PROTOTYPING INTERACTIVE SYSTEMS

CSE 599 Prototyping Interactive Systems | Lecture 1 | April 2

Jon Froehlich • Jasper O'Leary (TA)

DESIGN USE BUILD

MAKEABILITY LAB

PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

UNIVERSITY of WASHINGTON

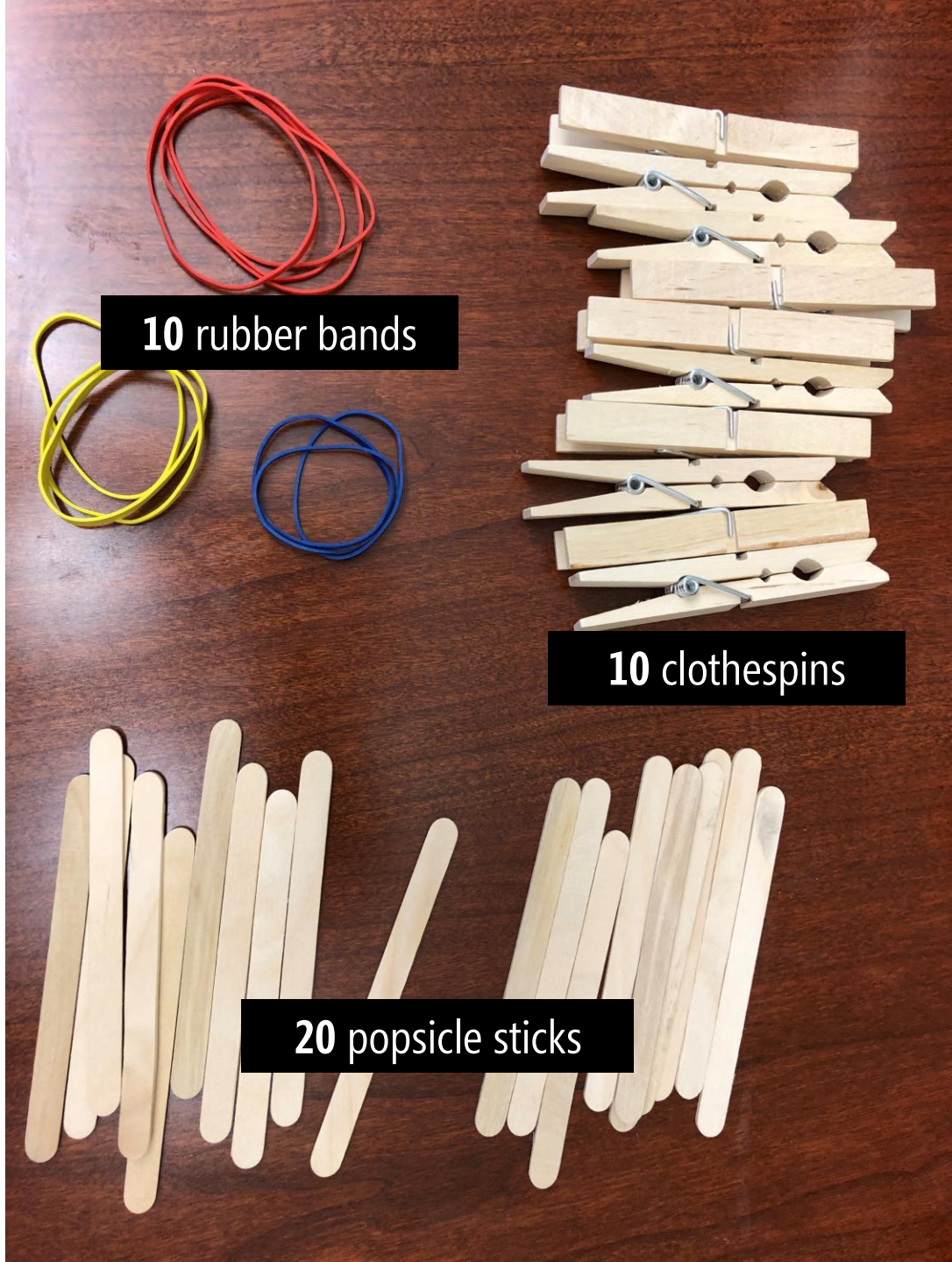
Assemble yourselves in **teams of two**

POPSICLE STICK DESIGN CHALLENGE

In teams of two, you have **18-minutes** to build a **free-standing tower** that **holds calibrated weights** with the supplies listed here →

We will score towers based on:

$$Score = height_{weight} * weight$$



18m 00s

START RESET

PROTOTYPING INTERACTIVE SYSTEMS

REFLECTING ON DESIGN PROCESS

What **strategies** did you use to maker your towers?

How **many towers** did you make?

How did you **learn**?

REFLECTING ON DESIGN PROCESS

How many teams **sketched out ideas** first before starting to build?

How many teams **tried multiple ideas** before settling on a final design?

How many teams **tried to use the weights** during the prototyping process?

How many teams **used parts in unintentional ways** (took apart clothespins)?

PROTOTYPING INTERACTIVE SYSTEMS

MARSHMALLOW DESIGN CHALLENGE

Teams of four, 18 minutes

Tallest freestanding structure

20 sticks of spaghetti + 

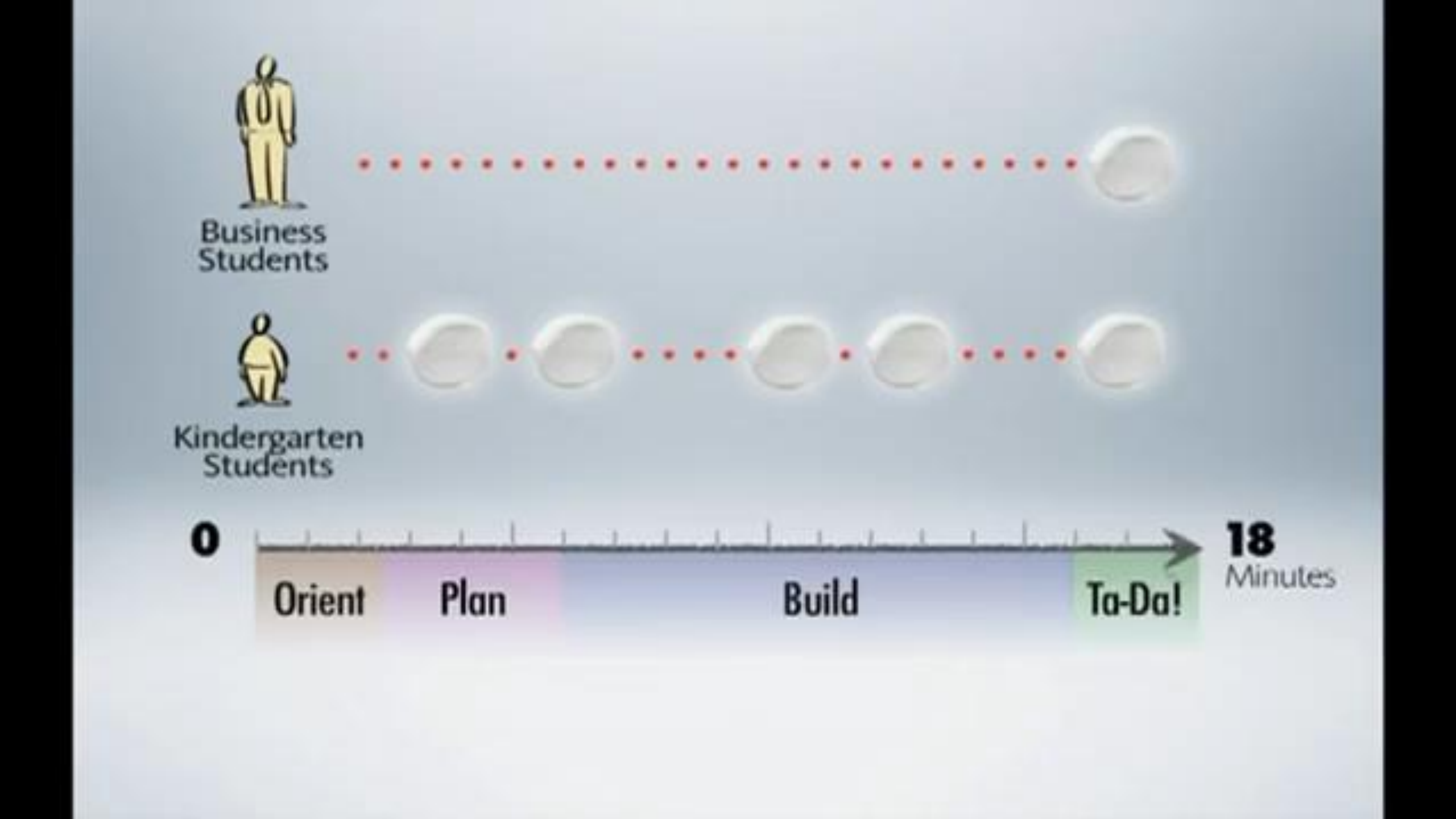
one yard tape + 

one yard string + 

one marshmallow


0
Orient
Plan
Ta-Da!
18
Minutes
TED
Tom Wujec
Technical Fellow at Autodesk

Start → **18** Minutes


Business Students
Kindergarten Students
0
Orient
Plan
Build
Ta-Da!
18
Minutes

“The essence of the **iterative design process**. Each version [creators] get instant feedback about what works and what doesn’t”

Tom Wujec
Autodesk Fellow

Source: Wujec, Build a Tower, Build a Team, TED 2010, https://youtu.be/H0_yKBitO8M

Source: http://www.dailymotion.com/video/xjmwqt_ideo-s-david-kelley-on-the-culture-of-prototyping_news


FIRE
ASPEN IDEAS FESTIVAL

DAVID KELLEY

IDEO'S CULTURE OF PROTOTYPING

Bias towards **action**

Get out **into messy world**—conduct formative research

Build prototypes (fast)—even "crumby ones"

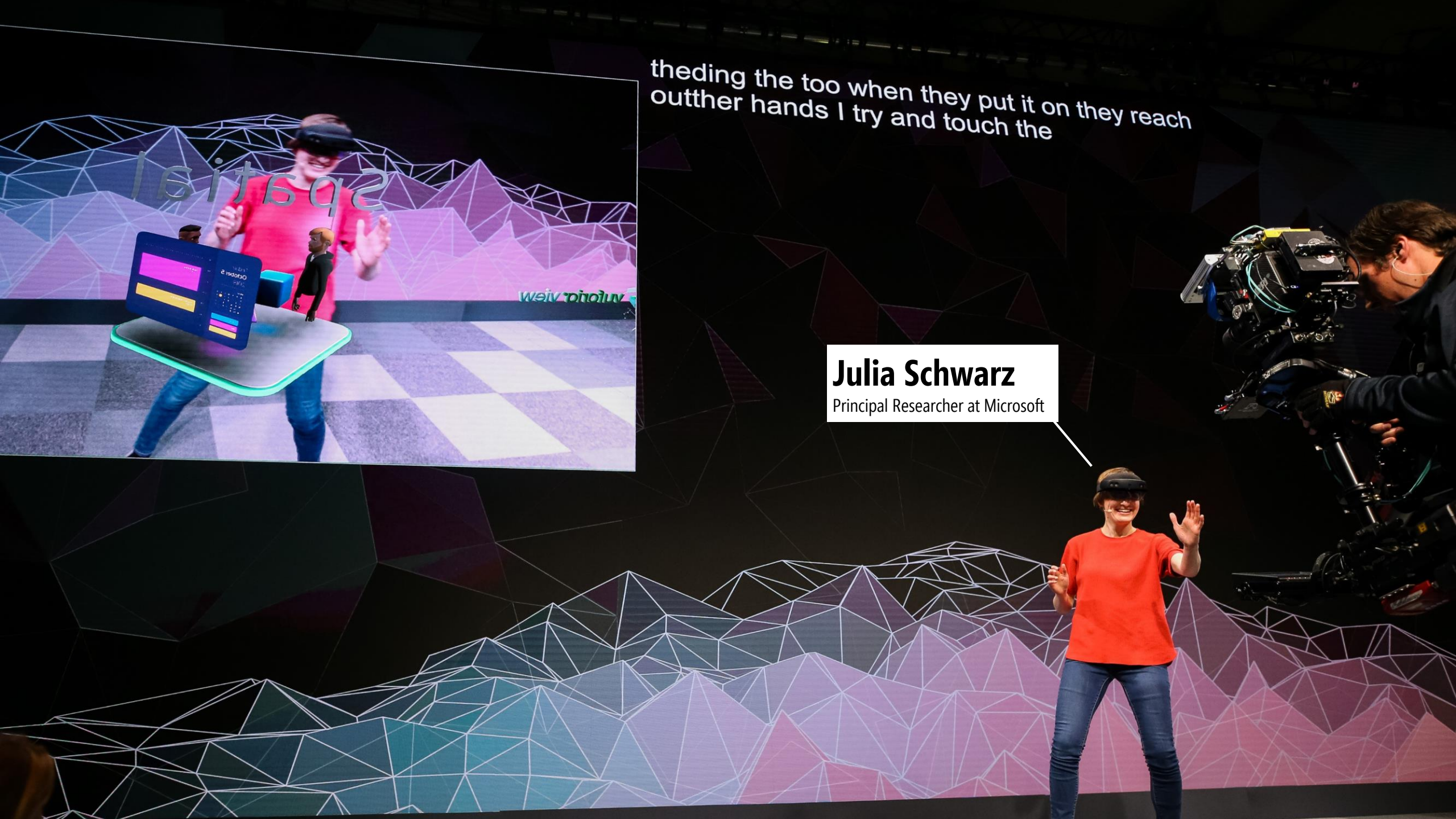
Test prototypes (watch people use them), learn, and iterate

“If a picture is worth a thousand words, a **prototype is worth ten thousand**.”

IDEO Design Principle

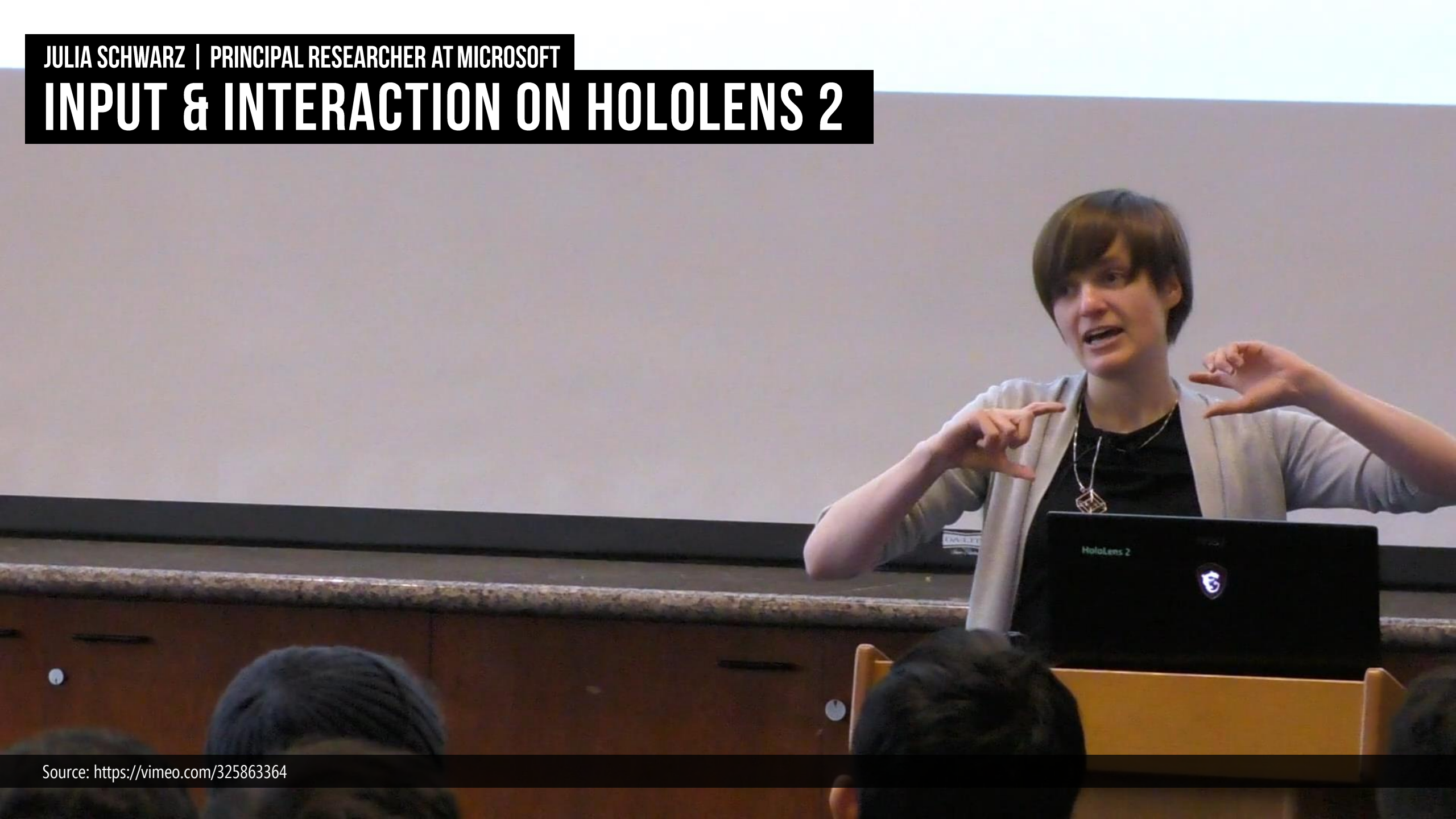
From: Stefan Thomke, *Experimentation Matters: Unlocking the Potential of New Technologies for Innovation*, 2003

Source: Thomke, *Experimentation Matters: Unlocking the Potential of New Technologies for Innovation*, 2003


theding the too when they put it on they reach
outther hands I try and touch the
Julia Schwarz
Principal Researcher at Microsoft

JULIA SCHWARZ | PRINCIPAL RESEARCHER AT MICROSOFT

INPUT & INTERACTION ON HOLOLENS 2



Source: https://vimeo.com/325863364


HoloLens 2

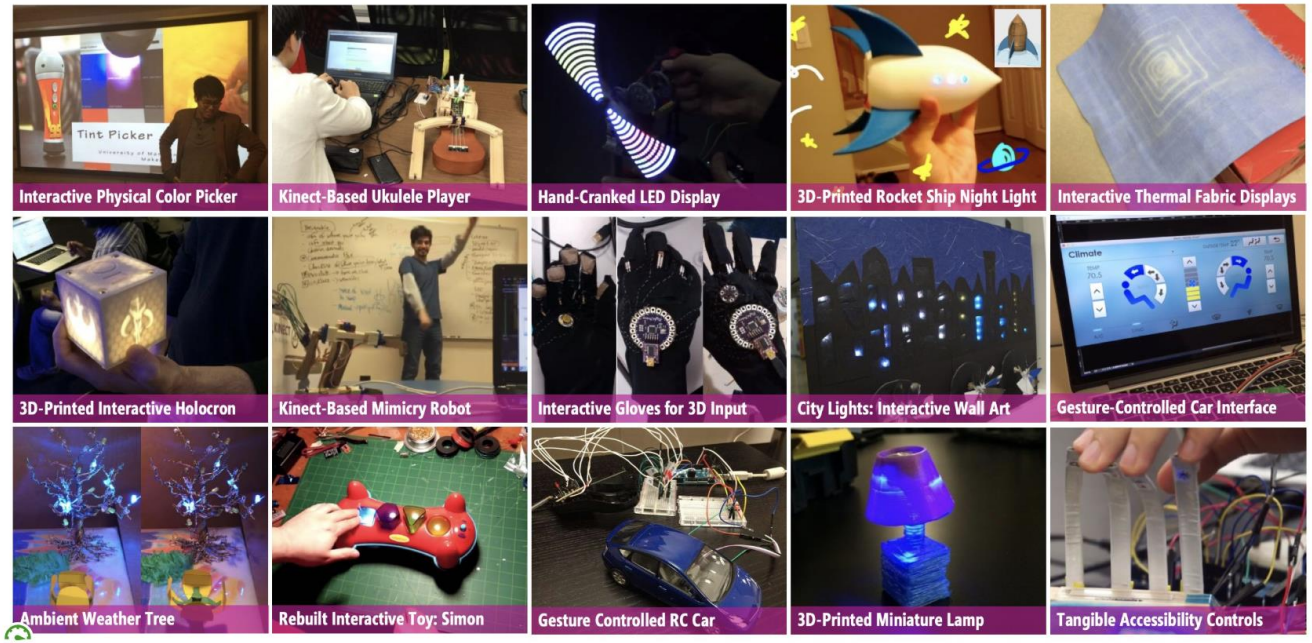
NO PROTOTYPE, NO MEETING

Source: AKathryn McElroy, *Prototyping for Designers,* 2017

CSE 599 H Sp 19: Special Topics In Computer Science

Jump to Today Edit

CSE 599H: Prototyping Interactive Systems



Course Overview

This course explores the materiality and physicality of interactive computing via rapid prototyping. In the words of MIT professor Hiroshi Ishii, we will seek to "seamlessly couple the dual worlds of bits and atoms." This is a particularly interesting time to survey and explore this area because of three, interrelated technology trends:

- **The emergence of the DIY/Makers movement**, which has led to widespread opportunities to interface and work with hardware that has rather low barriers of entry (e.g., the Arduino), provides new opportunities for coupling form with computation (e.g., through digital fabrication), and provides countless online materials/tutorials to help us along.

Course Status

Unpublish | Published

Import from Commons
Choose Home Page
View Course Stream
Course Setup Checklist
New Announcement
Student View
View Course Analytics

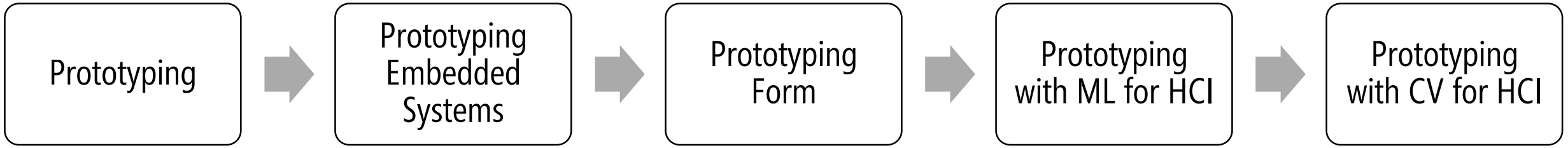
April 2019

31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	1	2	3	4
5	6	7	8	9	10	11

Course assignments are not weighted.

PROTOTYPING INTERACTIVE SYSTEMS

COURSE CURRICULUM



PEDAGOGICAL APPROACH

My teaching is rooted in **Papert's theory of constructionism**, which suggests a **strong connection between design and learning**.

Seymour Papert
MIT Professor
Pioneer of AI & new learning theories

PEDAGOGICAL APPROACH

My teaching is rooted in **Papert's theory of constructionism**, which suggests a **strong connection between design and learning**.

The theory posits that '**remarkable learning**' occurs when people are **working** with **materials** to **design**, **create**, and **invent** external and **shareable artifacts**.

Seymour Papert
MIT Professor
Pioneer of AI & new learning theories

PROTOTYPING INTERACTIVE SYSTEMS

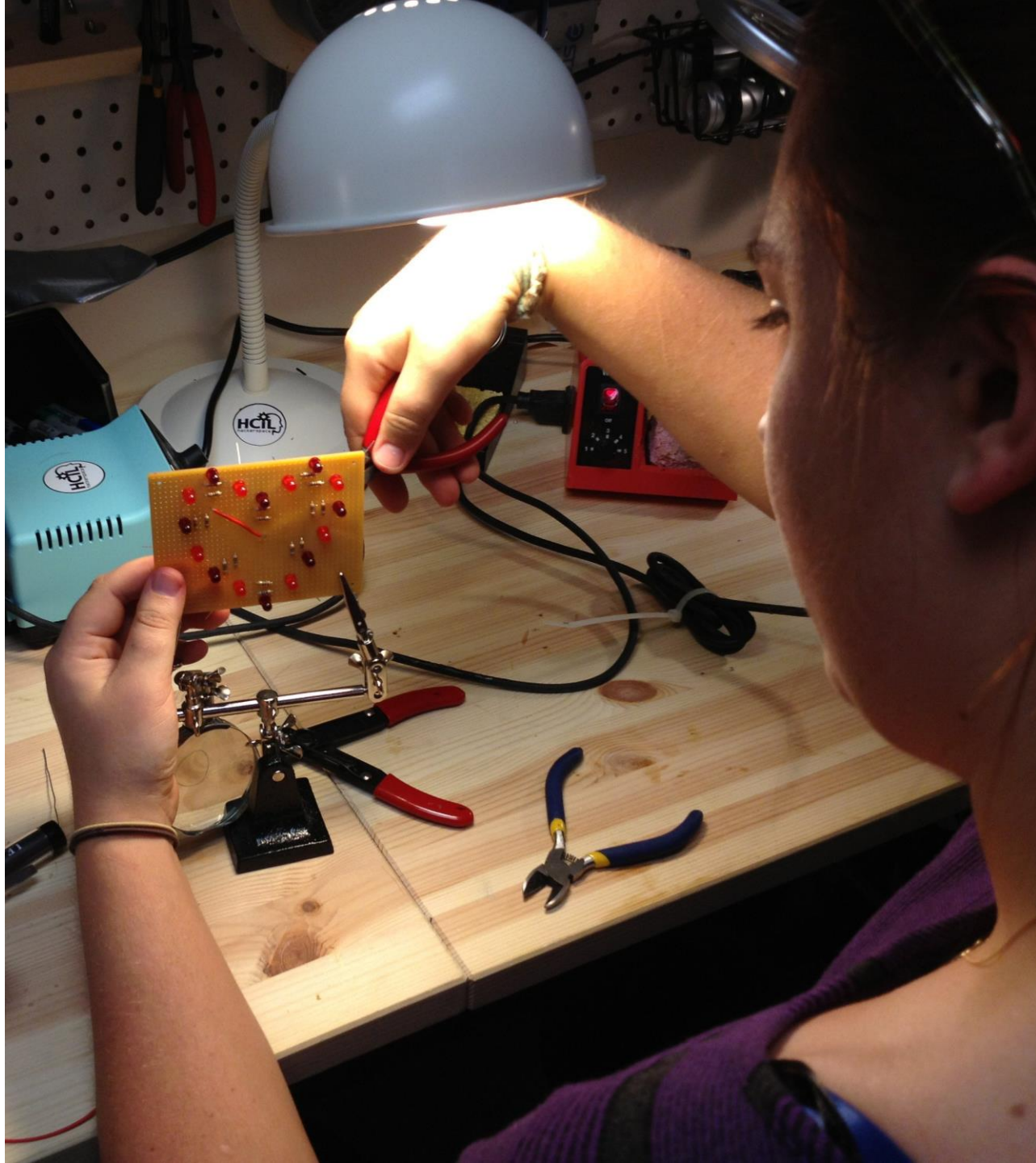
LEARNING AVENUES

Learn by doing (in-class exercises, homeworks)

Learn via critiques (share outs + critique)

Learn via lecture

Learn via self-exploration



Do not use any of the equipment in Sieg 322 until we have covered it in class or you have otherwise received my permission.

PROTOTYPING INTERACTIVE SYSTEMS

BY NEXT CLASS!

Please purchase a craft, tote, or toolbox to carry your supplies & artifacts

Sterilite 3-Layer Stack and Carry Box - Clear - 10.625 x 7.25 x 7.75 in

Be the first to review this product

$9.99

In stock

SKU#: 00073149413864

1 Add to Cart

Sterilite 3-Layer Stack and Carry Box - Clear - 10.625 x 7.25 x 7.75 in is available to buy in increments of 1

PROTOTYPING INTERACTIVE SYSTEMS

COURSE CURRICULUM

Prototyping → Prototyping Embedded Systems → Prototyping Form → Prototyping with ML for HCI → Prototyping with CV for HCI

MODULE LEARNING GOALS

1. **What** is a prototype?
2. **Why** prototype?
3. **When** to prototype?
4. The **fidelity** and **dimensions** of prototypes.
5. **How** to prototype. The "science" of prototyping—emerging research and industry examples supporting best practices in prototyping

LEARNING GOALS

1. **What** is a prototype?
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pro·to·type [/ˈprəʊtətʌɪp/]

<Take 60 seconds and write down your own definition of a prototype. Can bullet point. Then we'll fill in our own definition here>

- CSE599, Spring 2019

pro·to·type [/ˈprəʊtətʌɪp/]

- *Your definitions here*

- CSE599, Spring 2019

pro·to·type [/ˈprəʊtətʌɪp/] A first, typical, or preliminary model of something, especially a machine, from which other forms are developed or copied.

- Oxford Dictionary, 2016

pro·to·type [/ˈprəʊtətʌɪp/] A draft version of a product that allows you to explore your ideas, show intention, and highlight concepts to users before investing time and money into development.

- Usability.gov

n. from Medieval Latin *prototypus* “original, primitive” and Greek *prototypon* “a first example or primitive form”

- Online Etymology Dictionary, 2010

Take 60 seconds and write down all of **the different types of prototypes** relevant to computer science/HCI

WHAT IS A PROTOTYPE

IN HCI, PROTOTYPES CAN BE…

This slide was filled in by class…

A paper prototype

<filled in by class/>

WHAT IS A PROTOTYPE

IN HCI, PROTOTYPES CAN BE…

Prototypes differ in terms of time investment, resources required, fidelity…

Paper prototypes

Hand crafted physical prototypes (*e.g.*, wood, foam core)

Digital fabrications (e.g., laser cuts, 3D prints, CNC mill)

Graphic mockups (non-interactive)

Digital prototypes made with prototyping tools (*e.g.*, Sketch, Balsamiq, InVision)

Video prototypes (*e.g.*, animations highlighting particular interaction or concept)

Interactive prototypes made in actual code (*e.g.*, in Java, Swift, Processing)

… other things?

Take 60 seconds and write down **who are prototypes for**? And **why**?

WHO ARE PROTOTYPES FOR?

This slide was filled in by the class...

<filled in by class/>

WHO ARE PROTOTYPES FOR?

Yourself (to help act through a problem, to test an idea)

End users (*e.g.*, usability tests, etc.)

Other team members (*e.g.*, for design critiques)

Management (*e.g.*, to advocate for a feature, to demonstrate viability)

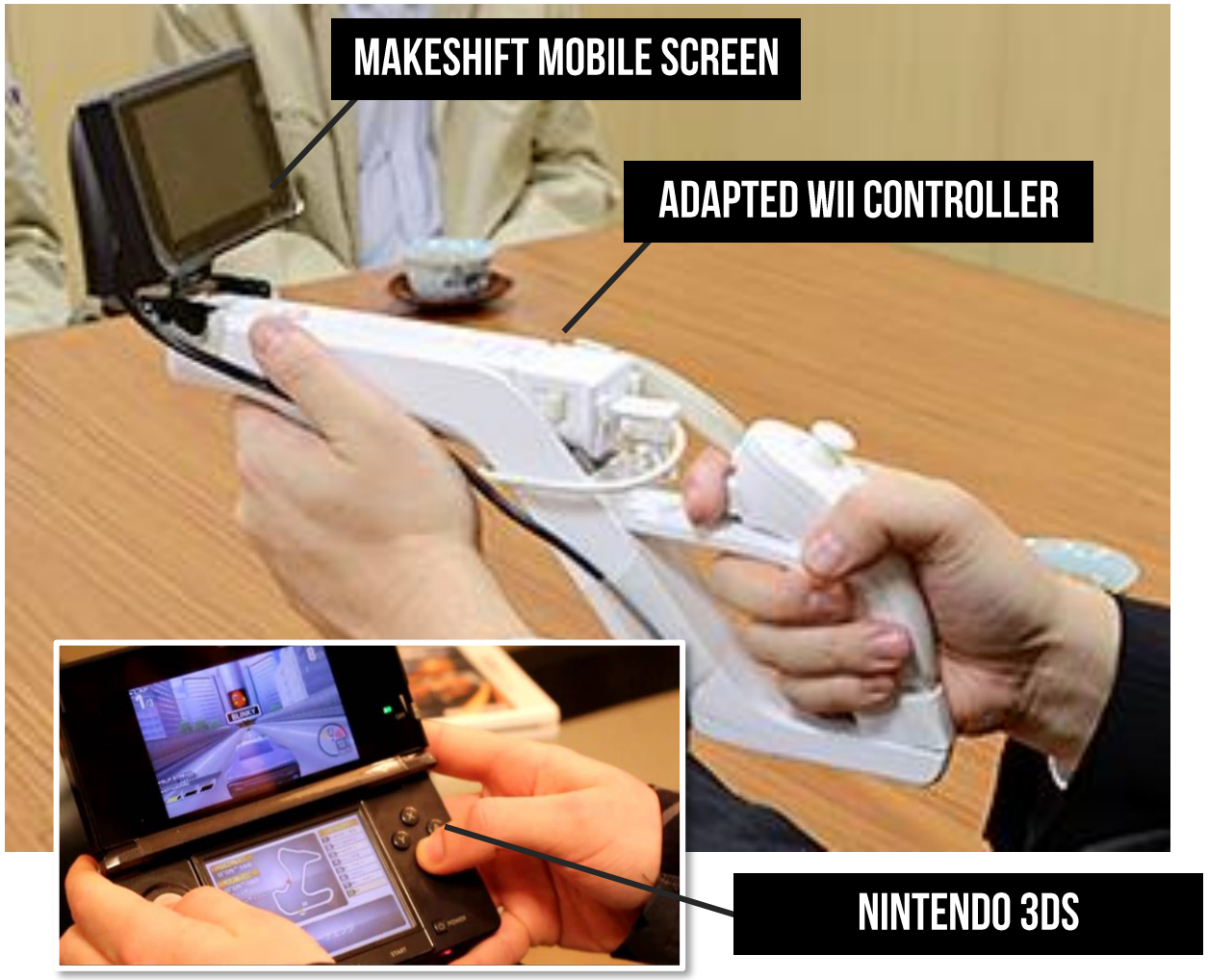
Clients (*e.g.*, to compare designs, show progress, solicit feedback)

SOME EXAMPLE PROTOTYPES

EXAMPLE 1: PROTOTYPING AT NINTENDO

Source: http://prototyping.club/case-study/nintendo-wiiu

EXAMPLE 1: PROTOTYPING NINTENDO 3DS



Source: http://prototyping.club/case-study/nintendo-wiiu

EXAMPLE 1: PROTOTYPING NINTENDO 3DS

"We tested gameplay that involved moving the **Wii Zapper** and **having images** from the **Wii move in sync** on a **monitor in your hands**. It was fairly well received...

When **Miyamoto-san saw that experiment**, he said that he **definitely wanted to put a gyro sensor** in **Nintendo 3DS**... This happened after the people in the hardware department had already been declared that "all features are now set!

Thanks to this **prototype**, however, we were able to **explain [our idea]** and it became **more compelling**."

- Nintendo Designer

Source: http://prototyping.club/case-study/nintendo-wiiu

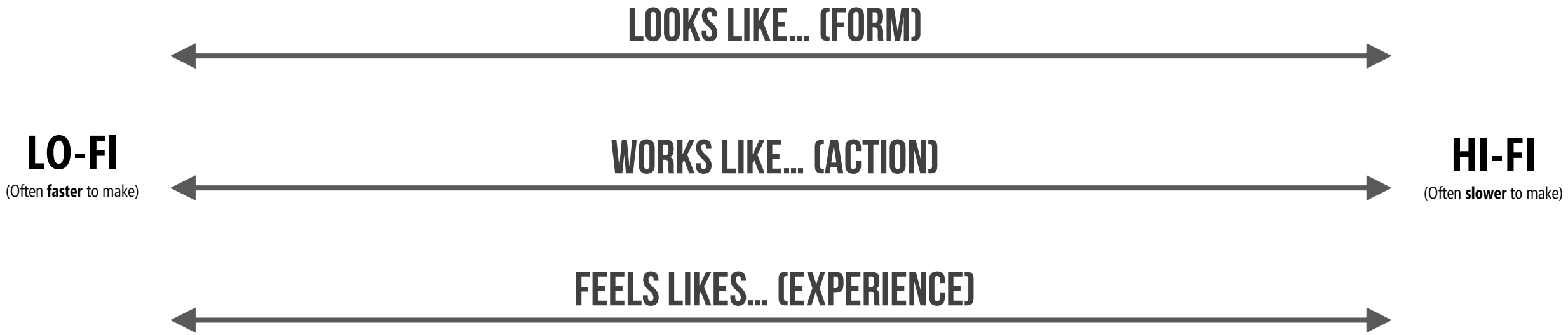
“The way that Nintendo makes hardware is to **take an idea** that has arisen and **make something makeshift** and **actually try it out**.

- Nintendo Designer

Source: http://prototyping.club/case-study/nintendo-wiiu

PROTOTYPING DIMENSIONS

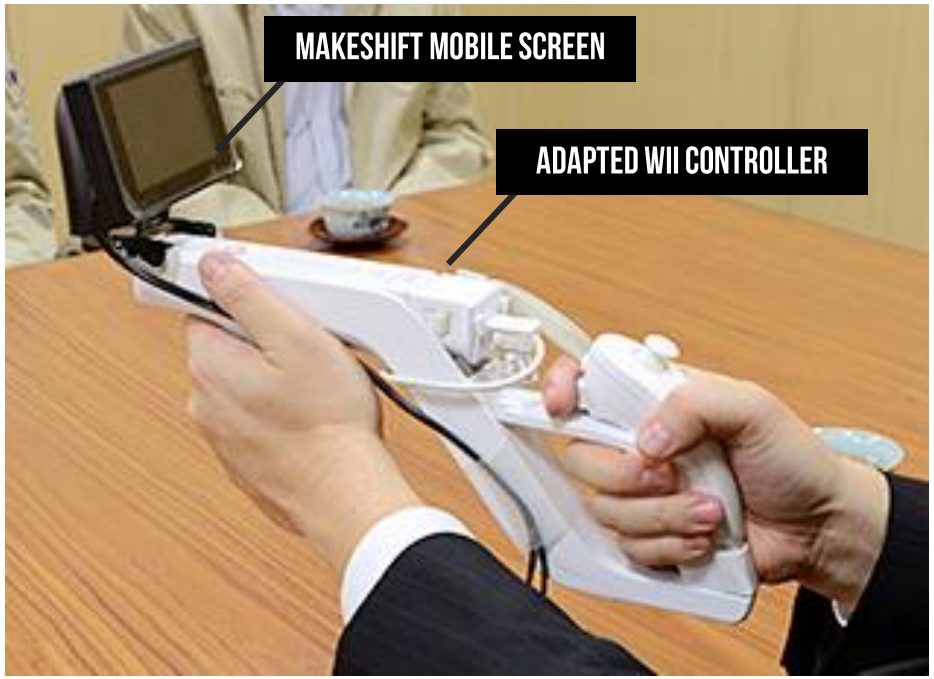
Three primary dimensions. Dimensions not purely independent.



Source: Stanford d.School: http://hci.stanford.edu/dschool/resources/prototyping/prototyping.doc

PROTOTYPING FIDELITY & DIMENSIONS

WHAT IS THIS PROTOTYPE EXPLORING?



LOOKS LIKE... (FORM)

WORKS LIKE... (ACTION)

FEELS LIKES... (EXPERIENCE)

Source: Stanford d.School: http://hci.stanford.edu/dschool/resources/prototyping/prototyping.doc

PROTOTYPING FIDELITY & DIMENSIONS

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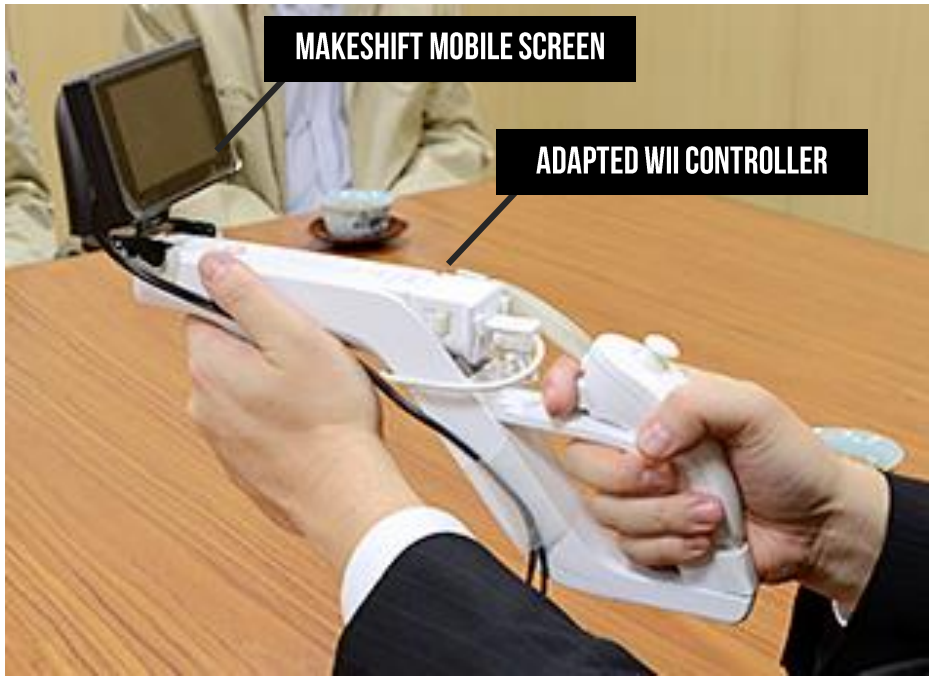

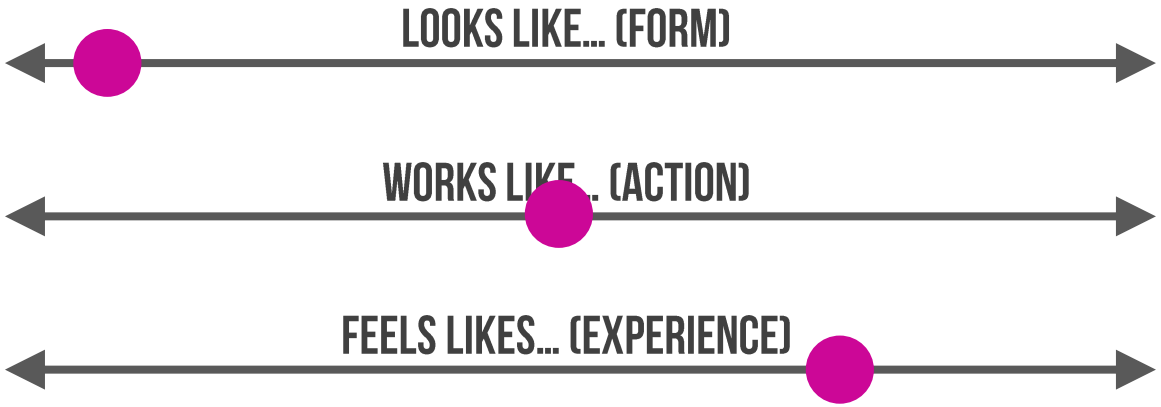

Source: Stanford d.School: http://hci.stanford.edu/dschool/resources/prototyping/prototyping.doc

IDEO

EXAMPLE 2: PROTOTYPING ELMO'S IPHONE APP

Source: IDEO, Prototyping for Elmo's Monster Maker iPhone App, https://youtu.be/-SOeMA3DUEs

BACK STORY

VIDEO PROTOTYPING ELMO'S APP

Source: http://www.slate.com/blogs/the_eye/2013/10/23/the_importance_of_prototyping_creative_confidence_by_tom_and_david_kelley.html

PROTOTYPING FIDELITY & DIMENSIONS

WHAT IS THIS PROTOTYPE EXPLORING?

LOOKS LIKE... (FORM)

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PROTOTYPING FIDELITY & DIMENSIONS

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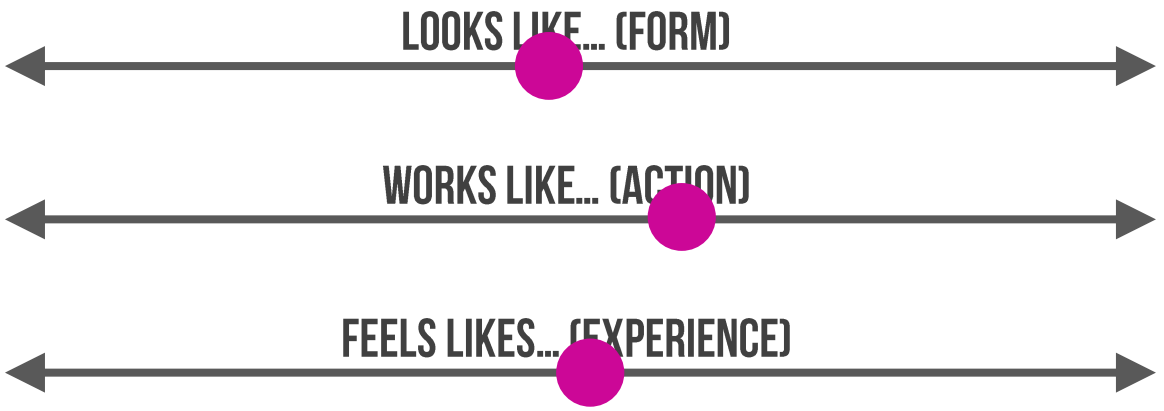


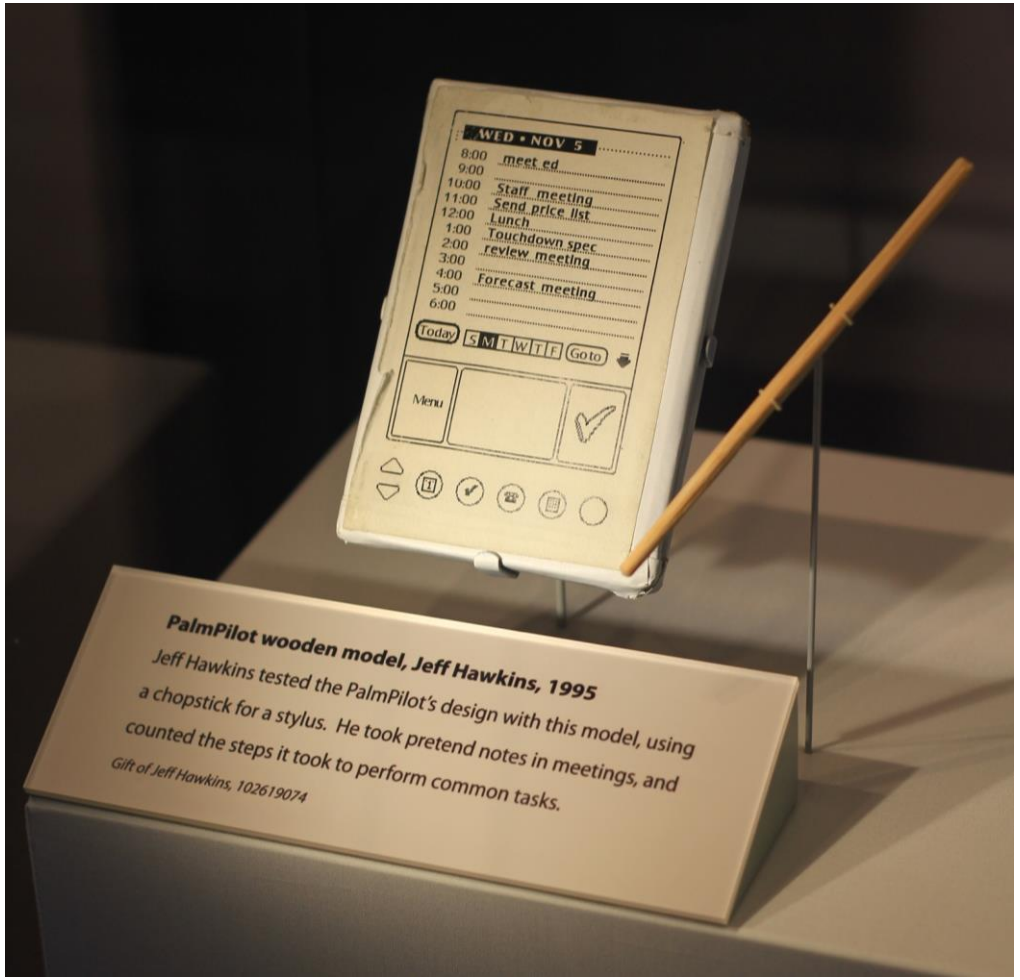
Elmo video prototype

JEFF HAWKINS, FOUNDER OF PALM

EXAMPLE 3: PROTOTYPING THE PALM PILOT

Source: http://www.designinginteractions.com/interviews/JeffHawkins

EXAMPLE 3: PROTOTYPING THE PALM PILOT



...[Hawkins] cut a block of wood to fit his shirt pocket. **Then he carried it around for months, pretending it was a computer.** Was he free for lunch on Wednesday? Hawkins would haul out the block and tap on it as if he were checking his schedule. If he needed a phone number, he would pretend to look it up on the wood. Occasionally he would try out different design faces with various button configurations, using paper printouts glued to the block."

Source: Jackson, Palm-to-Palm Combat, Time, 1998: http://content.time.com/time/magazine/article/0,9171,987979,00.html

PROTOTYPING FIDELITY & DIMENSIONS

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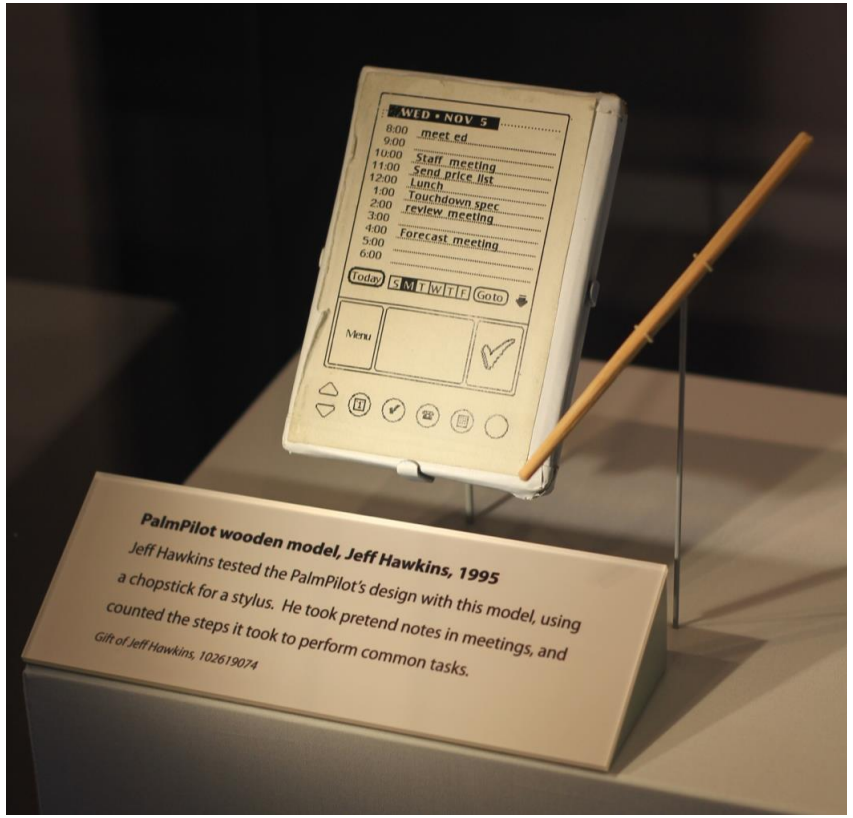

LOOKS LIKE... (FORM)

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FEELS LIKES... (EXPERIENCE)

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PROTOTYPING FIDELITY & DIMENSIONS

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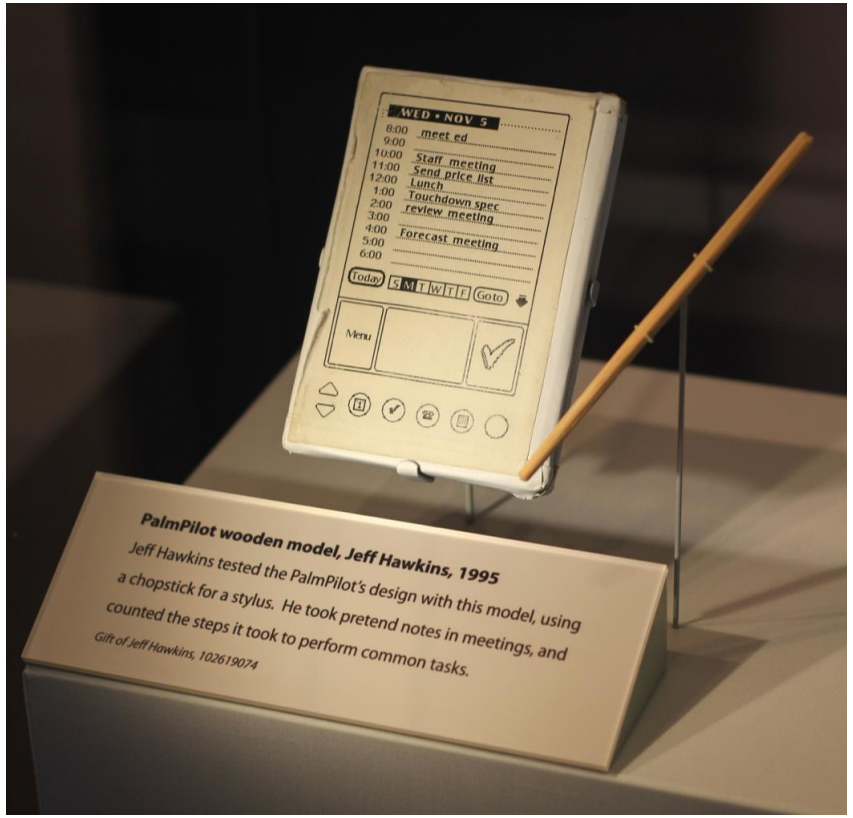
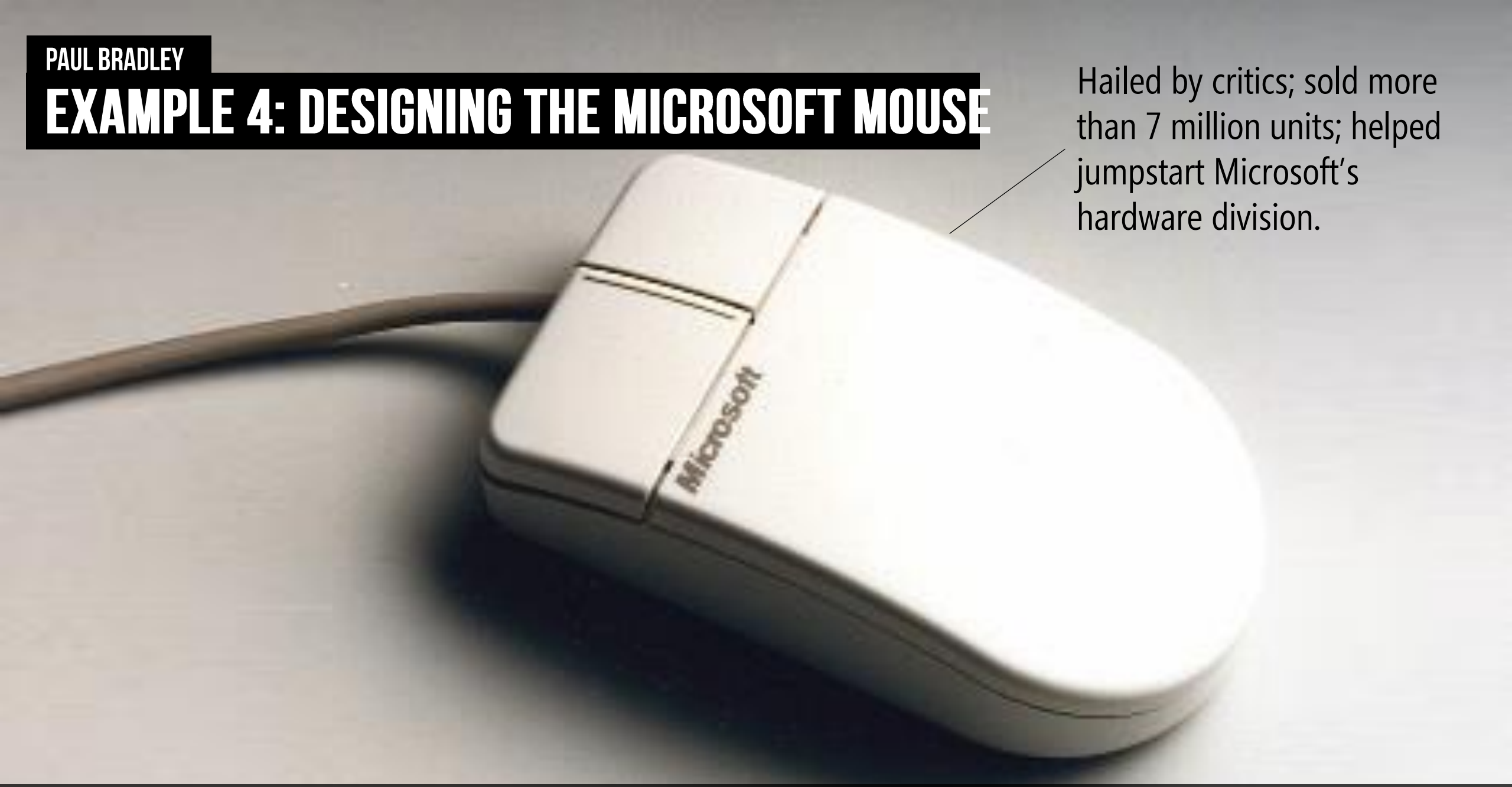


Source: Stanford d.School: http://hci.stanford.edu/dschool/resources/prototyping/prototyping.doc

PAUL BRADLEY

EXAMPLE 4: DESIGNING THE MICROSOFT MOUSE



Hailed by critics; sold more than 7 million units; helped jumpstart Microsoft's hardware division.

Source: http://www.designinginteractions.com/interviews/PaulBradley; see also Kelley, *The Art of Innovation*, 2001

Paul Bradley

Microsoft Mouse

Interview September 2003

WHAT WERE SOME COMMON THEMES?

<Filled in by class/>

WHAT WERE SOME COMMON THEMES?

A **bias towards rapid** creation

A **focus on testing** (even if by own design team)

A **focus on breadth** to examine multiple ideas quickly

Prototype **to learn** but also **to show** & **convince**…

WHY PROTOTYPE

QUESTION POSED TO CLASS

SO, WHY PROTOTYPE?

<To fill in by class/>

WHY PROTOTYPE?

BENEFITS OF PROTOTYPING

Sony PlayStation 1 controller prototypes

Microsoft mouse prototypes

1. **Cognitive benefits:** *e.g.*, prototypes support creativity—they help use capture and generate ideas (prototyping is generative!)
2. **Facilitate exploration of design space:** prototypes can target and manifest different attributes in a design space
3. **Permit early and iterative evaluation:** prototypes can be tested in various ways including traditional usability studies and informal user feedback, throughout design process
4. **Allow you to fail fast:** relatedly, prototypes allow you to try out and experiment with multiple ideas rapidly & fail (& learn!)
5. **Rapid prototyping** prevents feeling attached to an idea simply because you invested effort into it
6. **To communicate:** help designers, engineers, managers, software devs, clients, and users to understand & discuss

Based on: Beaudouin-Lafon & Mackay, Chapter 47: Prototyping Tools and Techniques; *The Human Computer Interaction Handbook, 3rd Edition,* 2012, p. 1082; additions by Jon Froehlich

WHY PROTOTYPE?

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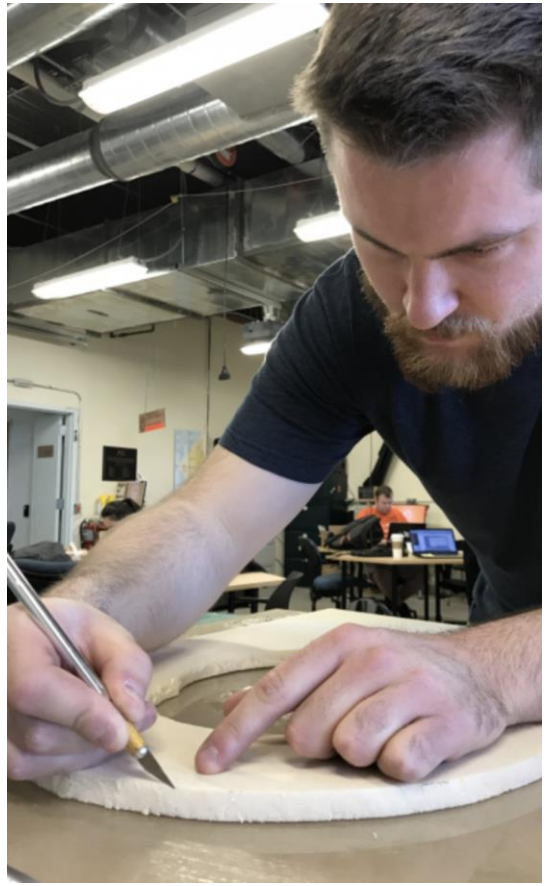
WHY PROTOTYPE

COGNITIVE BENEFITS OF PROTOTYPING

1. Allows for **exploration of tacit knowledge**
2. **Thinking through doing**— using our bodies, tools, & the environment to aid thought
3. Some **actions** in the world can **outperform mental operations**

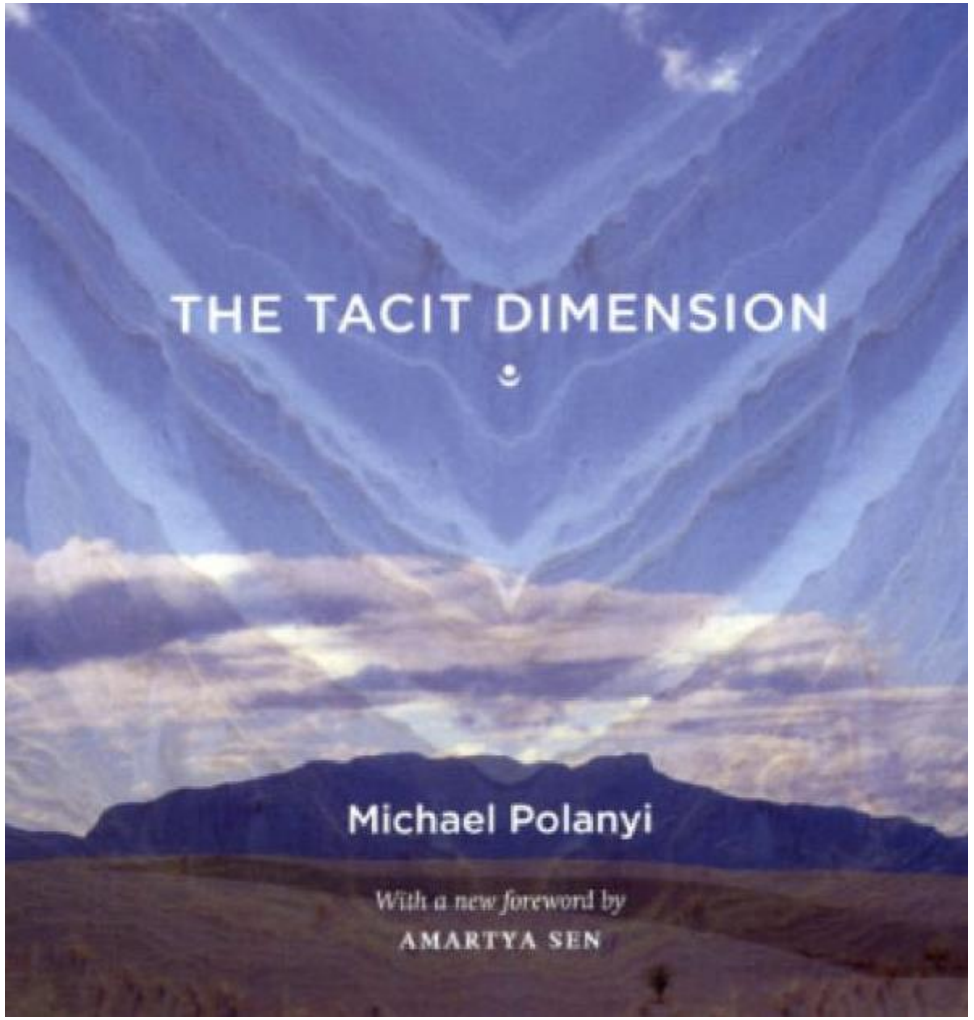


Builds on theories of embodied & distributed cognition

Based on: Bjoern Hartmann, PhD Dissertation, 2009; Chapter 2: "Prototypes in the Design Process";; additions by Jon Froehlich

COGNITIVE BENEFITS OF PROTOTYPING

THE TACIT DIMENSION OF KNOWLEDGE



I shall reconsider human knowledge by starting from the fact that **we can know more than we can tell.**

Michael Polanyi
Philosopher, Scientist, and Writer
Quote from: The Tacit Dimension, 1966

PROTOTYPING ALLOWS FOR EXPRESSION OF TACIT KNOWLEDGE

Creating intermediate tangible artifacts—i.e., *prototyping*—allows for the **expression of tacit knowledge**

Scott Klemmer, Bjoern Hartmann, Leila Takayama
From: *How Bodies Matter: Five Themes for Interaction Design*
DIS, 2006, p. 142


How Bodies Matter: Five Themes for Interaction Design

Scott R. Klemmer, Björn Hartmann
Stanford University HCI Group
Computer Science Department
Stanford, CA 94305-9035, USA
{srk, bjoern}@cs.stanford.edu

Leila Takayama
Stanford University CHIMe Lab
Communication Department
Stanford, CA 94305-2050, USA
takayama@stanford.edu

WHY PROTOTYPE

COGNITIVE BENEFITS OF PROTOTYPING

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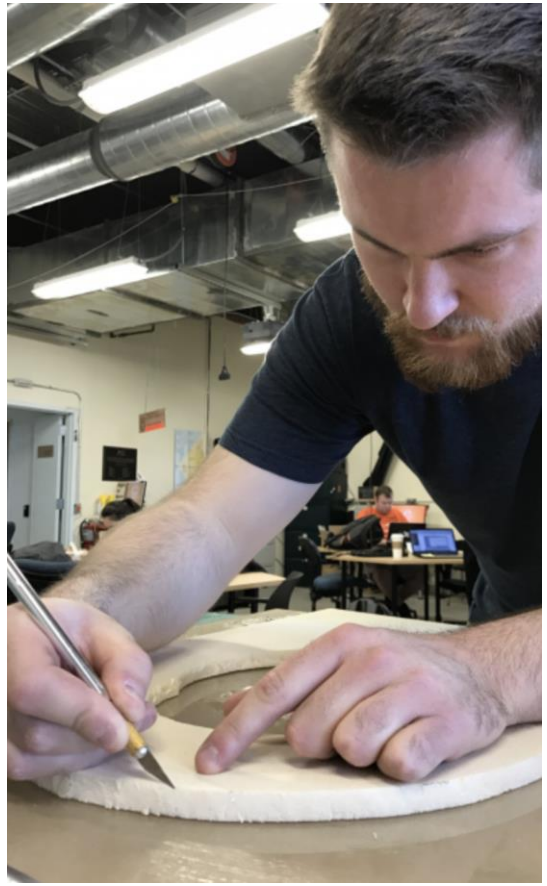
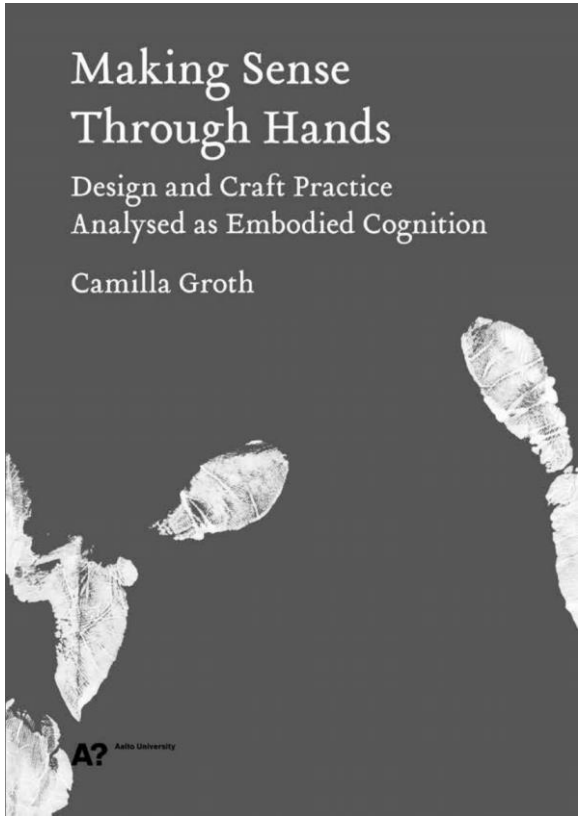


Builds on theories of embodied & distributed cognition

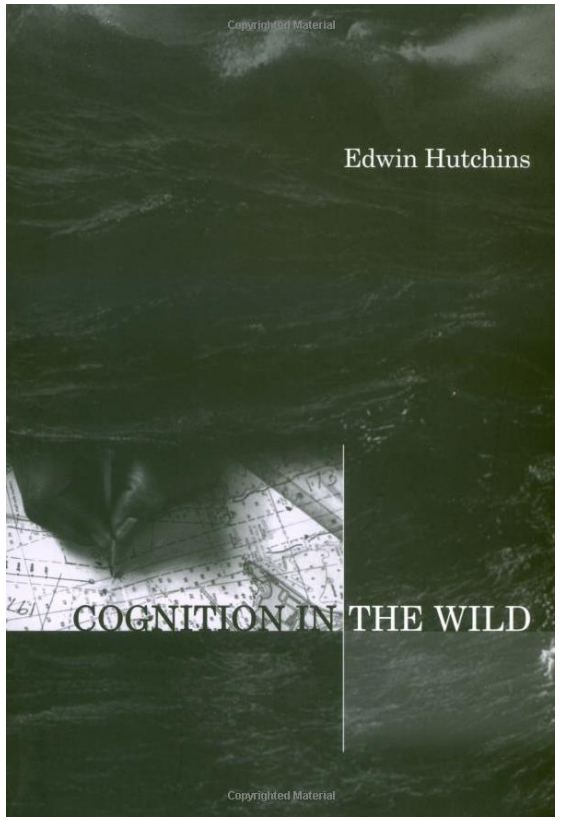
Based on: Bjoern Hartmann, PhD Dissertation, 2009; Chapter 2: "Prototypes in the Design Process";; additions by Jon Froehlich

COGNITIVE BENEFITS OF PROTOTYPING

TWO THEORETICAL MOTIVATIONS



Embodied Cognition
How do our bodies & actions in the world aid thought?



Distributed Cognition
How is cognition distributed into the world to aid thought?

COGNITIVE BENEFITS OF PROTOTYPING

THINKING THROUGH DOING: EMBODIED COGNITION

> Embodied cognition theory argues that **thought** (mind) and **action** (body) are **deeply integrated** and co-produce learning and reasoning. In this view, "**thinking through doing**" – engaging with ideas on a tangible level – is a more successful strategy for design than thinking about the problem alone.

Bjoern Hartmann
HCI Professor at UC Berkeley / Designer / Inventor

Quote from: Chapter 2 "Prototypes in the Design Process" in Bjoern's PhD Dissertation: *Gaining Design Insight Through Interaction Prototyping Tools*, 2009

COGNITIVE BENEFITS OF PROTOTYPING

EMBODIED COGNITION

USING OUR FINGERS TO HELP WITH BASIC MATHEMATICS

MONTESORRI METHOD EMPLOYS BODILY ENGAGEMENT WITH PHYSICAL OBJECTS TO FACILITATE LEARNING

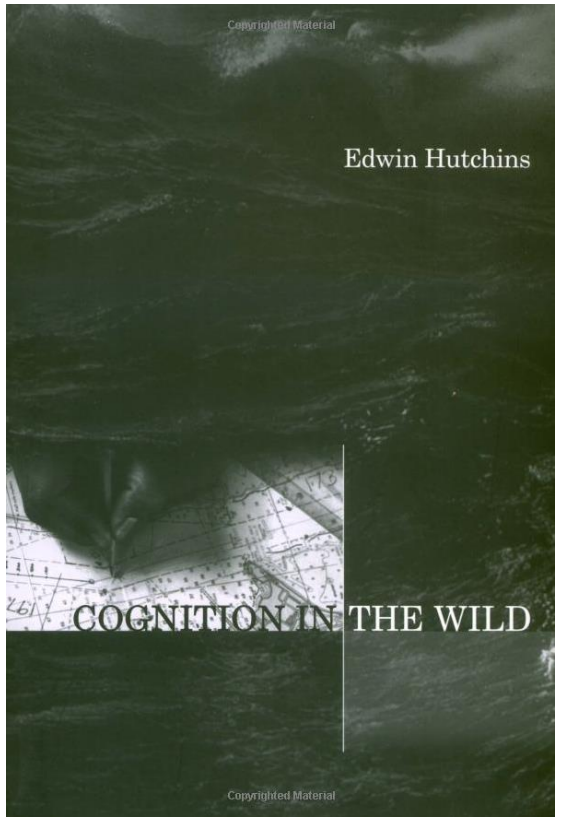
GESTURING DOES NOT JUST SUPPORT COMMUNICATION BUT ACTUALLY AIDS COGNITION (E.G., GOLDIN-MEADOW, 2001)

See: Klemmer *et al.,* How bodies matter: five themes for interaction design, DIS'06

COGNITIVE BENEFITS OF PROTOTYPING

TWO THEORETICAL MOTIVATIONS

Embodied Cognition
How do our bodies & actions in the world aid thought?



Distributed Cognition
How is cognition distributed into the world to aid thought?

COGNITIVE BENEFITS OF PROTOTYPING

THINKING THROUGH DOING: DISTRIBUTED COGNITION

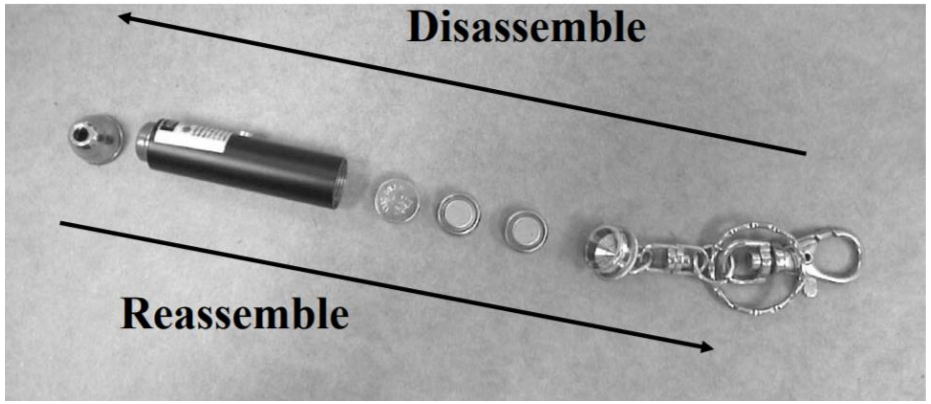
> Unlike traditional cognitive theories, distributed cognition extends the reach of what is considered cognitive **beyond the individual** to encompass interactions between people and with resources and materials in the environment.

Hollan, Hutchins, and Kirsh
Cogsci professors at UC San Diego

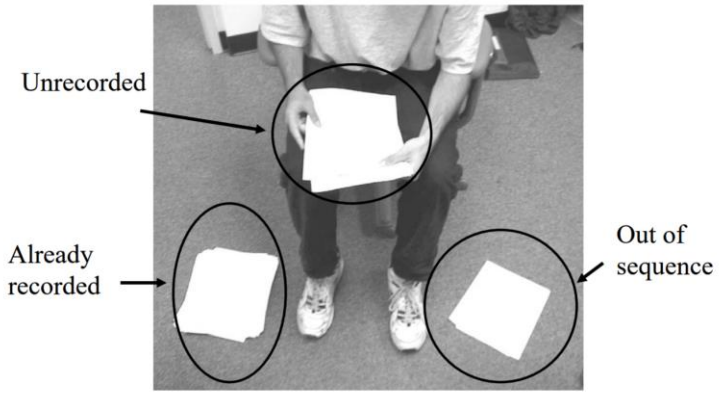
Source: Hollan, Hutchins, and Kirsh, Distributed cognition: toward a new foundation for human-computer interaction research, ACM TOCHI'00

COGNITIVE BENEFITS OF PROTOTYPING

DISTRIBUTED COGNITION



Disassembling object but maintaining part sequence to aid reassembly.



Sorting through paper by spatially arranging piles (*e.g.,* to help track what's been processed).

Arranging hand of cards to aid card play.

Sources: http://intersci.ss.uci.edu/wiki/pub/HutchinsDraft.pdf; http://adrenaline.ucsd.edu/kirsh/Articles/cogsci-final2/cogsci-final2.html

COGNITIVE BENEFITS OF PROTOTYPING

DISTRIBUTED COGNITION

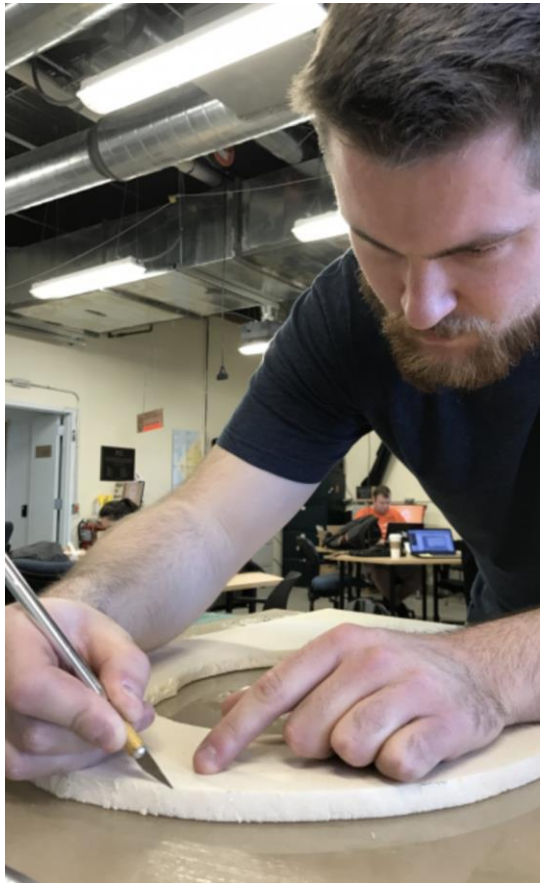
WHY PROTOTYPE

COGNITIVE BENEFITS OF PROTOTYPING

1. Allows for **exploration of tacit knowledge**

2. **Thinking through doing**— using our bodies, tools, & the environment to aid thought

3. Some **actions** in the world can **outperform mental operations**



Builds on theories of embodied & distributed cognition

Based on: Bjoern Hartmann, PhD Dissertation, 2009; Chapter 2: "Prototypes in the Design Process";; additions by Jon Froehlich

COGNITIVE BENEFITS OF PROTOTYPING

EPISTEMIC ACTION

Epistemic actions are physical actions whose primary function is to improve cognition by:

1. Reducing the memory involved in mental computation (*i.e.*, space complexity)
2. Reducing the number of steps involved in mental computation (*i.e.*, time complexity).
3. Reducing the probability of error of a mental computation (*i.e.*, unreliability)

Source: Kirsh, D. and Maglio, P. (1994), On Distinguishing Epistemic from Pragmatic Action. Cognitive Science,

COGNITIVE BENEFITS OF PROTOTYPING

TETRIS EXAMPLE

Who rotates their pieces more frequently: expert Tetris players or novices?

And why?

Source: Kirsh, D. and Maglio, P. (1994), On Distinguishing Epistemic from Pragmatic Action. Cognitive Science,

COGNITIVE BENEFITS OF PROTOTYPING

TETRIS EXAMPLE

Kirsh and Maglio studied expert and novice Tetris players—in particular, the amount of piece rotations performed by both groups.

Source: Kirsh, D. and Maglio, P. (1994), On Distinguishing Epistemic from Pragmatic Action. Cognitive Science,

COGNITIVE BENEFITS OF PROTOTYPING

TETRIS EXAMPLE

Kirsh and Maglio studied expert and novice Tetris players—in particular, the amount of piece rotations performed by both groups.

Counter to intuition, perhaps, they found that **experts rotated their pieces more frequently**.

Kirsh and Maglio theorized that **experts were using piece rotations to help visualize game states**, which was easier and faster than mentally rotating pieces and checking for fits.

Source: Kirsh, D. and Maglio, P. (1994), On Distinguishing Epistemic from Pragmatic Action. Cognitive Science,

COGNITIVE BENEFITS OF PROTOTYPING

SCRABBLE EXAMPLE

How does manipulating the arrangement of scrabble letters impact gameplay?

Source: Maglio *et al.,* Interactive skill in Scrabble. CogSci Society'99

COGNITIVE BENEFITS OF PROTOTYPING

SCRABBLE EXAMPLE

In a controlled, between-subjects lab study, participants were asked to **generate as many words as possible from seven letters**.

In one condition, participants **could use their hands**, and in another, they could not.

They found that participants who could physically manipulate the letters generated more words.

Source: Maglio *et al.,* Interactive skill in Scrabble. CogSci Society'99

COGNITIVE BENEFITS OF PROTOTYPING

CONVERSATIONS WITH MATERIALS

Successful product designs result from a series of "conversations with materials." Here, the "conversations" are interactions between the designer and the design medium — sketching on paper, shaping clay, building with foam core…

Scott Klemmer, Bjoern Hartmann, Leila Takayama

From: *How Bodies Matter: Five Themes for Interaction Design*
DIS, 2006, p. 142

How Bodies Matter: Five Themes for Interaction Design

Scott R. Klemmer, Björn Hartmann
Stanford University HCI Group
Computer Science Department
Stanford, CA 94305-9035, USA
{srk, bjoern}@cs.stanford.edu

Leila Takayama
Stanford University CHIMe Lab
Communication Department
Stanford, CA 94305-2050, USA
takayama@stanford.edu

ABSTRACT

Author Keywords

ACM Classification Keywords

INTRODUCTION

THINKING THROUGH DOING

Breadboard/Sensor Kits for CSE599 Prototyping Interactive Systems Sp2019

File Edit View Insert Format Data Tools Add-ons Help Last edit was made 6 days ago by Chiemi Yamaoka-Vismale

	A	Thing	Type	Dealer	Cost	Count Per Student	Overall Count	Total Price	Url	Order Date	Rece
2	x	Full breadboard	Equip	Adafruit	$5.36	1	19	$101.84	https://www.adafruit.com/product/239	3/14/2019	
3	x	Mini breadboard	Equip	Adafruit	$4.50	1	19	$85.50	https://www.adafruit.com/product/64	3/14/2019	
4	x	9V Battery Clip	Equip	Adafruit	$2.66	1	19	$50.54	https://www.adafruit.com/product/80	3/14/2019	
5	x	Jumper Wire (Breadboarding Wire)	Equip	Adafruit	$4.46	1	19	$84.74	https://www.adafruit.com/product/153	3/14/2019	
6	x	Alligator Clips	Equip	Adafruit	$3.56	1	19	$67.64	https://www.adafruit.com/product/1008	3/14/2019	
7	x	Magnet	Equip	Adafruit	$2.25	1	19	$42.75	https://www.adafruit.com/product/9	3/14/2019	
8	x	Adafruit Feather nRF52840 Express	Microcontroller	Adafruit	$22.46	1	19	$426.74	https://www.adafruit.com/product/4062	3/14/2019	
9	x	RGB LEDs	Output	Adafruit	$1.50	3	57	$85.50	https://www.adafruit.com/product/159	3/14/2019	
10	x	Micro servo	Output	Adafruit	$5.36	1	19	$101.84	https://www.adafruit.com/product/169	3/14/2019	
11	x	10K Resistors (25 Pack)	Resistor	Adafruit	$0.68	1	19	$12.92	https://www.adafruit.com/product/2784	3/14/2019	
12	x	Potentiometers 10K	Resistor/Input	Adafruit	$1.13	3	57	$64.41	https://www.adafruit.com/product/356	3/14/2019	
13	x	Force-Sensitive Resistor	Sensor	Adafruit	$6.30	1	19	$119.70	https://www.adafruit.com/product/166	3/14/2019	
14	x	IMU	Sensor	Adafruit	$13.46	1	19	$255.74	https://www.adafruit.com/product/163	3/14/2019	
15	x	Electret Microphone Amplifier - MAX9814 v	Sensor	Adafruit	$7.16	1	19	$136.04	https://www.adafruit.com/product/1713	3/14/2019	
16	x	Photocell	Sensor	Adafruit	$0.86	2	38	$32.68	https://www.adafruit.com/product/161	3/14/2019	
17	x	Tactile Switch Buttons	Sensor	Adafruit	$2.25	1	19	$42.75	https://www.adafruit.com/product/1119	3/14/2019	
18	x	Analog Temperature Sensor	Sensor	Adafruit	$1.35	1	19	$25.65	https://www.adafruit.com/product/165	3/14/2019	
19				**sub total**	**$85.30**			**$1,736.98**	**Tax**	**175.43**	
20	x	9V Battery 8-Pack	Equip	Amazon	$9.99	1	3	$29.97	https://www.amazon.com/AmazonBasics-Everyday-Alkali	3/14/2019	
21	x	Pack of 12 Sterlite 6-Quart Bins	Equip	Amazon	$23.91	1	2	$47.82	https://www.amazon.com/Sterilite-16428012-Quart-Liter-Storage/dp/B002BDTETW/ref=sr_1_4?keywords=plastic%2Bbins&qid=1552568536&s=gateway&sr=8-4&th=1	3/14/2019	
22	x	Arduino Leonardo	Microcontroller	Amazon	$22.19	1	19	$421.61	https://www.amazon.com/Arduino-org-A000057-Arduino-Leonardo-Headers/dp/B008A36R2Y	3/14/2019	
23				**Sub total**	**$56.09**			**$499.40**	**Tax**	**50.41**	
24	x	Piezo buzzer	Output	Mouser	$0.62	1	19	$11.82	https://www.mouser.com/ProductDetail/810-PS1240P02BT	3/14/2019	
25	x	Linear Hall Effect Sensor	Sensor	Mouser	$1.23	1	19	$23.37	https://www.mouser.com/ProductDetail/Texas-Instruments/DRV5055A1QLPGM?qs=sGAEpiMZZMve4%2fbfQkoj%252bOyN%252bPcJF6k3Pkf5o60GQ5I%3d	3/14/2019	
									https://www.mouser.com/ProductDetail/FTDI/CUB-100-B		

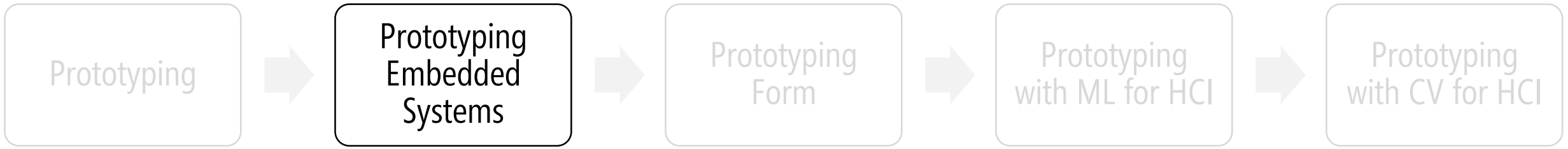
COGNITIVE BENEFITS OF PROTOTYPING

IN SUMMARY

Our bodies, physical actions, and use of tools and the environment shape how we think.

The act of prototyping engages our bodies and senses in thought and can be faster/easier/better than mental operations alone

NEXT TIME


Prototyping
Prototyping Embedded Systems
Prototyping Form
Prototyping with ML for HCI
Prototyping with CV for HCI

PROTOTYPING INTERACTIVE SYSTEMS

CSE 599 Prototyping Interactive Systems| Lecture 1 | April 2

Jon Froehlich • Jasper O'Leary (TA)

DESIGN USE BUILD

MAKEABILITY LAB

PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

UNIVERSITY of WASHINGTON