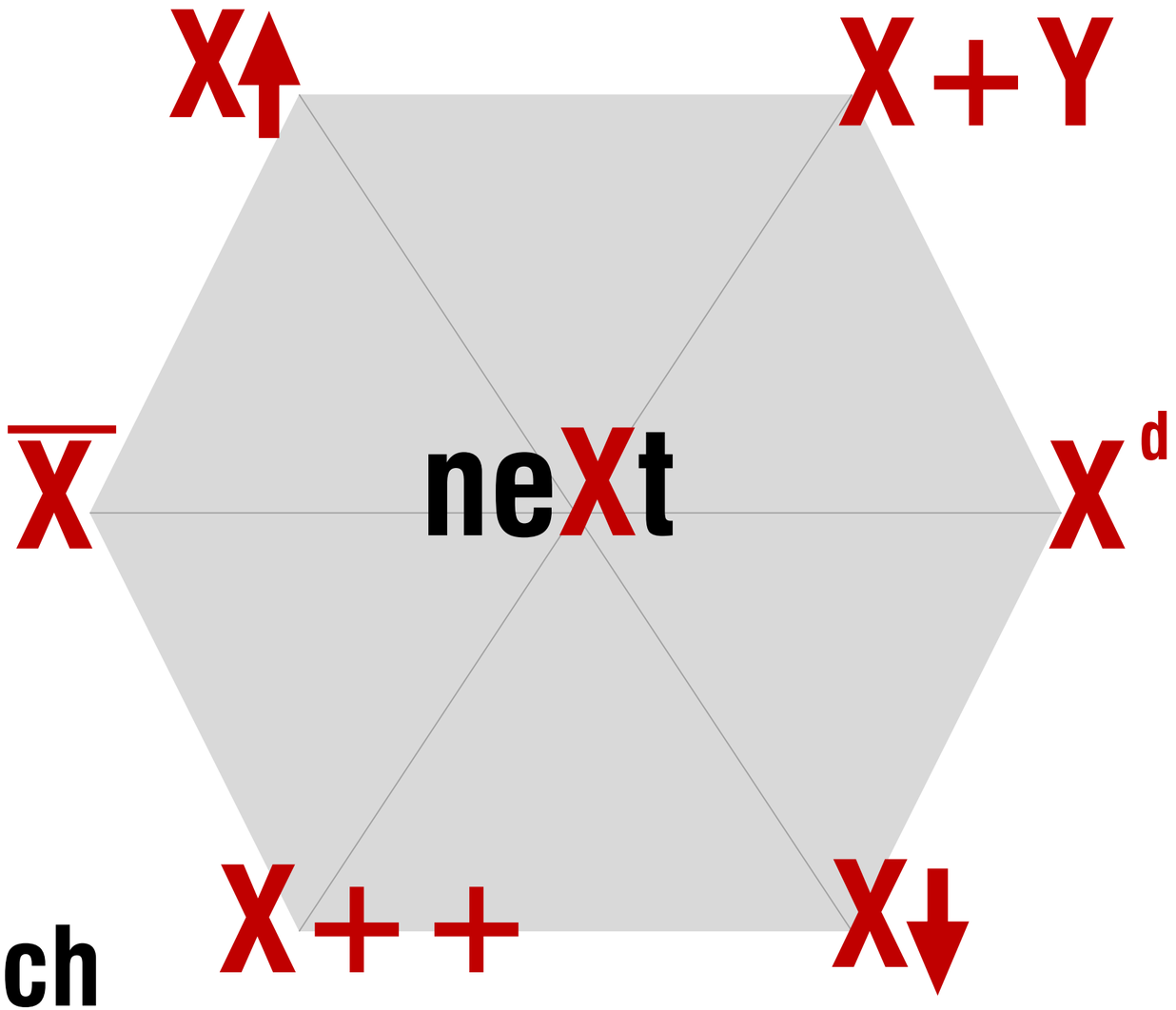
3D modeling
Digital IO -> ESP32
Analog sensing
Servo motor
Ultrasonic sensor
I2C protocol
IMU
Shift register
3D printing
Laser cutting







Robot Competition



Future Interactive Tech

how to invent
future interactive technology?

how about user centered design?

- interview potential users
- find something that is hard to do or hard to use…
- e.g. via evaluation (5 experts list usability issues)

We talk about user-centered design in
CMSC434 Introduction to Human-Computer Interaction

do you think any of the cool stuff
I showed in the past few weeks came out of this?

nope.

Usability Evaluation Considered Harmful (Some of the Time)

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Principle Researcher
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ABSTRACT
Current practice in Human Computer Interaction as encouraged by educational institutes, academic review processes, and institutions with usability groups advocate usability evaluation as a critical part of every design process. This is for good reason: usability evaluation has a significant role to play when conditions warrant it. Yet evaluation can be ineffective and even harmful if naively done 'by rule' rather than 'by thought'. If done during early stage design, it can mute creative ideas that do not conform to current interface norms. If done to test radical innovations, the many interface issues that would likely arise from an immature technology can quash what could have been an inspired vision. If done to validate an academic prototype, it may incorrectly suggest a design's scientific worthiness rather than offer a meaningful critique of how it would be adopted and used in everyday practice. If done without regard to how cultures adopt technology over time, then today's reluctant reactions by users will forestall tomorrow's eager acceptance. The choice of evaluation methodology – if any – must arise from and be appropriate for the actual problem or research question under consideration.

Author Keywords
Usability testing, interface critiques, teaching usability.

INTRODUCTION
Usability evaluation is one of the major cornerstones of user interface design. This is for good reason. As Dix et al., remind us, such evaluation helps us "assess our designs and test our systems to ensure that they actually behave as we expect and meet the requirements of the user" [7]. This is typically done by using an evaluation method to measure or predict how effective, efficient and/or satisfied people would be when using the interface to perform one or more tasks. As commonly practiced, these usability evaluation methods range from laboratory-based user observations, controlled user studies, and/or inspection techniques [7,22,1]. The scope of this paper concerns these methods.

The purpose behind usability evaluation, regardless of the actual method, can vary considerably in different contexts. Within product groups, practitioners typically evaluate products under development for 'usability bugs', where developers are expected to correct the significant problems found (i.e., iterative development). Usability evaluation can also form part of an acceptance test, where human performance while using the system is measured quantitatively to see if it falls within an acceptable criteria (e.g., time to complete a task, error rate, relative satisfaction). Or if the team is considering purchasing one of two competing products, usability evaluation can

Challenge:

we have it pretty good already.
the current world offers most
of what the current world needs

going with **immediate needs -> small steps**

but if user-centered design won’t work here
how do you do it, how to make **big steps into the future?**

but if user-centered design won’t work here
how do you do it, how to make **big steps into the future?**

anticipate the future using **what-if questions**

what-if questions

The Mother of All Demos, presented by Douglas Engelbart (1968)

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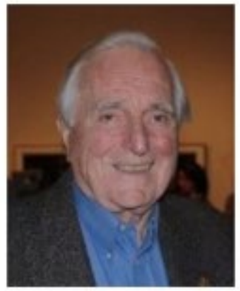
first time the world saw:
the mouse, interactive editing, hyperlinks…

-> his **main contribution was not these technologies,** but…



Douglas Engelbart

SRI, Bootstrap Institute
human-computer interaction - interactive computing
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Title / Author	Cited by	Year
Augmenting human intellect: a conceptual framework (1962) DC Engelbart PACKER, Randall and JORDAN, Ken. Multimedia. From Wagner to Virtual Reality ...	737	2001
A research center for augmenting human intellect DC Engelbart, WK English	713	1968
Conceptual Framework for the Augmentation of Man\'s Intellect DC Engelbart Spartan Books	606	1963
DC Engelbart, RW Watson, JC Norton	231 *	1973

ask the right question:

‘How can we augment human intellect using computing?’

keep in mind
that he asked this at a time when it **sounded absurd:**

this was the time of mainframes & time sharing systems
no one had personal access to a computer;
there were no tools for intellectual workers

(also, he could have been wrong. computer prices could have stayed high; his work would never have become relevant)

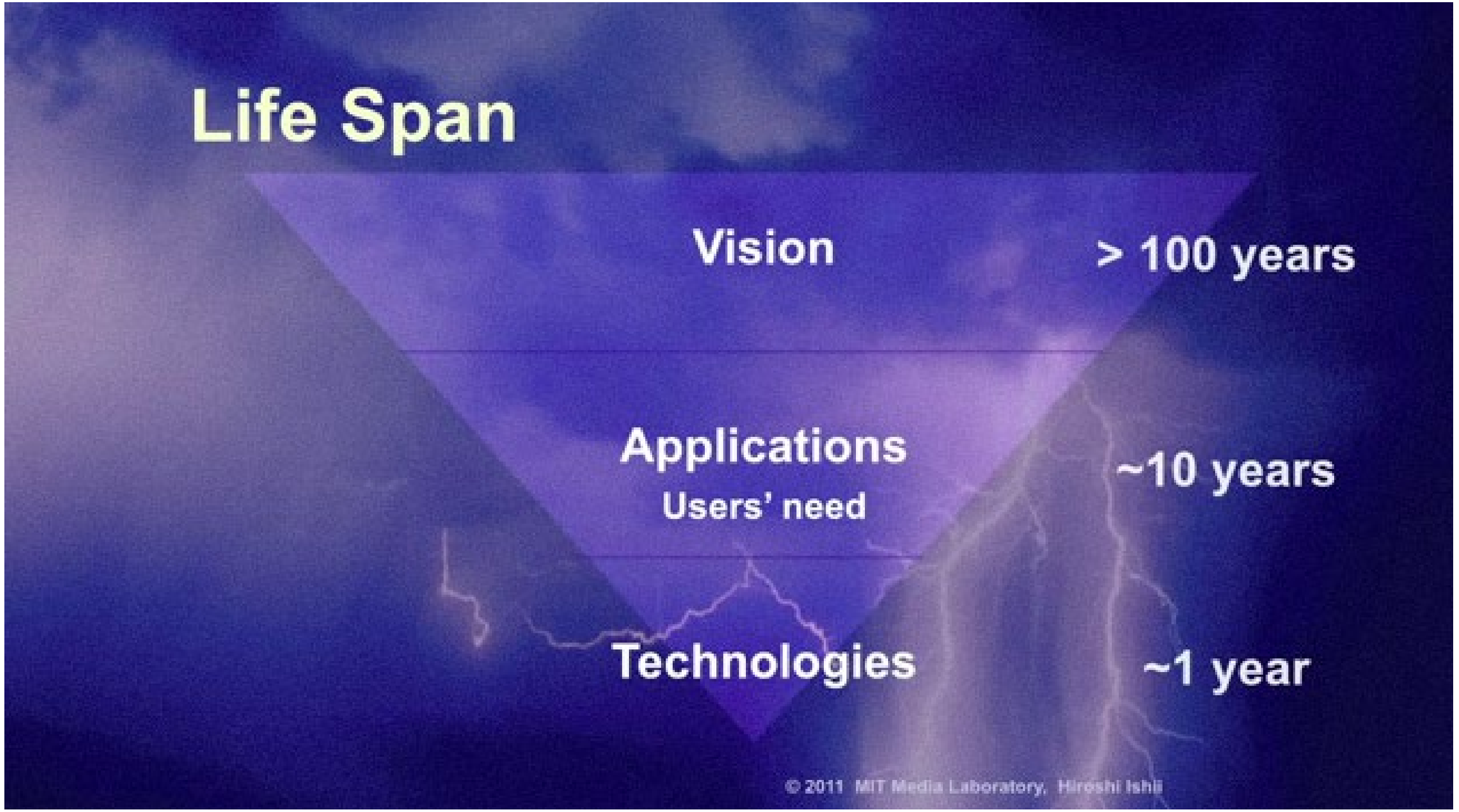
Article Talk

Turing Award

From Wikipedia, the free encyclopedia

		contributions to program and systems verification.
1997	Douglas Engelbart	For an inspiring vision of the future of interactive computing and the invention of key technologies to help realize this vision.
1998	Jim Gray	For seminal contributions to database and transaction processing research and technical leadership in

why **what-if vision questions are more important**
than individual tech contributions



Hiroshi Ishii, Keynote at TEI 2008, Bonn Germany, 18.02.2008

ACM SIG CHI Lifetime Research Award

how to **choose** a what-if question?

here's what most people do, don't do it:

(1) wait for wave

(2) start paddling

better:

(1) look far out, on horizon locate wave, estimate motion

(2) paddle towards extrapolated point

(3) prepare, when it arrives hop on

what-if question

= a wild extrapolation of what we see today

(and maybe there's nothing, but at least you tried to be the first!)

better:

(1) look far out, on horizon locate wave, estimate motion

(2) paddle towards extrapolated point

(3) prepare, when it arrives hop on

some more selected **what-if questions**…

ubiquitous computing (1991):

what if a user had multiple computers/CPUs available?

The Computer for the 21st Century

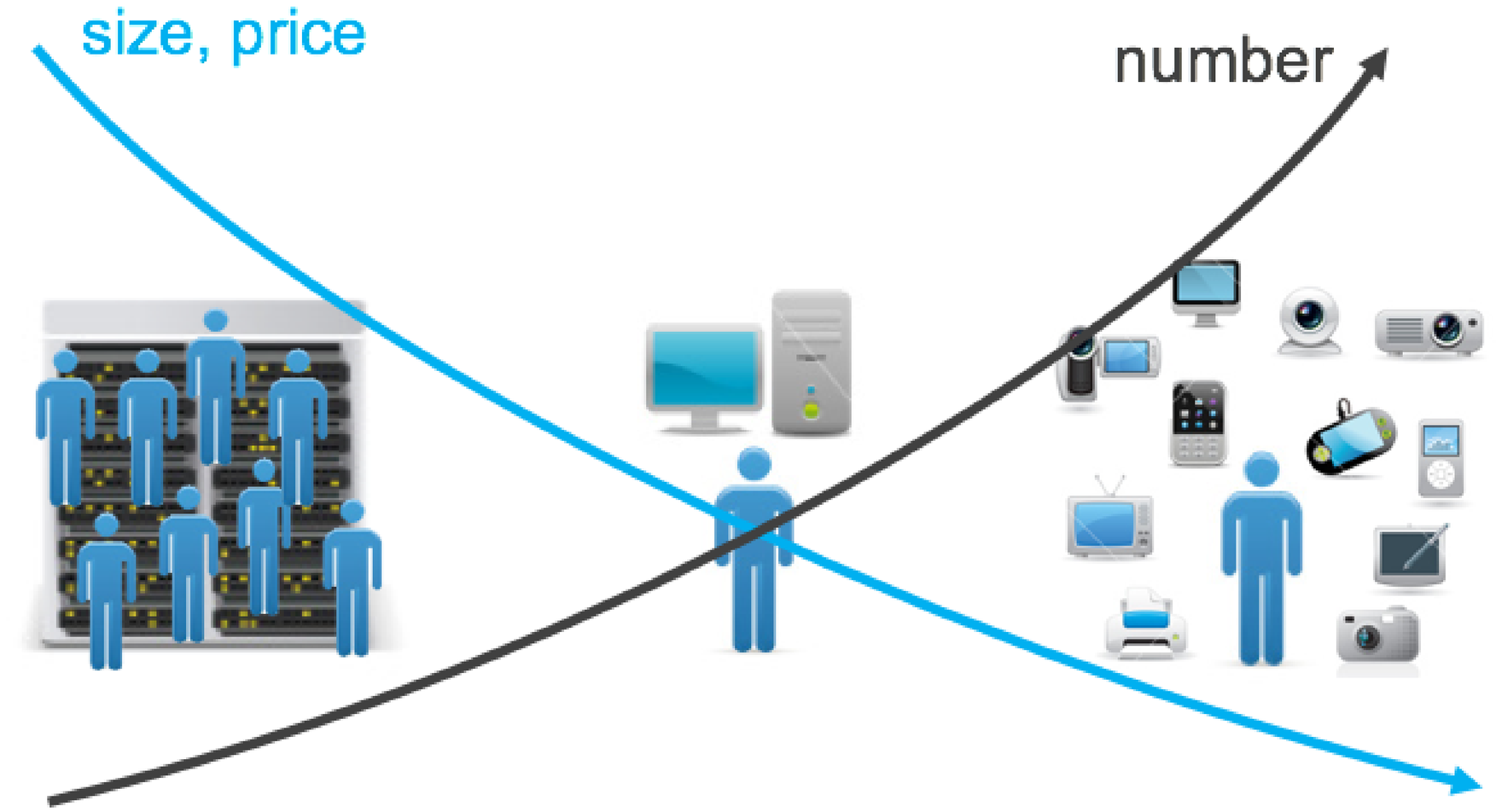
Mark Weiser 1991

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

Consider writing, perhaps the first information technology: The ability to capture a symbolic representation of spoken language for long-term storage freed information from the limits of individual memory. Today this technology is ubiquitous in industrialized countries. Not only do books, magazines and newspapers convey written information, but so do street signs, billboards, shop signs and even graffiti. Candy wrappers are covered in writing. The constant background presence of these products of "literacy technology" does not require active attention, but the information to be conveyed is ready for use at a glance. It is difficult to imagine modern life otherwise.

Silicon-based information technology, in contrast, is far from having become part of the environment. More than 50 million personal computers have been sold, and nonetheless the computer remains largely in a world of its own. It is approachable only through complex jargon that has nothing to do with the tasks for which which people actually use computers. The state of the art is perhaps analogous to the period when scribes had to know as much about making ink or baking clay as they did about writing.

The arcane aura that surrounds personal computers is not just a "user interface" problem. My colleagues and I at PARC think that the idea of a "personal" computer itself is misplaced, and that the vision of laptop machines, dynabooks and "knowledge navigators" is only a transitional step toward achieving the real potential of information technology. Such machines cannot truly make computing an integral, invisible part of the way


size, price
number
1960's
1980's
2000's
1 computer : n users
1 computer :: 1 user
n computers :: 1 user

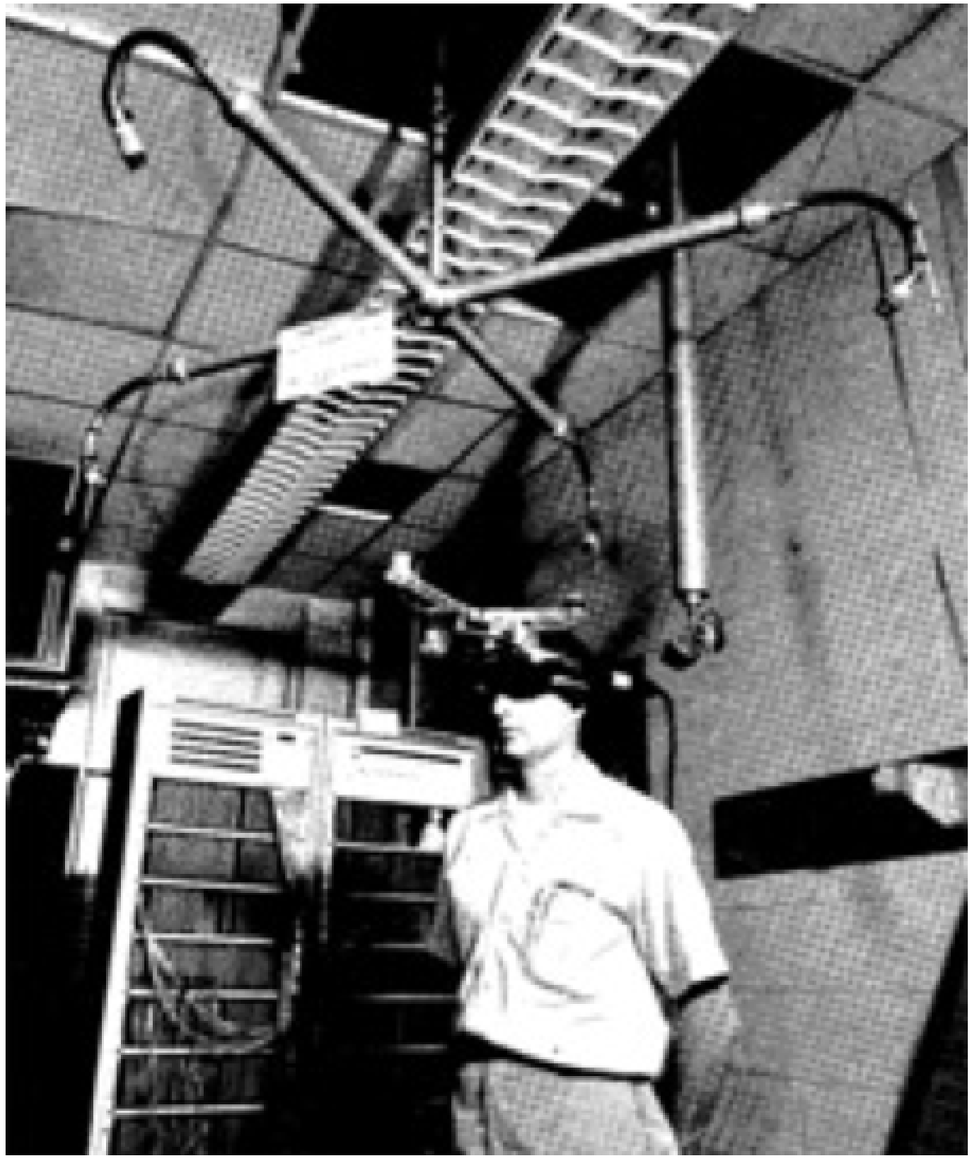
ubiquitous computing: the **obvious answer**

ubiquitous computing: **computers start to disappear**

augmented reality (1968):

what if there was the perfect display

everywhere I look



tangible computing (1997):

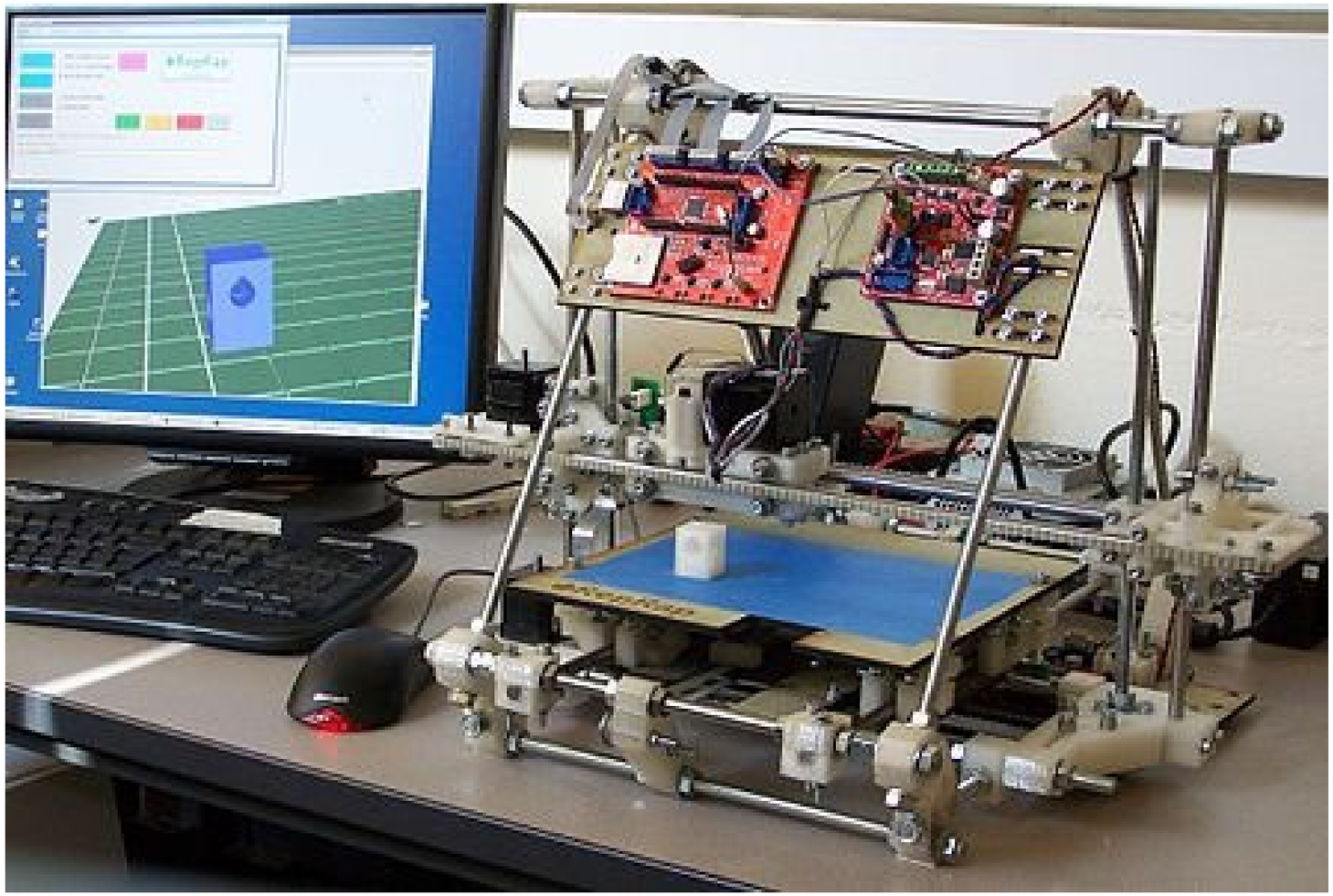
what if I operated stuff in the world not via a computer,
but by actually **manipulating it?**

wearable (1961) + implanted:

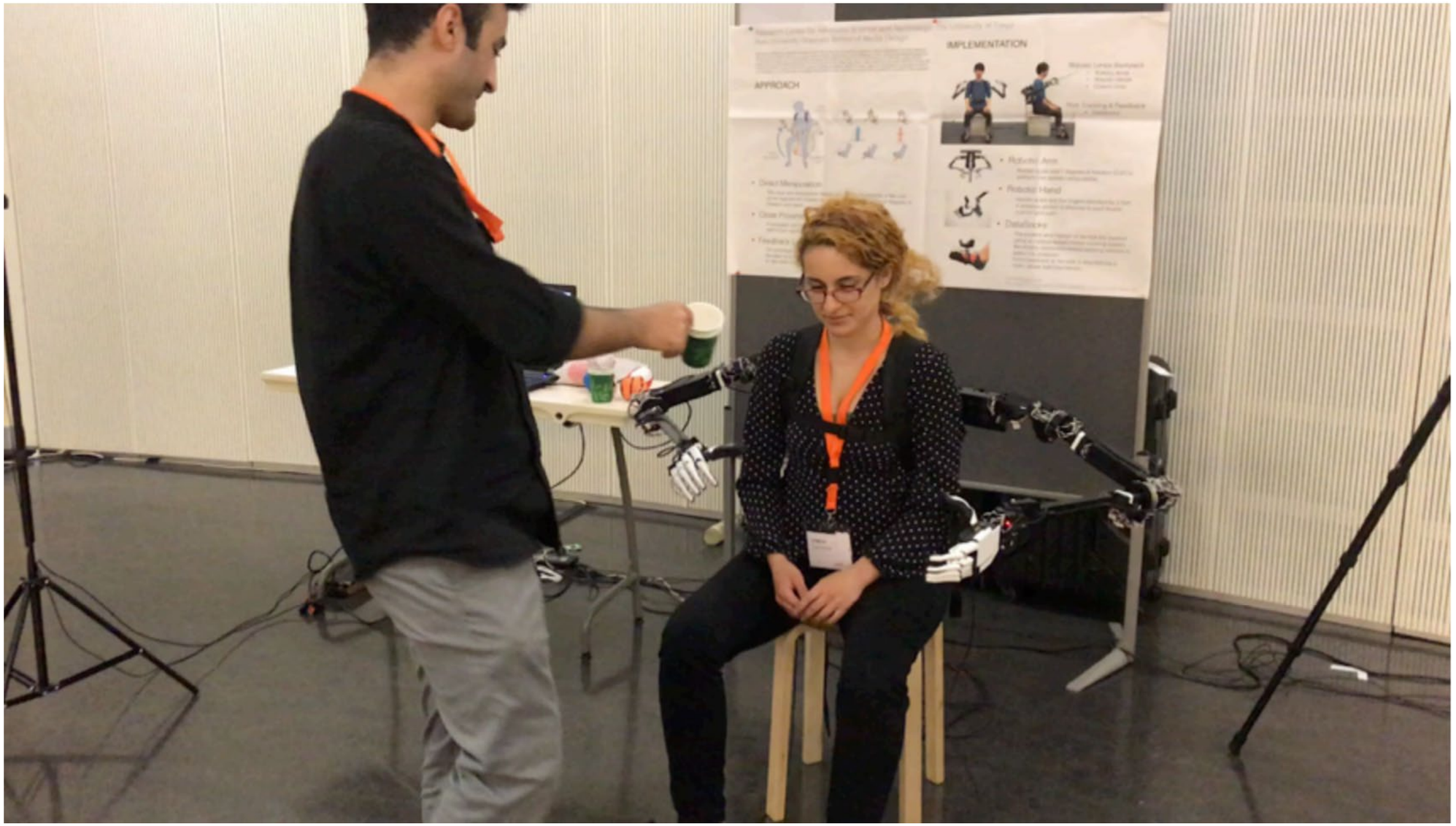
what if **technology shrink past mobile?**

personal fabrication (2005):

what if **fabrication machinery is available** in every office and/or every household?



MetaArms (2018): what if people **had extra limbs**?



looking back through the history of HCI,
we see that **quantum leaps have rarely resulted from studies on user needs or market research;**

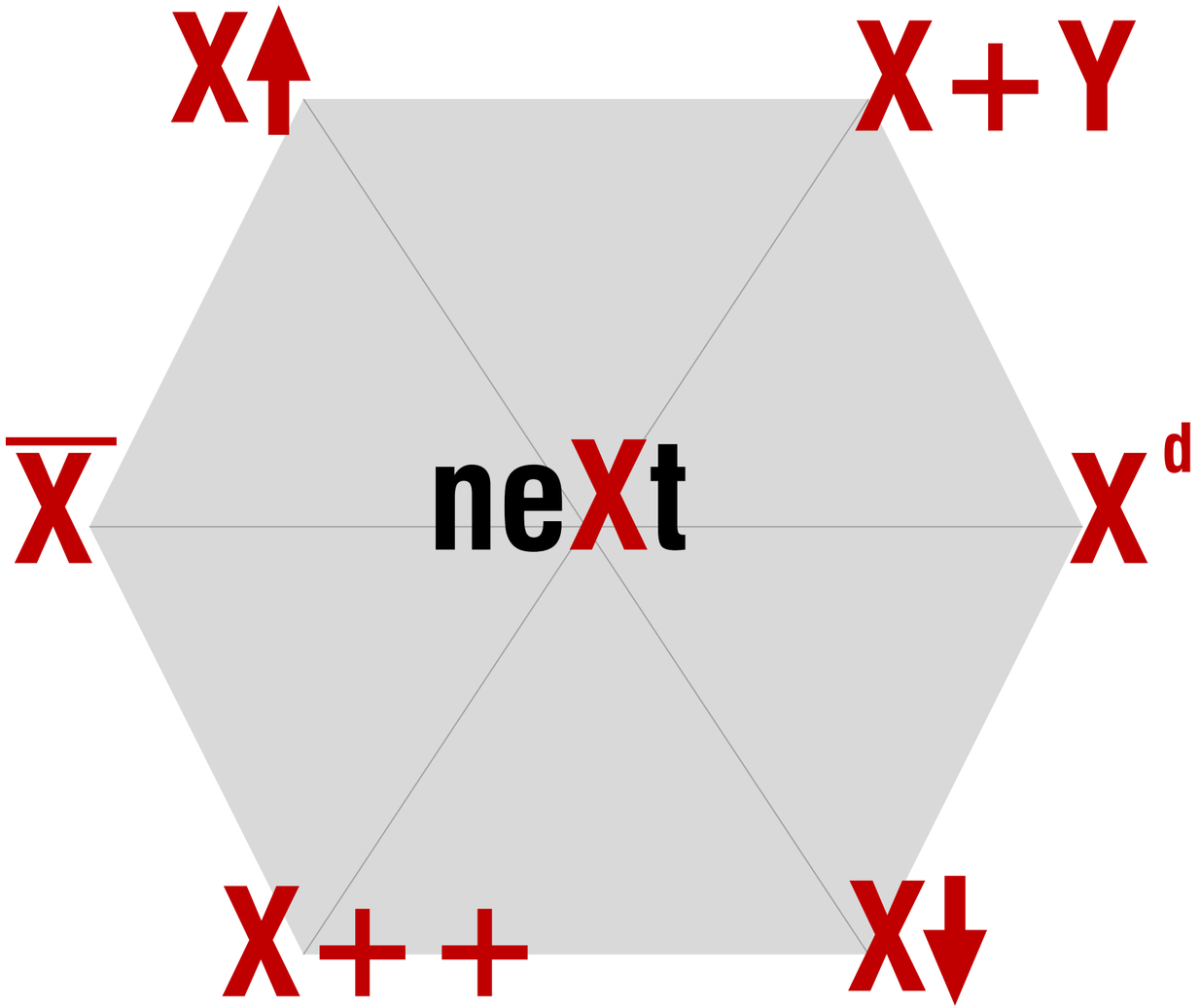
they have come from people
asking **visionary what-if questions!**

any what if questions that come to your mind right now?

what if questions are hard…

another way to extrapolate into the future
is to use **invention iterators…**

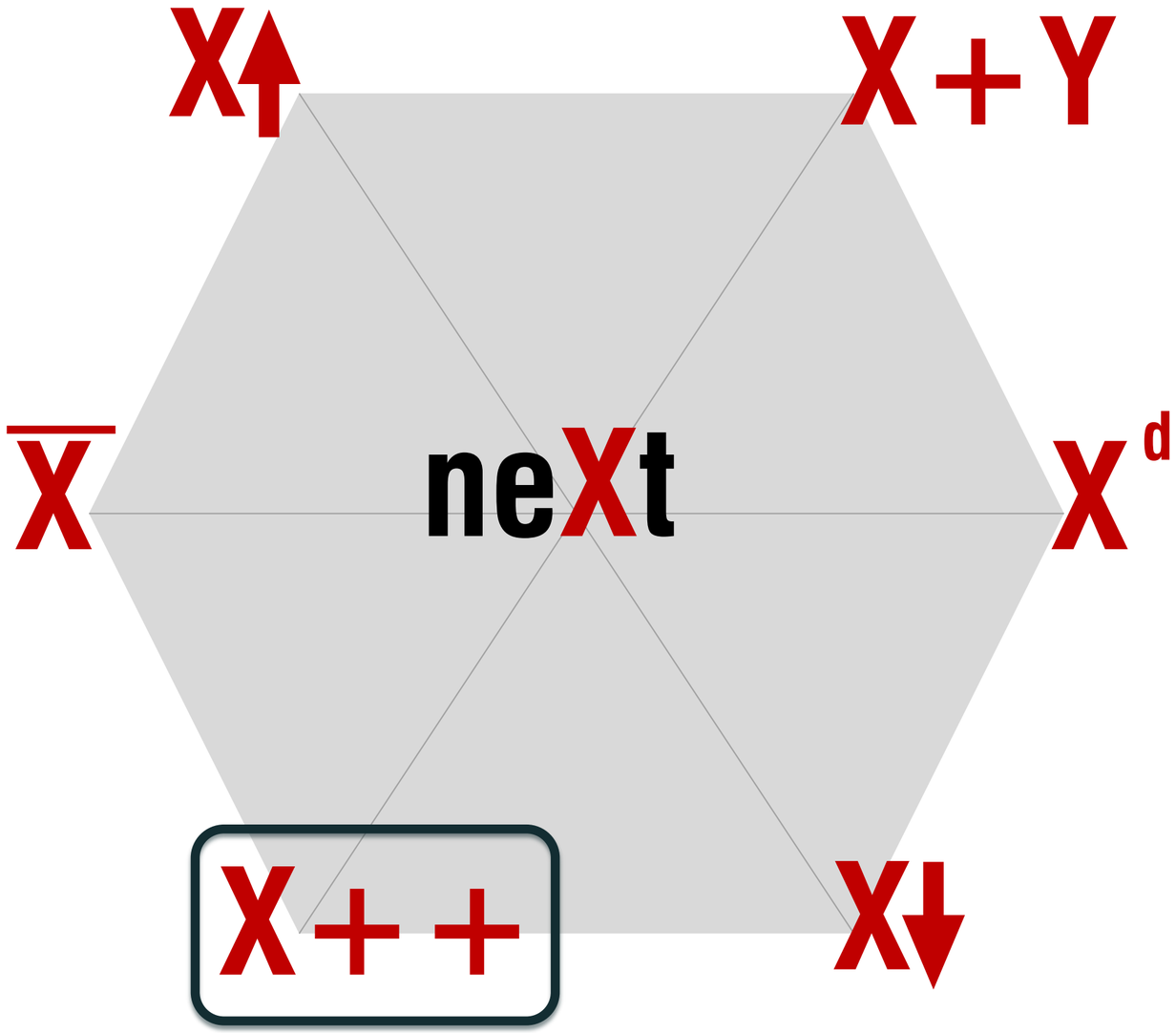
after X, what is neXt?



[Ramesh Raskar]

X =

idea you just heard
concept
patent
new product
product feature
design
art
algorithm


X↑
X+Y
X̄
neXt
X^d
X++
X↓

X++ increment
(make it faster, better, cheaper)

the first iPhone was a huge leap forward…
everything else is mainly **incremental**

								
	iPhone	**iPhone 3G**	**iPhone 3GS**	**iPhone 4**	**iPhone 4S**	**iPhone 5**	**iPhone 5c**	**iPhone 5s**
Code Name	M68	N82	N88	N90	N94	N41	N48	N51
Model Name	iPhone 1,1	iPhone 1,2	iPhone 2,1	iPhone 3,1	iPhone 4,1	iPhone 5,1	iPhone 5,3	iPhone 6,1
OS	iPhone OS 1.0	iPhone OS 2.0	iPhone OS 3.0	iOS 4	iOS 5	iOS 6	iOS 7	iOS 7
Screen Size	3.5-inch 480x320 at 163ppi	3.5-inch 480x320 at 163ppi	3.5-inch 480x320 at 163ppi	3.5-inch IPS 960x640 at 326ppi	3.5-inch IPS 960x640 at 326ppi	4-inch 1136x640 in-cell IPS LCD at 326ppi	4-inch 1136x640 in-cell IPS LCD at 326ppi	4-inch 1136x640 in-cell IPS LCD at 326ppi
System-on-chip	Samsung S5L8900	Samsung S5L8900	Samsung APL0298C05	Apple A4	Apple A5	Apple A6	Apple A6	64-bit Apple A7, M7 motion c-processor
CPU	ARM 1176JZ(F)-S	ARM 1176JZ(F)-S	600MHz ARM Cortex A8	800MHz ARM Cortex A8	800MHz dual-core ARM Cortex A9	1.3GHz dual-core Swift (ARM v7s)	1.3GHz dual-core Swift (ARM v7s)	1.3GHz dual-core Cyclone (ARM v8)
GPU	Power VR MBX Lite 3D	Power VR MBX Lite 3D	PowerVR SGX535	PowerVR SGX535	PowerVR dual-core SGX543MP4	PowerVR triple-core SGX543MP3	PowerVR triple-core SGX543MP3	PowerVR G6430
RAM	128MB	128MB	256MB	512MB	512MB	1GB	1GB	1GB DDR3
Storage	4GB/8GB (16GB later)	8GB/16GB	16GB/32GB	16GB/32GB	16GB/32GB/64GB	16GB/32GB/64GB	16GB/32GB	16GB/32GB/64GB
Top Data Speed	EDGE	3G 3.6	HSPA 7.2	HSPA 7.2	HSPA 14.4	LTE/DC-HSPA	LTE/DC-HSPA	LTE/DC-HSPA
SIM	Mini	Mini	Mini	Micro	Micro	Nano	Nano	Nano
Rear Camera	2MP	2MP	3MP/480p	5MP/720p, f2.8, 1.75*μ*	8MP/1080p, f2.4, BSI, 1.4*μ*	8MP/1080p, f2.4, BSI, 1.4*μ*	8MP/1080p, f2.4, BSI, 1.4*μ*	8MP/1080p, f2.2, BSI, 1.5*μ*
Front Camera	None	None	None	VGA	VGA	1.2MP/720p, BSI	1.2MP/720p, BSI	1.2MP/720p, BSI
Bluetooth	Bluetooth 2.0 + EDR	Bluetooth 2.0 + EDR	Bluetooth 2.1 + EDR	Bluetooth 2.1 + EDR	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0
WiFi	802.11 b/g	802.11 b/g	802.11 b/g	802.11 b/g/n (2.4GHz)	802.11 b/g/n (2.4GHz)	802.11 b/g/n (2.4 and 5GHz)	802.11 b/g/n (2.4 and 5GHz)	802.11 b/g/n (2.4 and 5GHz)
GPS	None	aGPS	aGPS	aGPS	aGPS, GLONASS	aGPS, GLONASS	aGPS, GLONASS	aGPS, GLONASS
Sensors	Light, accelerometer, proximity	Light, accelerometer, proximity	Light, accelerometer, proximity, compass	Light, accelerometer, proximity, compass, gyroscope	Light, accelerometer, proximity, compass, gyroscope, infrared	Light, accelerometer, proximity, compass, gyroscope, infrared	Light, accelerometer, proximity, compass, gyroscope, infrared	Light, accelerometer, proximity, compass, gyroscope, infrared, fingerprint identity

touch screen is better to use…
screen size becomes a bit bigger..
camera resolution becomes a bit higher…

better
= pick your favorite adjective:

- more context aware
- more adaptive
- more (temporally) coherent
- more progressive
- more efficient
- more parallelized
- more distributed
- more personalized/customized
- more democratized

least innovative

X++ is a sign that the **field or tech is “maturing”**

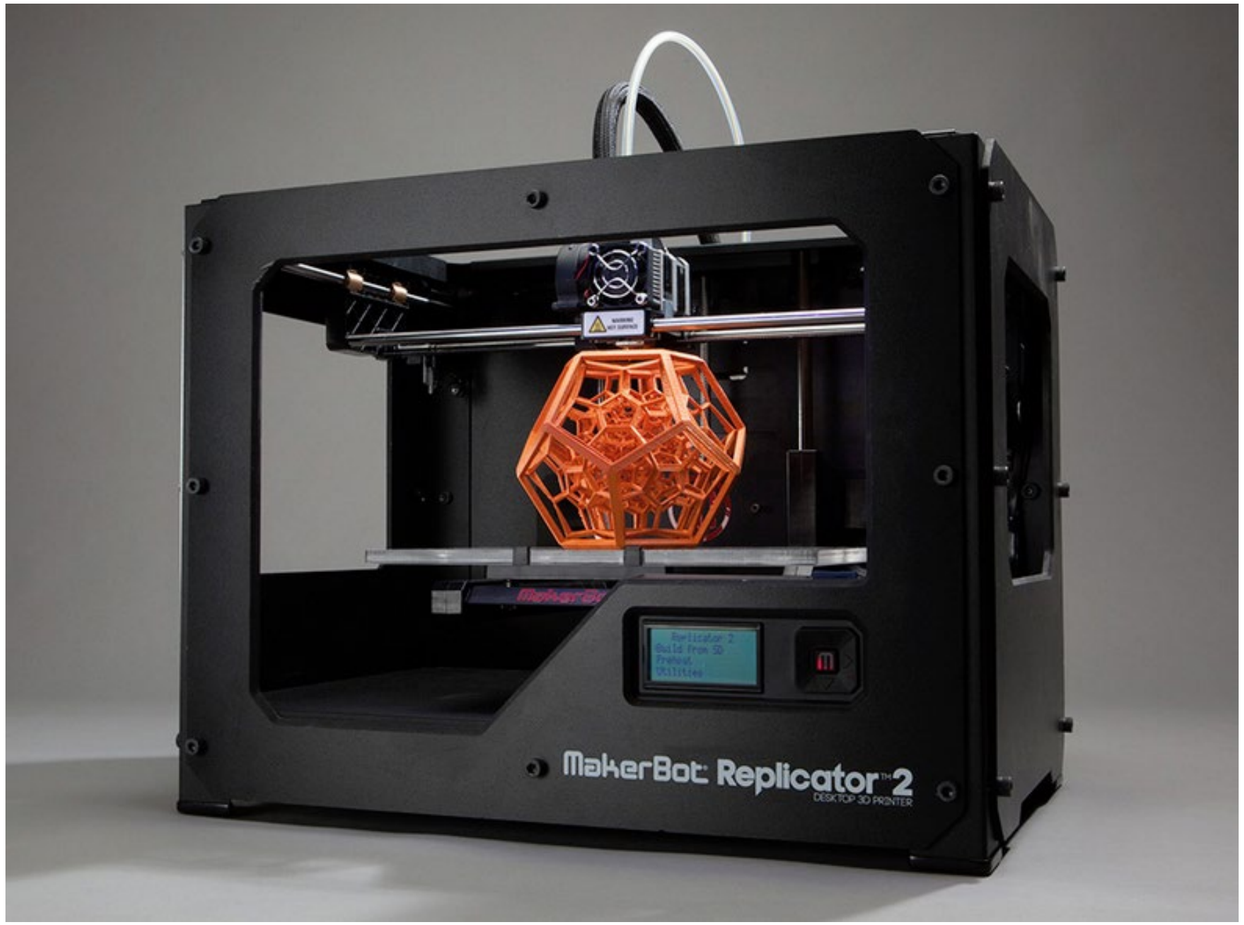
increments get smaller, less ground-breaking

given a nail

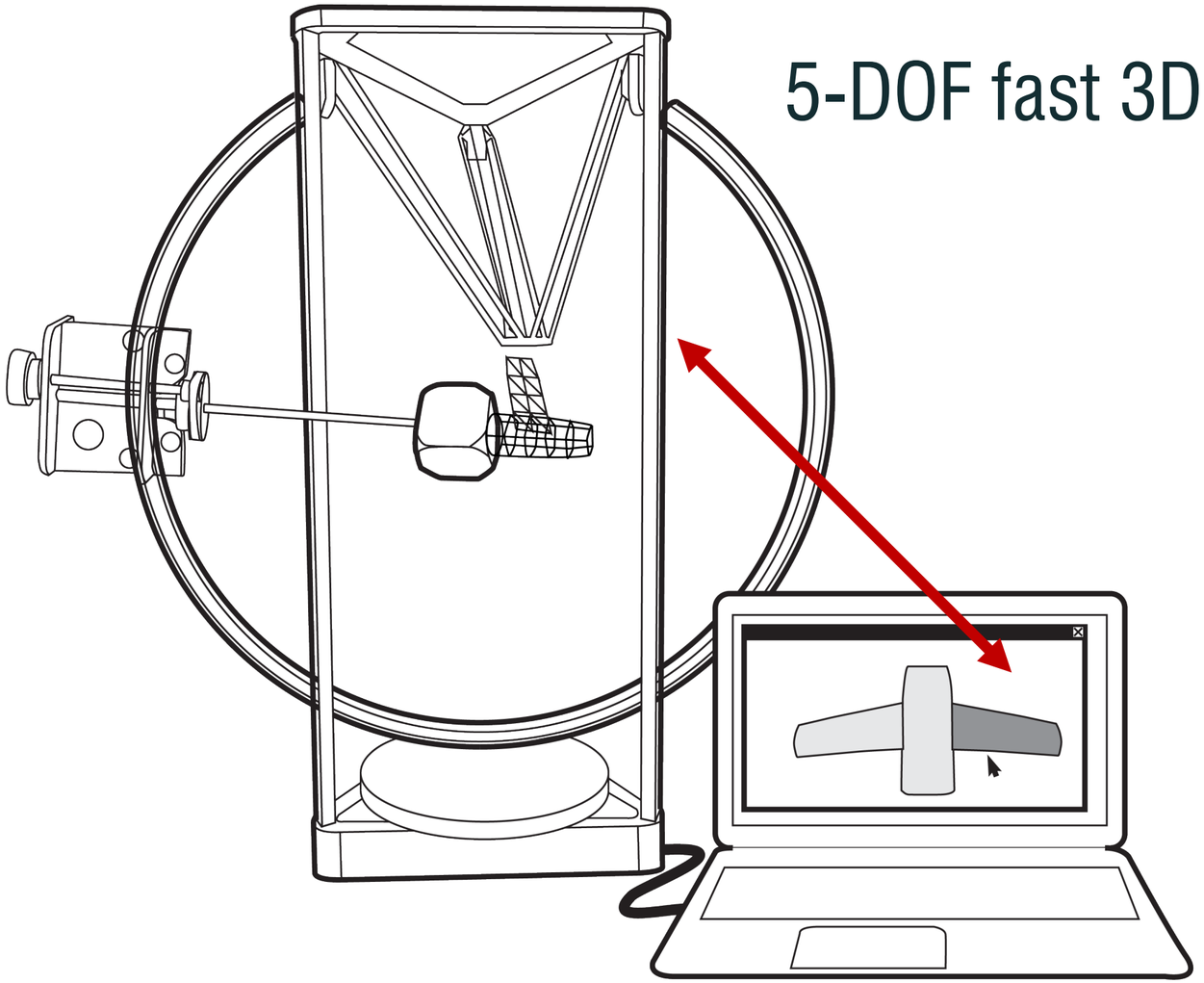
find all the hammers

given a problem,
find all solutions…

e.g. 3D Printing is **not interactive**



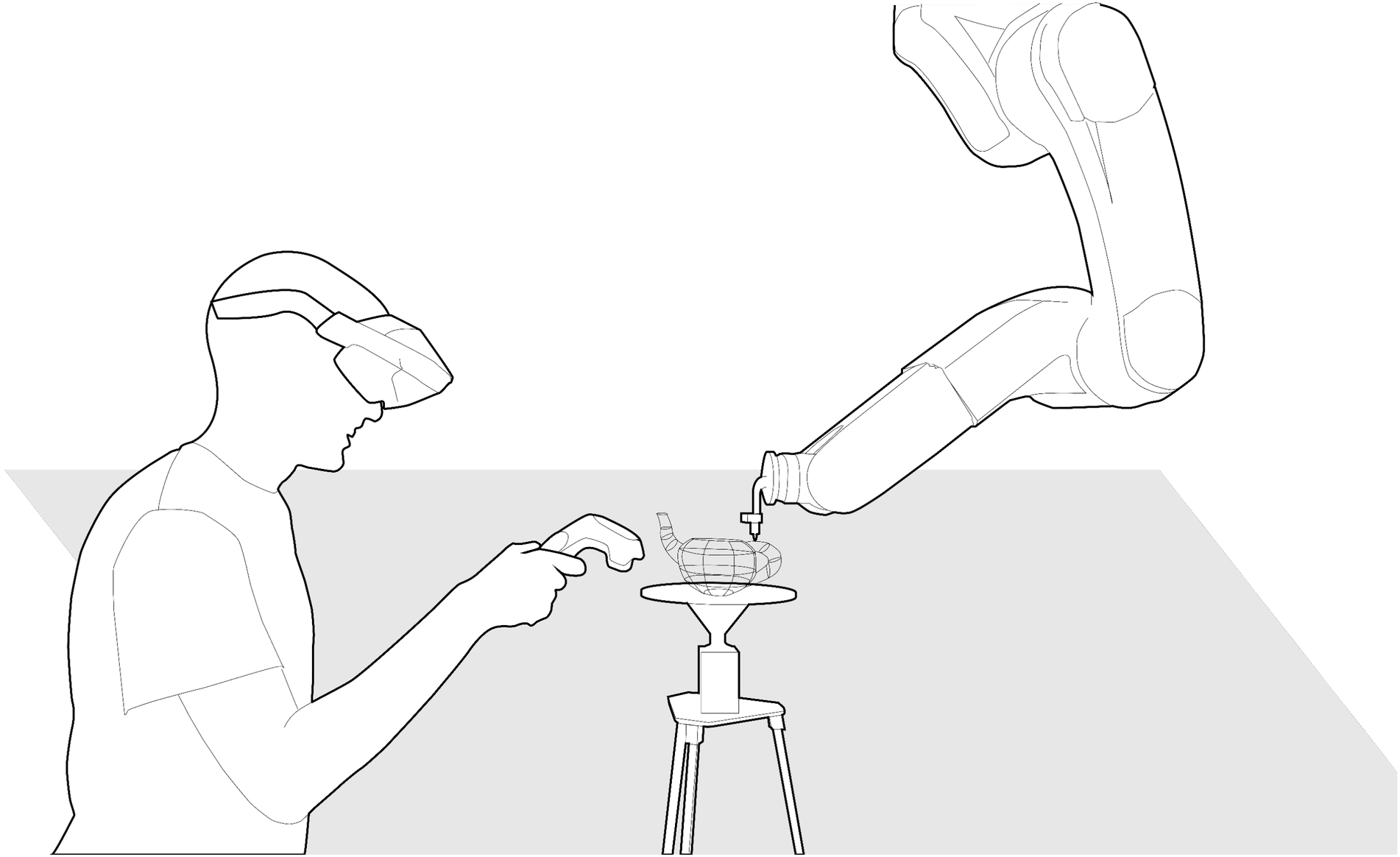
solution 1: hands-on design



5-DOF fast 3D printer

CAD modeling plugin

solution 2: in-parallel design and print



solution 3: in-situ design and print

— dance **around the same problem**

given a hammer

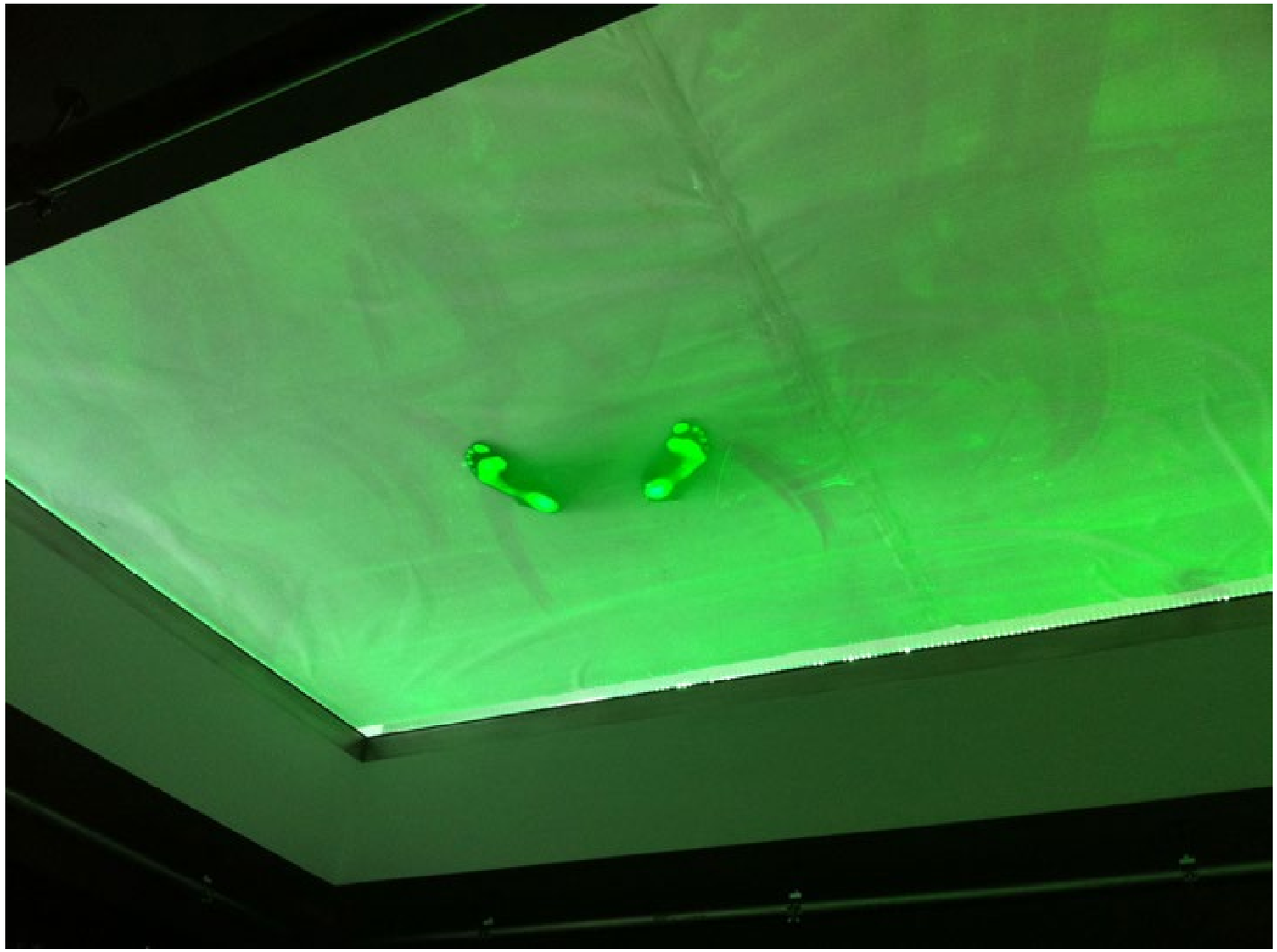
find all the nails

given a cool solution find other problems

-> high inventive power

multitouch:

for hands -> multitouch for feet



look back at your career
what could be **your hammer?**
<something you know a lot about but others know little>

extend it
to the **next dimension**

flickr -> youtube
text, audio (speech), image, video -> physical objects

visible images -> infrared
sound -> ultrasound -> electromagnetic spectrum

macro scale -> micro scale
airbag for car -> airbag for .. ?

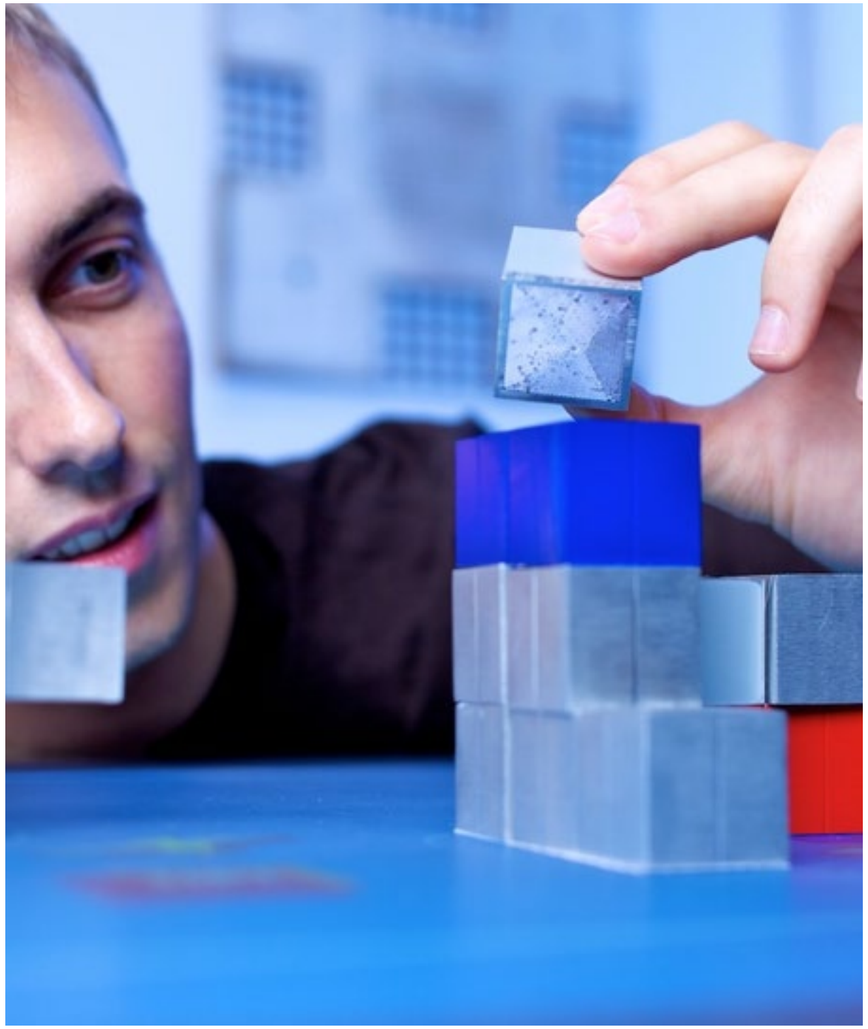
= generalize the concept (common in patent applications)

variation for hammer re-use, but more **actionable**
(extend solution to next dimension)

X+Y fusion of the dissimilar

X+Y is only good when
value(X+Y) > value(X)+value(Y)

bad example:
mounting touchscreen on mouse offers
exactly the same value as mouse & touchscreen separate



good example:
glass fibers + diffuse illumination touch screen -> Fingerprint sensing full screen (Fiberio)

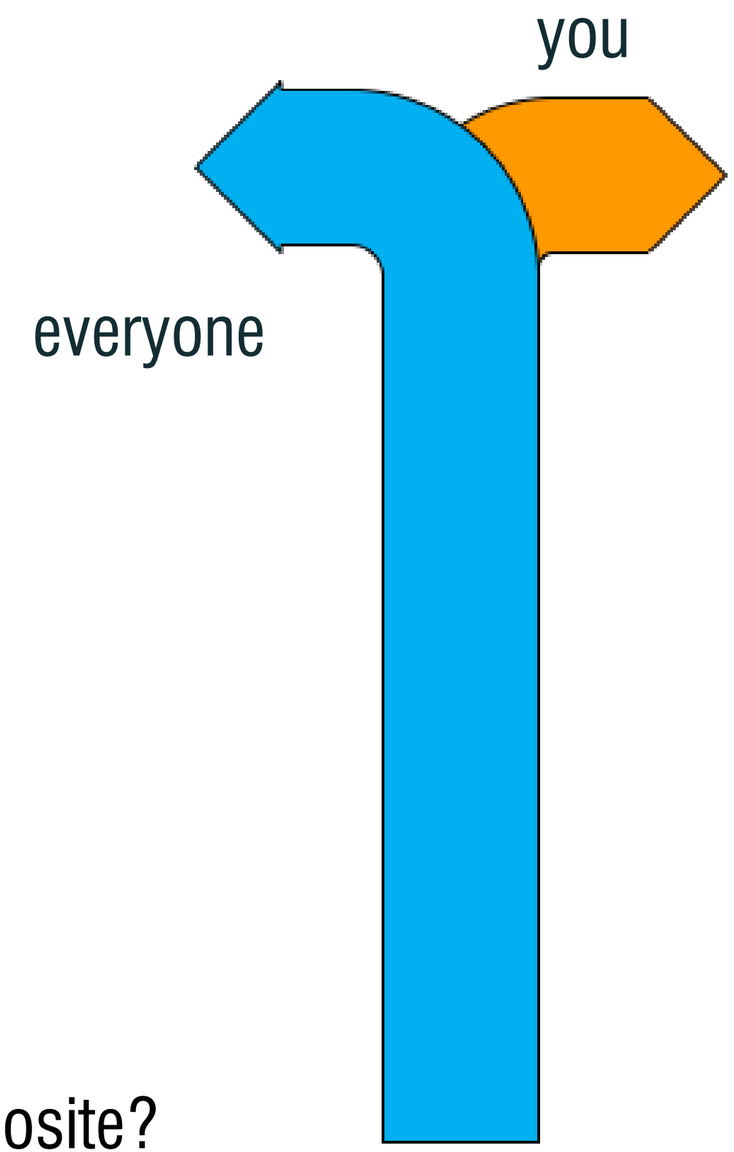
good example: food printing + perception:
maybe automation can feed some new insight back into perception research

high innovative power, but not very actionable
because for a given X the search space of all Y is large and unstructured

do the opposite

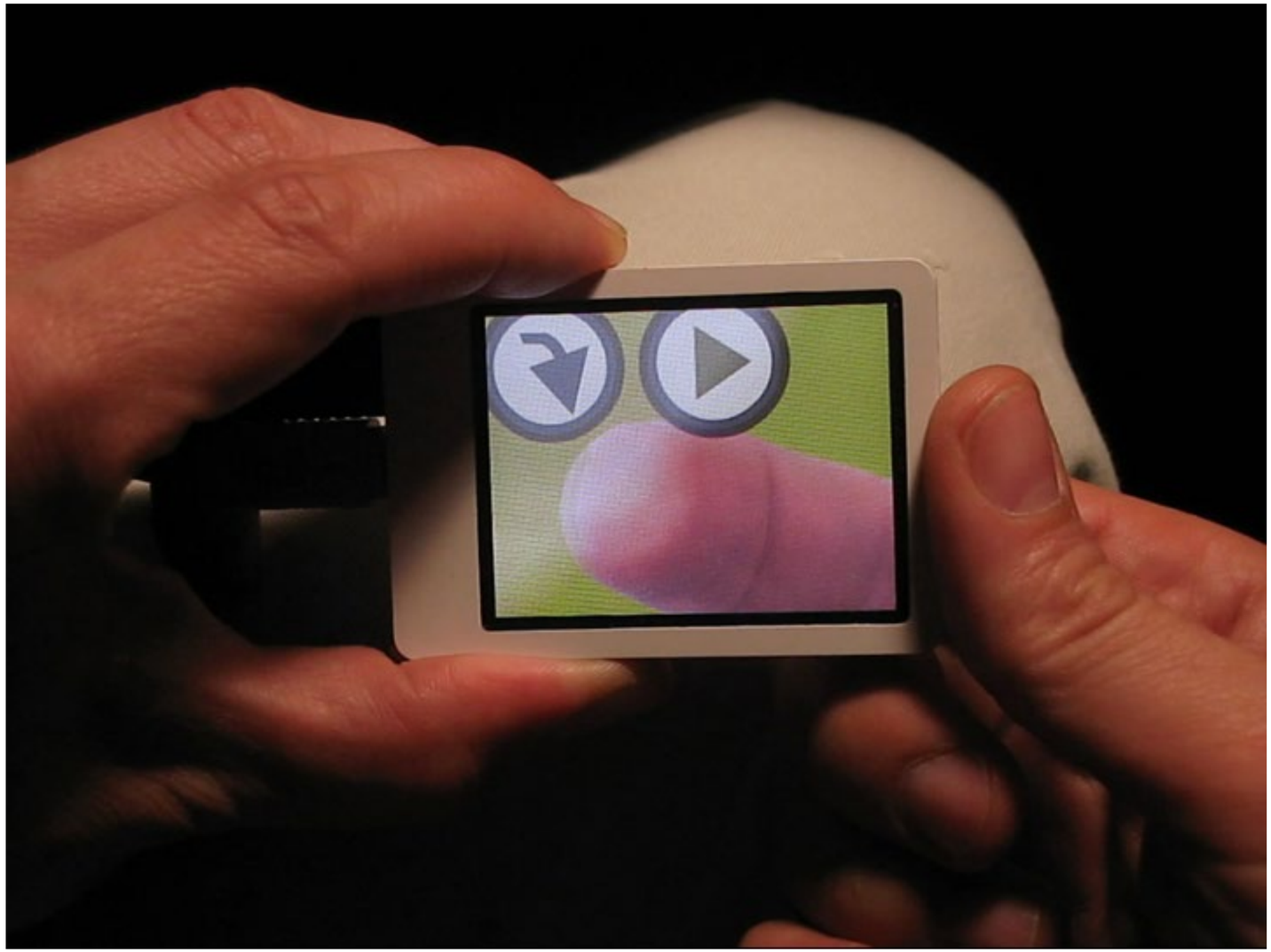
Straddle Method for High Jump

1968 Olympics: “Fosbury Flop”



find the opposite?

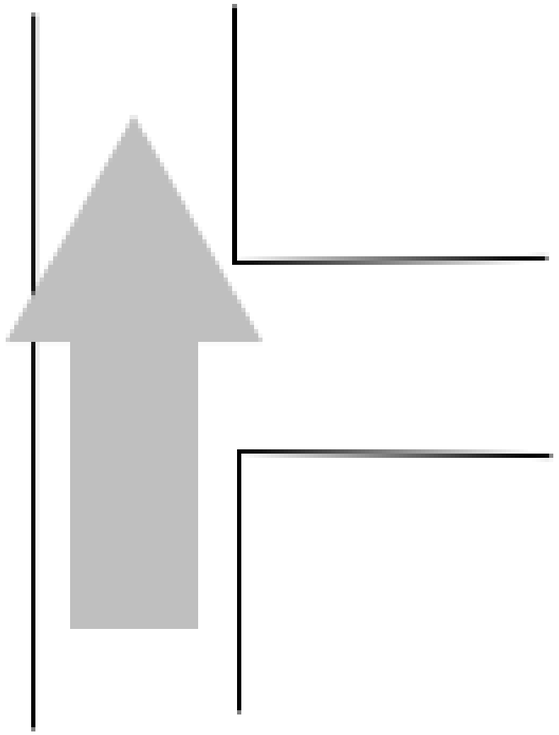
strong and actionable in brainstorming



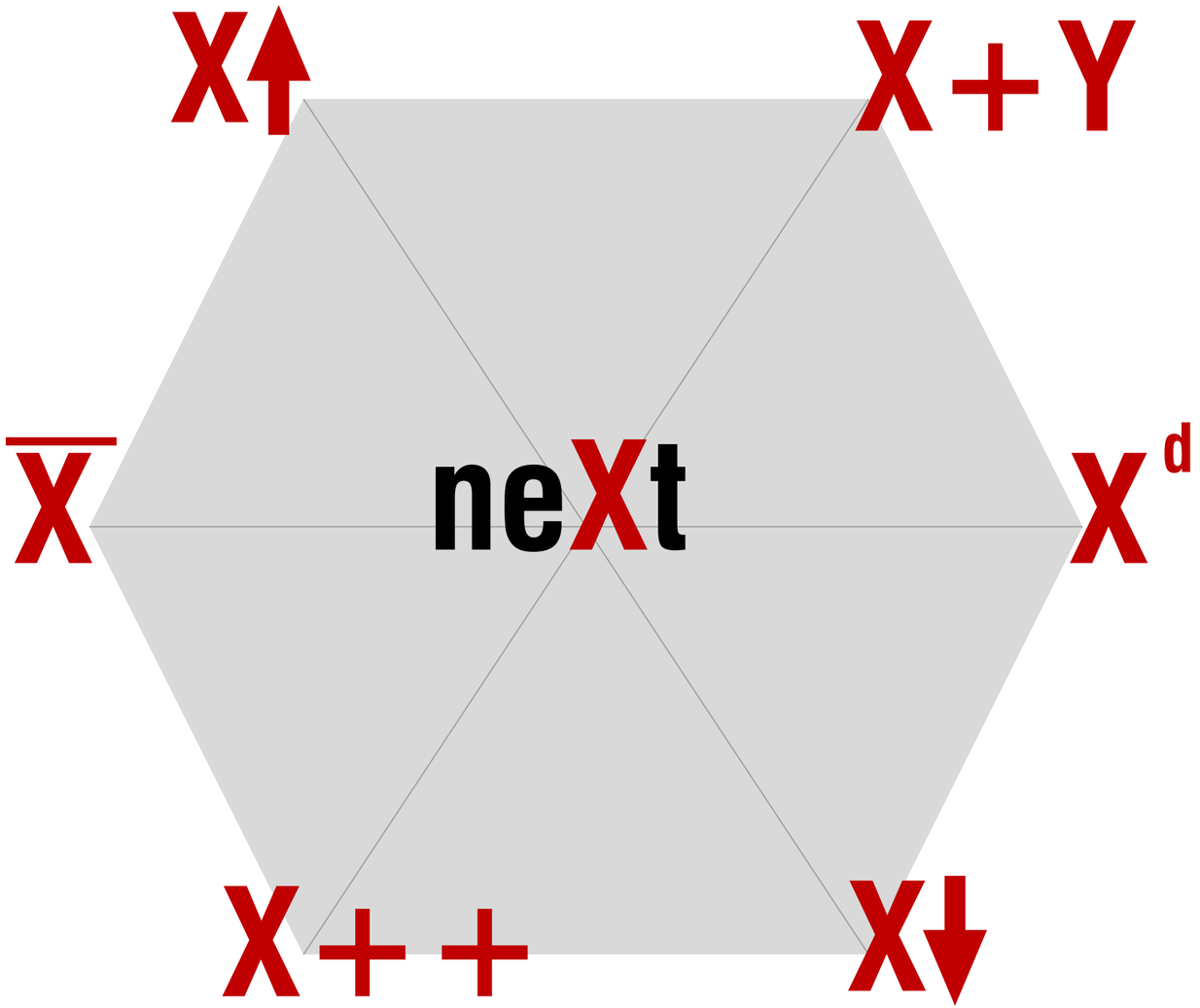
everyone adds touch screens to the front,

instead add it on the back

process:
look at existing designs.
find point(s) where everyone
made the same decision



finding X



these were the 6 iterators…

X =

idea you just heard
concept
patent
new product
product feature
design
art
algorithm

but how to **find the right X to start** out with?

stand at the edge of the ‘known world’ to find new land

awards (best paper, best product, researchers)

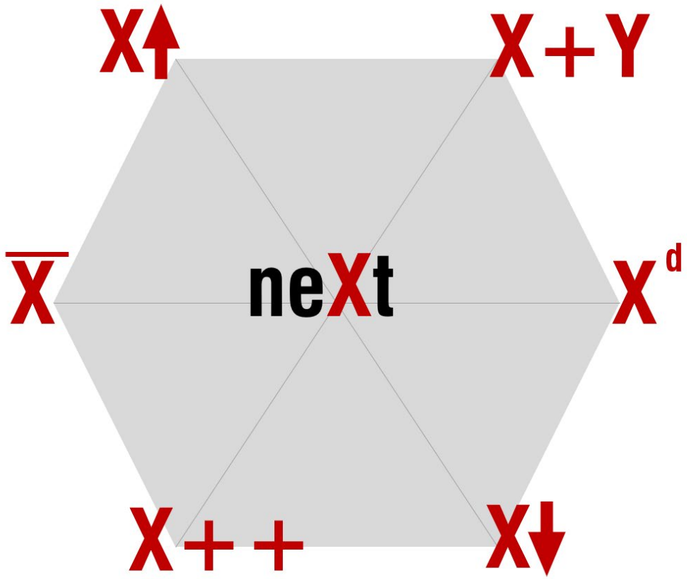
network and talk to people:
avoid small-talk .. ask ‘what is the latest x’

patents (but searching them is time-consuming)

(DIY community 10-15 years behind research.)

do not follow the hype

too much competition



any template will produce the same ideas
as everyone else who uses the same templates

address this by
1. using a wilder set of iterators than others
2. make your very own iterators

conclusions

“so many people get **stuck in incremental research:**
‘my double click mouse is better
than your double click mouse’”

“do what I call **vision-driven research…**”

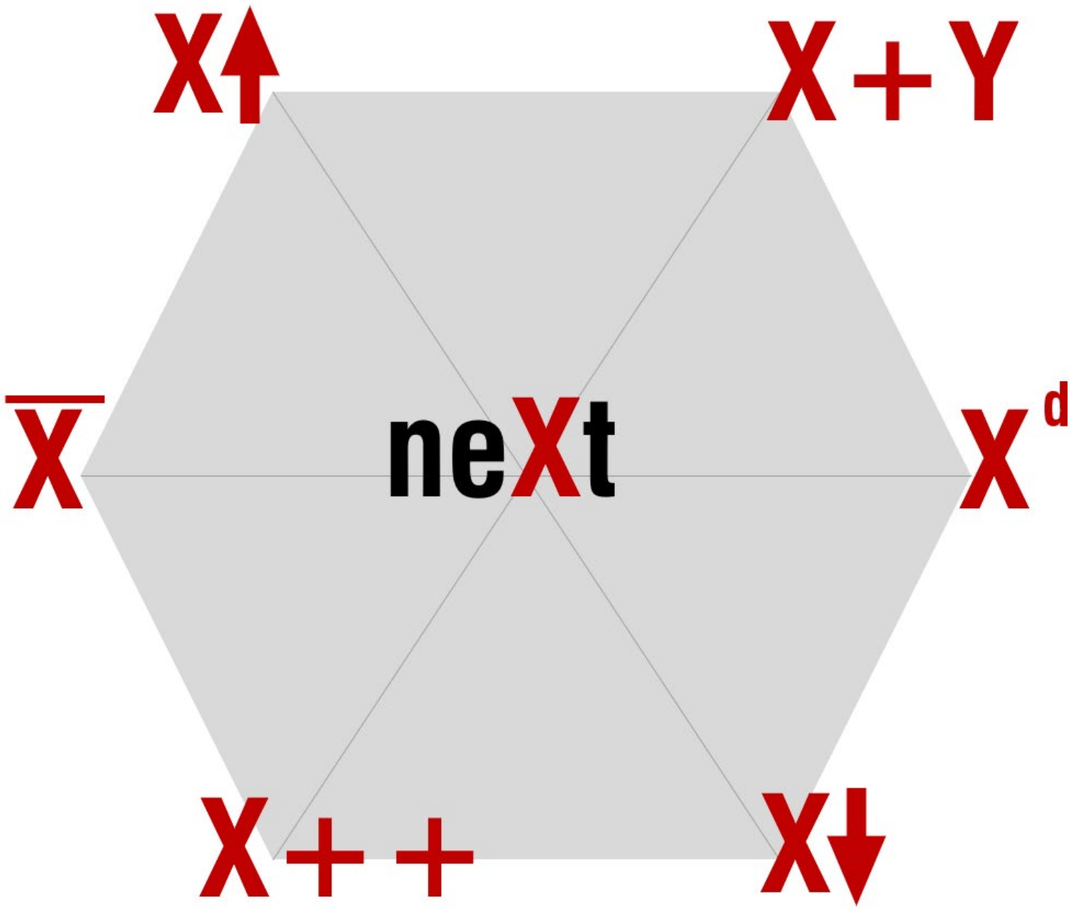
[Ishii at UIST’11]

great project:

1. **novel** = not done

2. **important** = future people will say “this matters to us”

3. **something you can do** = you have/can acquire the skills



Try this for your next class project / start up / research

Based on Prof. Stefanie Mueller's slides.

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