Announcement

Final Exam –

Date: Fri, Dec. 13, 4pm - 6pm

Location: Online

Open book: laptop and digital material – Yes; Chat/ChatGPT/LLM based tools – No

Final Milestone Presentation –

Date: Dec 9th 3:30pm - 5:00pm (Be there at least 15 min ahead of time to setup your 'booth')

Location: Sandbox

Live Demo! Bring your setup to Sandbox early, and prepare to give a live demonstration, walkthrough key features/iterations you've made throughout the semester.

Final Milestone Summary –

Date: Dec 15 EOD (Sun)

Format: 2 options.

1) Online https://www.hackster.io/smartlab/projects with Documentation + simple video.

2) UIST paper format. https://uist.acm.org/2024/author-guide/

More details on ELMS.

Team Eval Survey –

Date: Dec 15 EOD

https://forms.gle/TtPvygMeq9VXvVPs5

Accessibility

CMSC730 | Huaishu Peng | Fall 2024

Accessibility

Impairment

Disability

Usability

Inclusive Design

Universal Design

Assistive Technology

What is accessibility?

- **Definition of Usability**: The effectiveness, efficiency, and satisfaction with which a specified set of users can achieve a specified set of tasks in a particular environment. – ISO 9241-11

- **Definition of Accessibility**: The usability of a product, service, environment, or facility by people with the widest range of capabilities. – ISO 9241-20

How is accessibility related to disability?

- *Accessibility* is the extent to which an interactive product is accessible to as many people as possible.
- The primary focus of accessible design is making systems accessible to individuals with *disabilities*.

What are key challenges regarding accessibility?

Risks	Description
Inaccessible devices/services	Devices or services that cannot be used by people with special needs, even if they have adequately adapted equipment
Loss of privacy	When personal information stored and/or transmitted without the authorization of the user
Loss of autonomy	When decisions about the user are taken by others instead of the user or the person(s) authorized by the user
Economic factors	Devices and services out of the financial capability of the users because excessive technology is used
Invasive and/or socially unacceptable location systems	Systems for personal location that invade personal freedom and/or devices for location that are socially unacceptable

Abascal & Nicolle, 2005, Moving towards inclusive design guidelines for socially and ethically aware HCI

What is disability?

- **Definition**: A disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions).
- Disability can change over time with age or recovery, and the severity of the impact of disability can change over time.
- Fewer than 20% are born with a disability, although 80% of people will have a disability once they reach 85.

CDC

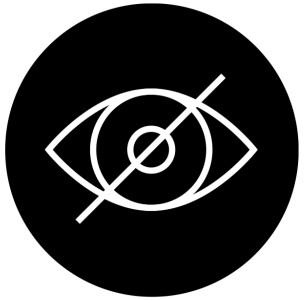
Three Dimensions of Disability

- **Impairment** in a person's body structure or function, or mental functioning (e.g., loss of a limb, loss of vision, or memory loss)
- **Limitation in activities** (e.g., difficulty seeing, hearing, walking, or problem solving)
- **Restrictions in participation** in activities of daily living (e.g., working, engaging in social and recreational activities, and obtaining health care)

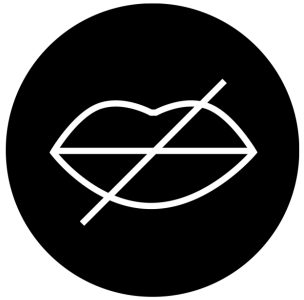
World Health Organization

Types of Impairments:

- **Sensory Impairment**: involves impairment in one or more senses, such as loss of vision or hearing.
- **Physical Impairment**: Involves loss of function to one or more parts of the body, e.g., congenitally or after stroke or spinal-cord injury.
- **Cognitive Impairment**: Includes cognitive deficits, such as learning impairment or loss of memory/ cognitive function due to aging or conditions such as Alzheimer's disease.



Can't see



Can't speak

Can't hear

Can't touch

[Microsoft Inclusive Design Toolkit]

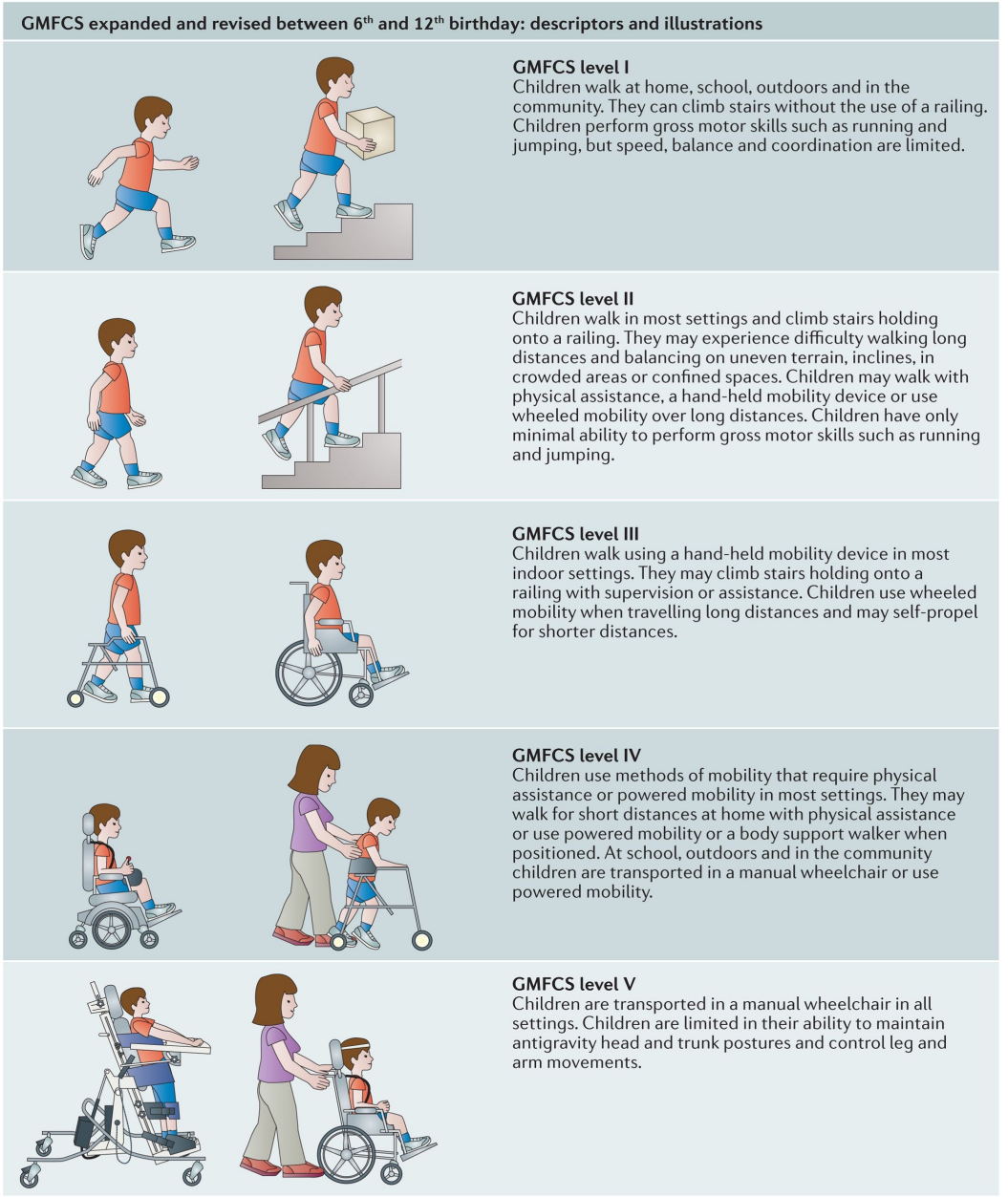
What are some common impairments?

- **Visual Disabilities**: Vision impairments, including blindness and low vision
- **Motor/Mobility**: Muscular or skeletal impairments in the hands, arms, or the whole body that affect user and mobility, e.g., users are in a wheelchair or bedridden.
- **Auditory**: Hearing deficits differing in severity, e.g., deafness.
- **Seizures**: Neurological impairments, e.g., photosensitive epilepsy, that result in sensitivity to light, motion, and flickering and trigger seizures.
- **Cognitive/Learning**: Limitations in mental functioning or in skills such as communication, self-help, and social skills, e.g., autism, ADHD, dyslexia

How do impairments vary?

- Impairments can vary in severity or structure depending on the source and nature of the impairment.
- **Severity**: Children with cerebral palsy can have basic mobility or completely depend on caretaker
- **Structure**: vision impairments can include central vision loss, peripheral vision loss, extreme light sensitivity, etc.

[Gross Motor Function Classification System (GMFCS)]



Cataract

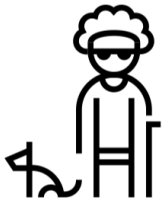
Age Related Macular Degeneration

Diabetic Retinopathy

Glaucoma

Are impairments permanent?

- **Permanent Impairment**: Congenital or long-term conditions, such as blindness, missing body parts, etc.
- **Temporary Impairment**: Impairments that improve over time, such as recovery after illness or accidents, e.g., a broken arm.
- **Situational Impairment**: Impairments introduced by context, such as environments with low light or noise.

	Permanent	Temporary	Situational
Touch	 One arm	 Arm injury	 New parent
See	 Blind	 Cataract	 Distracted driver
Hear	 Deaf	 Ear infection	 Bartender
Speak	 Non-verbal	 Laryngitis	 Heavy accent

How do we improve accessibility?

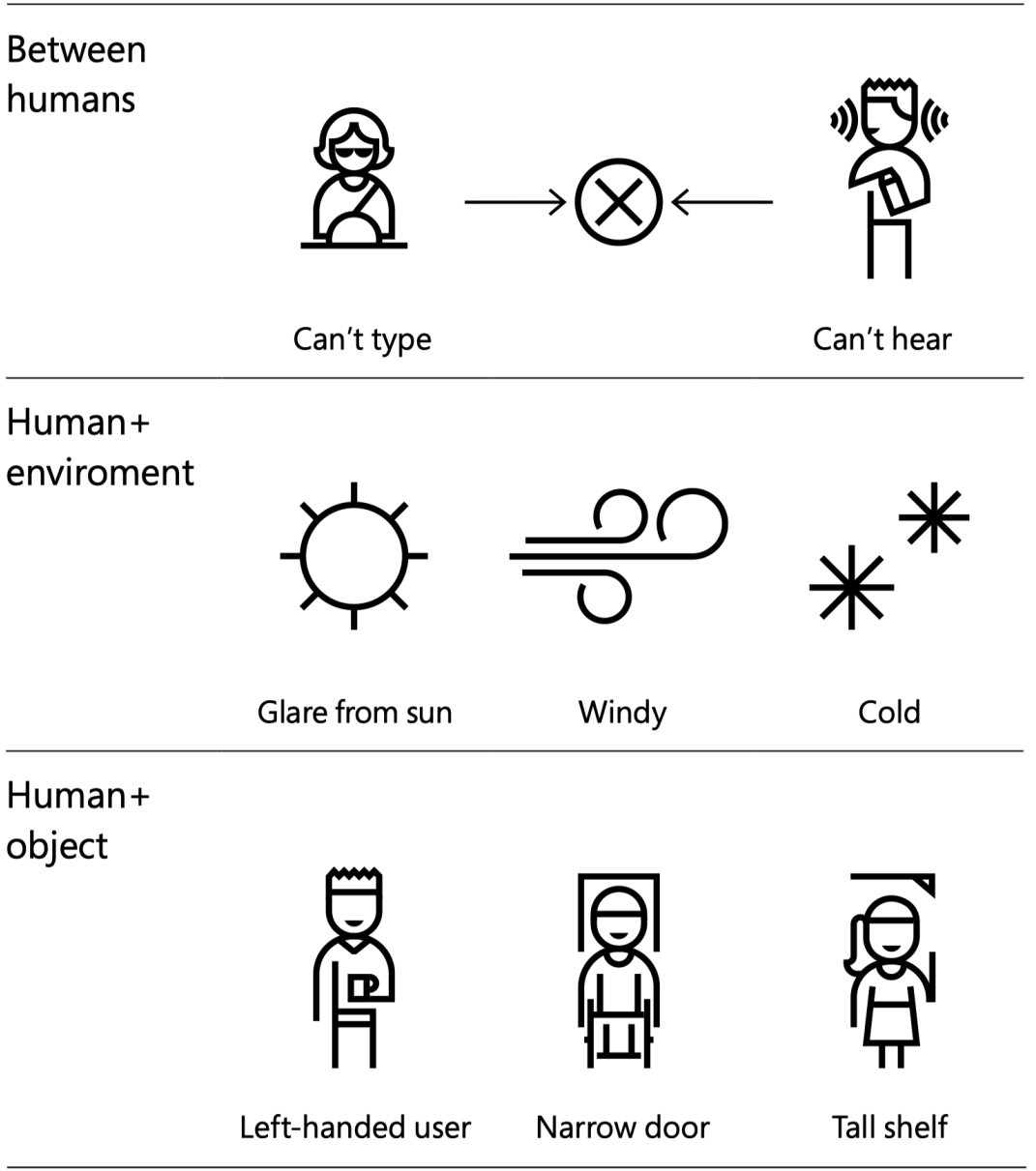
- Two ways to address accessibility problems:
  - Universsal design
  - Assistive technologies

Social model of disability

Disability as **context dependent**:

- People are disabled by barriers in society, not by their impairments or differences.
- Context-dependent disability results from a mismatch between abilities and the environment:

$$\text{Ability} + \text{Context} => \text{Disability}$$



Shakespeare, Tom. "The social model of disability." The disability studies reader 2 (2006): 197-204.

Universal design

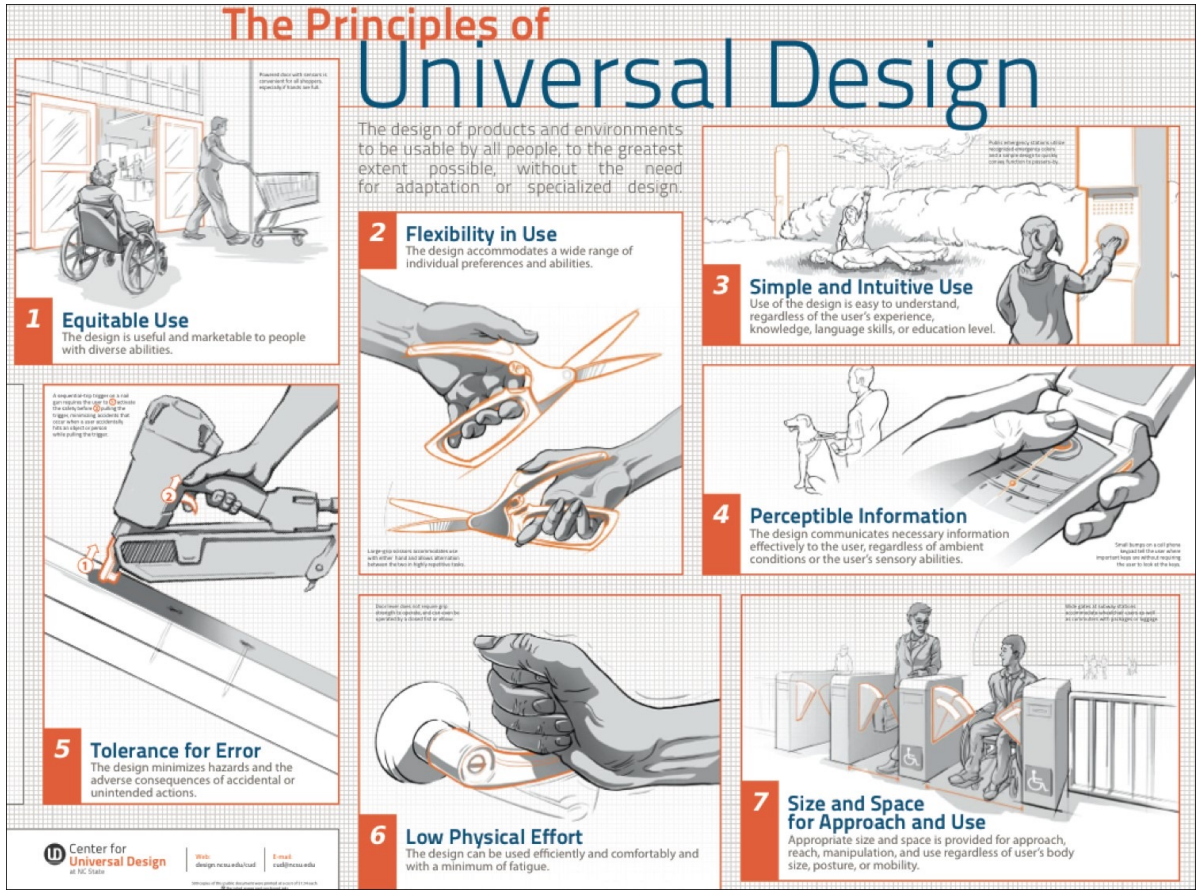
- **Definition**: The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.
- **The main premise**: Design solutions that benefit some individuals may benefit the whole society. E.g., in the US, only 26K people suffer loss of upper extremities. Designs that would benefit these 26K would also benefit another 21M people with temporary or situational disabilities.

Ron Mace, 1996

- **Closed Captioning**: Although closed captioning was originally developed for individuals with hearing impairments, they now also benefit reading in noisy environment and learning to read.

How do you do universal design?

- Equitable use
- Flexibility in use
- Simple and intuitive use
- Perceptible information
- Tolerance for error
- Low physical effort
- Size and space for approach and use

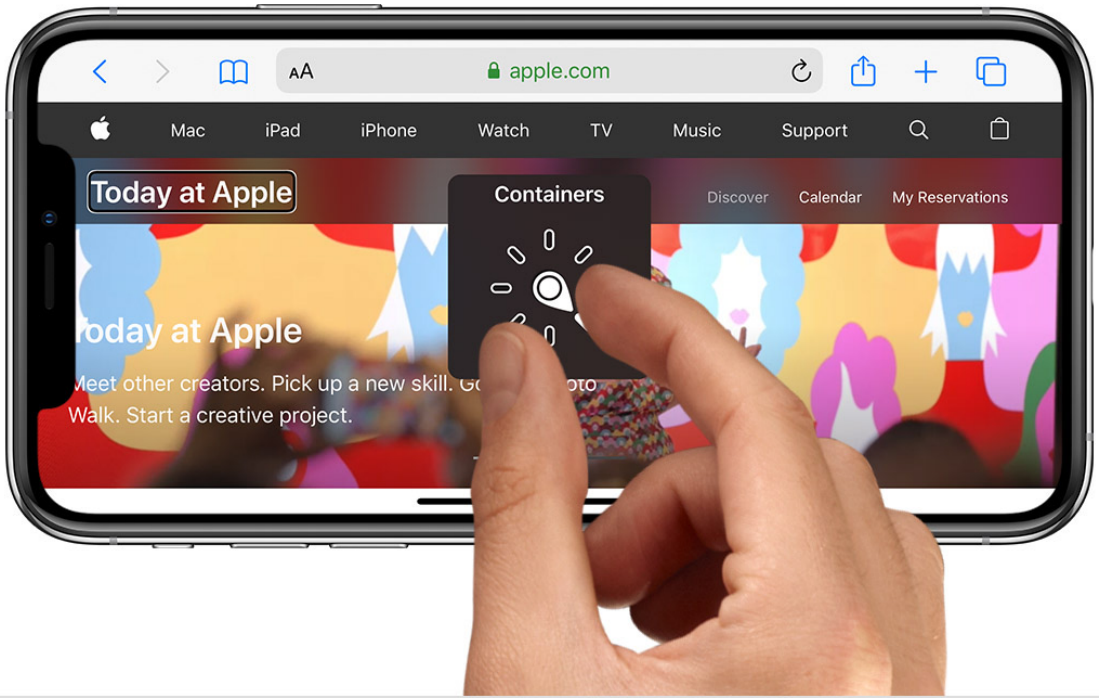


[Interaction Design Foundation]

What are assistive technologies?

- Definition: Specialized tools that close accessibility gaps.

Screen Reader: Software used by individuals with vision impairments to read screen content, e.g., VoiceOver in iOS.



Screen Magnifier: Enlarges text or graphics on screens to improve visibility of content for individuals with limited vision

Text Reader: Tools that read out loud text on screens to support vision and learning disabilities

Braille display: A mechanical device that translates textual content on the screen into Braille

Alternative Input Devices: Tools that help users with motor impairments who cannot use a mouse or keyboard with pointing. E.g., motion/eye tracking.

Alternative & Augmentative Communication: Tools that help individuals who are unable to use verbal speech to communicate.

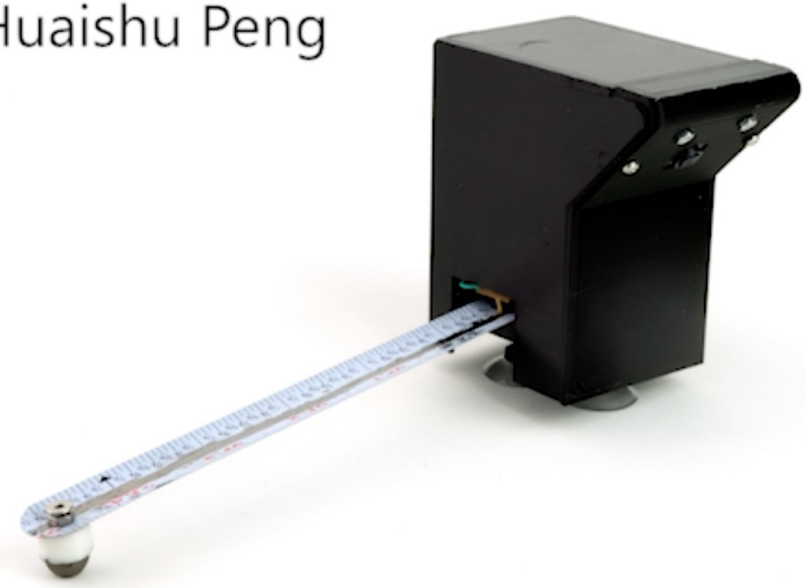
What is the research space like?

- Understanding people with disabilities
- Designing technologies for people with disabilities

Toucha11y

Making Inaccessible Public Touchscreen Accessible

Jiasheng Li, Zeyu Yan, Arush Shah, Jonathan Lazar, Huaishu Peng
University of Maryland, College Park

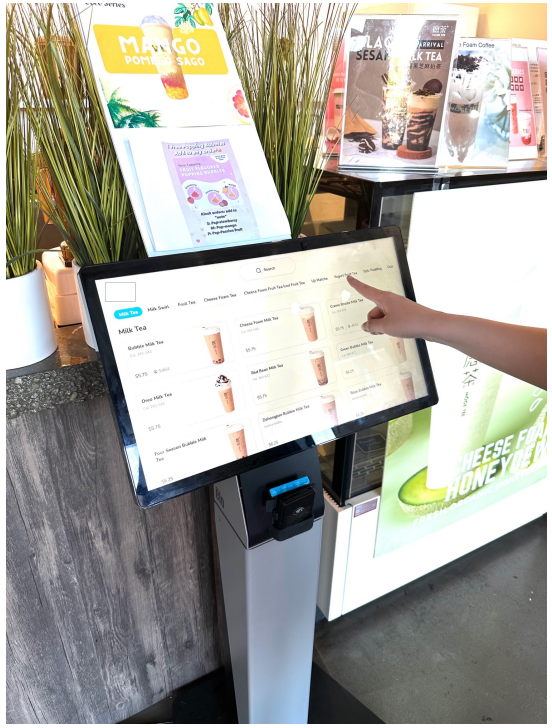


SMALL _ARTIFACTS LAB;

UNIVERSITY OF MARYLAND

Touchscreen devices in public areas

Printing kiosk (2018)



Food order kiosk (2021)

Soda vending machine (2022)

Vending machine (2023)

(Photos are taken in April 2023)

Formative study

(Semi-structured interview)

- Nine blind participants
- Interview last 30 minutes
- Sample questions:
  - Do you have any experience with touchscreen devices in public spaces?
  - Can you give one or two recent examples of the tasks you completed using the devices?

Formative study

(Semi-structured interview)

Findings:

- The common practice: seek assistance or not to use at all
- Two barriers:
    1. hard to identify the kiosks are accessible or not
    2. Uncleared instructions make more difficult to use
- Privacy concerns: assistance from unknown people

Formative study

(Semi-structured interview)

Findings:

- The common practice: seek assistance or not to use at all
- Two barriers:
  1. hard to identify the kiosks are accessible or not
  2. Uncleared instructions make more difficult to use
- Privacy concerns: assistance from unknown people

> "I was told that the ATM was accessible, so I wanted to give it a chance...
> ...there was no clear instruction on how to do it after I plugged in the headphones."

Formative study

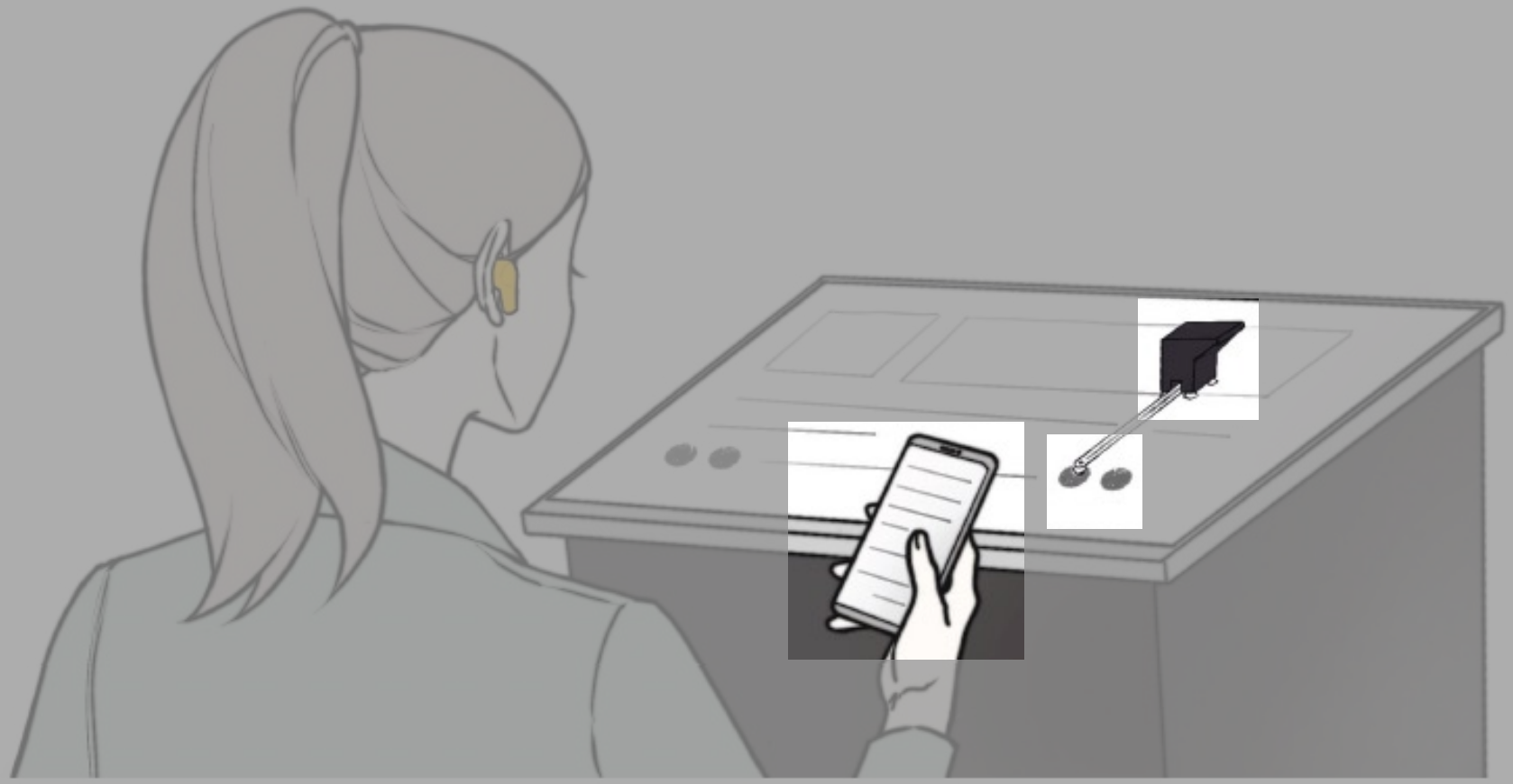
(Semi-structured interview)

Findings:

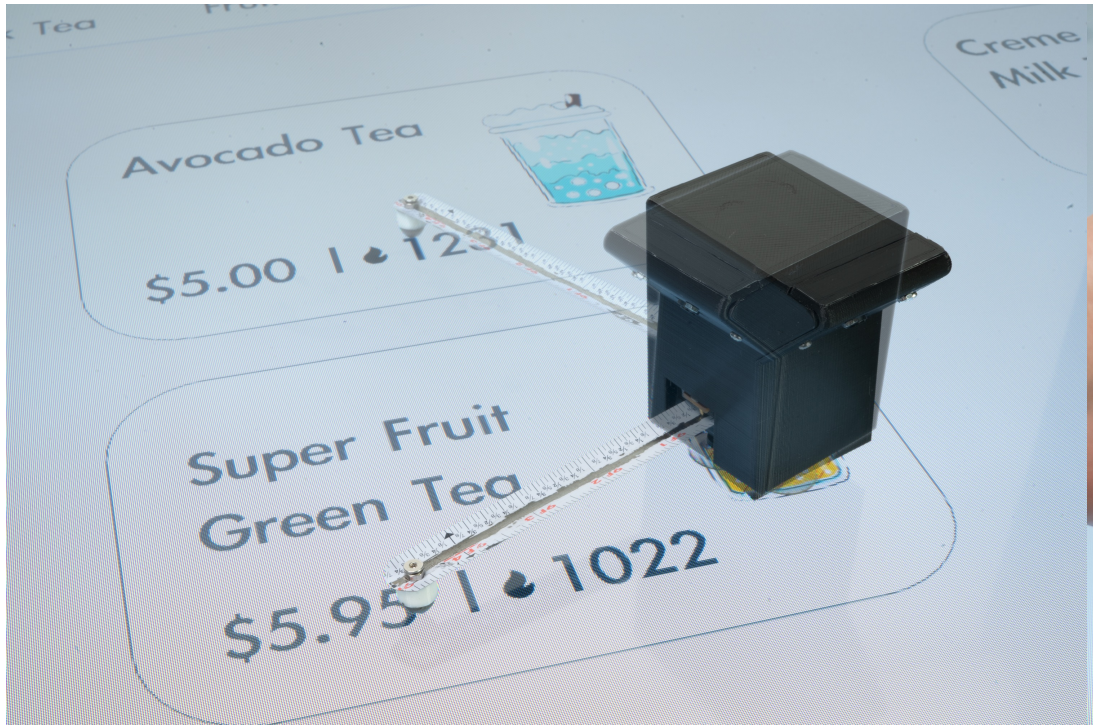
- The common practice: seek assistance or not to use at all
- Two barriers:
  1. hard to identify the kiosks are accessible or not
  2. Uncleared instructions make more difficult to use
- Privacy concerns: assistance from unknown people

> "There was a kiosk to let people register in the Social Security Office,… I had to find someone on-site to help me, and I needed to tell them my social security number, which I didn't wish to do."

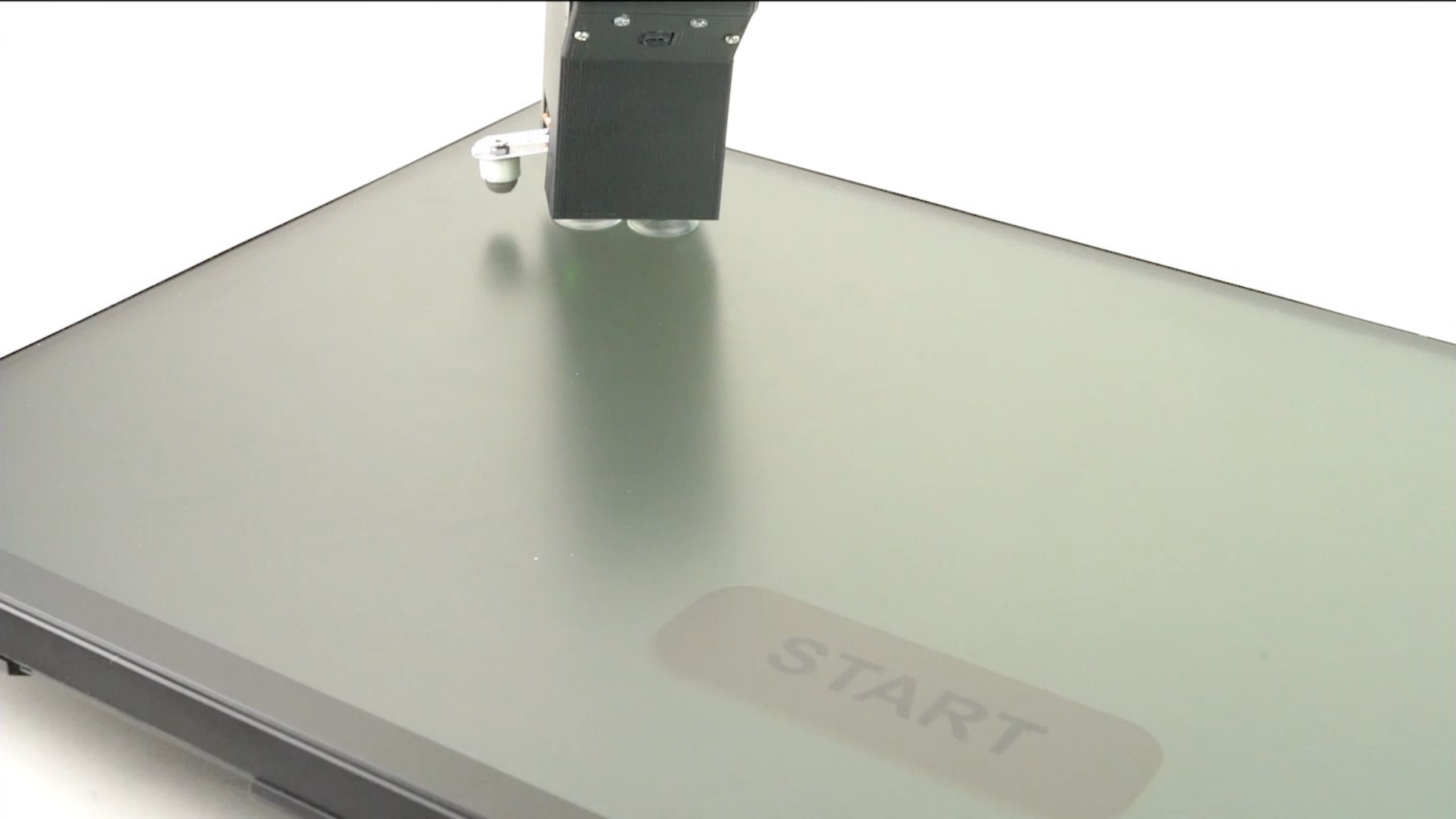
What are the solutions?



Toucha11y


Tea
Creme
Milk
Avocado Tea
$5.00 | 1251
Super Fruit
Green Tea
$5.95 | 1022


Cheese Foam Fruit Tea
famous innovative tea
Black Grape Tea
Avocado Tea
Mango Tea
Berry Tea
Red Dargon Tea
Pineapple Tea
screen-bot-proj.herokuapp.com
$5.95 | 1022


START

Popular Cheese Foam Fruit Tea Milk Tea Fruit Tea Fruit Yakult Milk Sw

Mango Tea

$5.95 | 1731

Avocado Tea

$5.00 | 1231

Crem ee Milk Tea

$5.00 | 1931

Strawberry Tea

$5.95 | 957

Super Fruit Green Tea

$5.95 | 1022

2:45

SMart Tea

Welcome to Smart Tea cafe

Popular

Try our popular innovative tea

Mango Tea

Add

Avocado Tea

Add

Creme Brulee Milk Tea

Add

Strawberry Tea

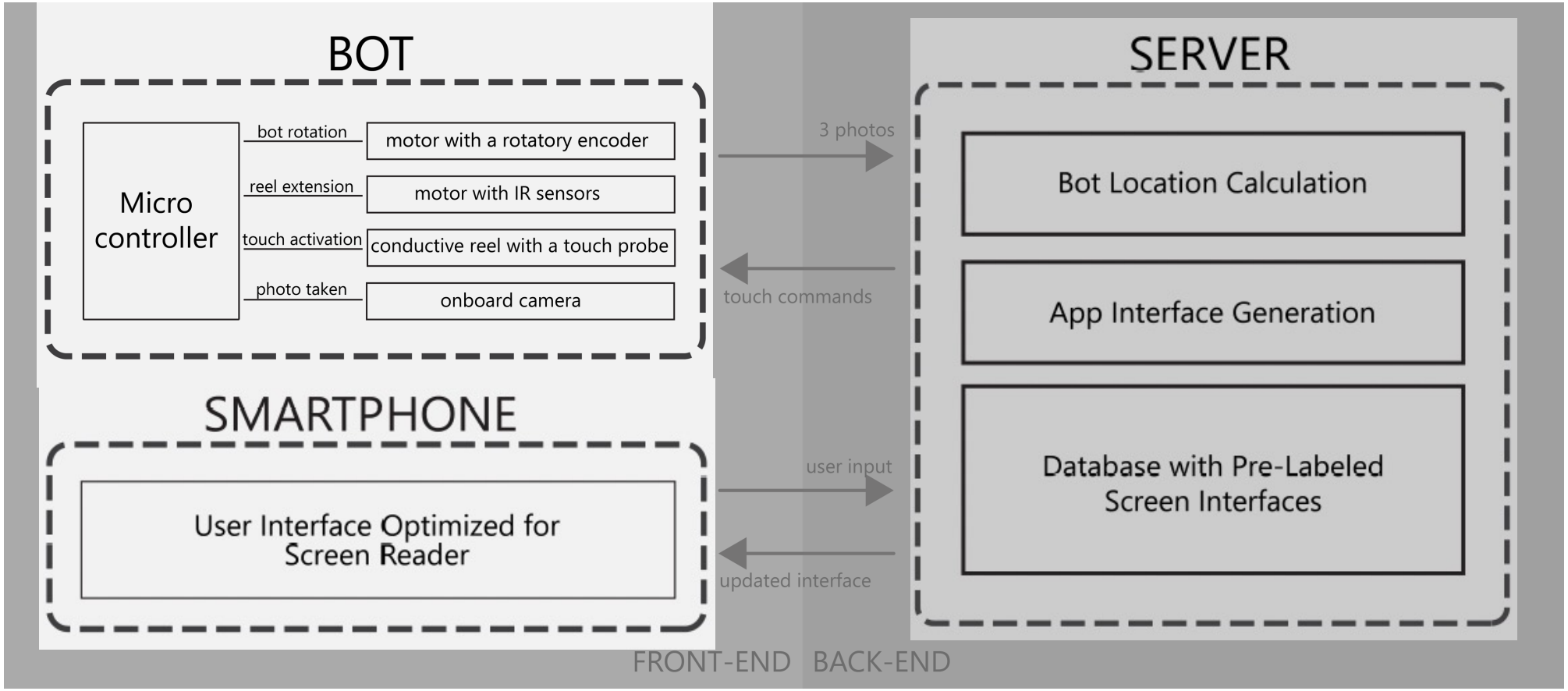
Add

Super Fruit Green Tea

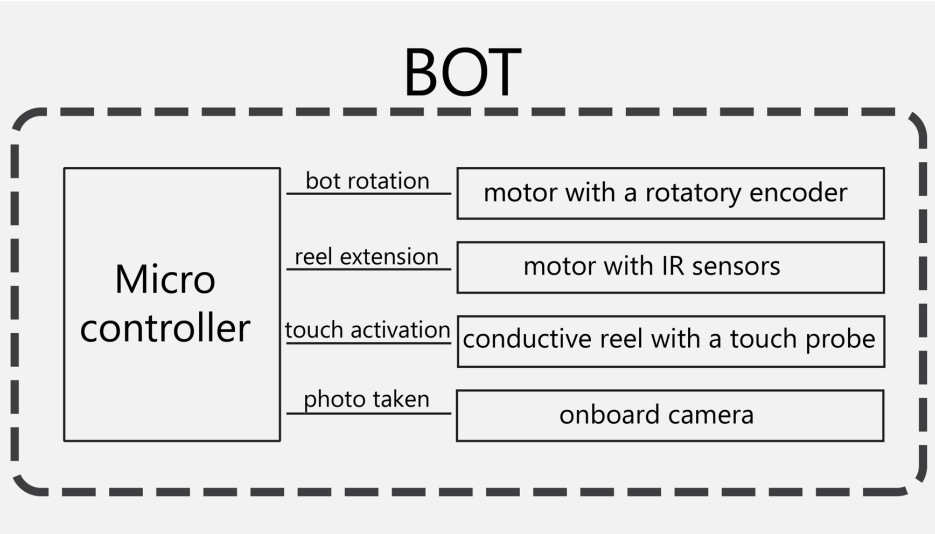
Add

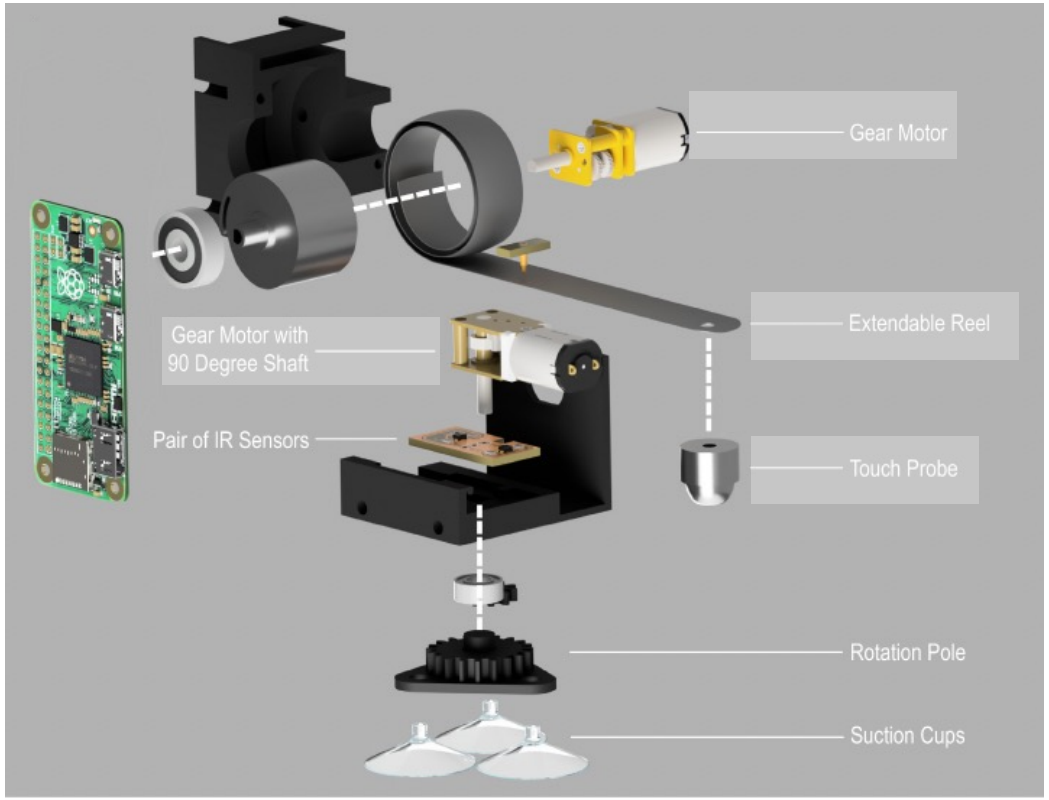
AA n-bot-proj.herokuapp.com

Toucha11y system



Toucha11y system





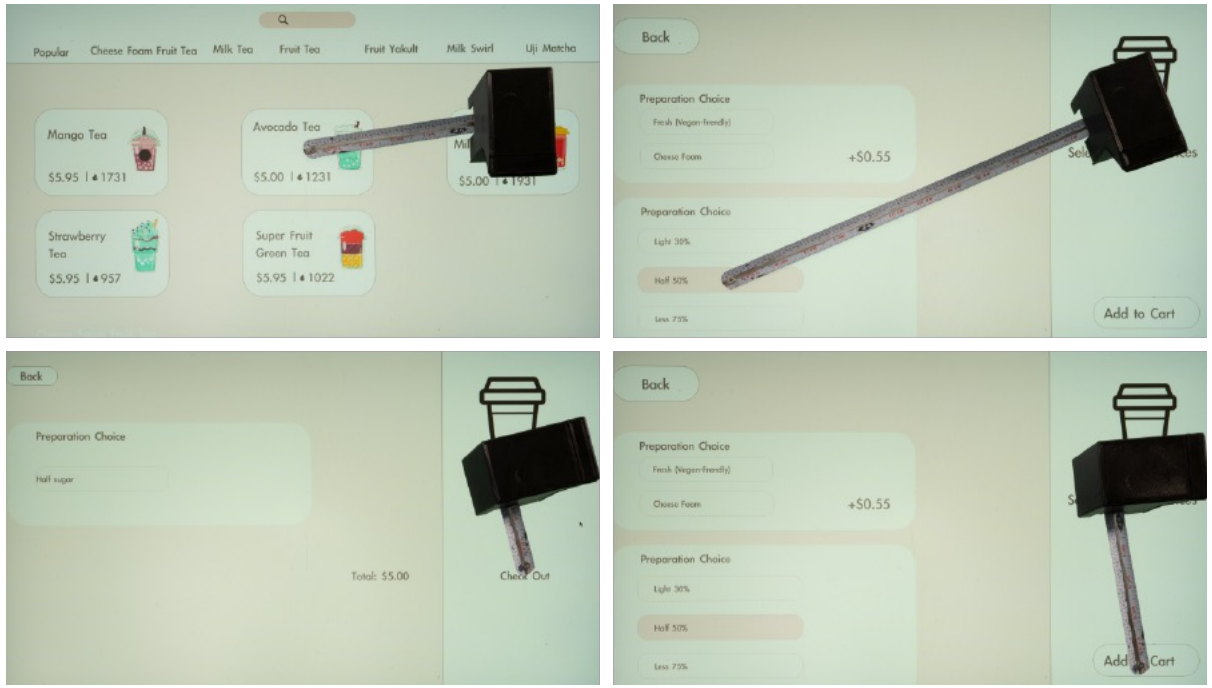
- Size: 50*70*93 mm
- Weight: 162.53 g
- Reel length: 700 mm

Technical evaluation

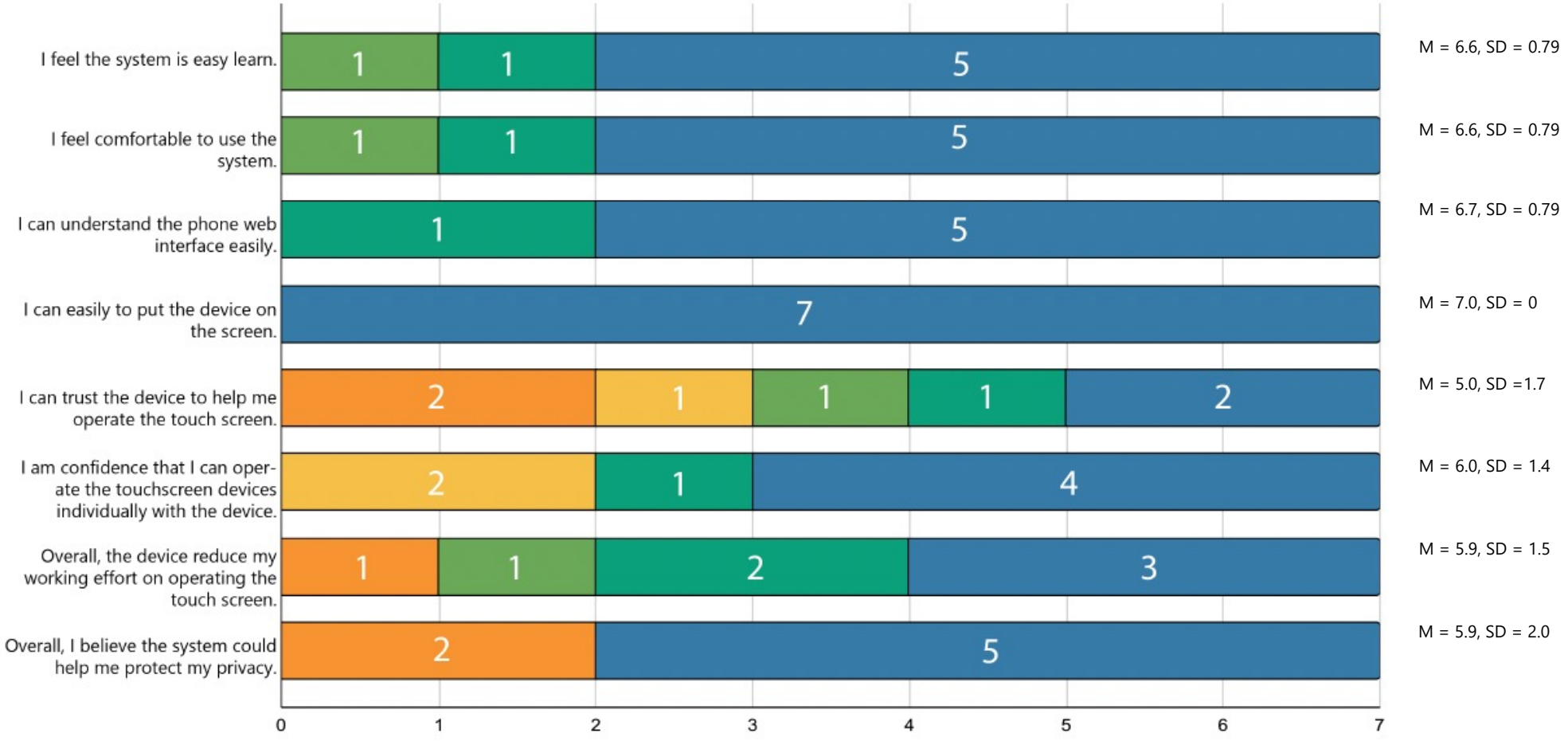
- Location accuracy
  - The average error is 6.5 mm.
- Rotation accuracy
  - The average error is 0.66 degrees.
- Extension accuracy
  - The average error is 3.052 mm.

User study

- Participants:
  - Seven participants (1 male, 6 female)
- Vision condition:
  - 2 low vision & 5 blind
- Task procedure:
  1. Place the Toucha11y robot on the touchscreen
  2. Find the correct tea options from their smartphones.
  3. Choose the sugar level on their smartphones.
  4. Confirm the order detail and complete the transaction.



User study


I feel the system is easy learn.
1
1
5
M = 6.6, SD = 0.79
I feel comfortable to use the system.
1
1
5
M = 6.6, SD = 0.79
I can understand the phone web interface easily.
1
5
M = 6.7, SD = 0.79
I can easily to put the device on the screen.
7
M = 7.0, SD = 0
I can trust the device to help me operate the touch screen.
2
1
1
1
2
M = 5.0, SD =1.7
I am confidence that I can oper-ate the touchscreen devices individually with the device.
2
1
4
M = 6.0, SD = 1.4
Overall, the device reduce my working effort on operating the touch screen.
1
1
2
3
M = 5.9, SD = 1.5
Overall, I believe the system could help me protect my privacy.
2
5
M = 5.9, SD = 2.0
0
1
2
3
4
5
6
7

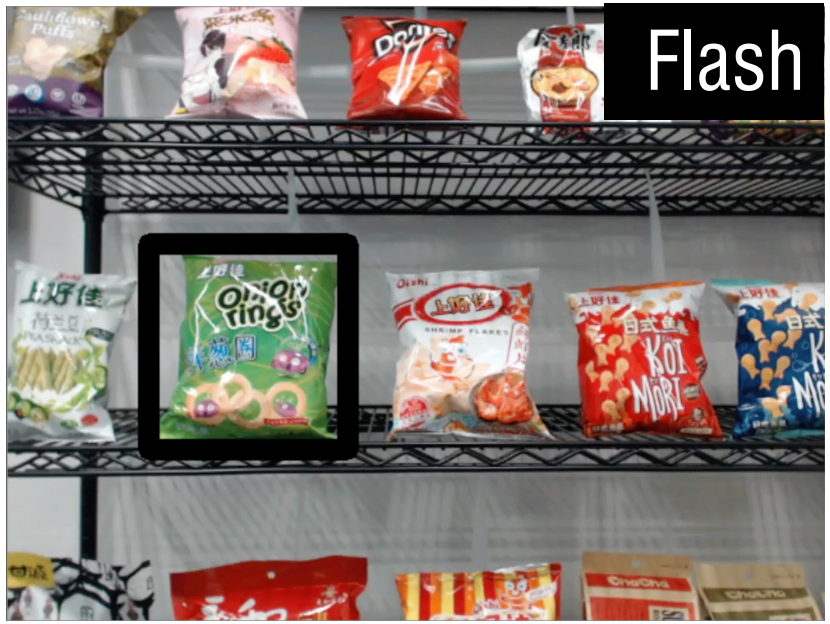
Visual search is extremely challenging for people with low vision and there were no aids that can help.

[Szpiro, Zhao, Azenkot, UbiComp'16a]

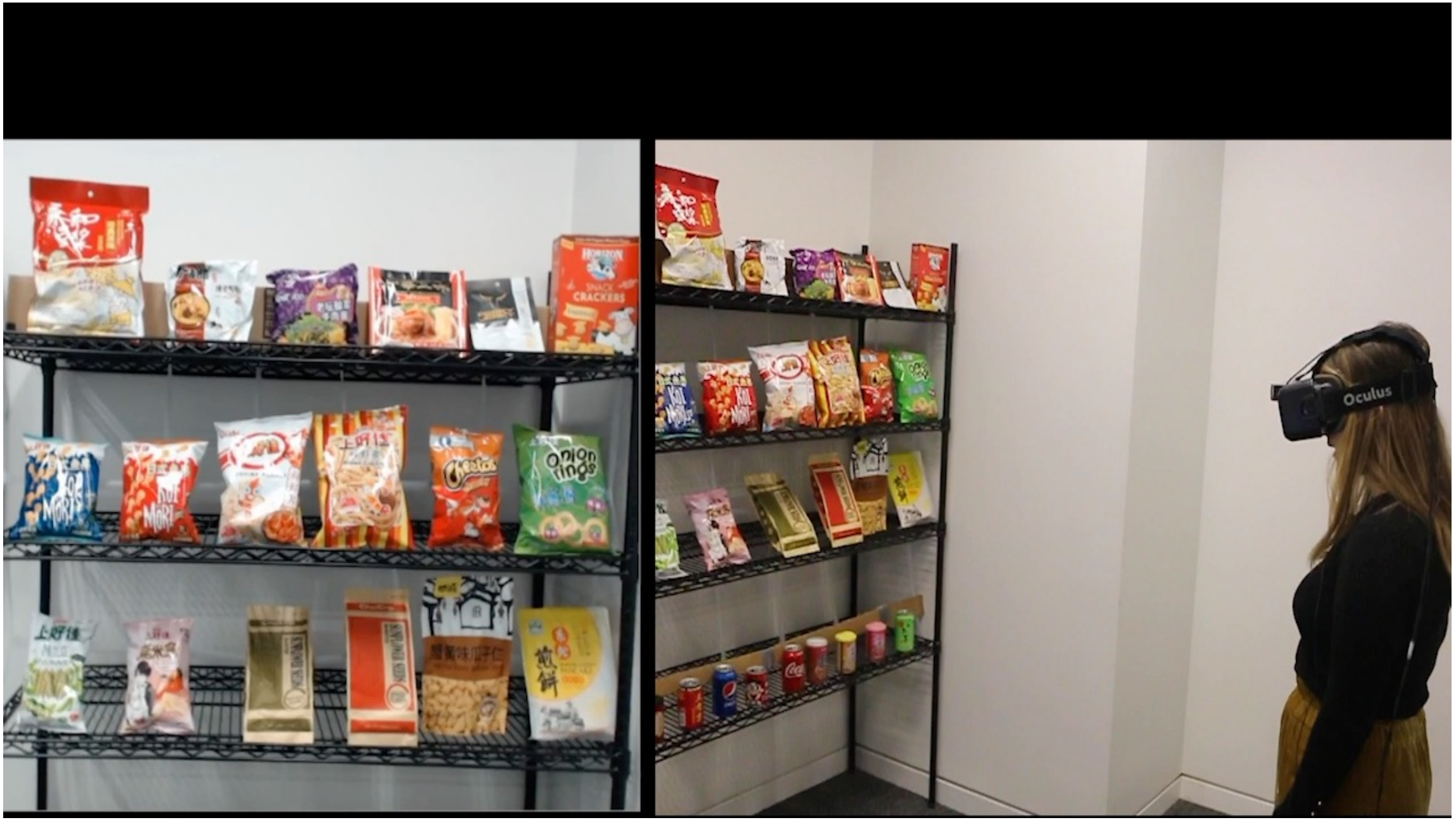

Guideline


Spotlight


Sunrays


Flash


Movement


CRACKERS
onion rings
Oculus

What denomination is this bill?

(24s) 20
(29s) 20

Do you see picnic tables across the parking lot?

(13s) no
(46s) no

What temperature is my oven set to?

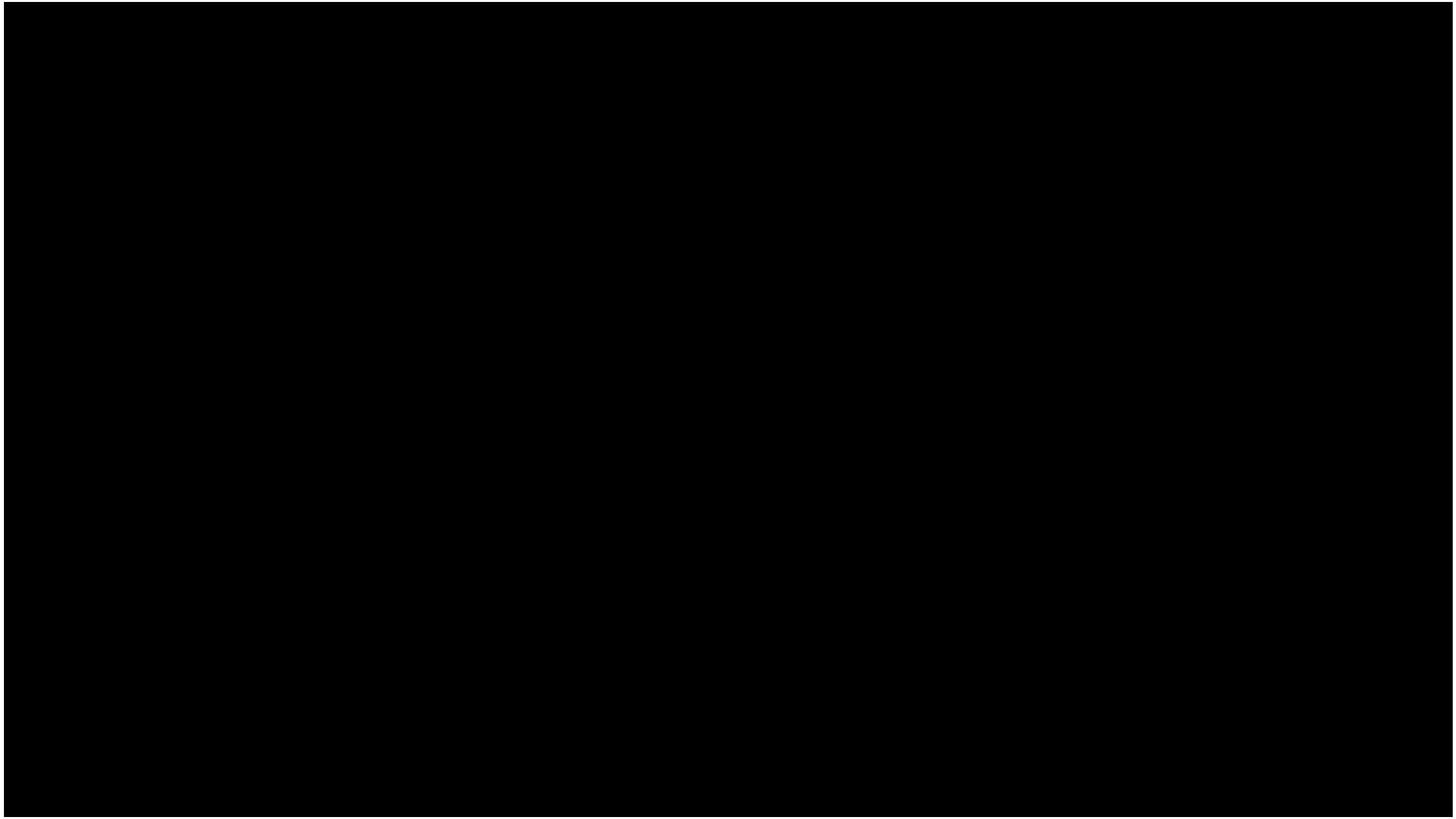
(69s) it looks like 425 degrees but the image is difficult to see.
(84s) 400
(122s) 450

Can you please tell me what this can is?

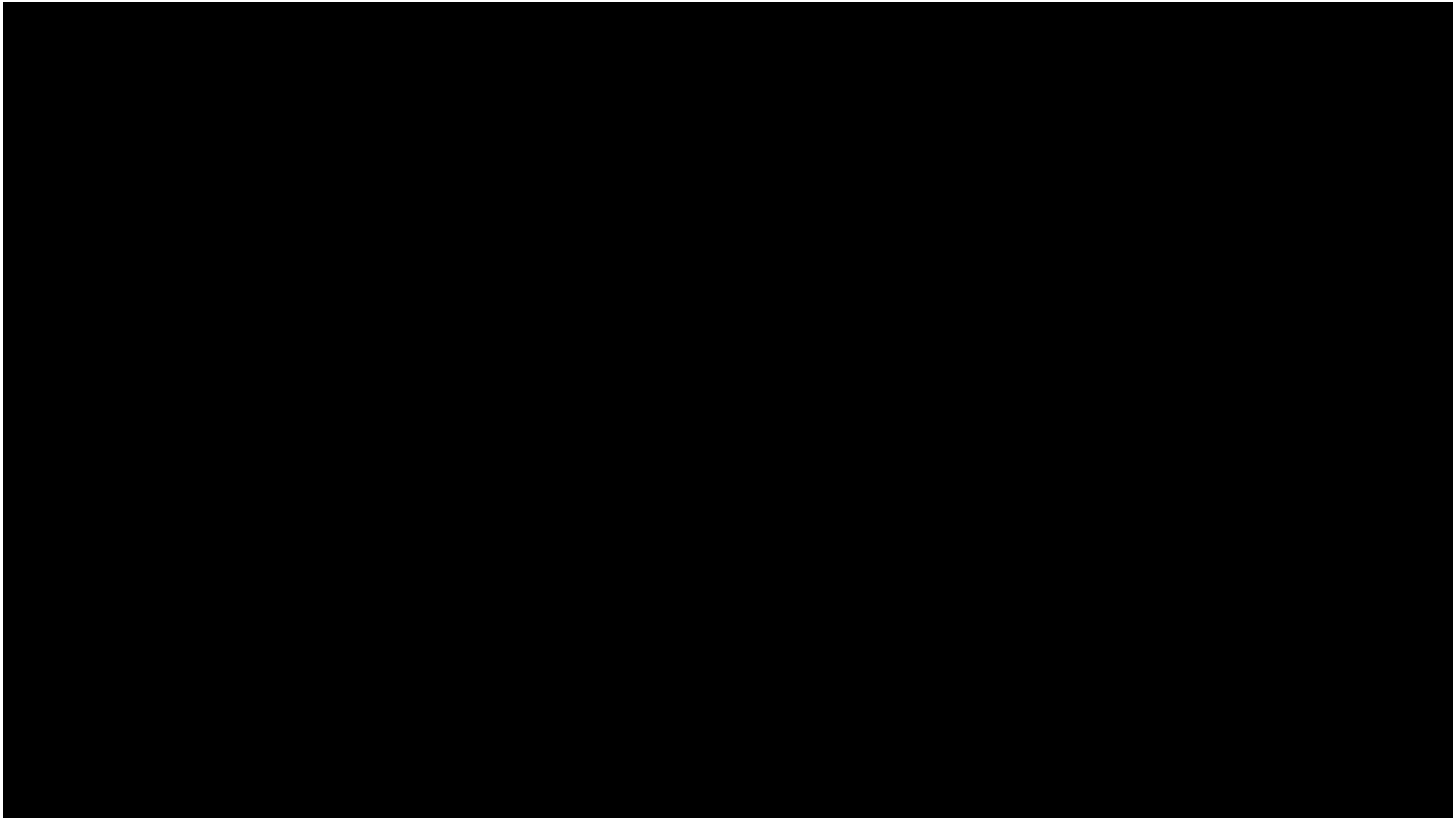
(183s) chickpeas.
(514s) beans
(552s) Goya Beans

Bigham, Jeffrey P., et al. "Vizwiz: nearly real-time answers to visual questions." UIST. 2010.

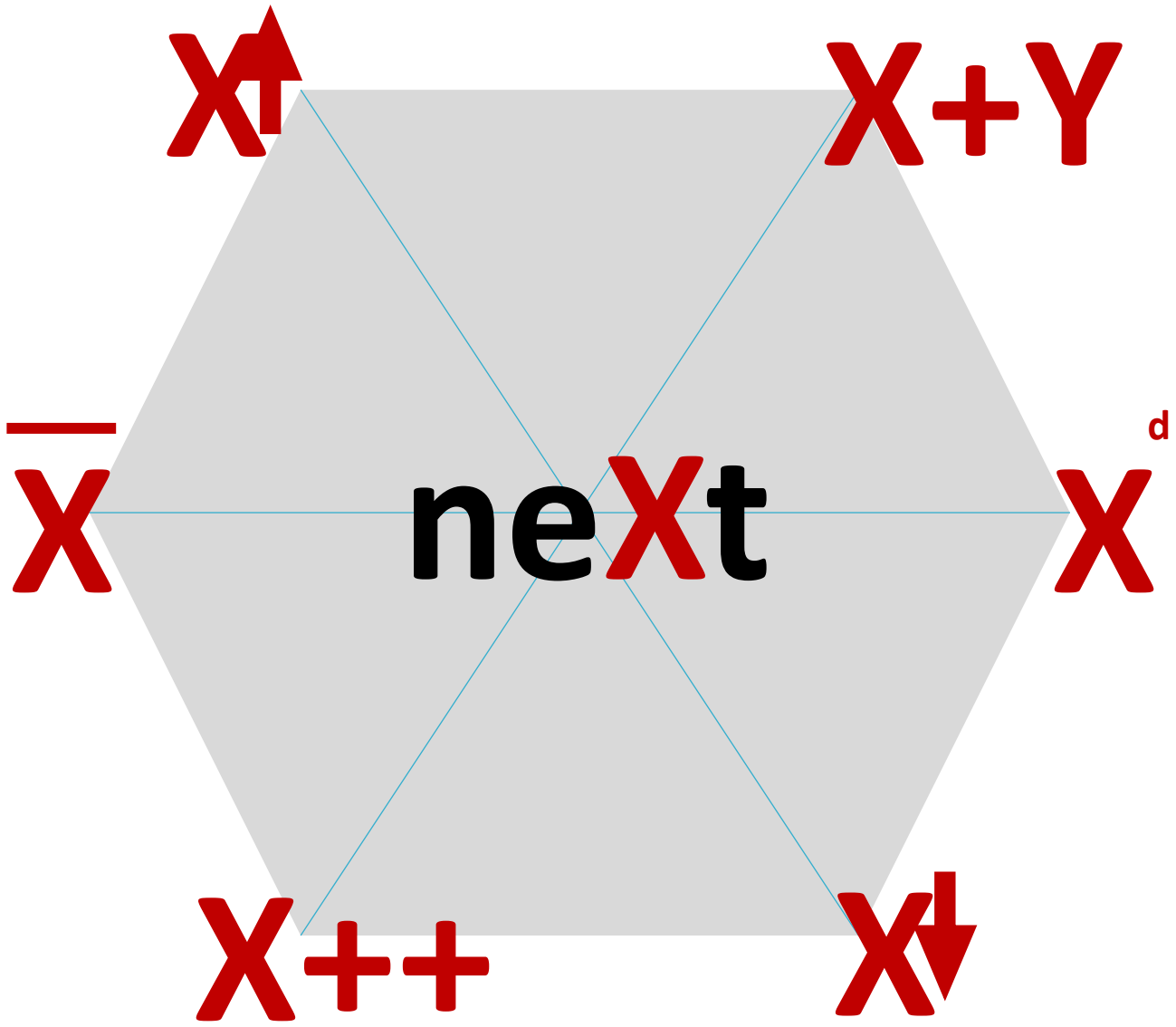
Jain et al. ”Head-Mounted Display Visualizations to Support Sound Awareness for the Deaf and Hard of Hearing." CHI. 2015.



ProgramAlly: Custom Visual Access Programs via Multi-Modal End-User Programming, UIST 2024



CookAR: Affordance Augmentations in Wearable AR to Support Kitchen Tool Interactions for People with Low Vision, UIST 2024



how to invent

Future Interactive Tech

what-if questions

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

565,601 views

5K 30 SHARE

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
No verified email
Homepage

Citation indices

	All	Since 2009
Citations	3887	776
h-index	21	12
i10-index	29	12

Citations to my articles

Show: 20 **1-20** Next >

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

‘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)

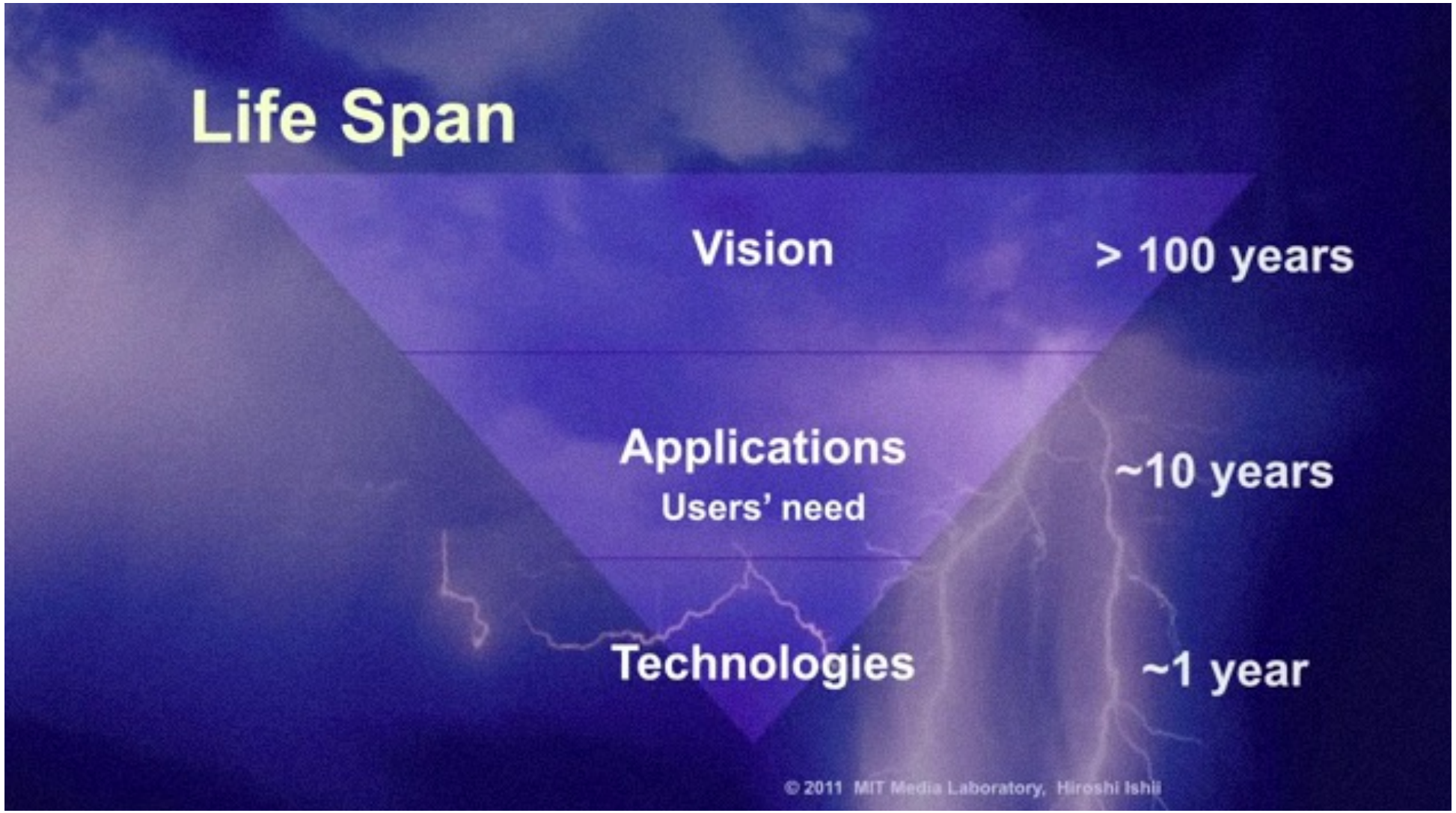
Article Talk

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

what-if vision questions are more important



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

ACM SIG CHI Lifetime Research Award

how to choose a what-if question?

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!)

some more selected what-if questions…

ubiquitous computing (1991):

what if a user had multiple computers/CPUs available?

The Computer for the 21st Century

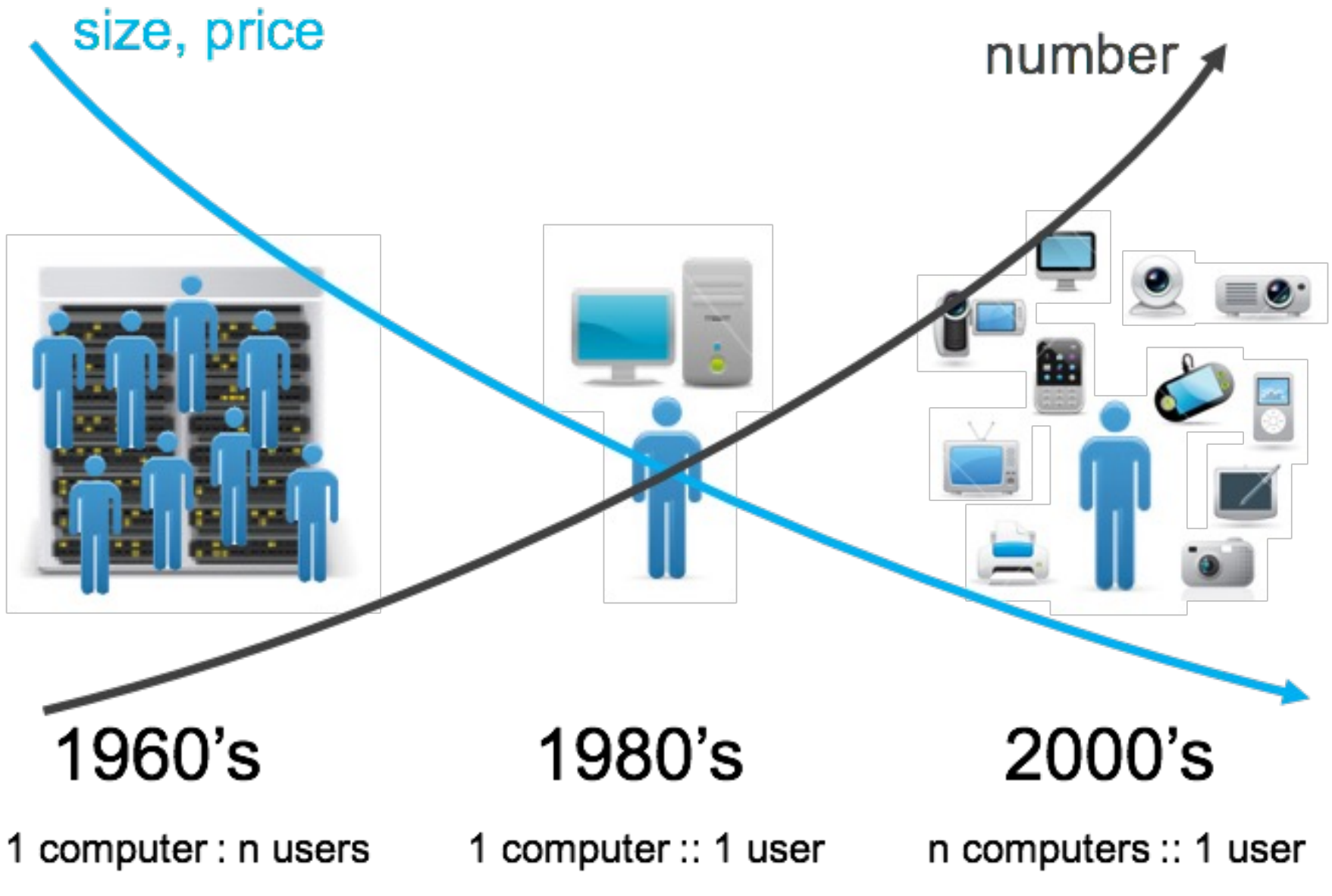
Mark Weiser 1991

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











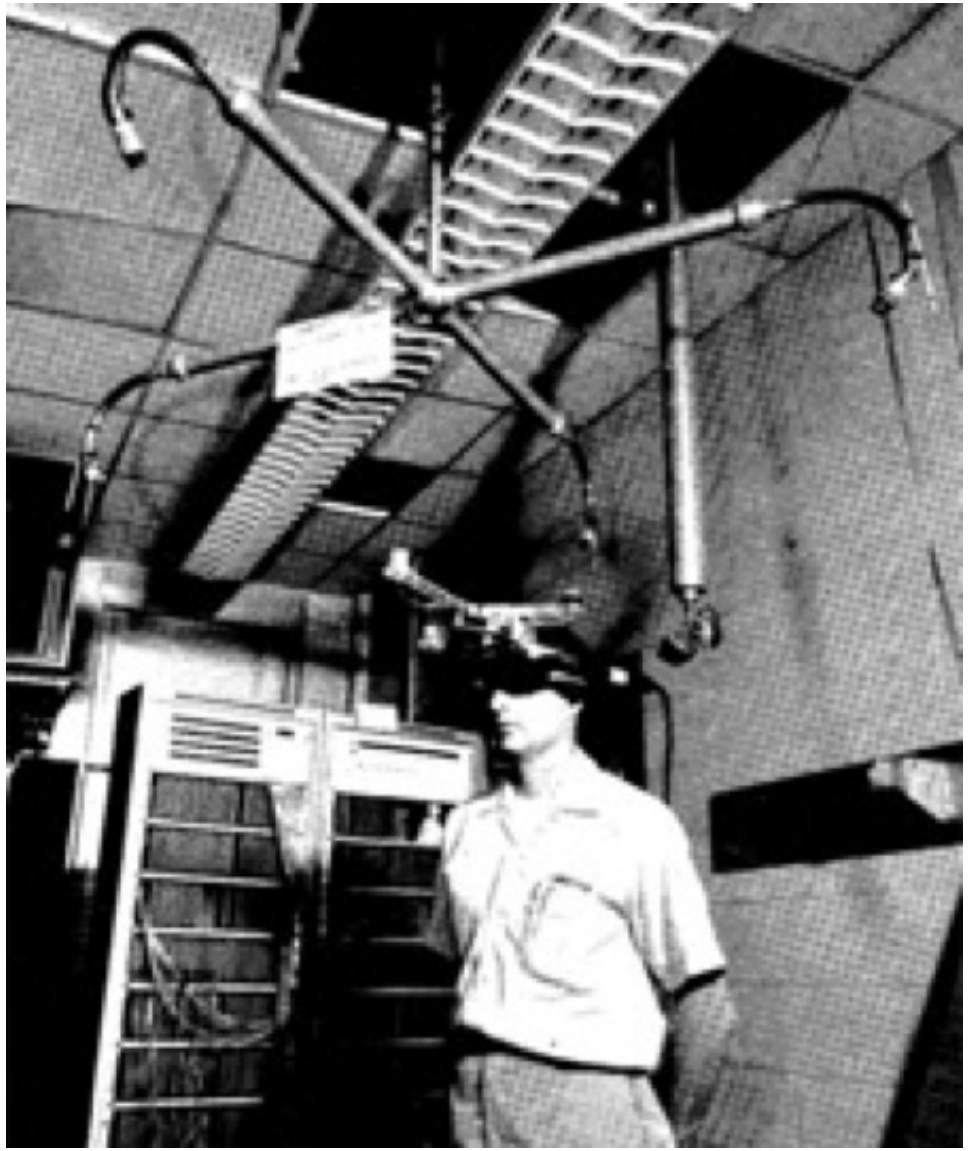



huc : 99

augmented reality (1968):

what if there was the perfect display

everywhere I look



tangible computing (1997):

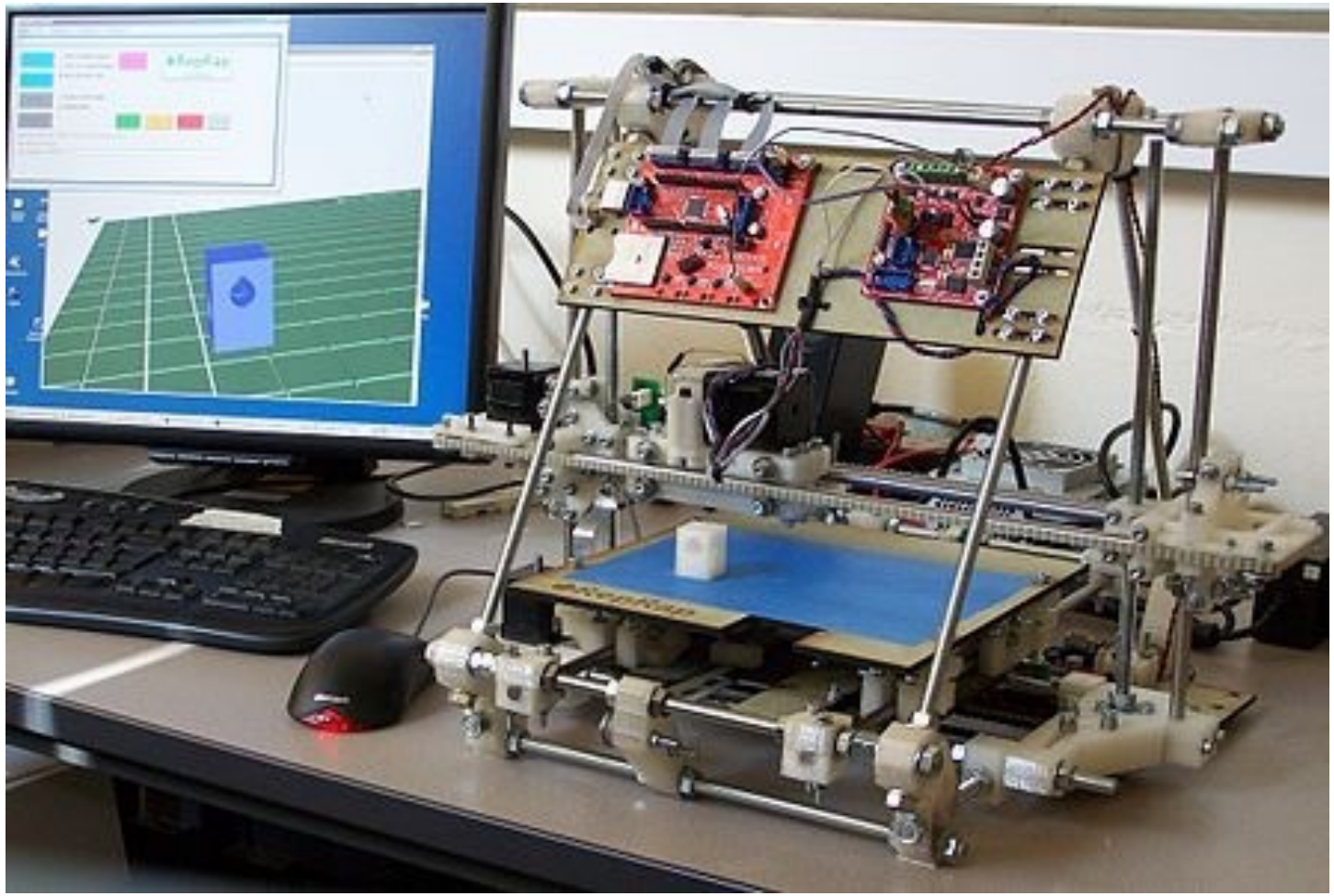
what if I operated stuff in the world not via a computer,
but by actually manipulating it?

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?



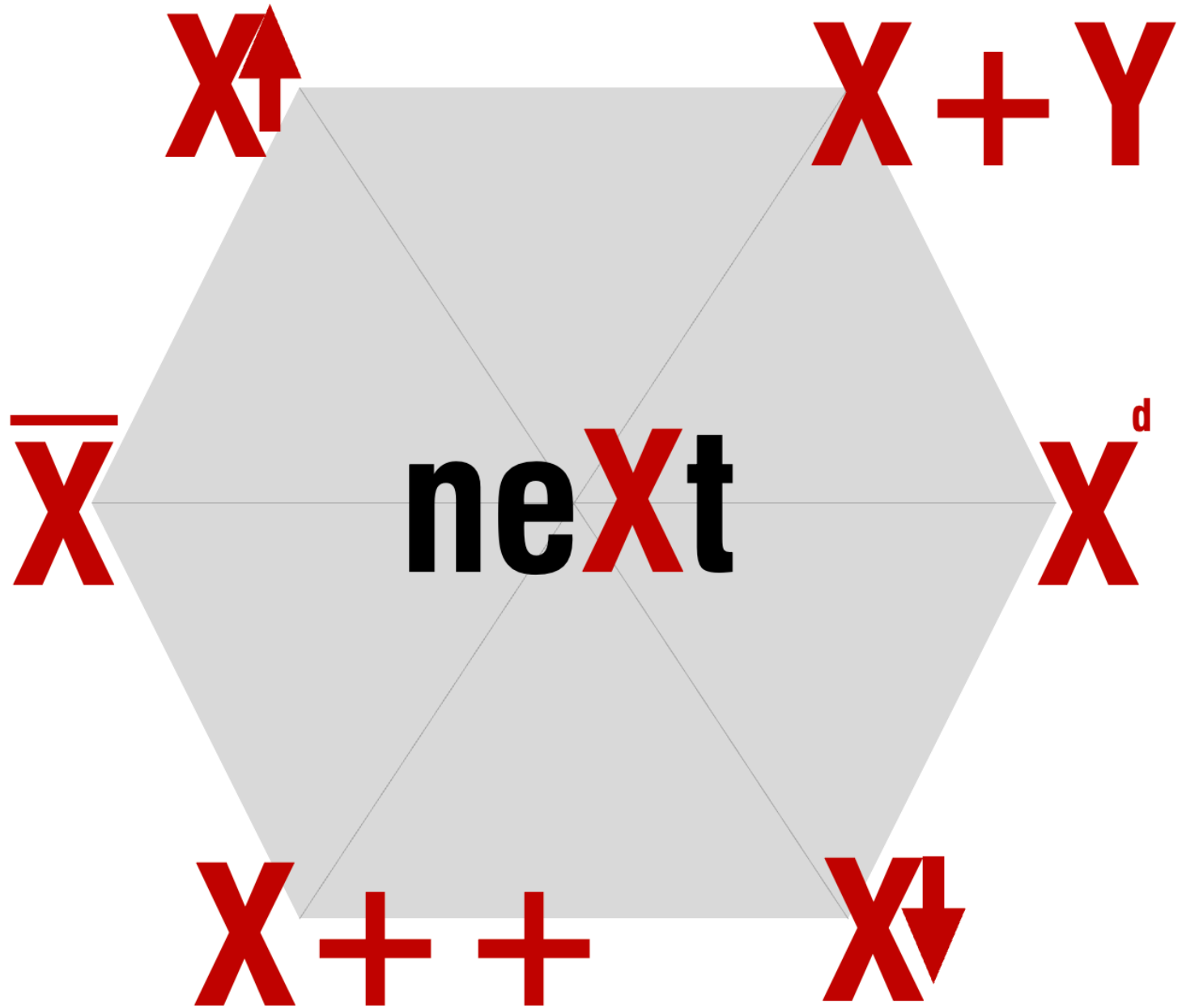
looking back through the history of HCI,
we see that quantum leaps have rarely resulted from studies on user needs or market research;

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

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++

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, 1.75μ	8MP/1080p, f2.4, BSI, 1.4μ	8MP/1080p, f2.4, BSI, 1.4μ	8MP/1080p, f2.4, BSI, 1.4μ	8MP/1080p, f2.2, BSI, 1.5μ
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”

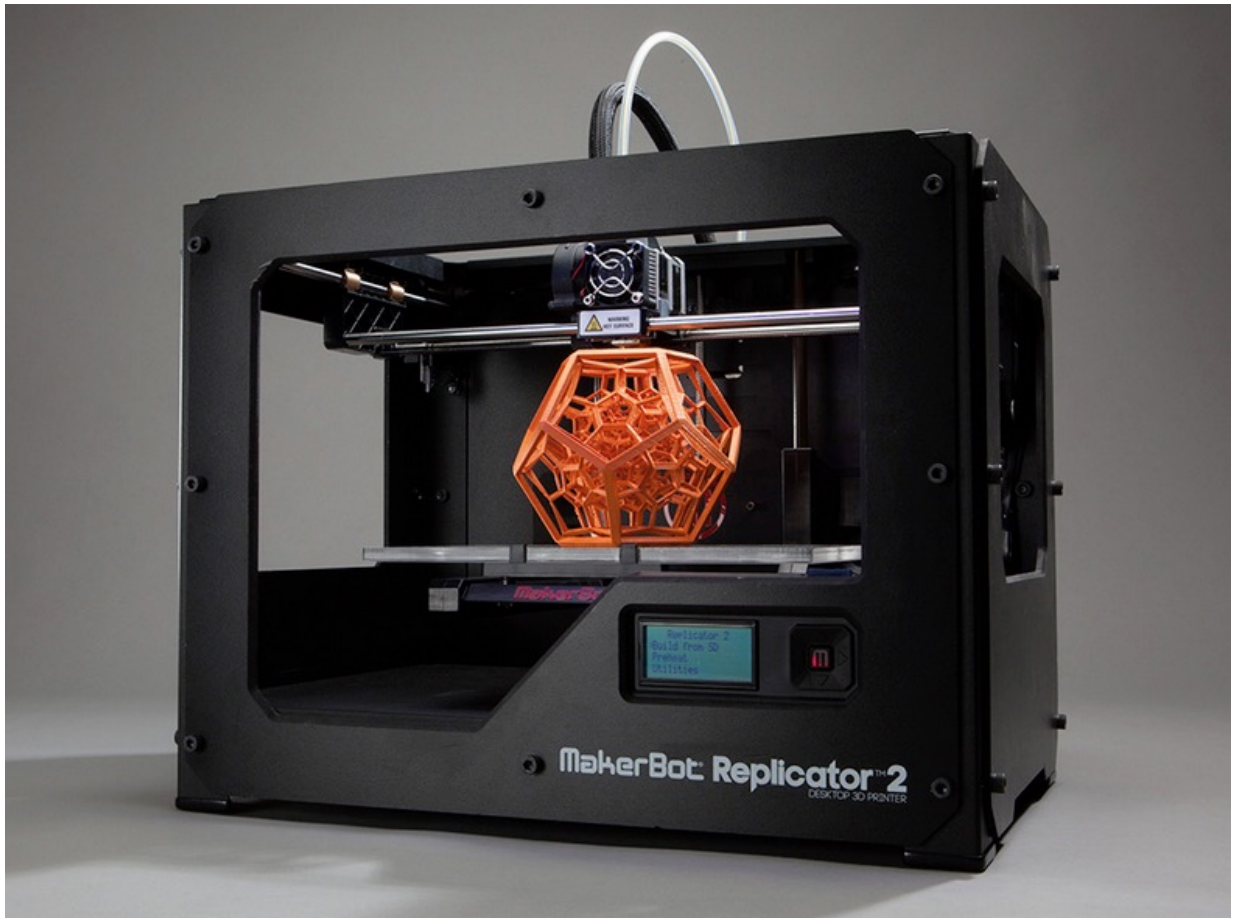
increments get smaller, less ground-breaking

given a nail

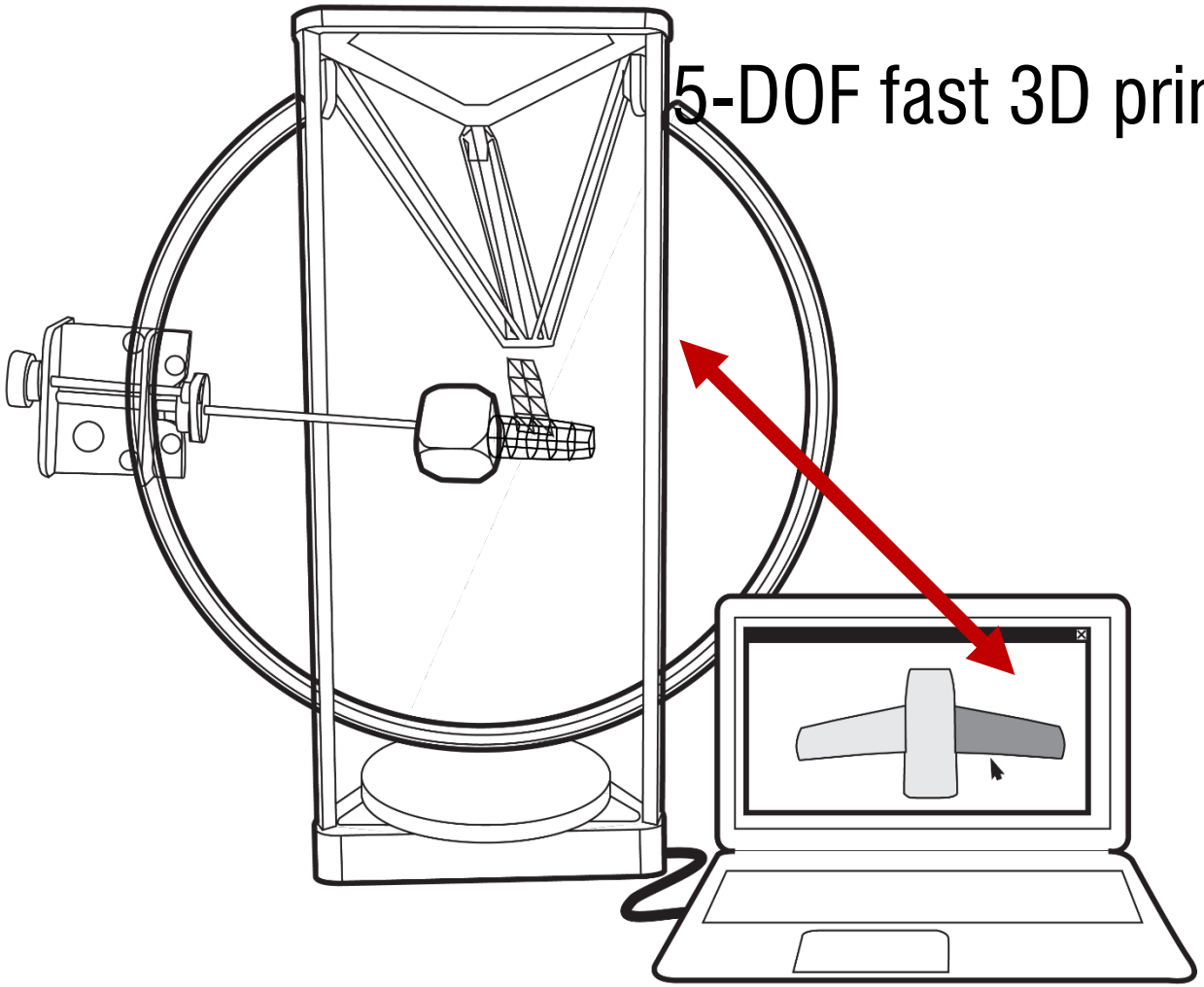
find all the hammers

given a problem,
find all solutions…

e.g. 3D Printing is not interactive



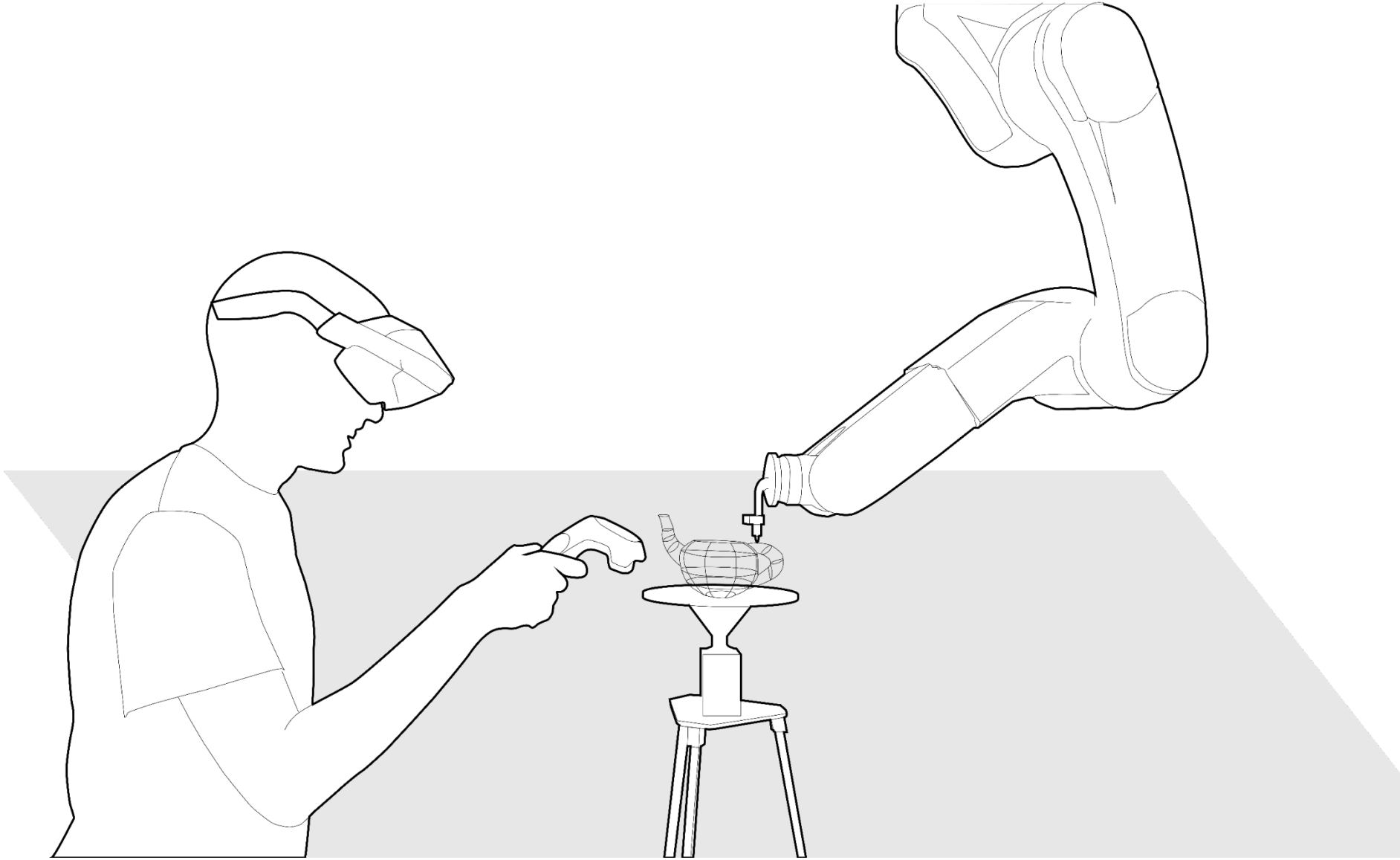
solution 1:



5-DOF fast 3D printer

CAD modeling plugin

solution 2:



solution 3:

— dance around the same problem

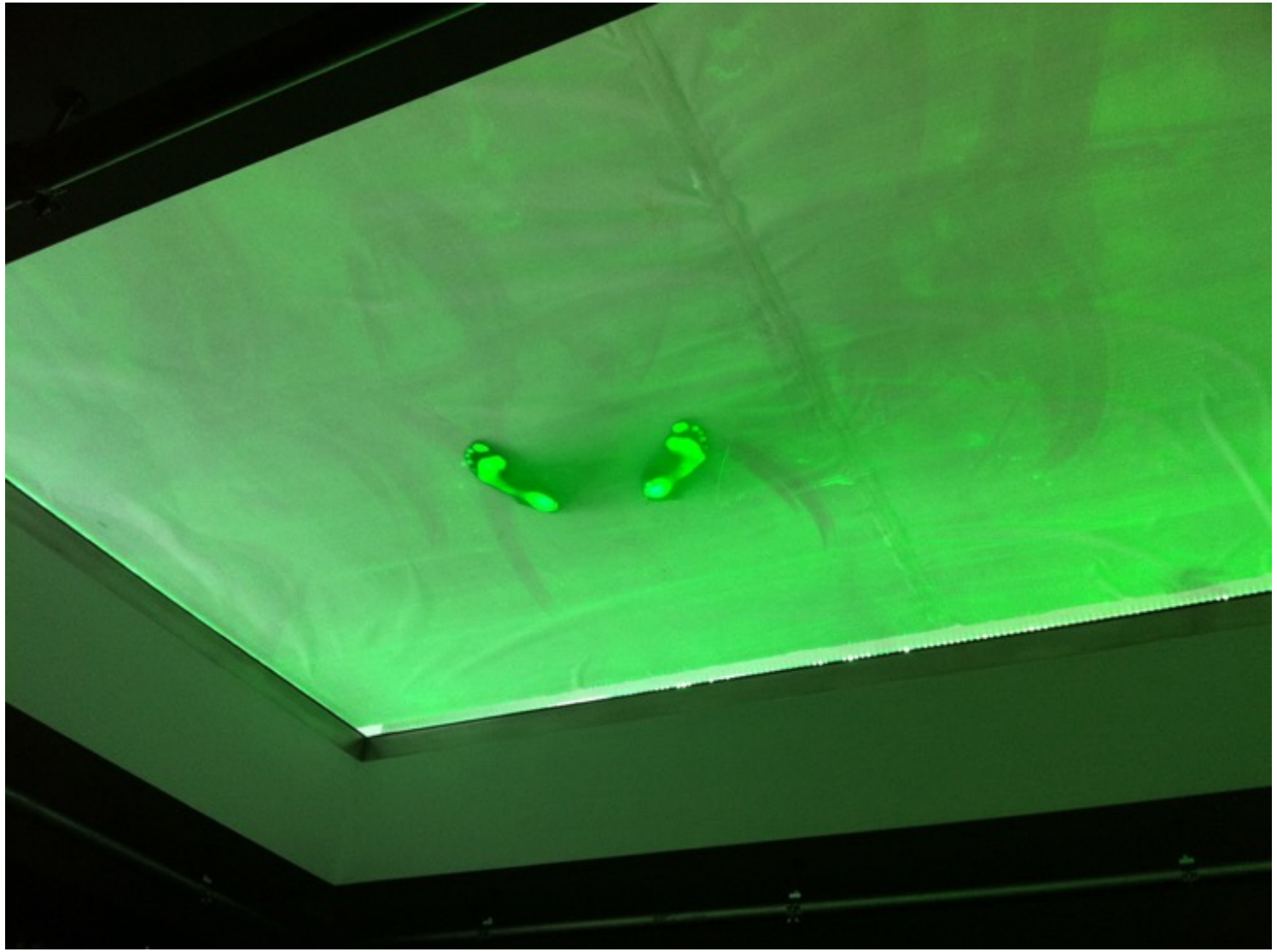

given a hammer
find all the nails

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: food printing + perception:

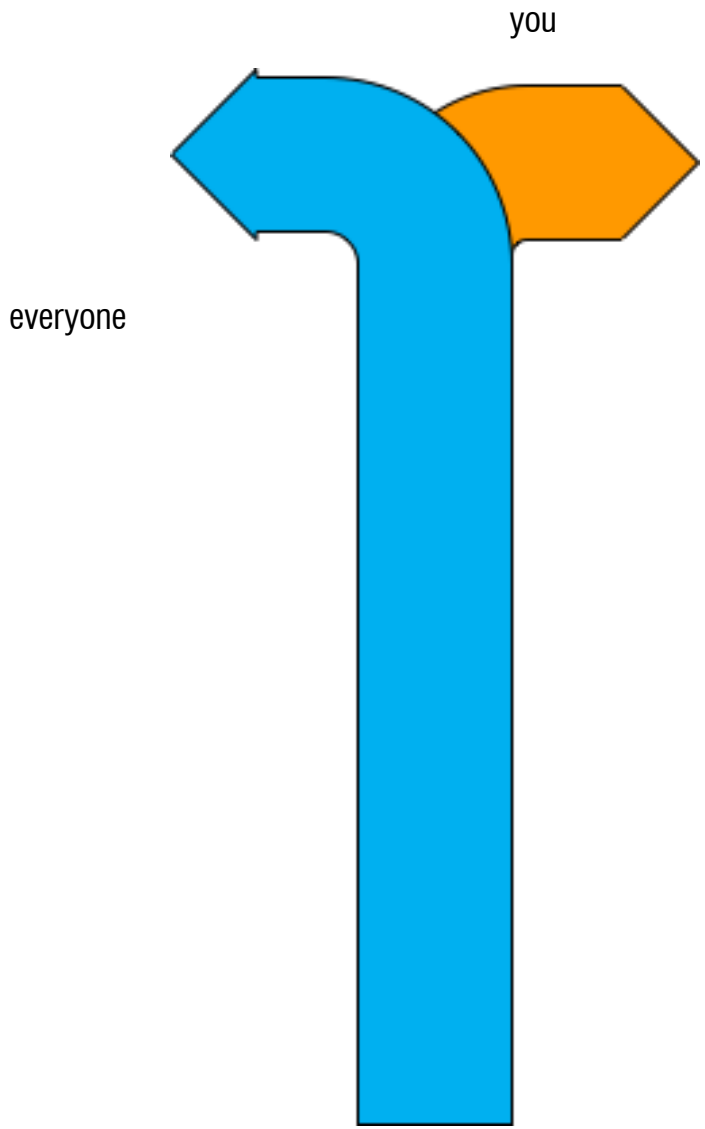
maybe automation can feed some new insight back into perception research

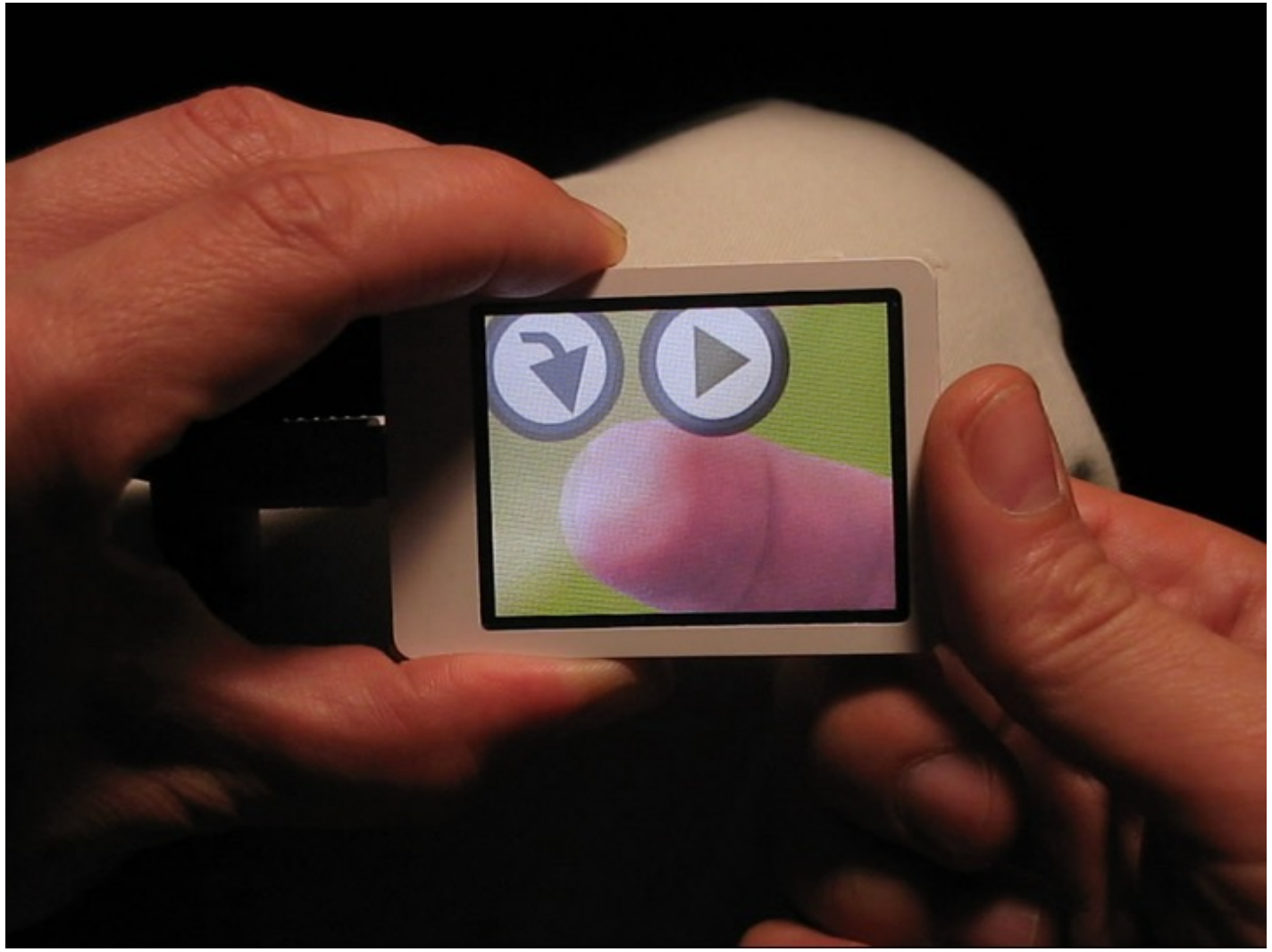
high innovative power, but not very actionable
because for a given X the search space of all Y is large and unstructured

do the opposite

Straddle Method for High Jump

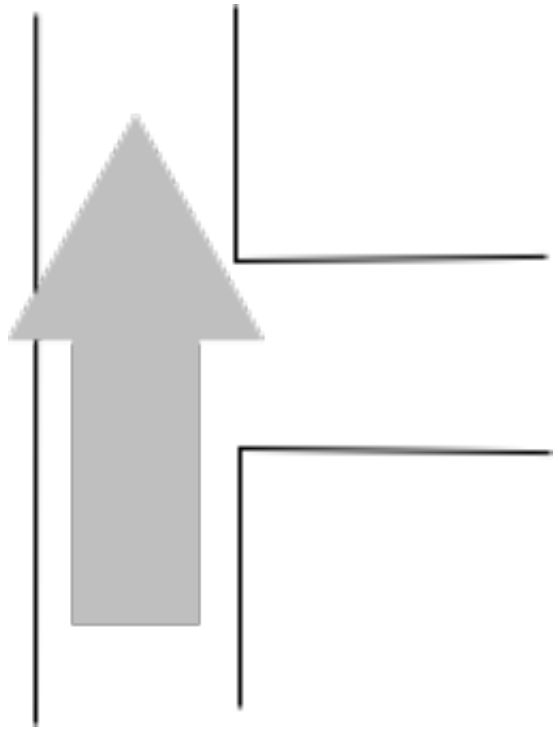
1968 Olympics: “Fosbury Flop”


you
everyone



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



stand at the edge of the ‘known world’

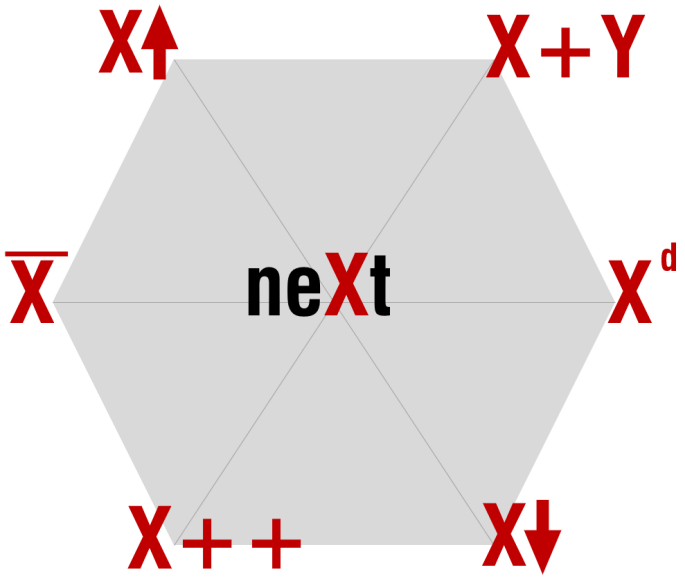
awards (best paper, best product, researchers)

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

patents (but searching them is time-consuming)

(do not always) 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

Based on Prof. Stefanie Mueller’s slides.

https://courseexp.umd.edu/

Your feedback will help us improve the course in the future☺