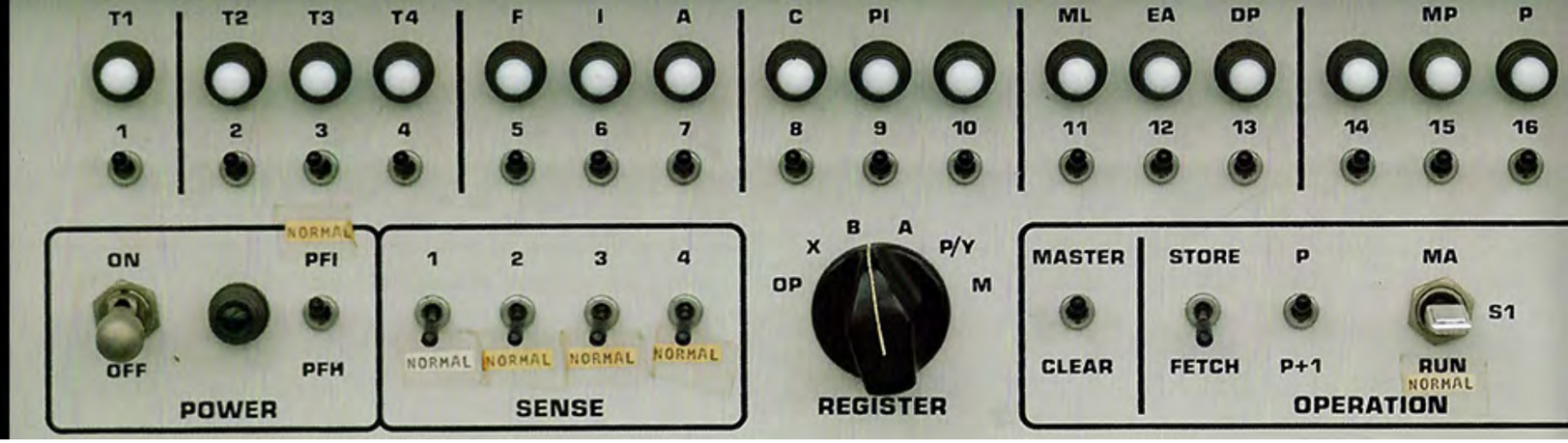
CS160

USER INTERFACE DESIGN

FALL 2018



INFORMATION VISUALIZATION

3 OCT 2018

ERIC PAULOS
www.paulos.net

UNIVERSITY OF CALIFORNIA Berkeley

11:18

ANNOUNCEMENTS

Grading — Qualitative

Midterm 15 Oct

PROG 02B Due Friday

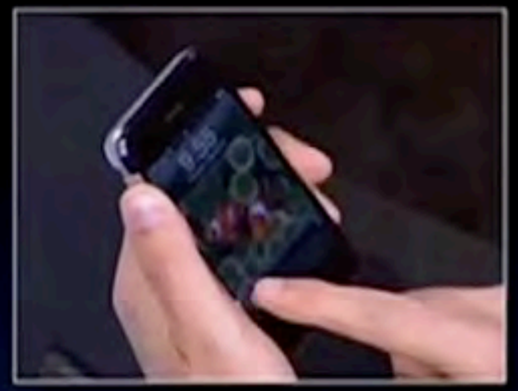
- Please try discussing with other people in the class
- Piazza is getting flooded with questions that are either really easily google-able or difficult to debug remotely without having access to the emulator
- You do not need to handle Committees or Bills
- Special Office Hour Thursday 6–8pm in 310C Jacobs Hall **TOMORROW**

Phase B Grading

- Does your app get the current location correctly on the phone? (3 points)
- Does your app correctly look up Senator and House Representative data by location? Do you disambiguate cases by ZIP code where there are multiple congresspeople? (5 points)
- Does your app use the APIs to get and display the required data for each congressperson: full name, their party (Democrat, Republican, Independent), email (with link), website (with link), on the phone? (10 points)
- Does your app implement a random feature for selecting a random location and updating the proper visuals on the phone? (2 points)
- Design: Does your app make good use of visual elements and an intuitive, easy-to-use interaction flow? (15 points)
- Documentation: narrated video, GitHub updated with new APKs, PDF contains screenshots + descriptions of the app (5 pts)

(MULTI-) TOUCH


cingular
9:55
Tuesday, January 9
slide to unlock



STRENGTHS

Direct input allows maximal screen space for mobile devices (ocular centrism).

More degrees of freedom.

“Virtual input devices” are adaptable.

No extra pieces to lose or break (styli!)

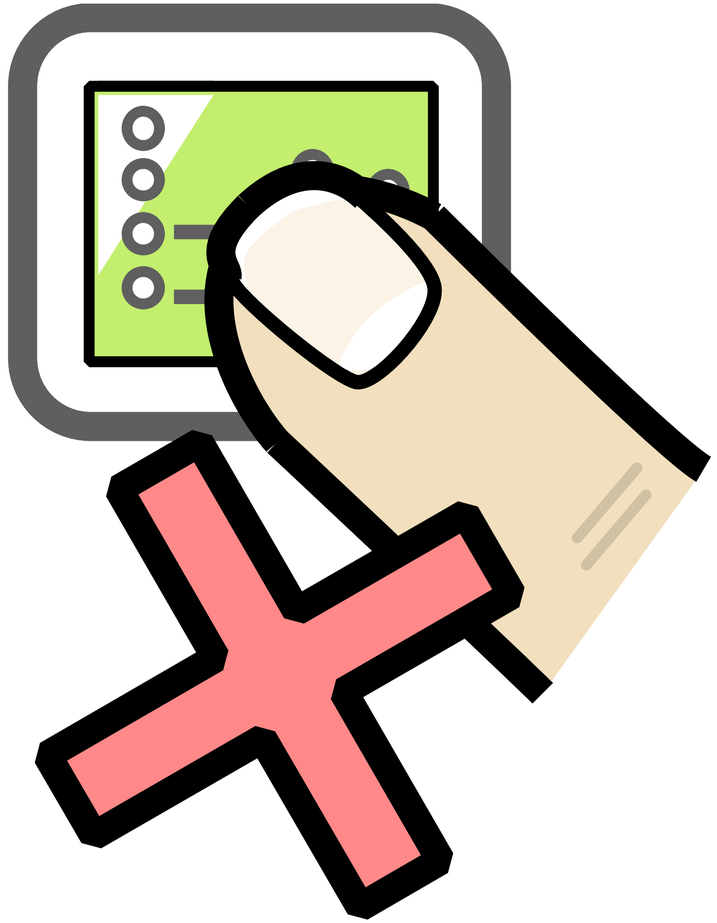
CHALLENGES

No tactile feedback.

Requires free use of (both) hands and eyes.

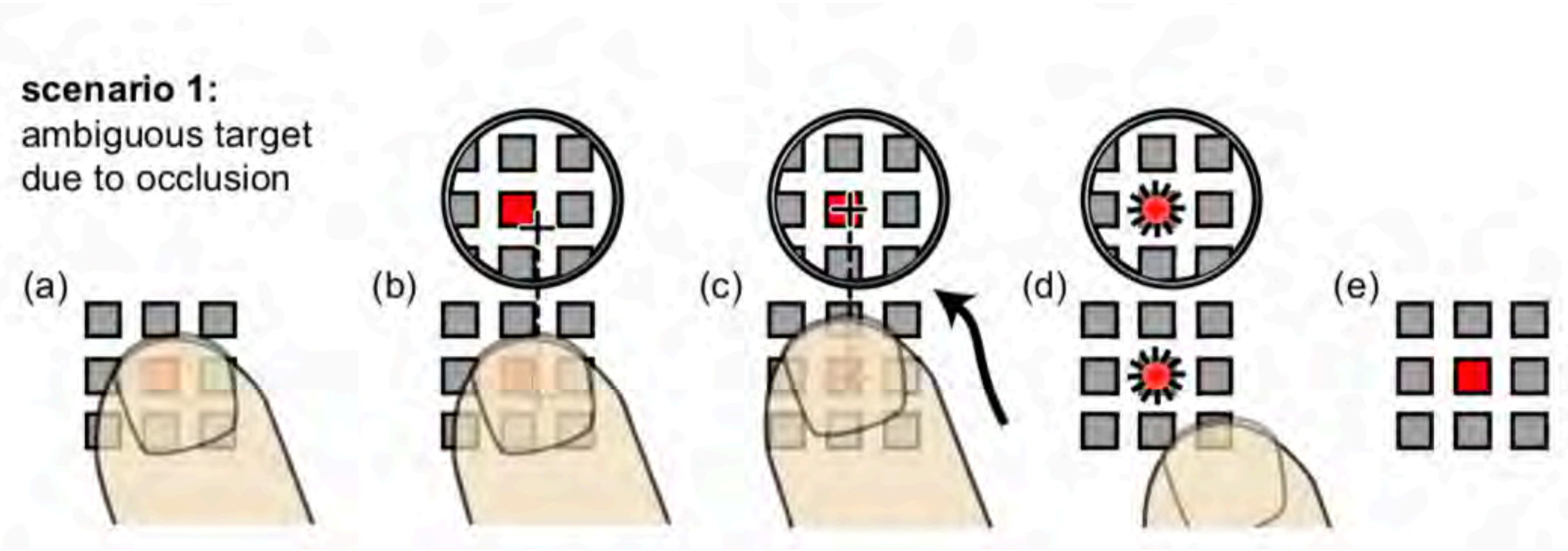
“Fat Finger” problems – precision & occlusion

THE “FAT FINGER” PROBLEM



Graphics: Patrick Baudisch, nanoTouch

A SOFTWARE SOLUTION



Graphics: D. Vogel, P. Baudisch - Shift 2007

A SOFTWARE SOLUTION

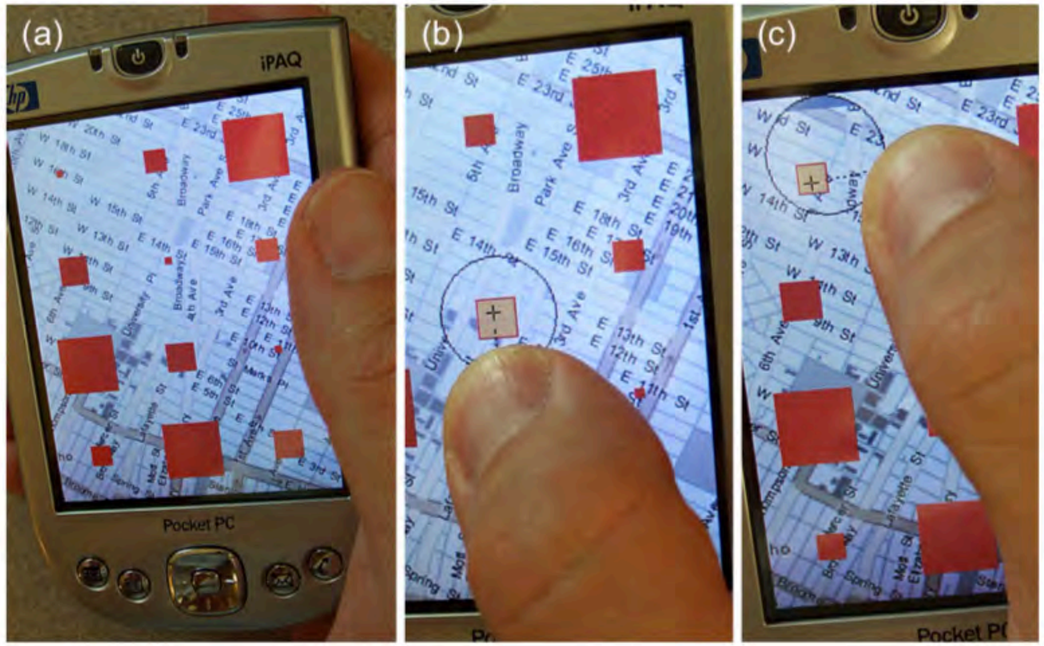
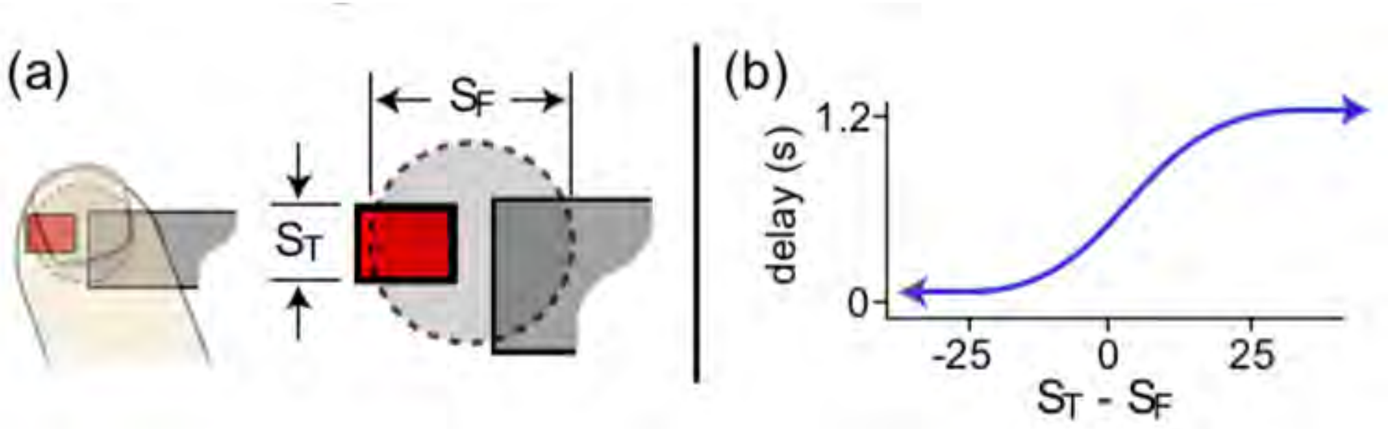
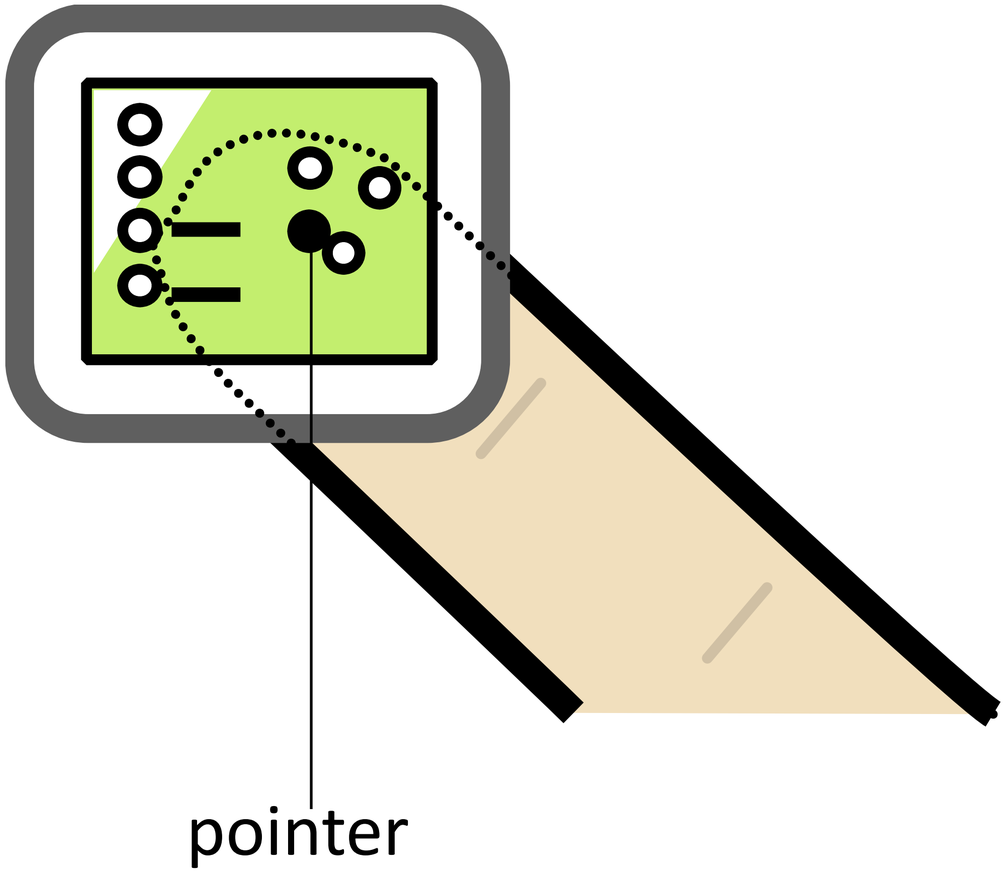


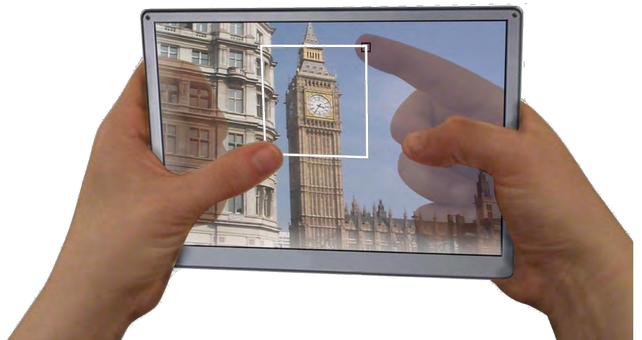
Figure 1. (a) Small targets are occluded by a user's finger. (b) The proposed *Shift* technique reveals occluded screen content in a callout displayed above the finger. This allows users to fine tune with take-off selection. (c) By adjusting the relative callout location, Shift handles targets anywhere on the screen.



Graphics: D. Vogel, P. Baudisch - Shift 2007

A HARDWARE SOLUTION: USE THE BACKSIDE

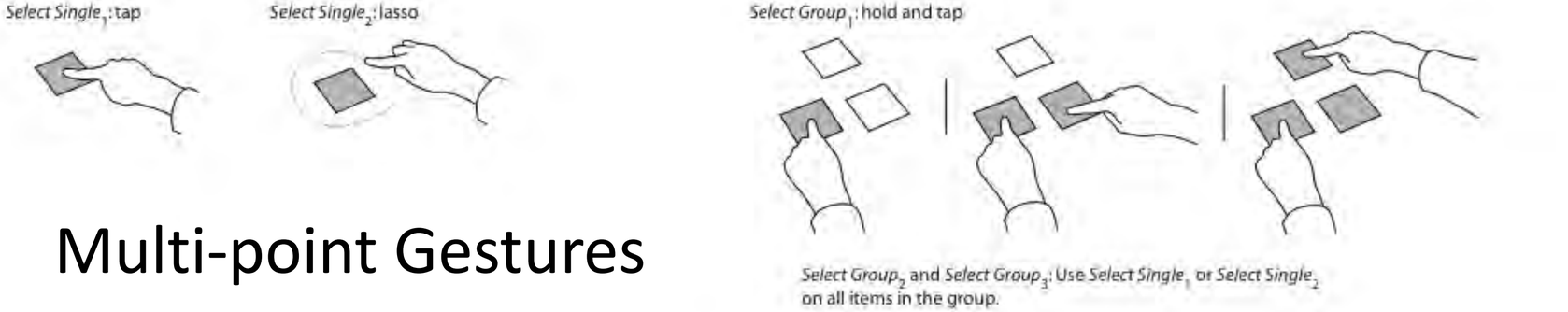




Graphics: Patrick Baudisch, nanoTouch 2009


A
B
C

Multi-point Gestures



Wobbrock, J., **Morris, M.R.**, and Wilson, A. User-Defined Gestures for Surface Computing. *Proceedings of CHI 2009*, 1083-1092.

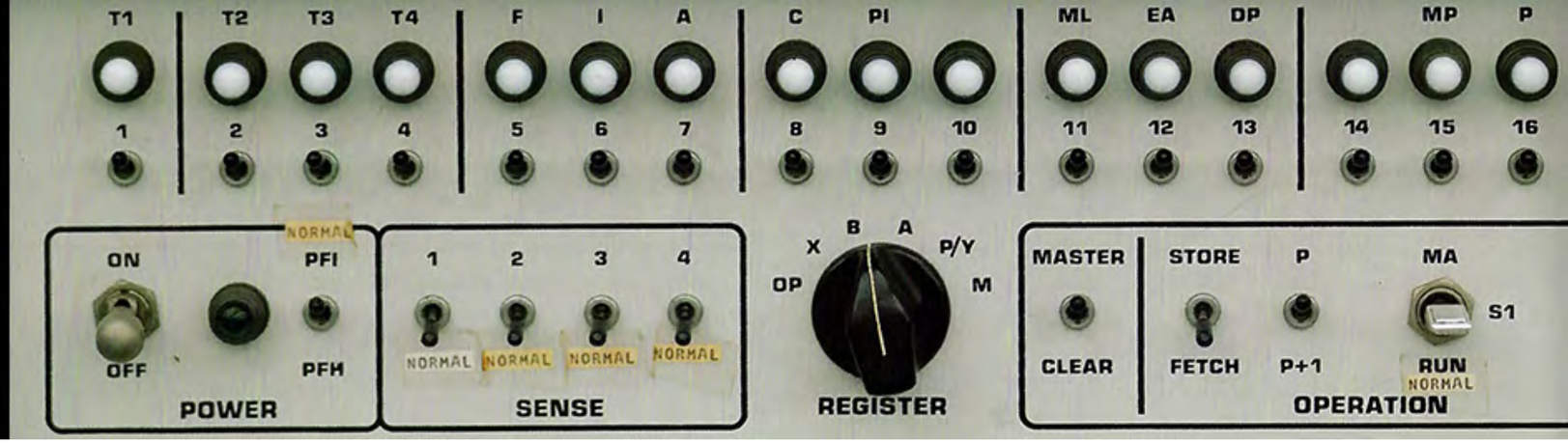
THE MANUAL INPUT SESSIONS: "NEGDROP"

golan levin / zach lieberman . 2004

CS160

USER INTERFACE DESIGN

FALL 2018



INFORMATION VISUALIZATION

3 OCT 2018

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WHAT IS VISUALIZATION?

The depiction of information using spatial and graphical representations

Bringing information to life, visually

WHAT IS VISUALIZATION?

Visualize: to form a mental image or vision of.

Visualize: to imagine or remember as if actually seeing.

American Heritage dictionary, Concise Oxford dictionary

WHAT IS VISUALIZATION?

“Transformation of the symbolic into the geometric”
(McCormick et al., 1987)

“... finding the artificial memory that best
supports our natural means of perception."
(Bertin, 1983)

THE POWER OF VISUALIZATION

Walk
Head north on Sather Rd
Turn left toward Grade St
Slight right onto Grade St
Turn left toward Frank Schlessinger Way
Turn left onto Frank Schlessinger Way
Turn right onto Hilgard Way
Turn left onto Grinnell Pathway
Slight left onto Crescent Lawn
Continue onto Center St
Downtown Berkeley Station
Richmond - Daly City/MillbraeMillbrae
Montgomery Stop
Walk
Head southwest on Market St toward Annie St
Turn left onto 3rd St
Pass by Starbucks (on the left in 135 ft)

THE POWER OF VISUALIZATION

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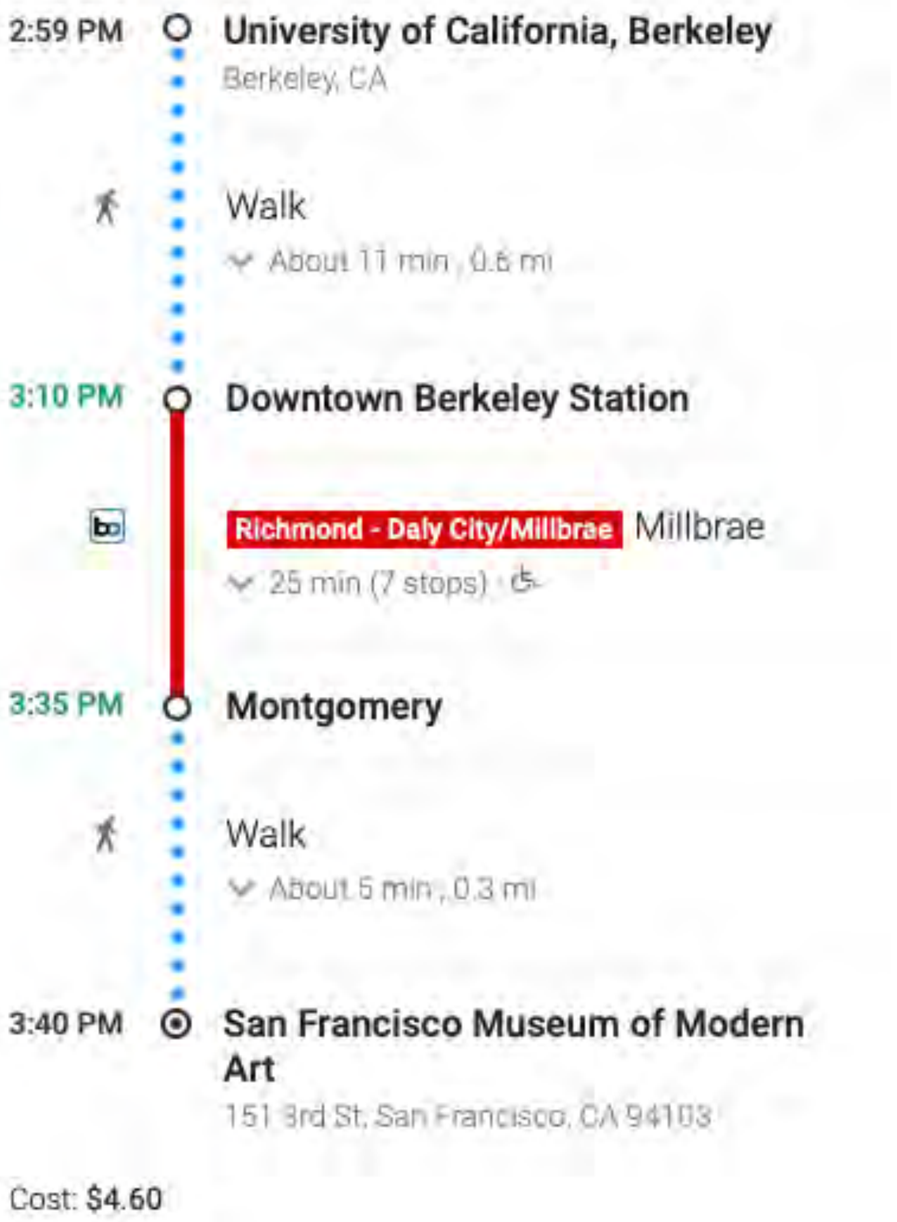
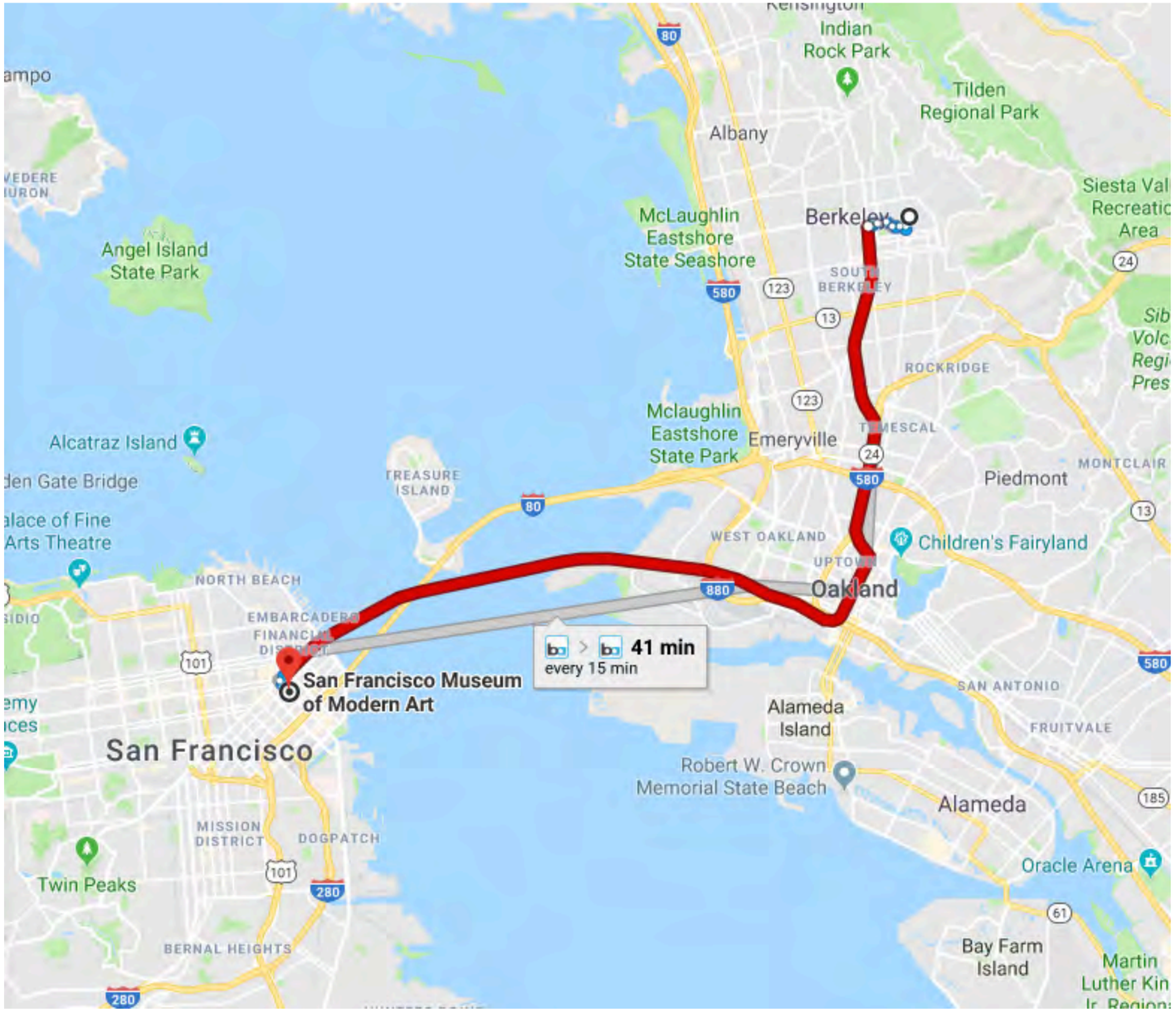
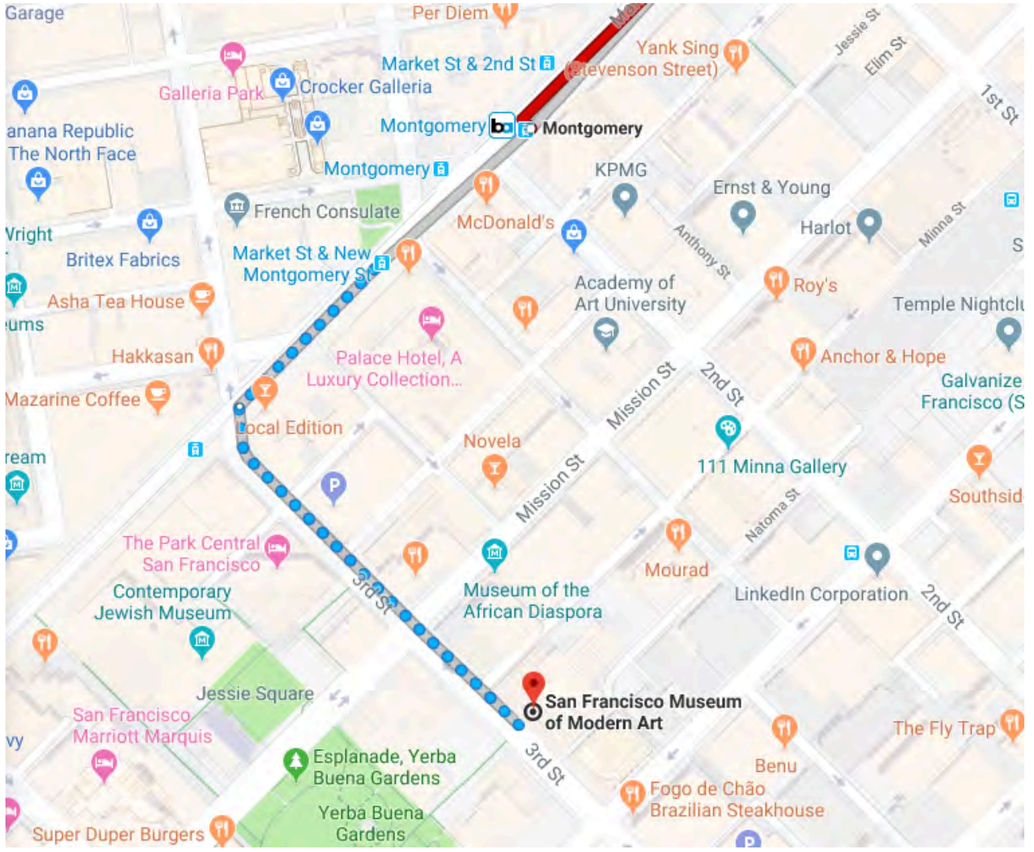
Richmond - Daly City/MillbraeMillbrae
Montgomery Stop
Walk
Head southwest on Market St toward Annie St
Turn left onto 3rd St
Pass by Starbucks (on the left in 135 ft)
San Francisco Museum of Modern Art
151 3rd St, San Francisco, CA 94103

THE POWER OF VISUALIZATION

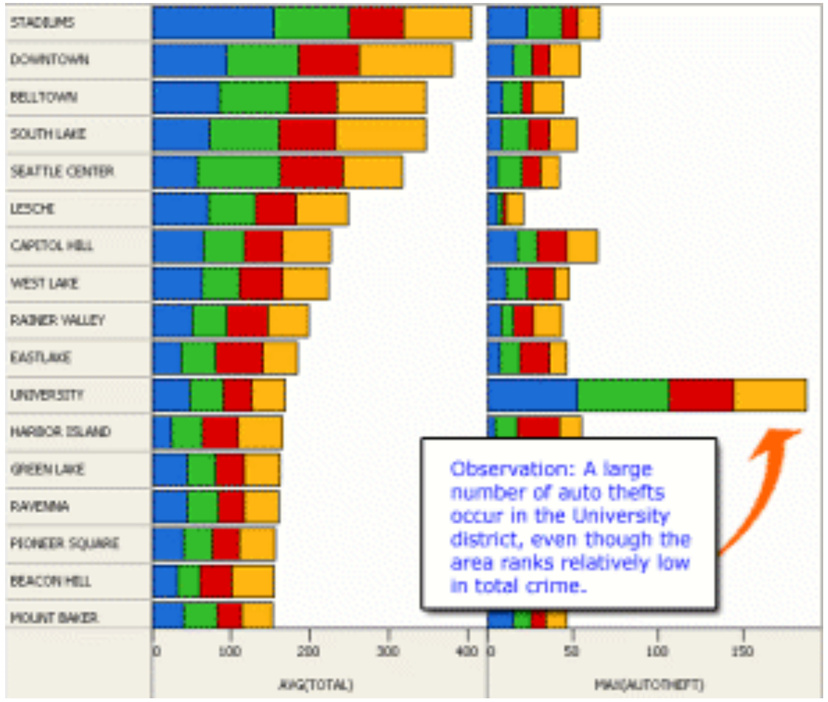


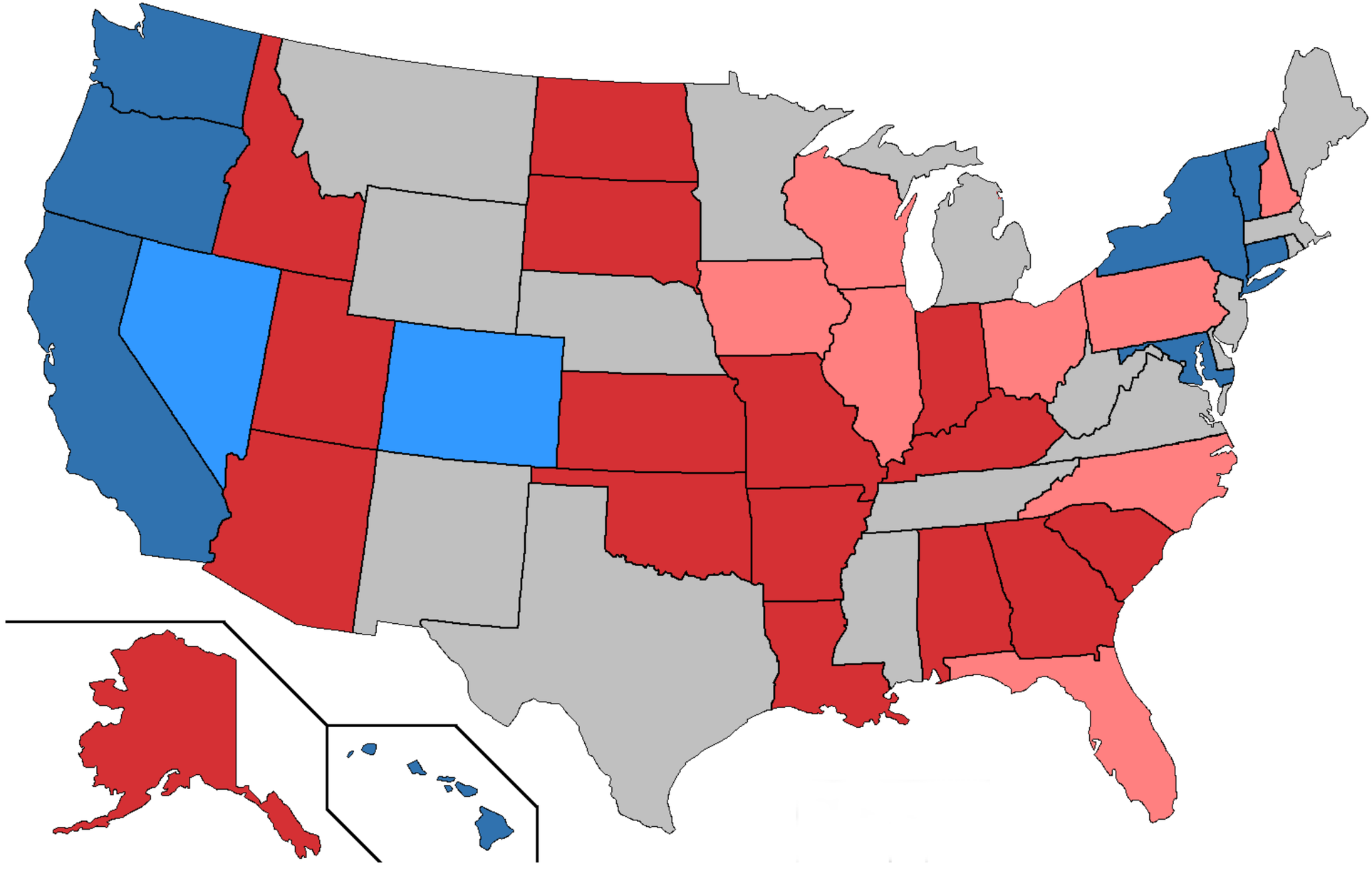
THE POWER OF VISUALIZATION

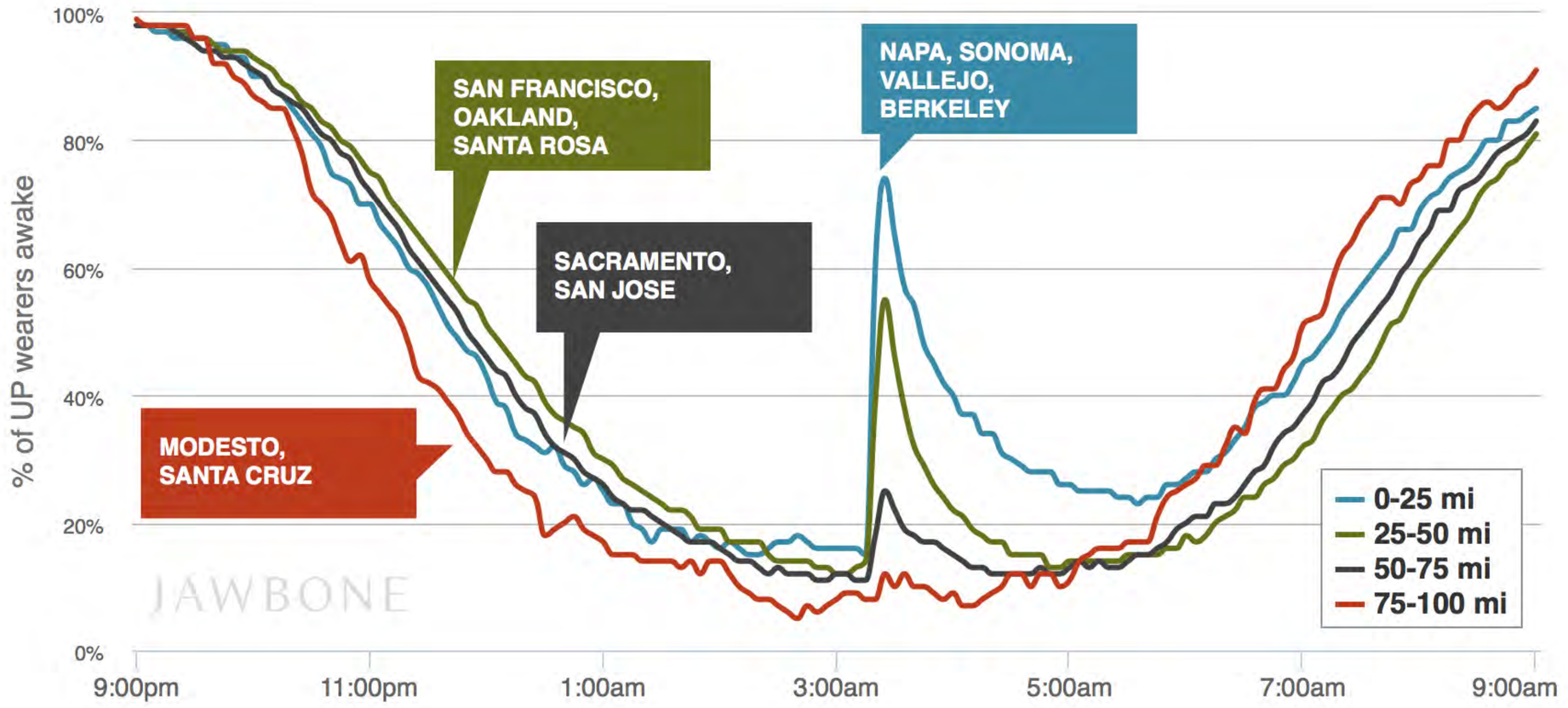


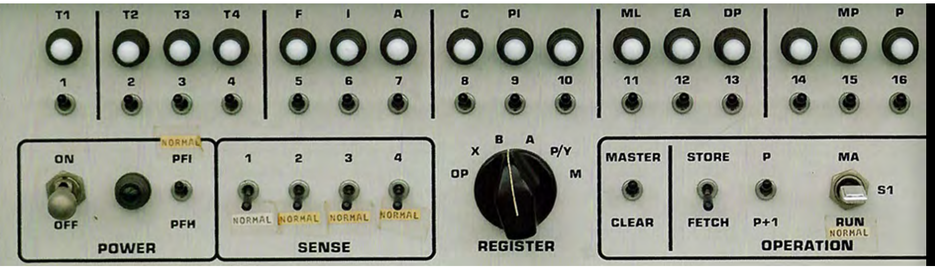


EXAMPLES


STADIUMS
DOWNTOWN
BELLTOWN
SOUTH LAKE
SEATTLE CENTER
LESCHI
CAPITOL HILL
WEST LAKE
RAINER VALLEY
EASTLAKE
UNIVERSITY
HARBOR ISLAND
GREEN LAKE
RAVENNA
PIONEER SQUARE
BEACON HILL
MOUNT BAKER
0
100
200
300
400
AVG(TOTAL)
0
50
100
150
MAX(AUTOTHEFT)
Observation: A large number of auto thefts occur in the University district, even though the area ranks relatively low in total crime.




100%
80%
60%
40%
20%
0%
% of UP wearers awake
9:00pm
11:00pm
1:00am
3:00am
5:00am
7:00am
9:00am
SAN FRANCISCO, OAKLAND, SANTA ROSA
SACRAMENTO, SAN JOSE
MODESTO, SANTA CRUZ
NAPA, SONOMA, VALLEJO, BERKELEY
0-25 mi
25-50 mi
50-75 mi
75-100 mi
JAWBONE



WHY DO WE CREATE VISUALIZATIONS?

THREE PRIMARY FUNCTIONS

Record information

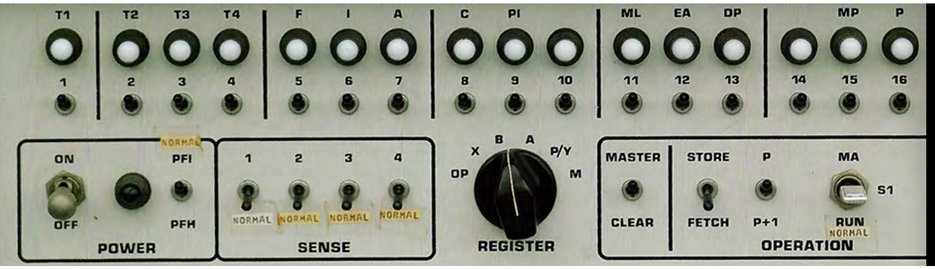
- Photographs, blueprints, ...

Support reasoning about information (analyze)

- Process and calculate
- Reason about data
- Feedback and interaction

Convey information to others (present)

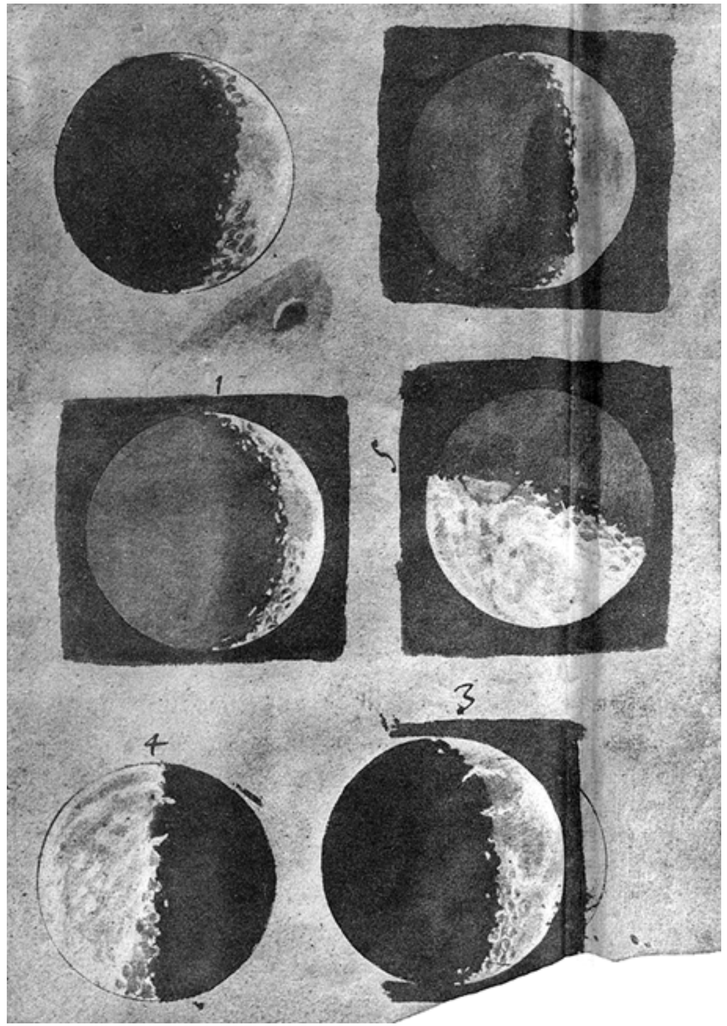
- Share and persuade
- Collaborate and revise
- Emphasize important aspects of data



RECORD INFORMATION

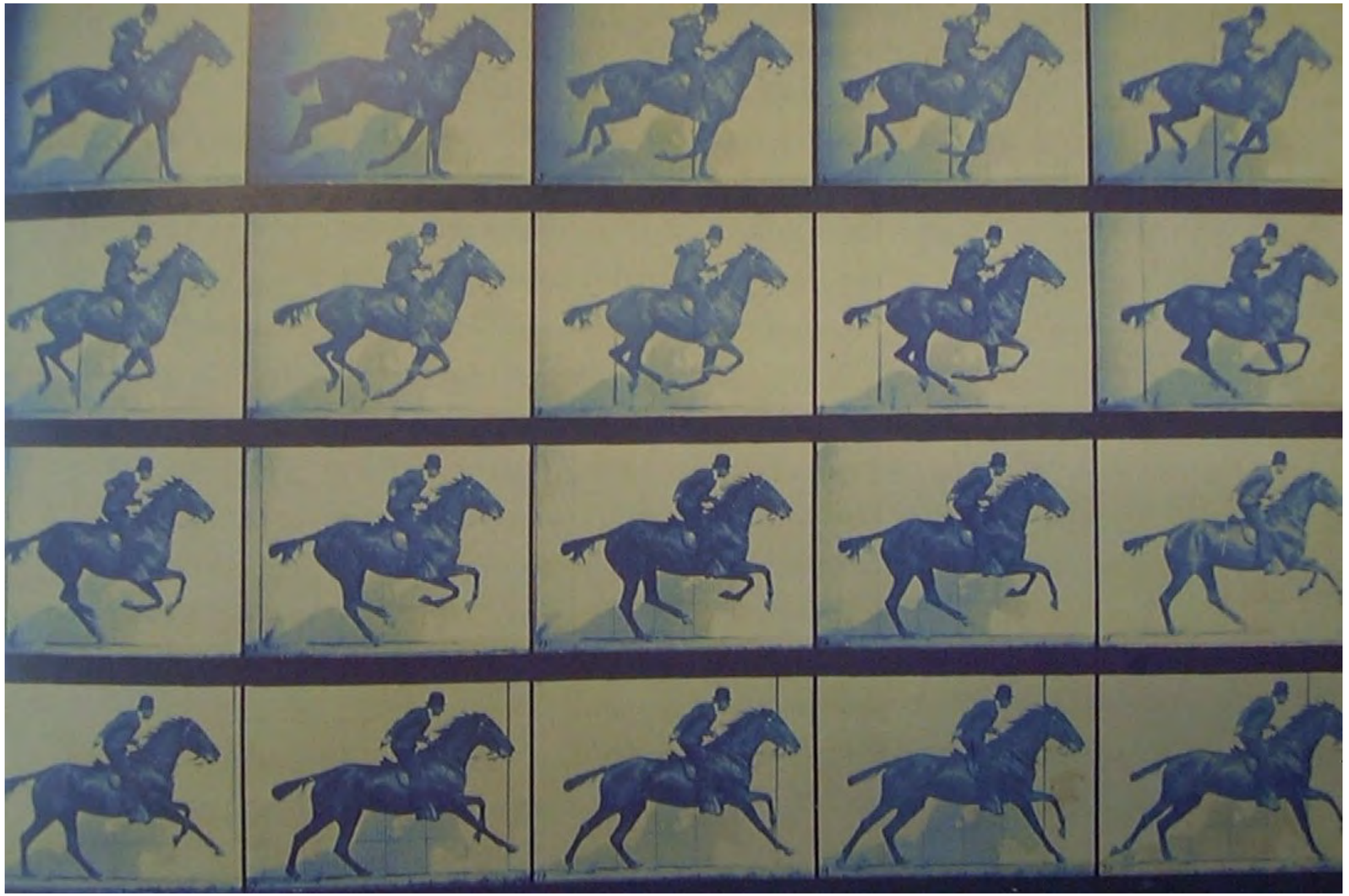
DRAWING: PHASES OF THE MOON

Galileo’s drawings of the phases of the moon from 1616



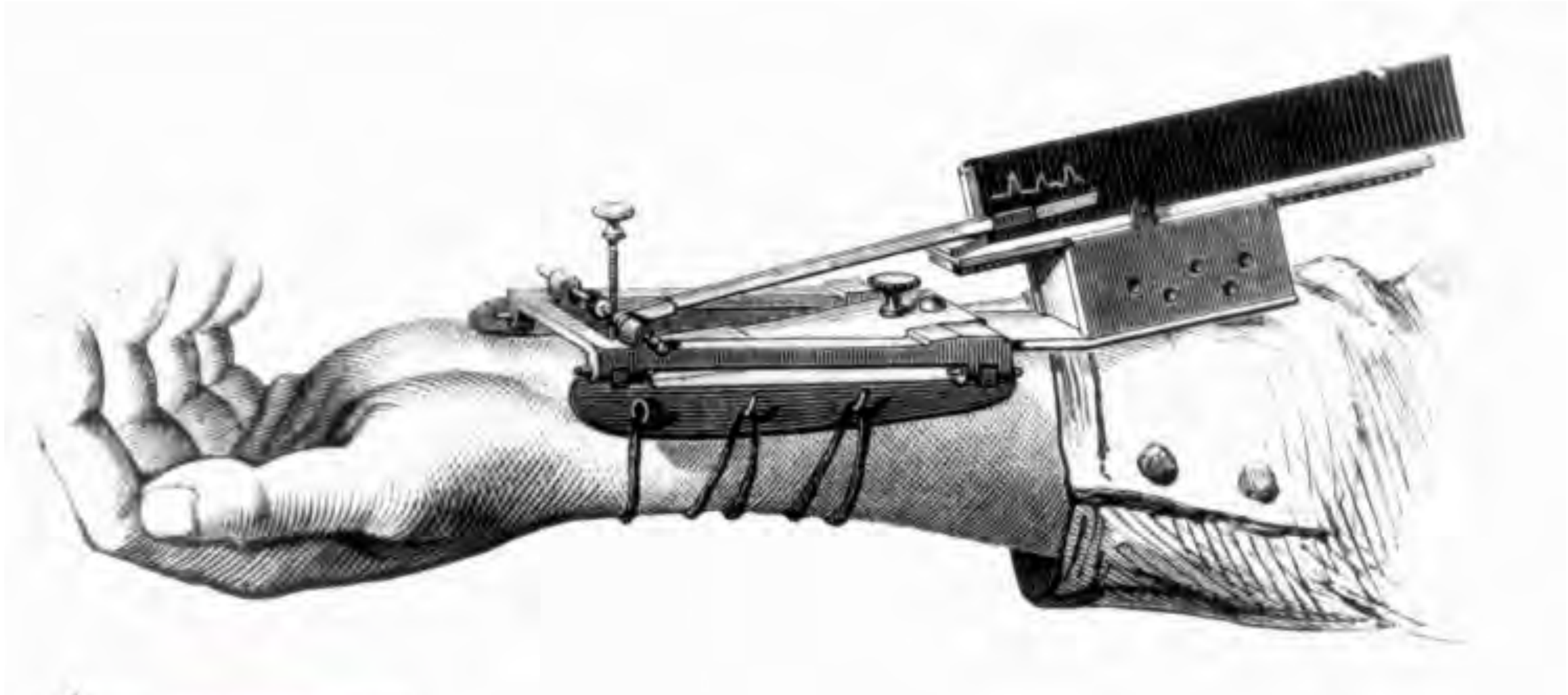
ANSWER QUESTION

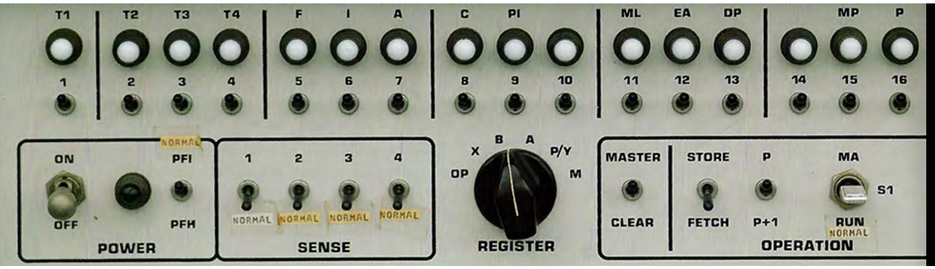
Gallop, Bay Horse “Daisy” ▪ Muybridge 1884–86



OTHER RECORDING INSTRUMENTS

Marey’s sphygmograph





SUPPORT REASONING

INFORMATION VIZ PROBLEM SOLVING

Mystery: what is causing a cholera epidemic in London in 1854?

DATA IN CONTEXT: CHOLERA OUTBREAK

In 1864 John Snow plotted the position of each cholera case on a map

DATA IN CONTEXT: CHOLERA OUTBREAK

Used map to hypothesize that pump on Broad St. was the cause

MAKE A DECISION: CHALLENGER

2 of 13 pages of material faxed to NASA by Morton Thiokol

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

	SRM No.	Cross Sectional View: Erosion Depth (in.)	Cross Sectional View: Perimeter Affected (deg)	Cross Sectional View: Nominal Dia. (in.)	Top View: Length Of Max Erosion (in.)	Top View: Total Heat Affected Length (in.)	Clocking Location (deg)
61A LH Center Field**	22A	None	None	0.280	None	None	36°--66°
61A LH ~~CENTER~~ FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°
51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
41D RH Forward Field	13B	0.028	110.0	0.280	3.00	None	275
41C LH Aft Field*	11A	None	None	0.280	None	None	--
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
**Soot behind primary O-ring.
***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

Blow By History

SRM-15 worst Blow-By
- 2 case joints (80°), (110°) arc
- much worse visually than SRM-22

SRM 22 Blow-By
- 2 case joints (30-40°)

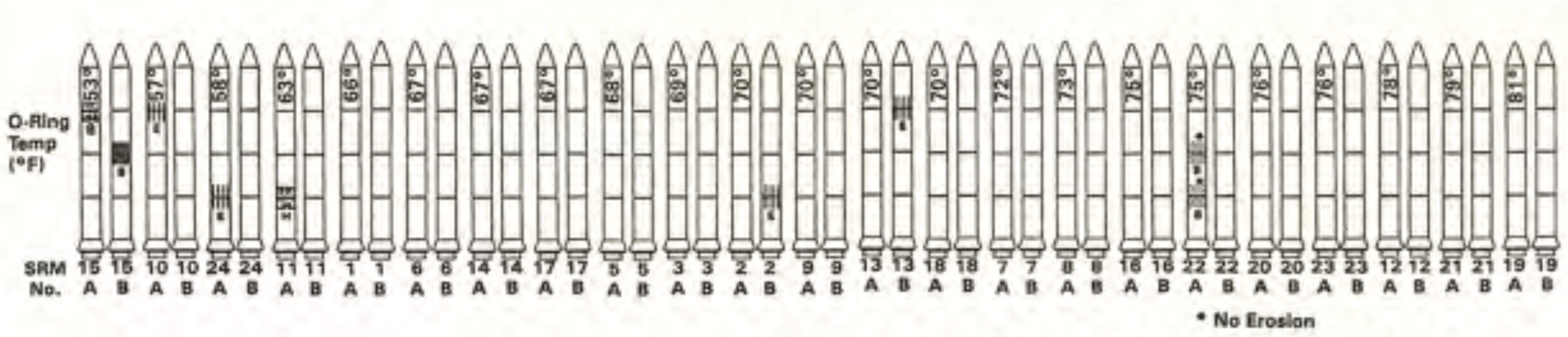
SRM-13A, 15, 16A, 18, 23A 24A
- nozzle Blow-By

HISTORY OF O-RING TEMPERATURES (DEGREES - F)

MOTOR	M&T	AMB	O-RING	WIND
DM-1	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29 27	10 MPH 25 MPH

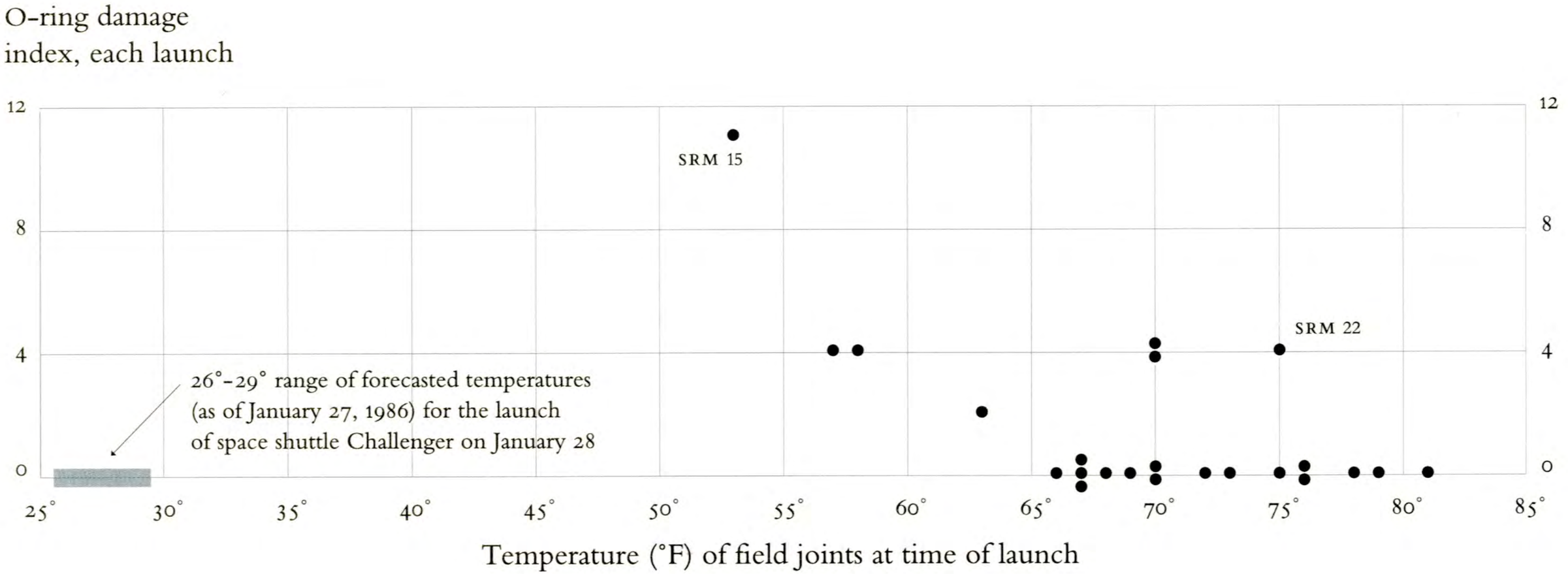
MAKE A DECISION: CHALLENGER

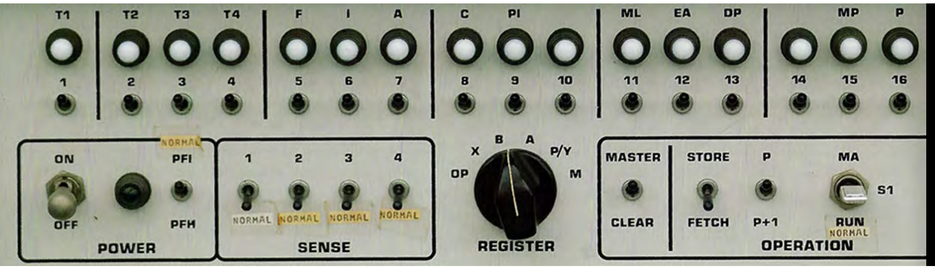
Visualizations by booster rocket manufacturer of damage to O-rings



MAKE A DECISION: CHALLENGER

Visualizations showing how low temperatures damage O-rings

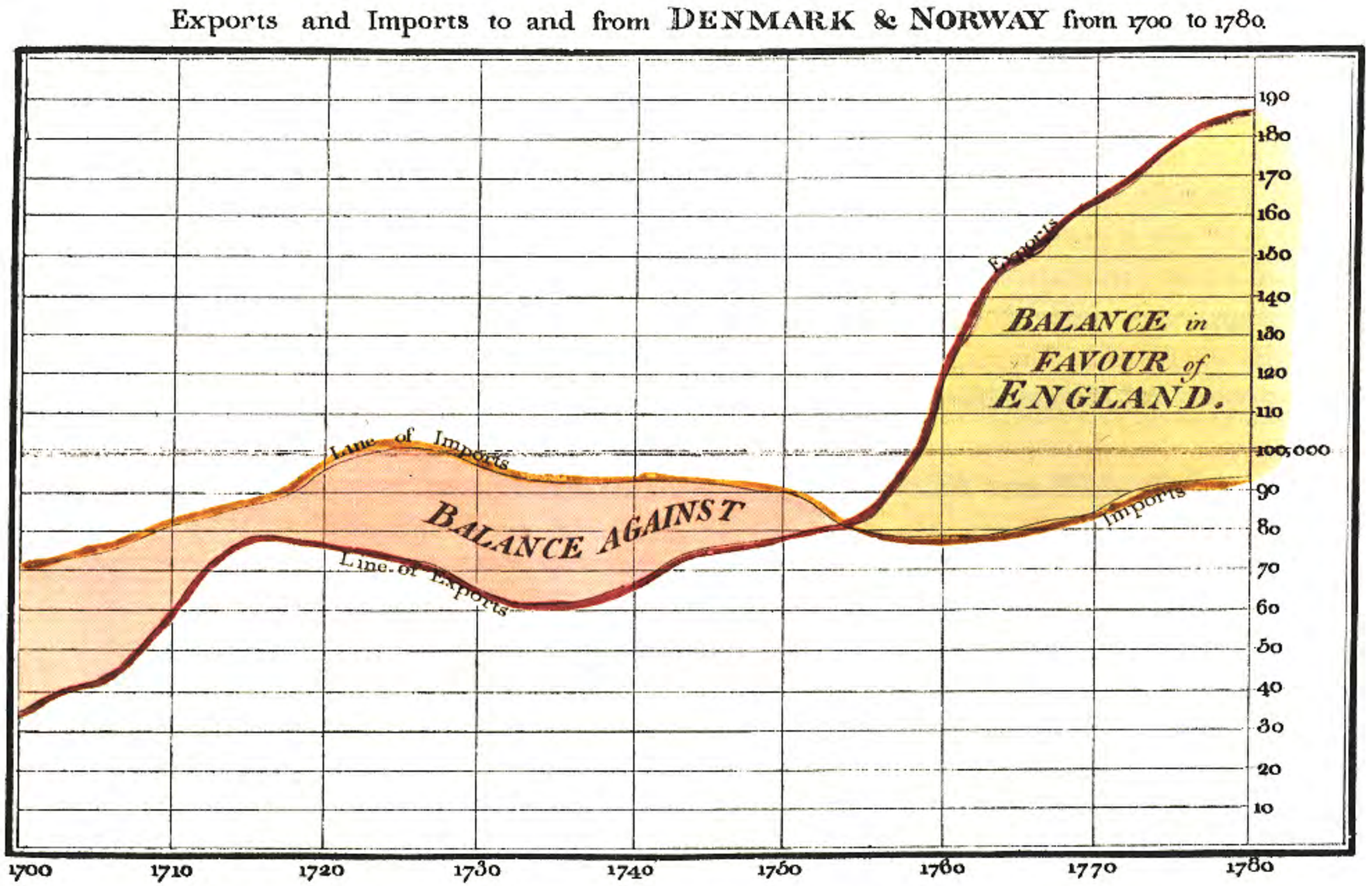




CONVEY INFORMATION TO OTHERS

PRESENT ARGUMENT: EXPORTS & IMPORTS

William Playfair 1786



TREE MAPS

The TreeMap (Johnson & Shneiderman ‘91)

Idea:

Show a hierarchy as a 2D layout

Fill up the space with rectangles representing objects

Nested rectangles indicated levels of hierarchy

Size on screen indicates relative size of underlying objects.

TREE MAP

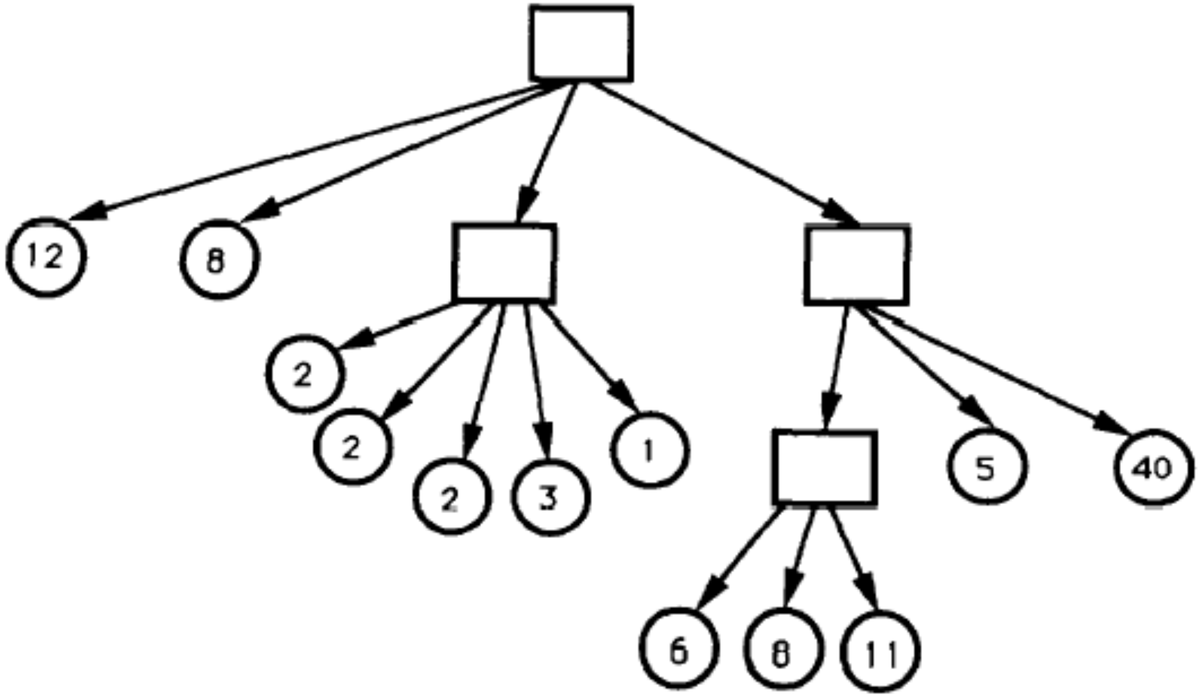


Fig. 1. Typical 3-level tree structure with numbers indicating size of each leaf node.

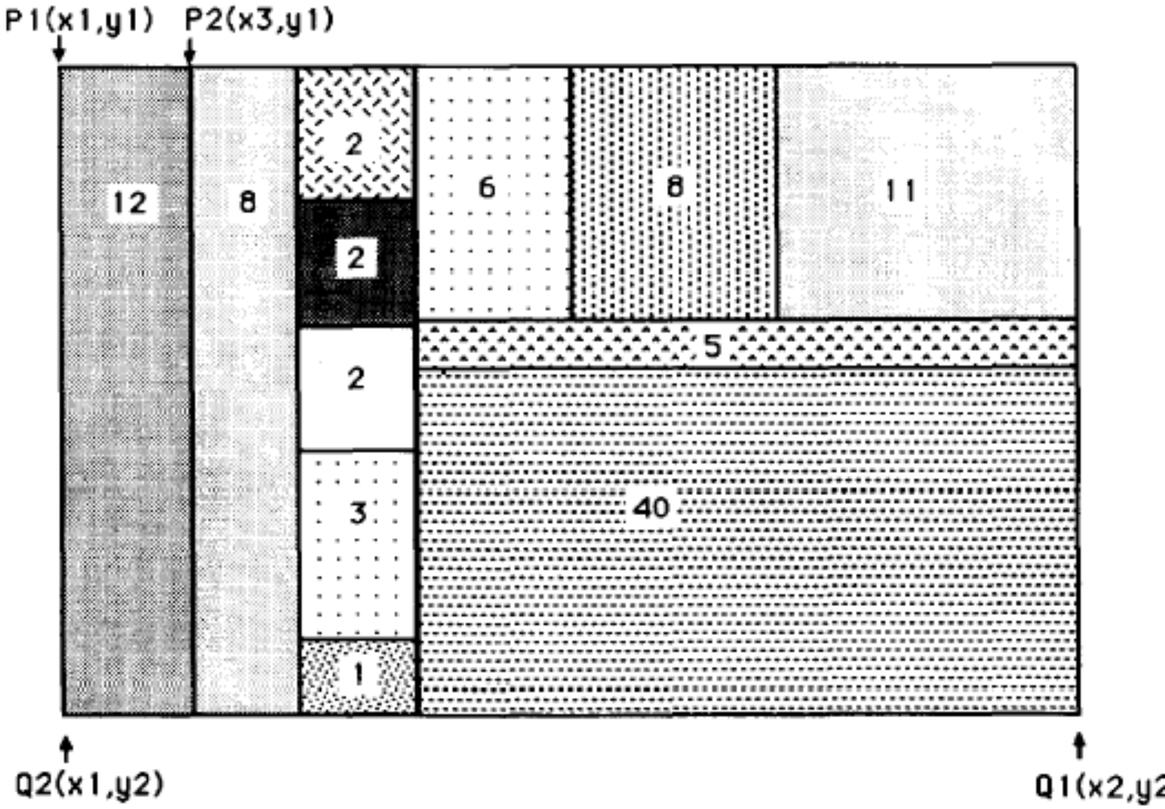


Fig. 2. Tree-map of Figure 1.

TREE MAP

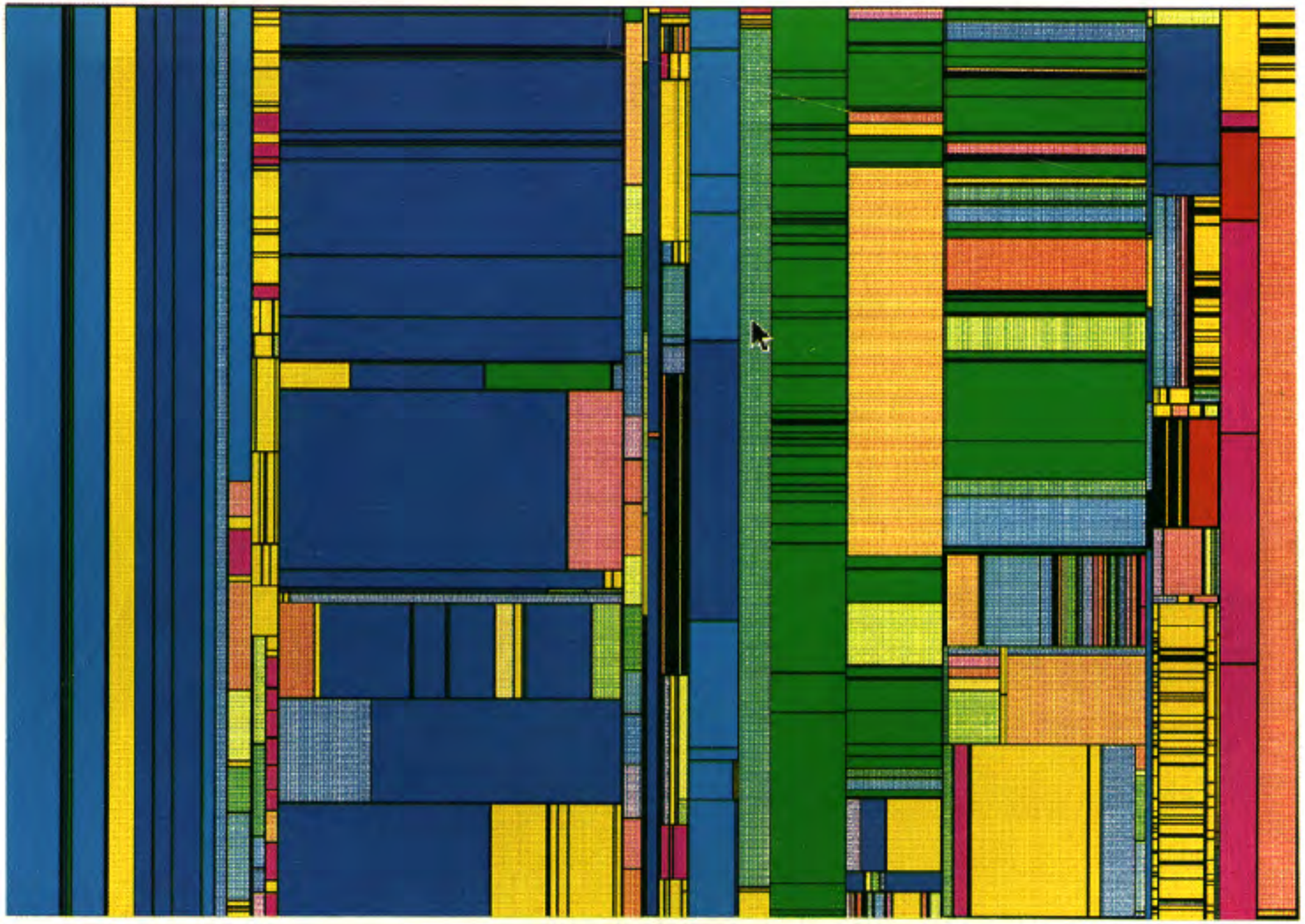


Fig. 4. 850 files at four levels with color coding by tile type. File name pops up when cursor rests on a file.

TREE MAP PROBLEMS

- Too disorderly
  - What does adjacency mean?
  - Aspect ratios uncontrolled leads to lots of skinny boxes that clutter
- Hard to understand
  - Must mentally convert nesting to hierarchy descent
- Color not used appropriately
  - In fact, is meaningless here
- Wrong application
  - Don’t need all this to just see the largest files in the OS

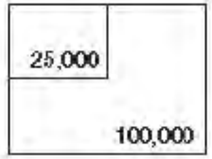
TREE MAP SUCCESSFUL APPLICATIONS

TREE MAP SUCCESSFUL APPLICATIONS

lead of Toyota
ıt as American
ontinued to
the country.

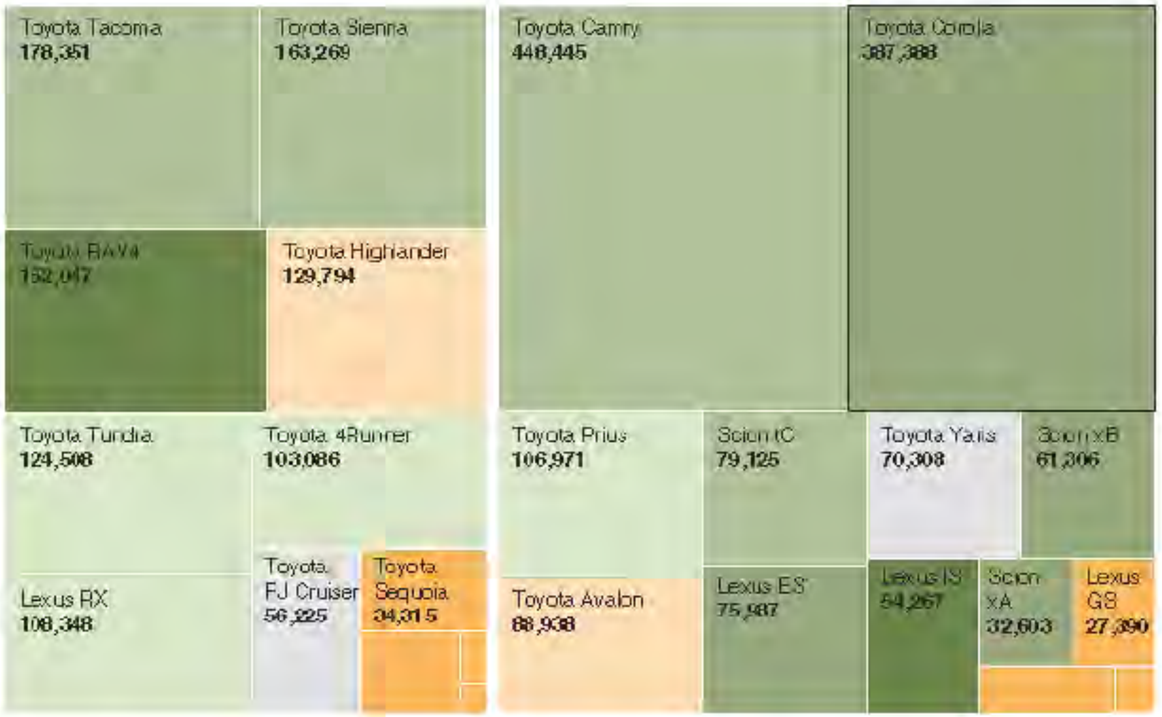
READING THE CHART

Boxes are scaled proportionally according to number of cars sold in 2006



Change in sales from 2005 to 2006

◀TRUCKS, VANS, S.U.V.'S | CARS▶



Toyota **+12.5%**

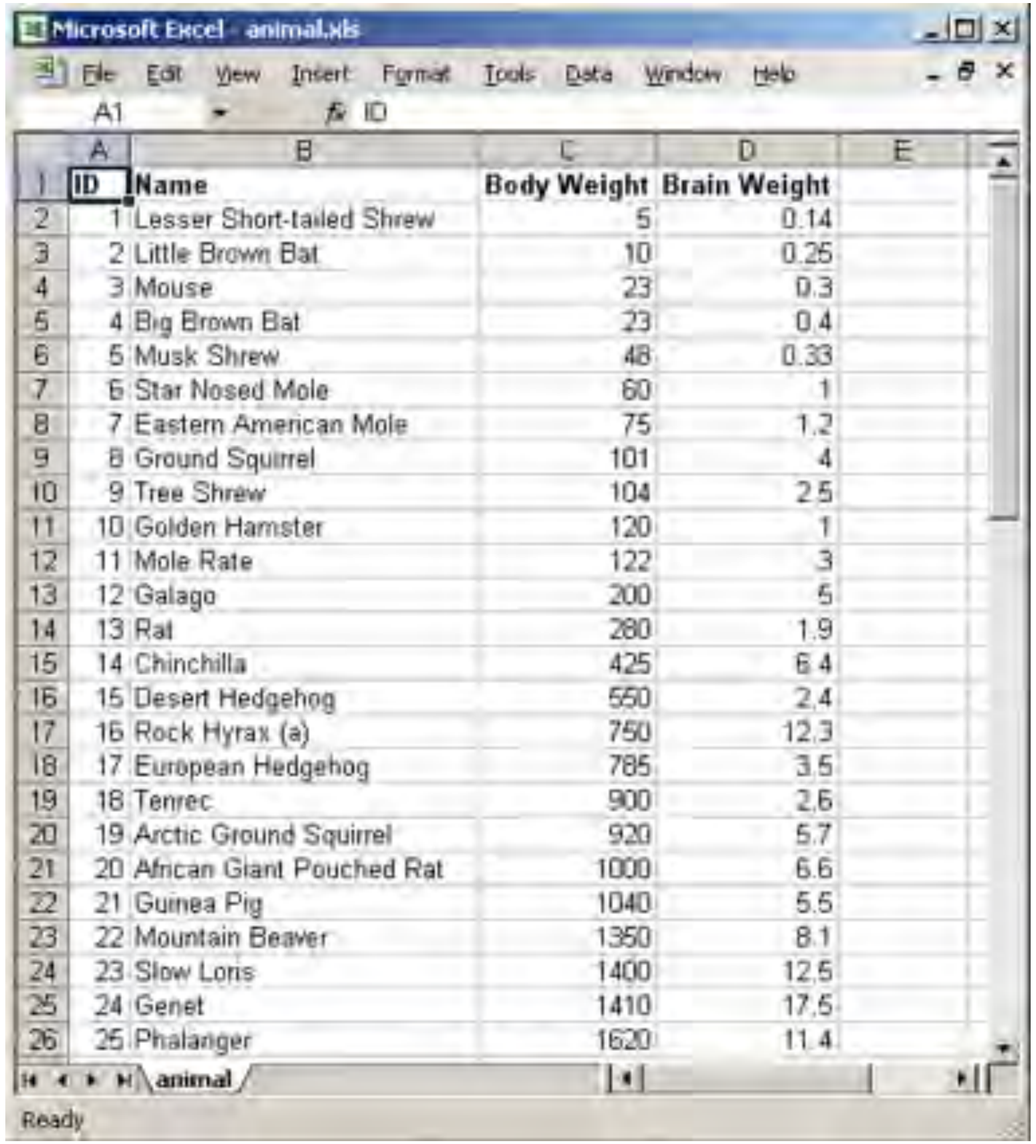
Trucks/vans/S.U.V.'s	1.1 million
Cars	1.5 million

Toyota rolled out a new version of the Camry, and once again it was the country's best-selling car.

Toyota Corolla

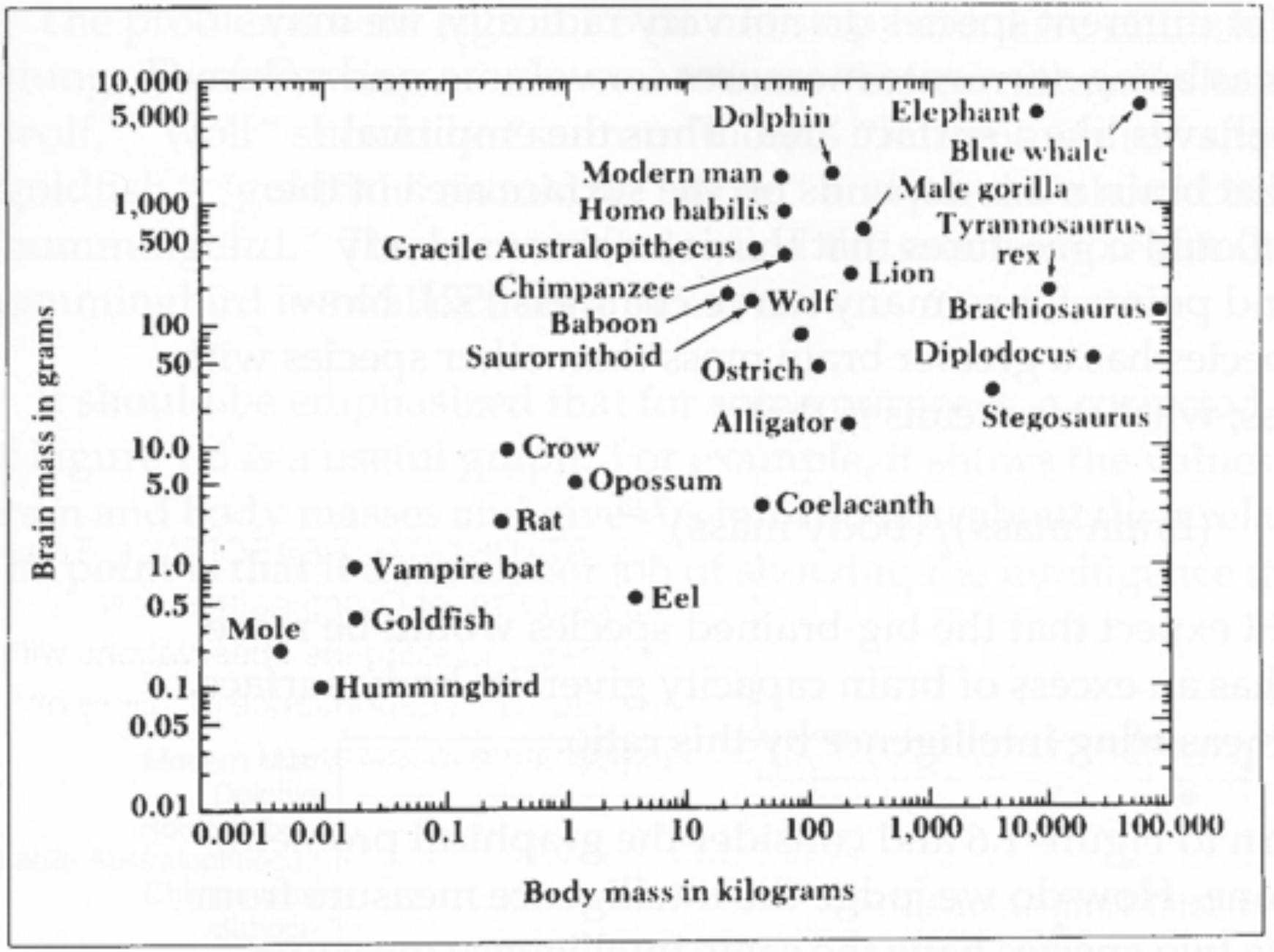
Corolla sales also jumped, along with gas prices. Toyota could not escape the decline in sales of supersized S.U.V.'s like its Sequoia.

TELL STORY: MOST POWERFUL BRAIN?

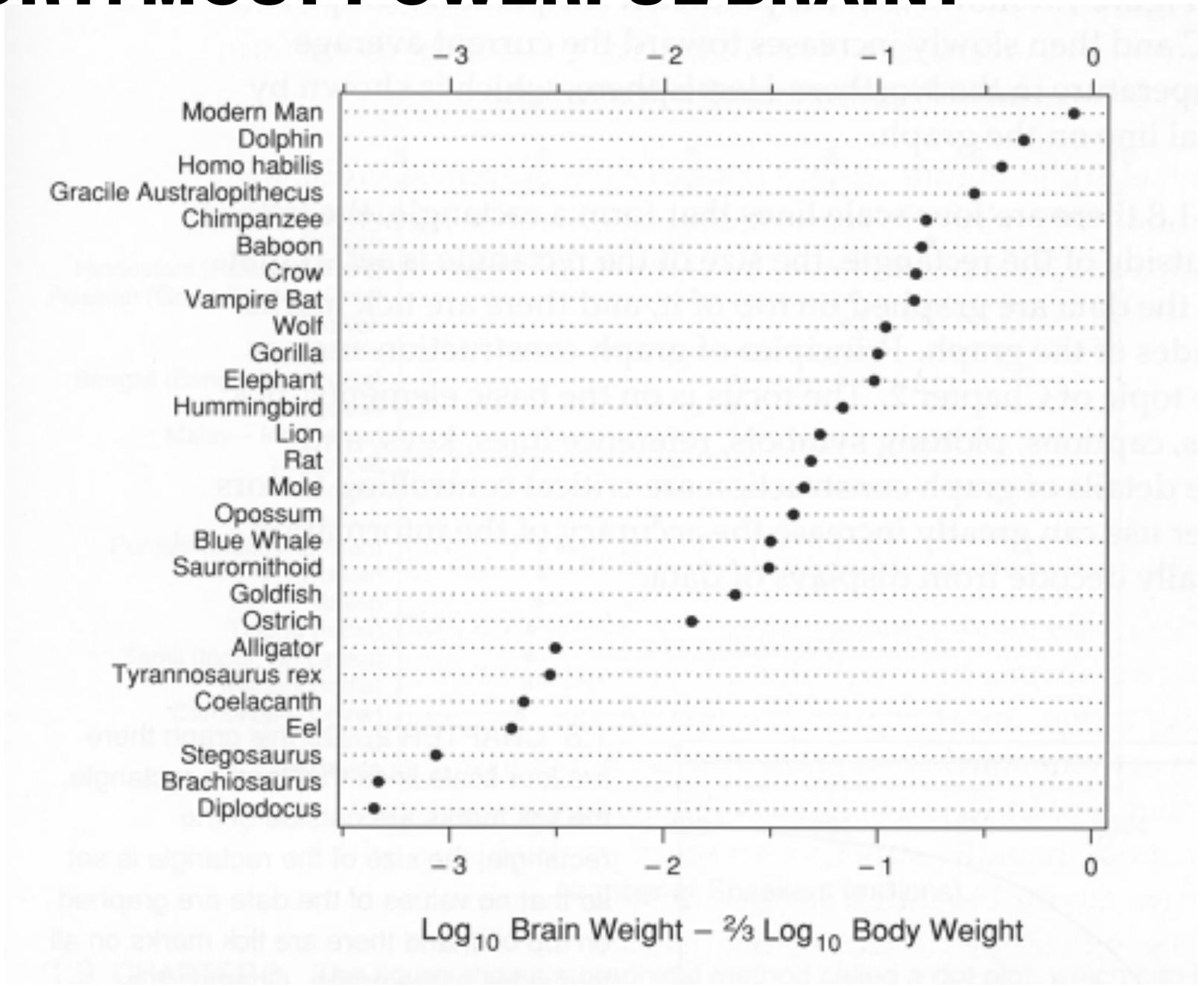


	A	B	C	D	E
1	ID	Name	Body Weight	Brain Weight	
2	1	Lesser Short-tailed Shrew	5	0.14	
3	2	Little Brown Bat	10	0.25	
4	3	Mouse	23	0.3	
5	4	Big Brown Bat	23	0.4	
6	5	Musk Shrew	48	0.33	
7	6	Star Nosed Mole	60	1	
8	7	Eastern American Mole	75	1.2	
9	8	Ground Squirrel	101	4	
10	9	Tree Shrew	104	2.5	
11	10	Golden Hamster	120	1	
12	11	Mole Rate	122	3	
13	12	Galago	200	5	
14	13	Rat	280	1.9	
15	14	Chinchilla	425	6.4	
16	15	Desert Hedgehog	550	2.4	
17	16	Rock Hyrax (a)	750	12.3	
18	17	European Hedgehog	785	3.5	
19	18	Tenrec	900	2.6	
20	19	Arctic Ground Squirrel	920	5.7	
21	20	African Giant Pouched Rat	1000	6.6	
22	21	Guinea Pig	1040	5.5	
23	22	Mountain Beaver	1350	8.1	
24	23	Slow Loris	1400	12.5	
25	24	Genet	1410	17.5	
26	25	Phalanger	1620	11.4	

TELL STORY: MOST POWERFUL BRAIN?



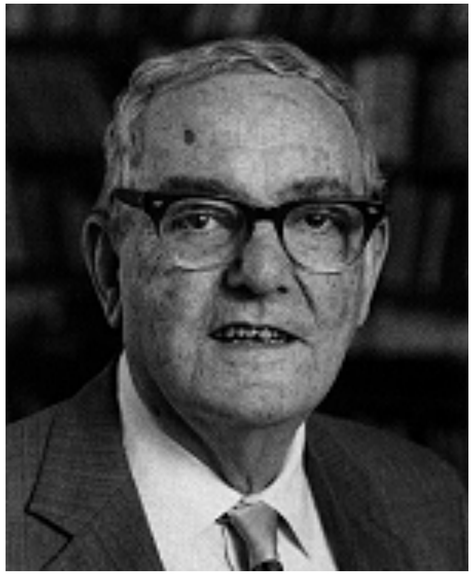
TELL STORY: MOST POWERFUL BRAIN?

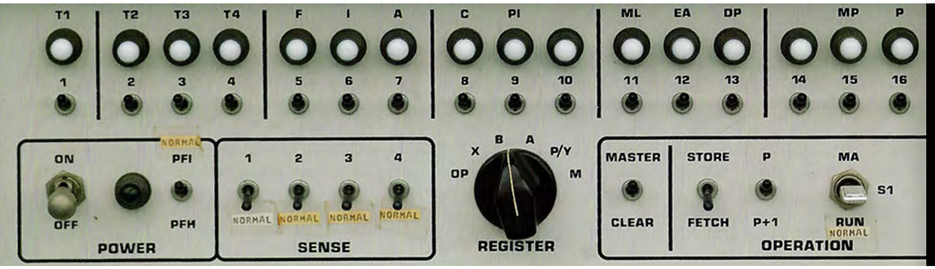


ATTENTION

"What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it."

— Herb Simon

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PFI
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PFH
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REGISTER
MASTER
CLEAR
STORE
FETCH
P
P+1
MA
S1
RUN
NORMAL
OPERATION

DATA

DATA TYPES

Physical type (model)

Characterized by storage format

Characterized by machine operations

Example:

bool, short, int32, float, double, string, ...

Abstract type

Provide (conceptual) descriptions of the data

May be characterized by methods/attributes

May be organized into a hierarchy

Example:

nominal, ordinal, quantitative, ...,

plants, animals, metazoans, ...

NOMINAL, ORDINAL, AND QUANTITATIVE

N - Nominal (labels)

Fruits: Apples, oranges, ...

O - Ordered

Quality of meat: Grade A, AA, AAA

Q - Quantitative

Real numbers

Ordered, with measurable distances, or amounts

Dates: Jan, 19, 2006; Location: (LAT 33.98, LONG -118.45)

Physical measurement: Length, Mass, Temp, ...

FROM DATA MODEL TO DATA TYPE

Data model

32.5, 54.0, -17.3, …

floats

Conceptual model

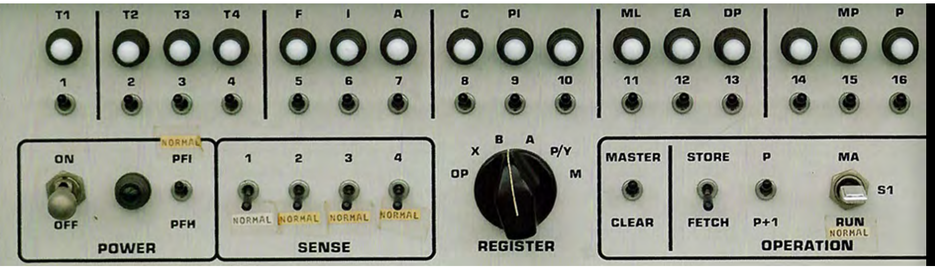
Temperature

Data type

Burned vs. Not burned (N)

Hot, warm, cold (O)

Continuous range of values (Q)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FETCH
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P+1
MA
S1
RUN
NORMAL
OPERATION

IMAGE

VISUAL VARIABLES

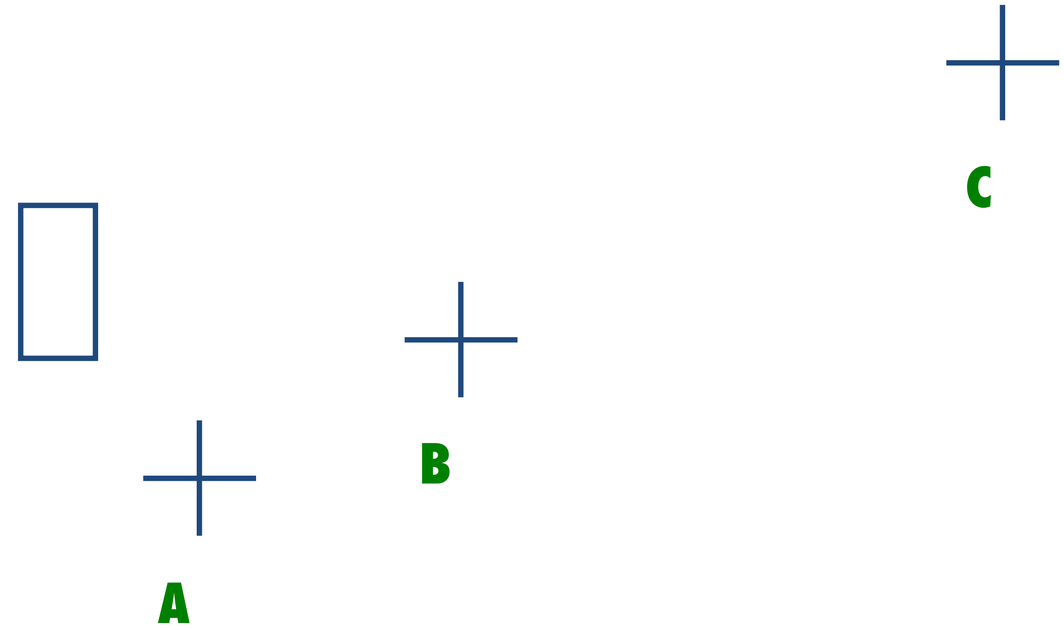
Jacques Bertin

	Points	Lines	Areas	Best to show
Shape		possible, but too weird to show	cartogram	qualitative differences
Size			cartogram	quantitative differences
Color Hue				qualitative differences
Color Value				quantitative differences
Color Intensity				qualitative differences
Texture				qualitative & quantitative differences

INFORMATION IN POSITION

1. A, B, C are distinguishable
2. B is between A and C.
3. BC is twice as long as AB.

4. ∴ Encode quantitative variables (Q)



INFORMATION IN COLOR AND VALUE

Value is perceived as ordered

∴ Encode ordinal variables (O)

∴ Encode continuous variables (Q) [not as well] – can't tell distance

Hue is normally perceived as unordered

∴ Encode nominal variables (N) using color

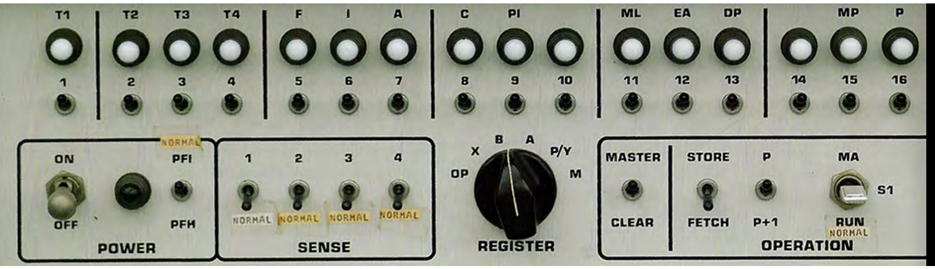
BERTINS' "LEVELS OF ORGANIZATION"

N Nominal

O Ordinal

Q Quantitative

Position	N	O	Q
Size	N	O	Q
Value	N	O	Q
Texture	N	O	
Color	N		
Orientation	N		
Shape	N		



ESTIMATING MAGNITUDE

DETECTING BRIGHTNESS

Which is brighter?

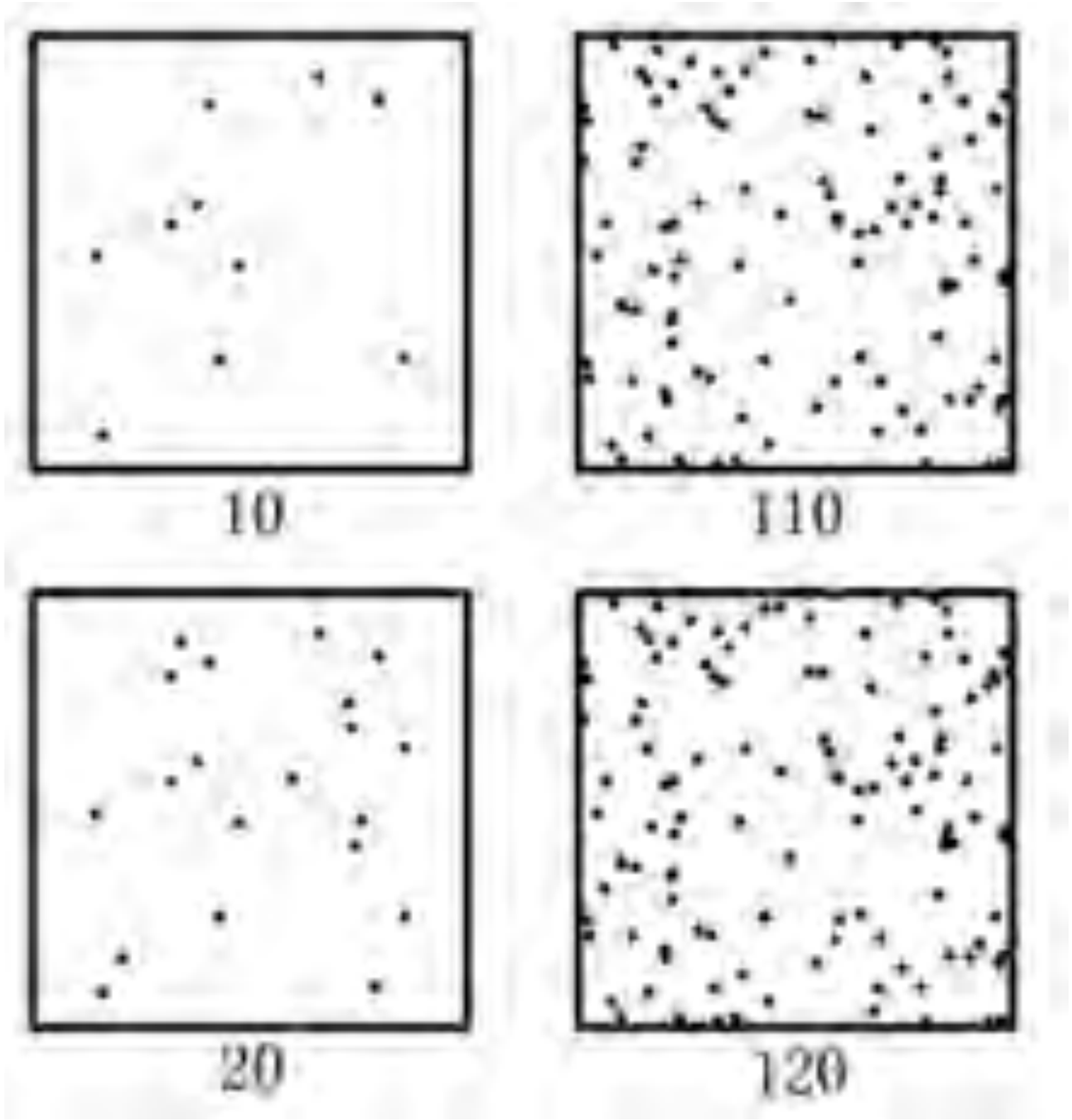
DETECTING BRIGHTNESS

(128, 128, 128)

(144, 144, 144)

Which is brighter?

JUST NOTICEABLE DIFFERENCES



JUST NOTICEABLE DIFFERENCES

JND (Weber's Law)

$$\Delta S = k\frac{\Delta I}{I}$$

Ratios more important than magnitude

This is the smallest change in stimuli that can be perceived.

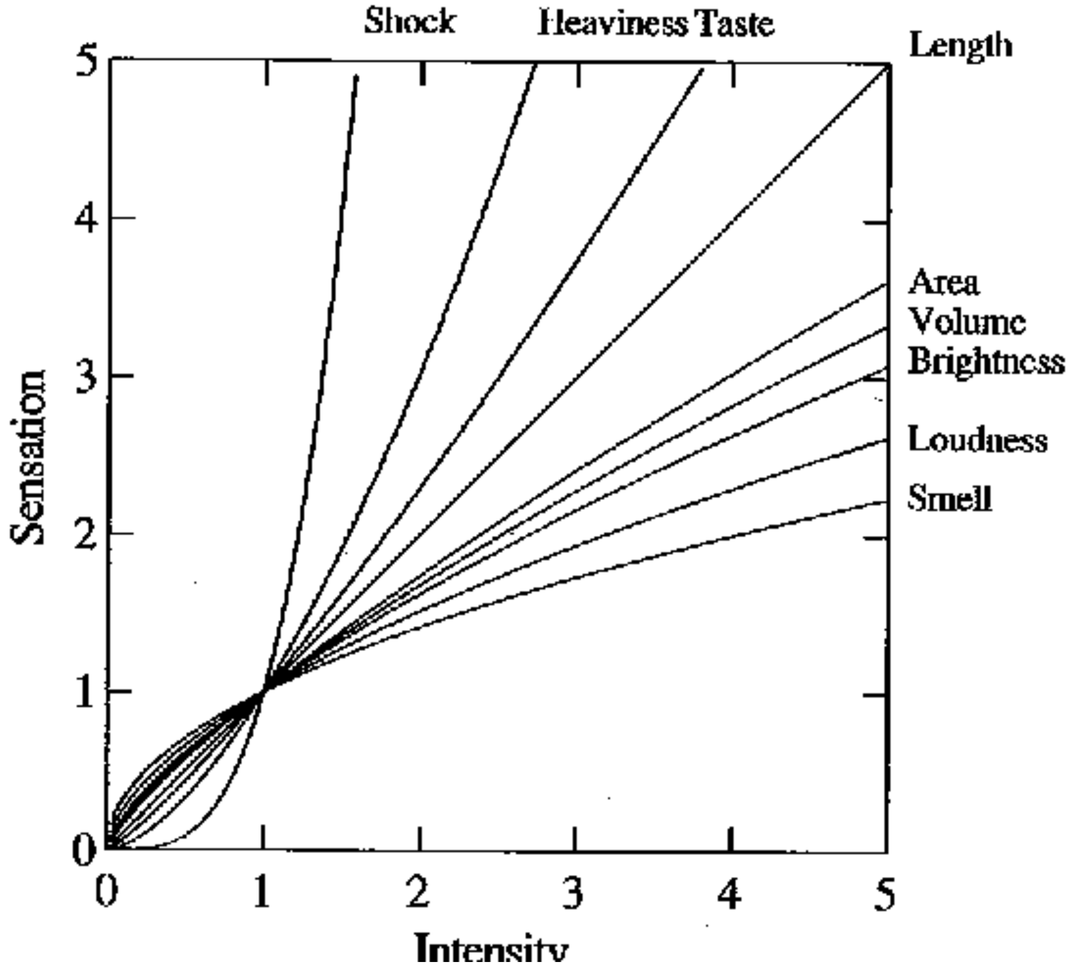
Most continuous variations perceived in discrete steps

STEVEN'S POWER LAW

$$S = I^p$$

p < 1 : underestimate

p > 1 : overestimate



relationship in psychophysics between an increased intensity or strength in a physical stimulus and the perceived magnitude

EXPONENTS OF POWER LAW

Sensation	*Exponent*
Loudness	*0.6*
Brightness	*0.33*
Smell	*0.55 (Coffee) - 0.6 (Heptane)*
Taste	*0.6 (Saccharine) -1.3 (Salt)*
Temperature	*1.0 (Cold) – 1.6 (Warm)*
Vibration	*0.6 (250 Hz) – 0.95 (60 Hz)*
Duration	*1.1*
Pressure	*1.1*
Heaviness	*1.45*
Electic Shock	*3.5*

SUMMARY

We create visualizations to

Record information

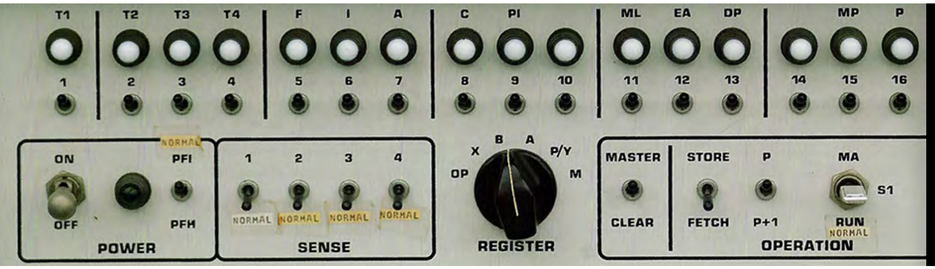
Support reasoning about the information

Convey information to others

Choose the right mark for your data

Position good for N, O, Q, but Hue best only for N

With careful design it is possible to display many dimensions at once



THE VALUE OF PROTOTYPING

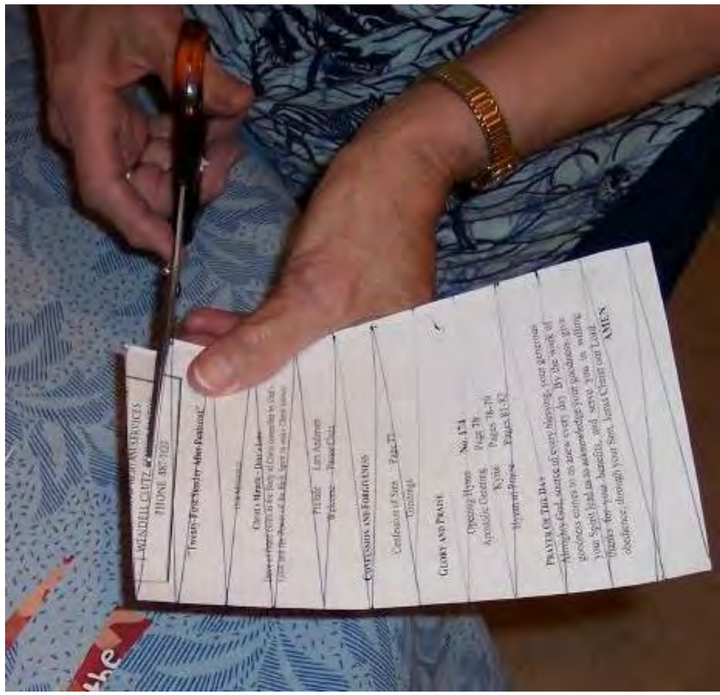
BENEFITS OF PROTOTYPING

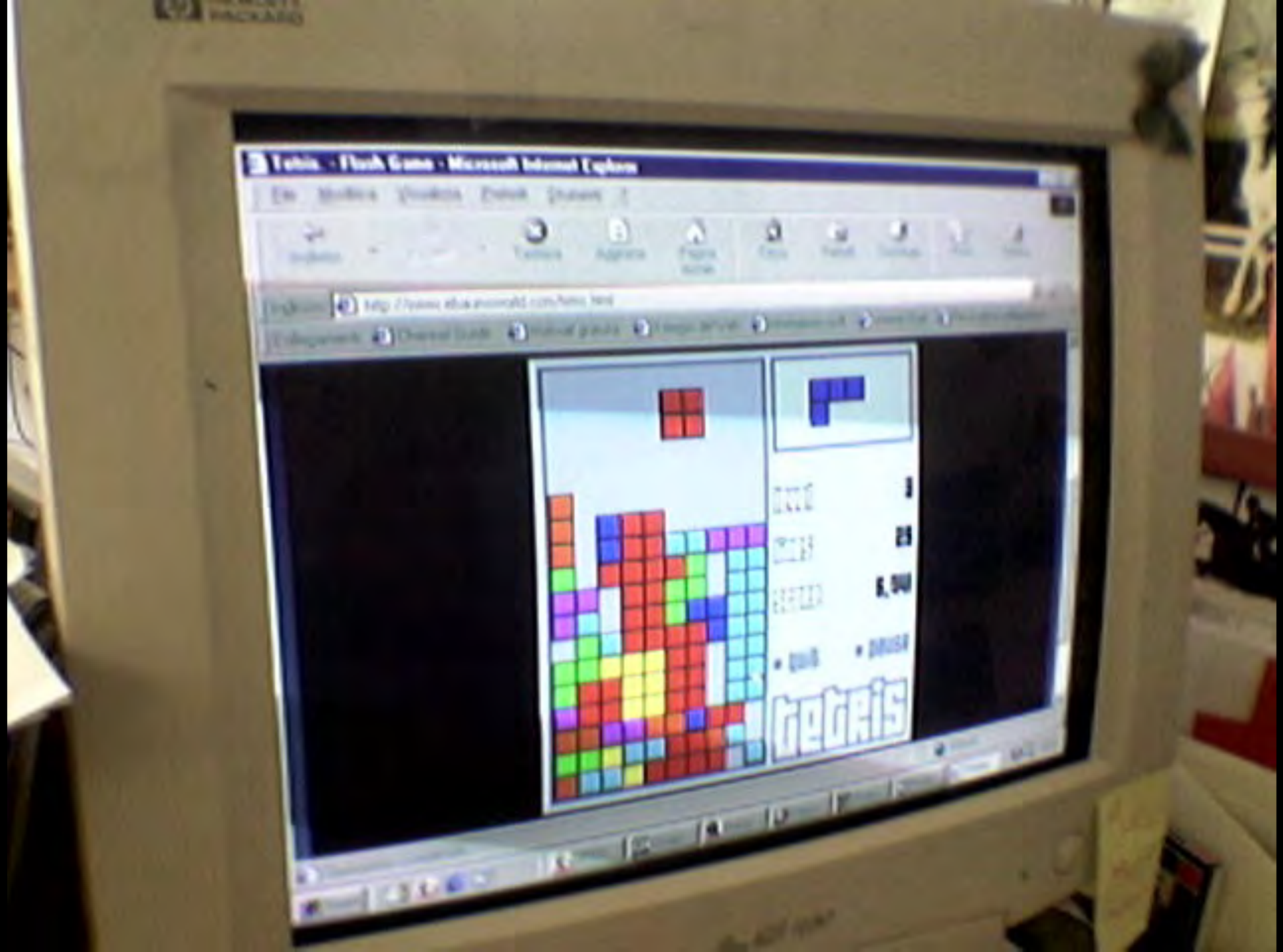
We know more than we can tell

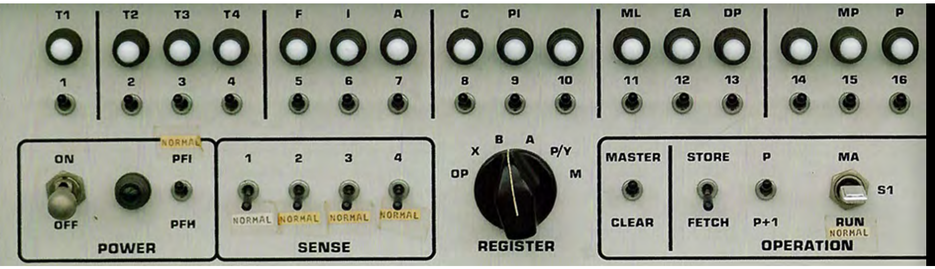
Actions in the world outperform mental operations

The value of surprise

TACIT KNOWLEDGE

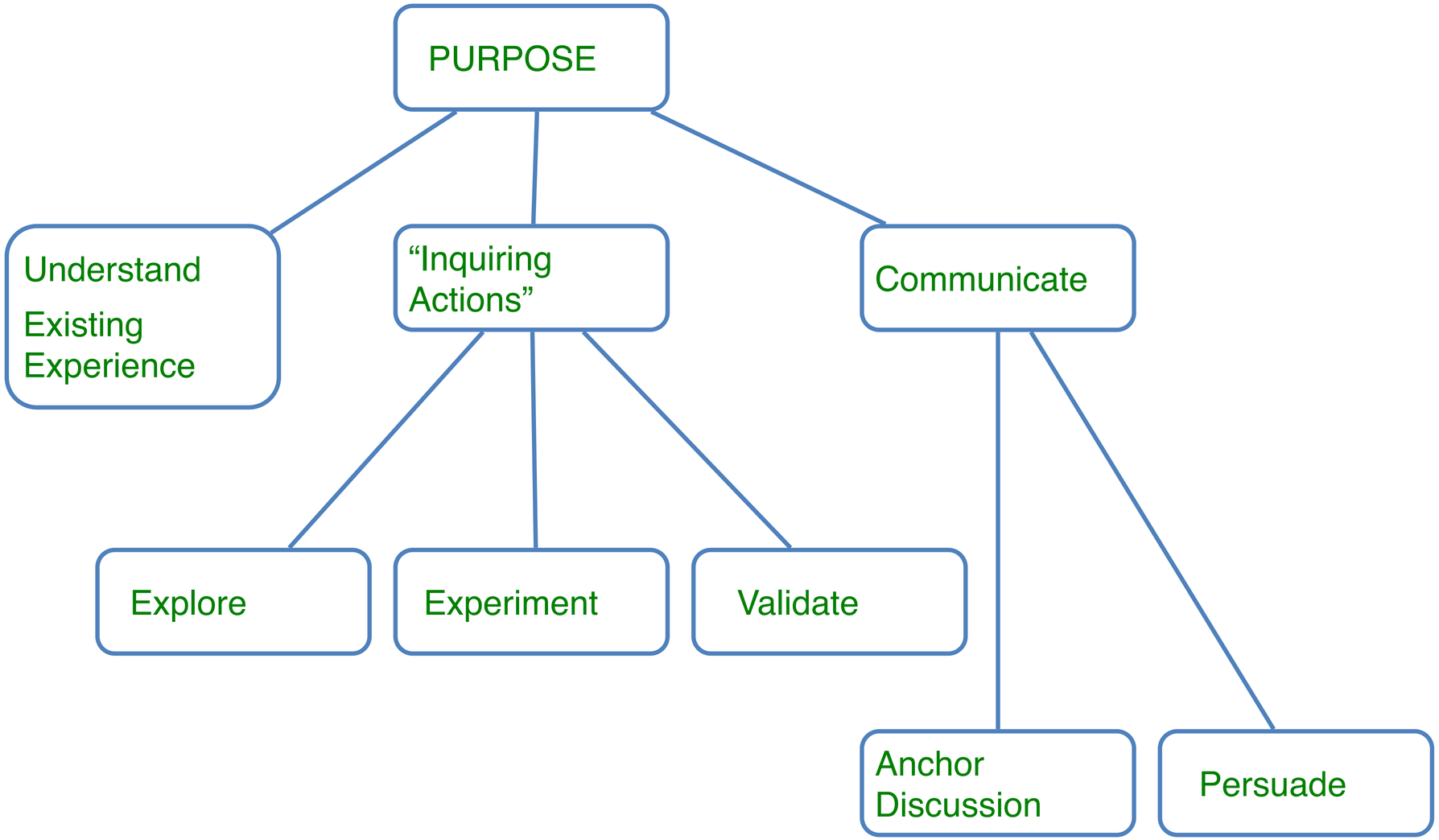



Tetris - Flash Game - Microsoft Internet Explorer
tetris



THE PURPOSE OF PROTOTYPING

What questions do prototypes answer?
When and how should they be constructed?

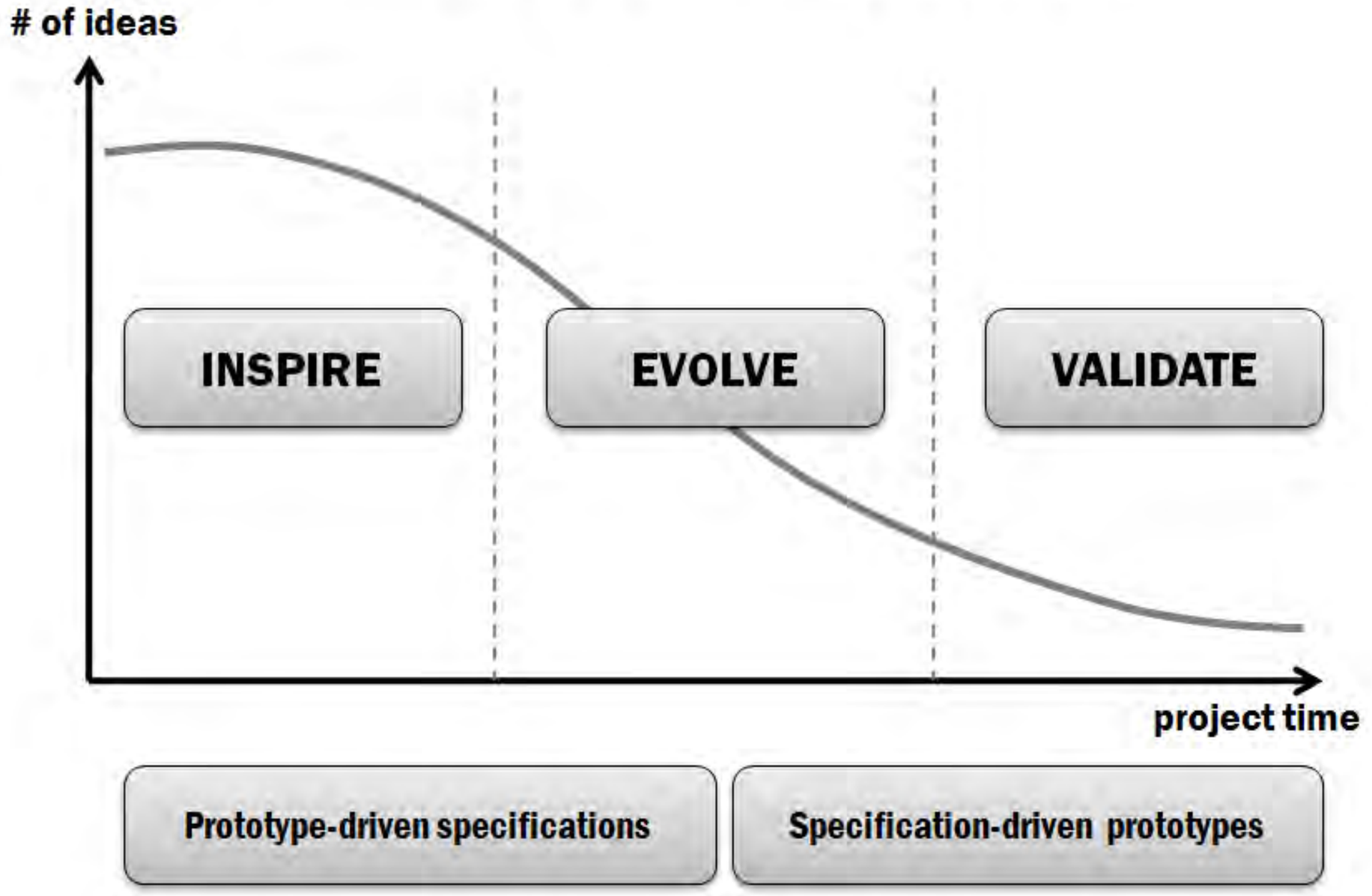

PURPOSE
Understand
Existing
Experience
“Inquiring
Actions”
Communicate
Explore
Experiment
Validate
Anchor
Discussion
Persuade

UNDERSTAND EXISTING EXPERIENCE

Figure 2: Experiencing a train journey.

INQUIRING ACTIONS

Three Stages of Prototyping (IDEO)




KOSAK UEP


31
Apple Proto 0897


iPod
Apple Proto 1015

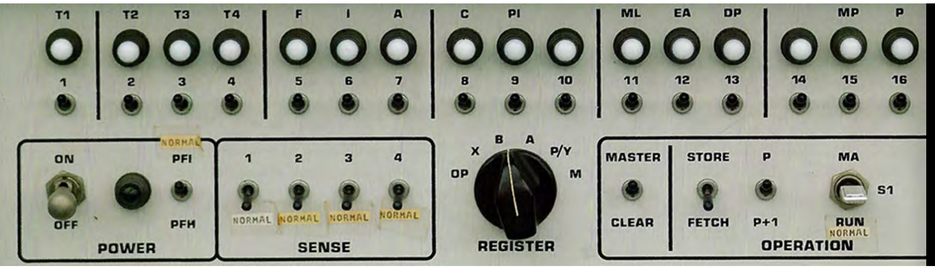

Apple Proto 0956


tm62-w1-111705


31
Apple Proto 0915

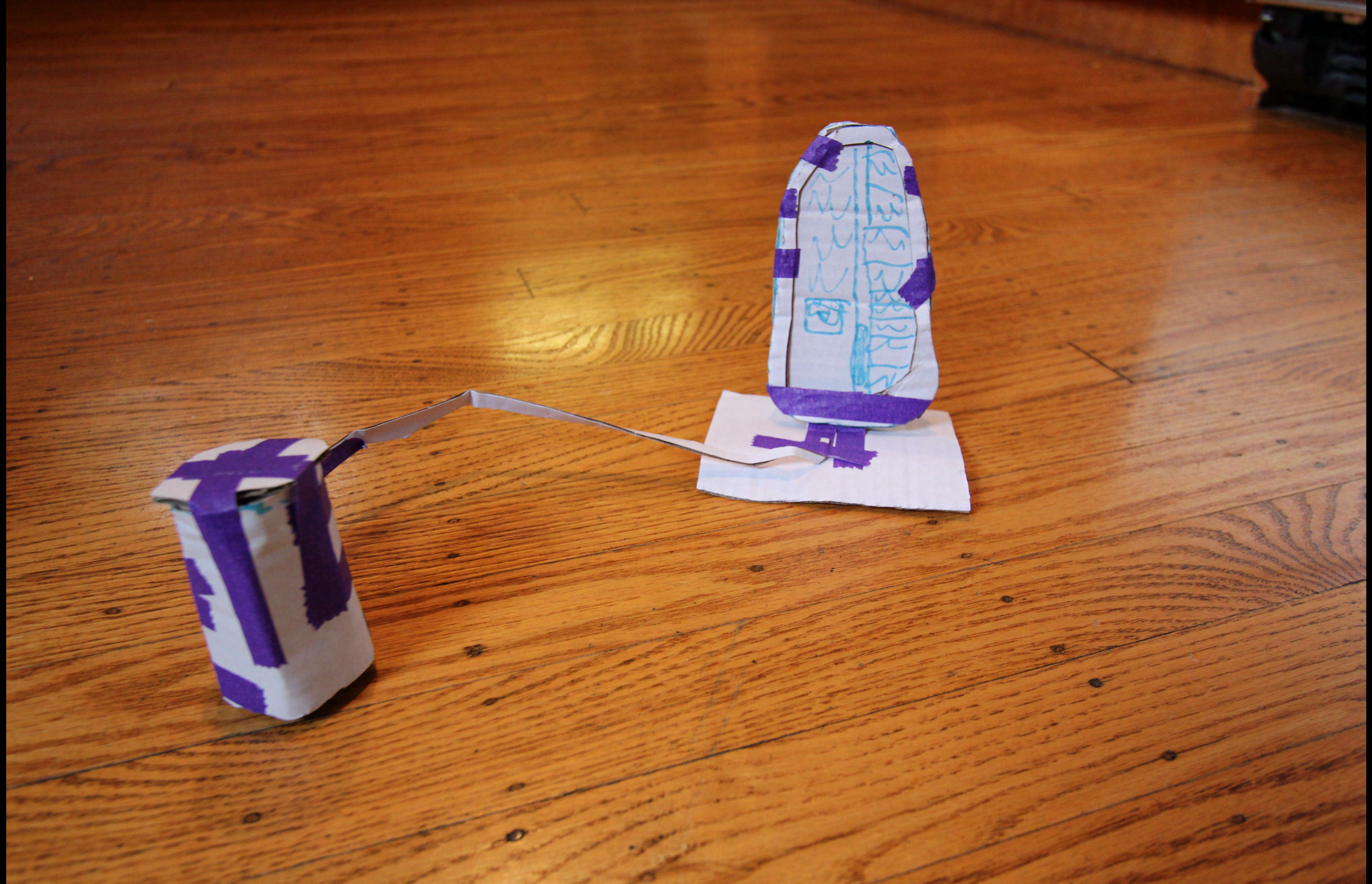
Prototypes for the
Microsoft mouse
From Moggridge,
Designing Interactions, Ch2

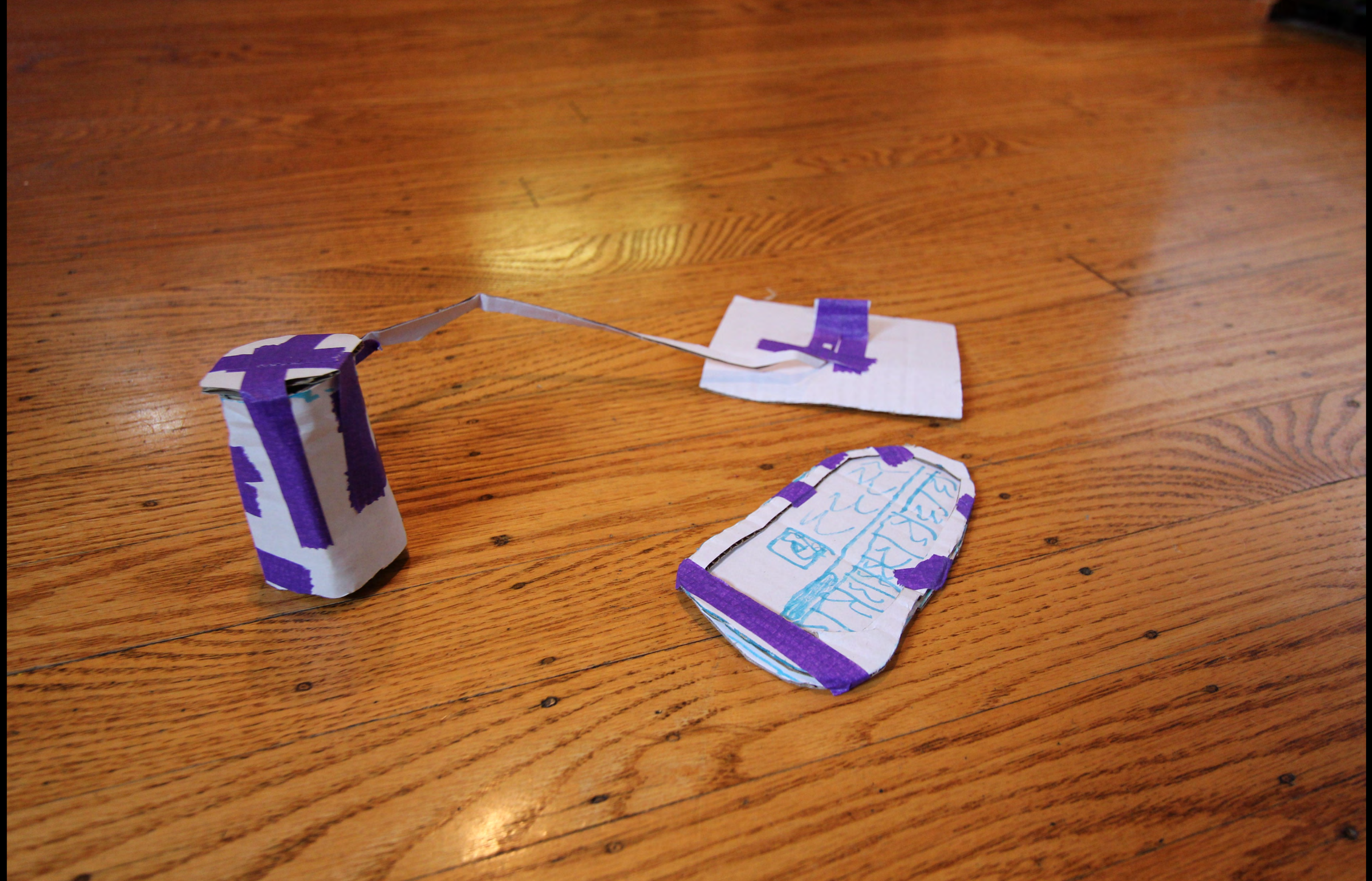
COMMUNICATE

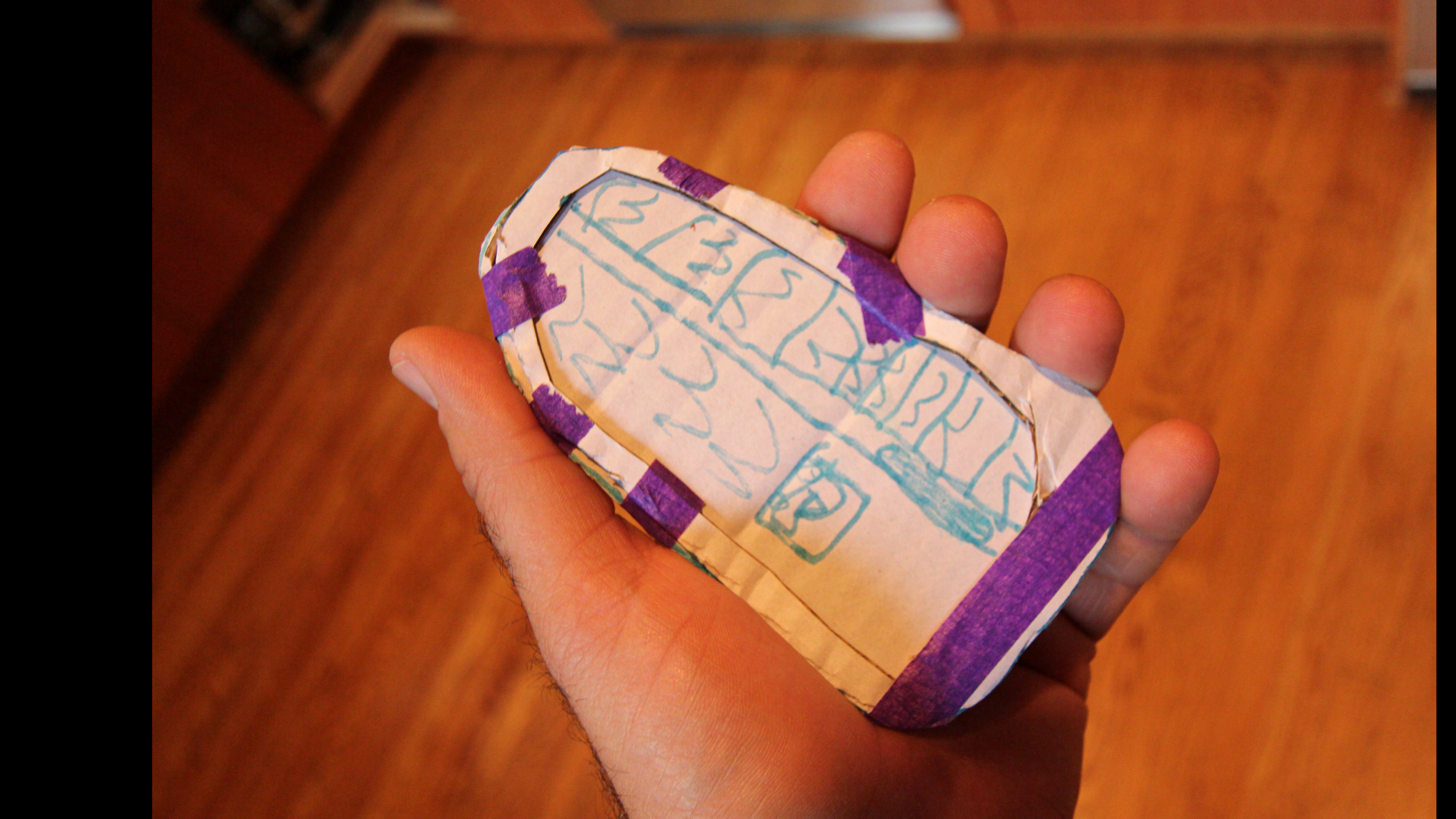


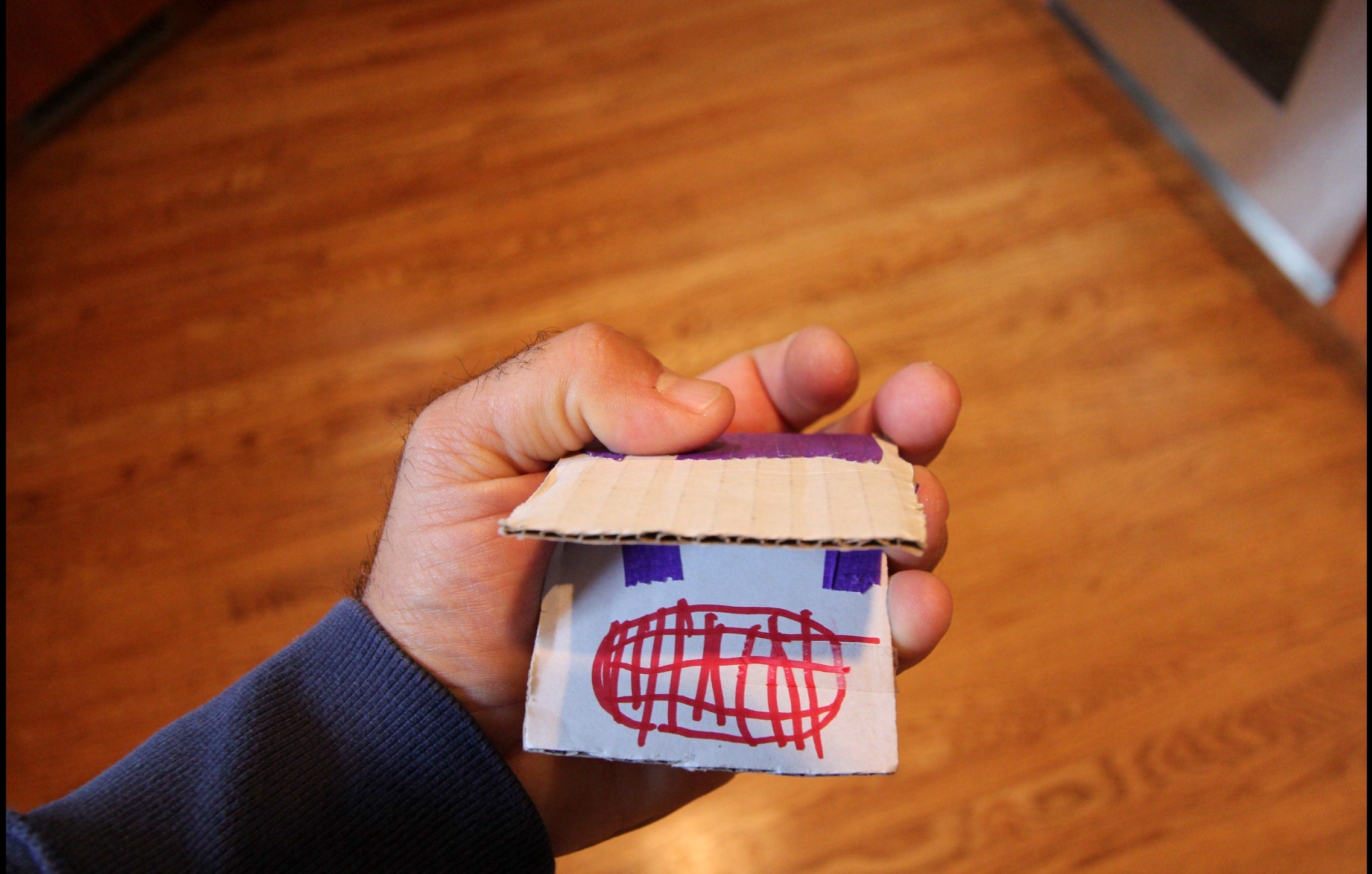
PAPER PROTOTYPING

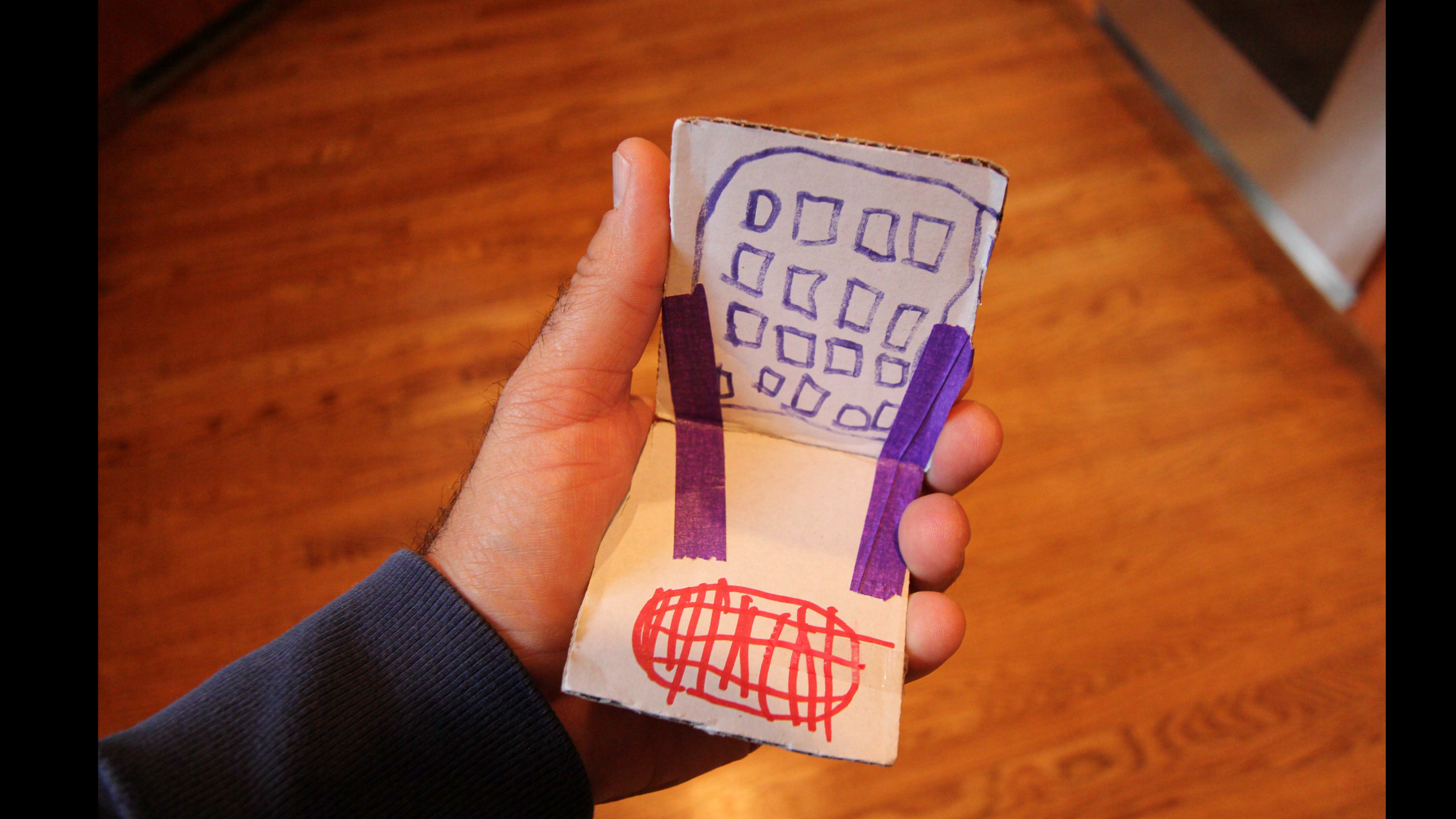
Towards Wizard of Oz Studies











MATERIALS

Large, heavy, white paper (11 x 17)

5x8 in. index cards

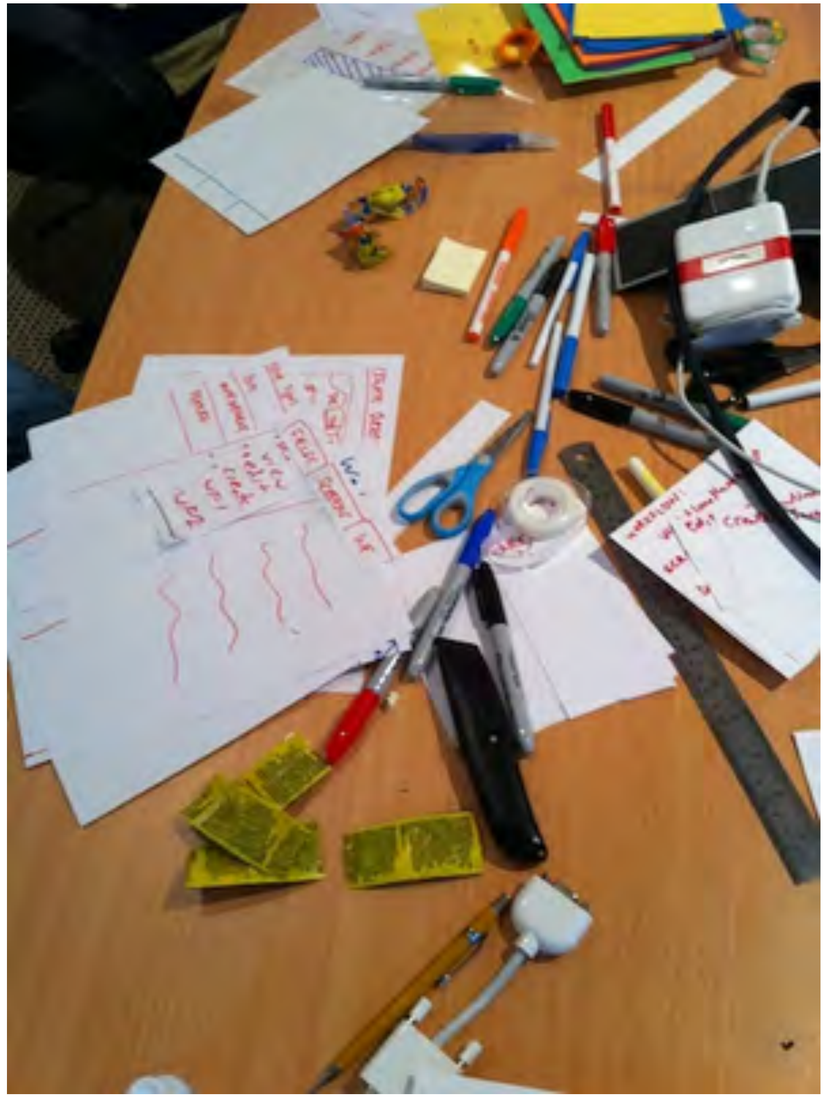
Post-it notes

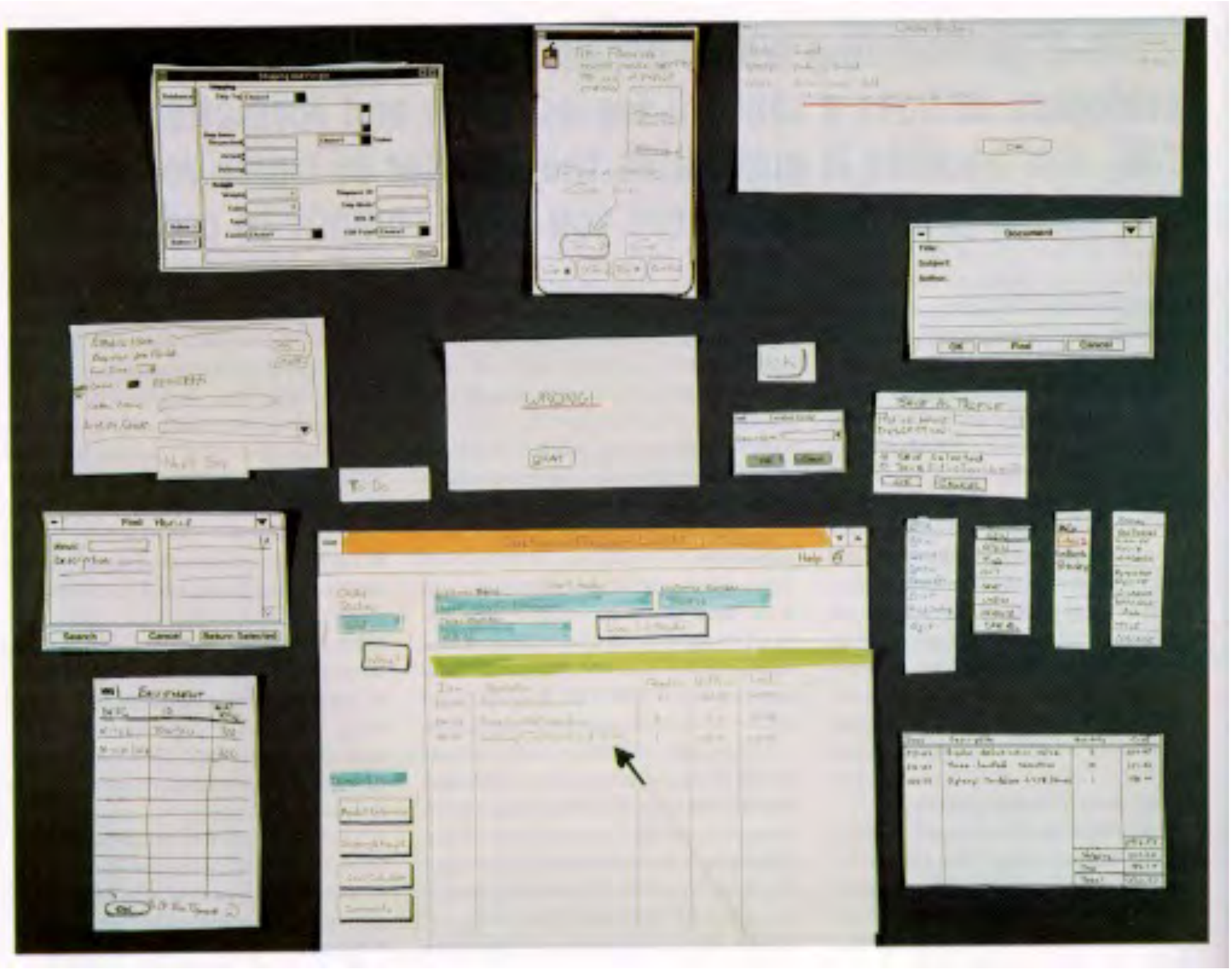
Tape, stick glue, correction tape

Pens & markers (colors & sizes)

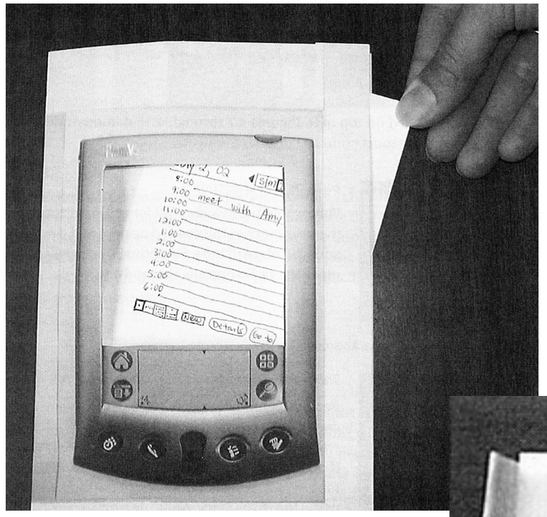
Transparencies (including colored)

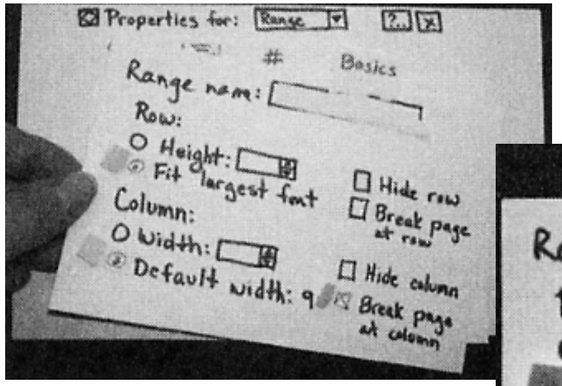
Scissors, X-acto knives, etc.

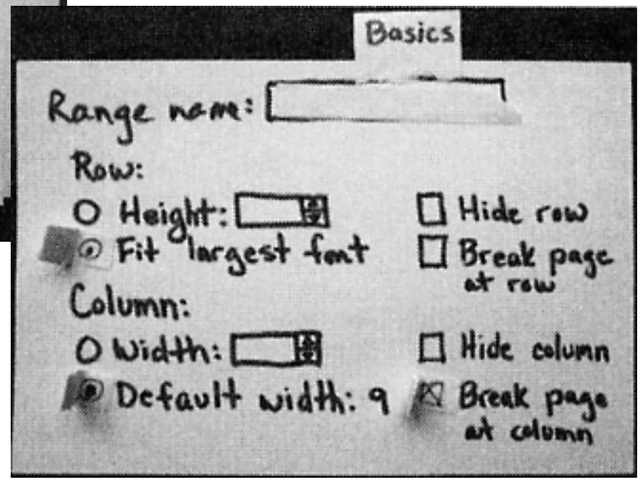


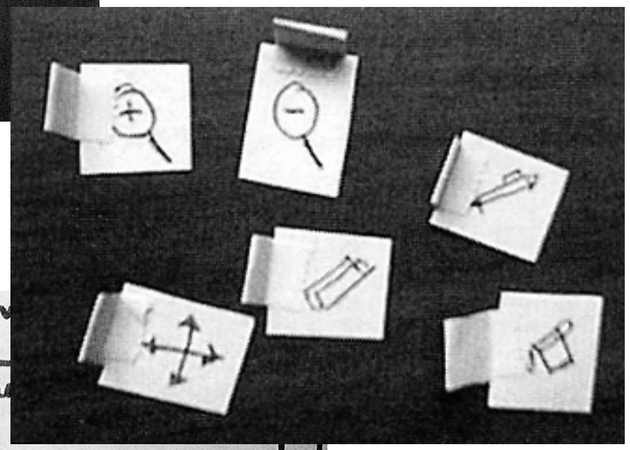

Document
OK
Print
Cancel
LANDING!
Search
Cancel
Return Selected
Help

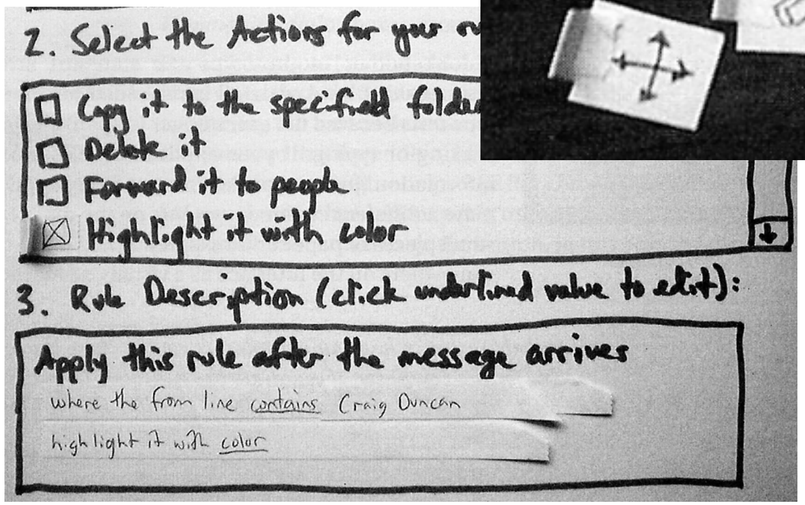
INTERFACE ELEMENTS

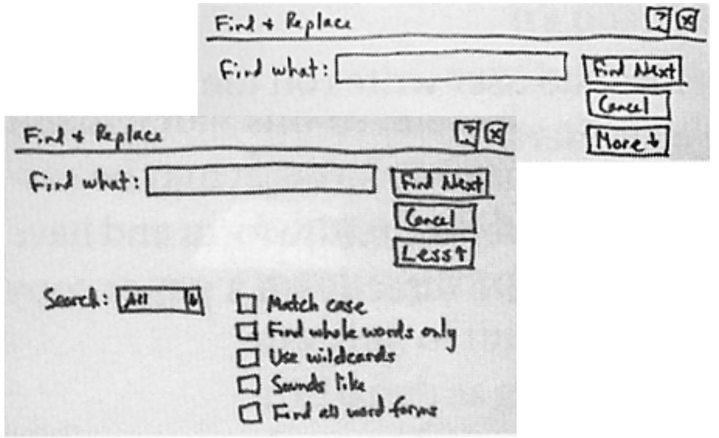












WIZARD OF OZ TESTING

A Wizard of Oz experiment is a research experiment in which subjects interact with a computer system that subjects believe to be autonomous, but which is actually being operated or partially operated by an unseen or seen human being.

CONSTRUCTING THE PROTOTYPE

Set a deadline

Don’t think too long - build it!

Draw a window frame on large paper

Draw at a large size, but use correct aspect ratio

Put different screen regions on cards

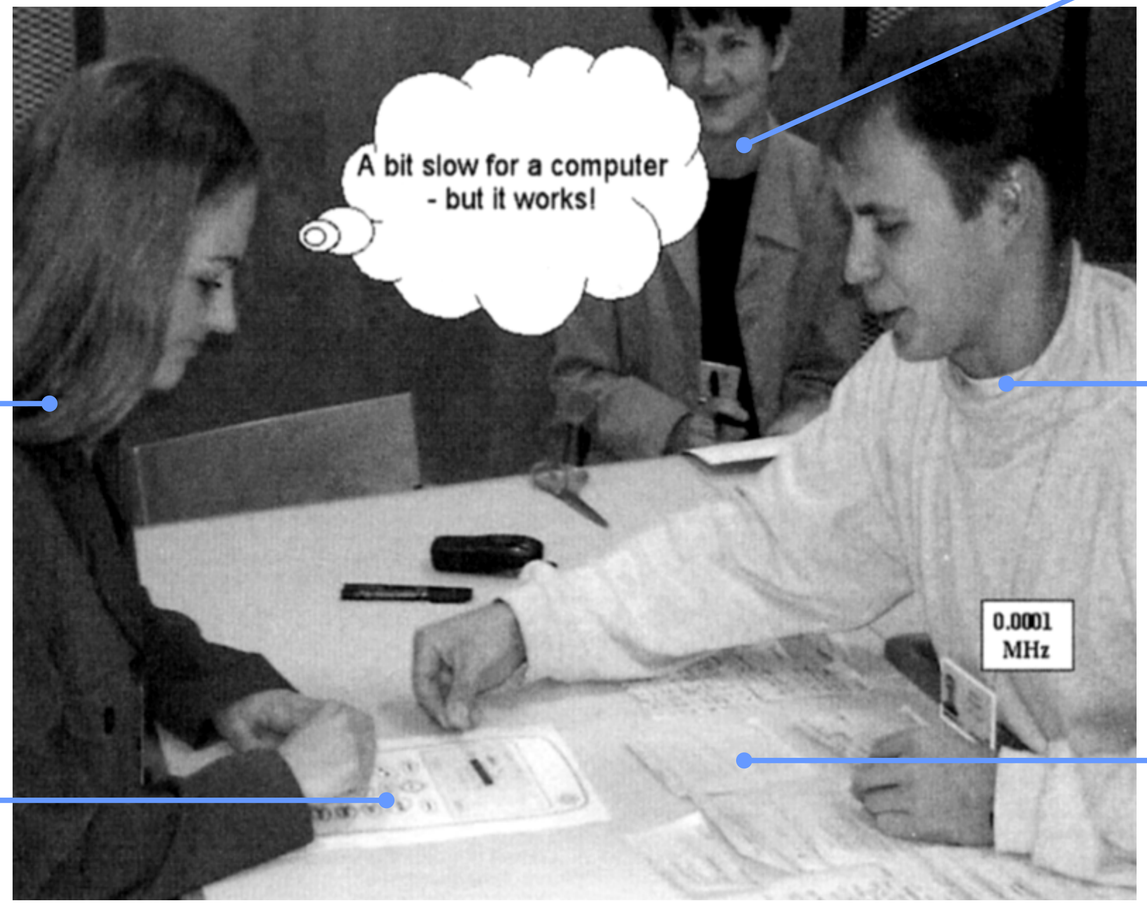
Anything that moves, changes, appears/disappears

Use greeking to indicate text if necessary

Ready response for any user action

e.g., Have those pull-down menus already made

Use photocopier to make many versions



Observer

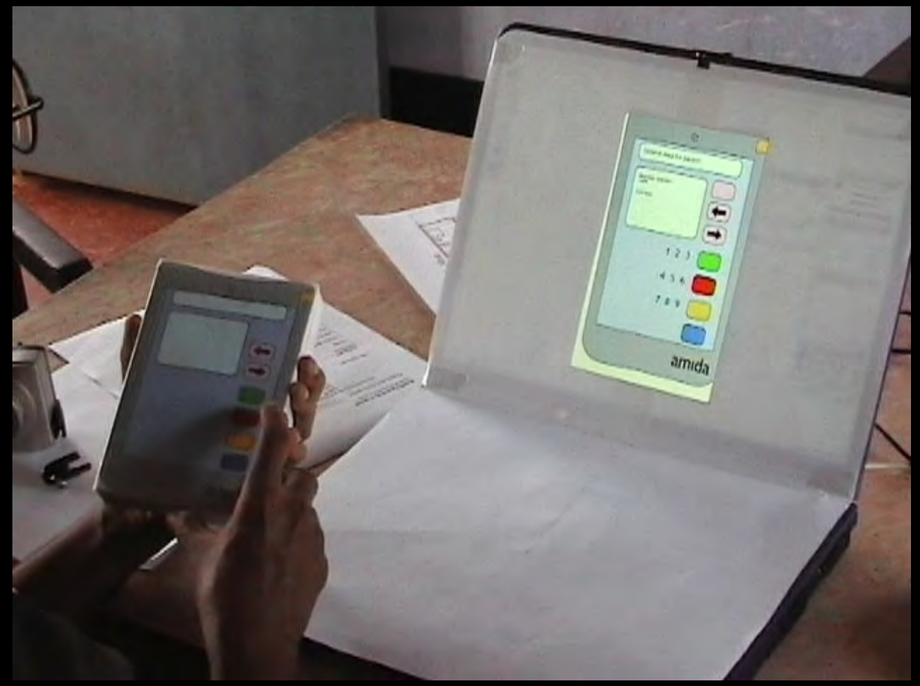
(or video camera)

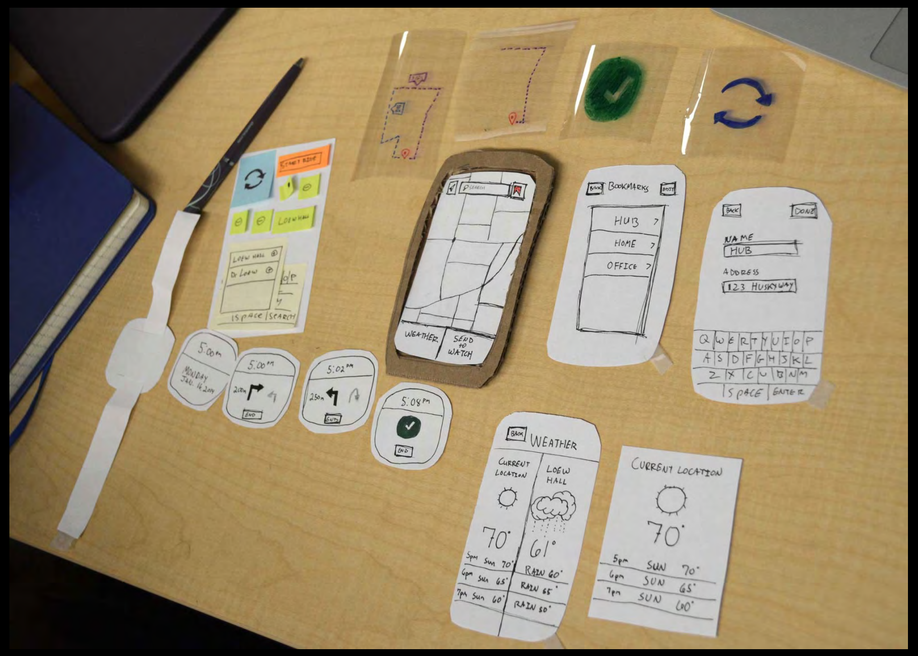
User

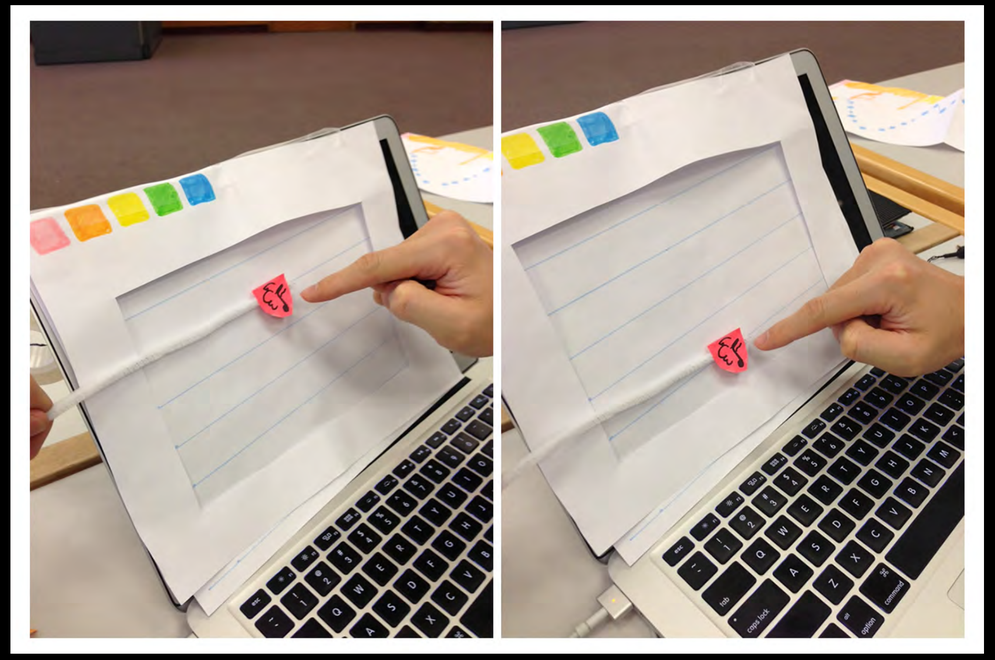
"Computer"

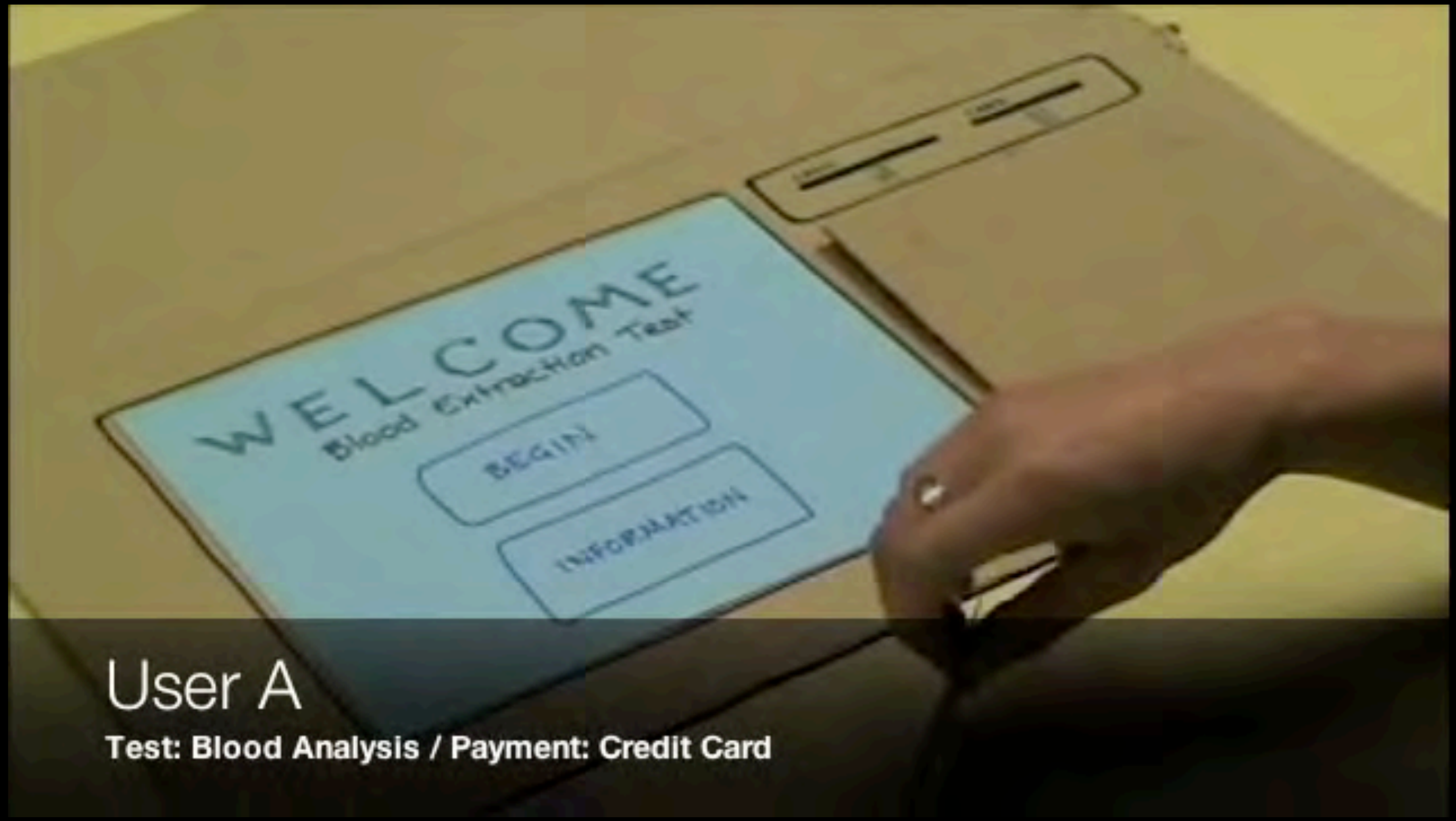
Interface

Interface elements


amida


BOOKMARKS
HUB
HOME
OFFICE
WEATHER
CURRENT LOCATION
70°
61°
CURRENT LOCATION
70°





User A

Test: Blood Analysis / Payment: Credit Card


000

CONDUCTING A TEST

Three or Four testers (preferable)

Greeter - Puts users at ease & gets data

Facilitator - only team member who speaks
Gives instructions & encourages thoughts, opinions

Computer - knows application logic & controls it
Always simulates the response, w/o explanation

Observer(s) - Take notes & recommendations

Typical session should be approximately 1 hour

Preparation, the test, debriefing

CONDUCTING A TEST (CONT.)

Greet

Get forms filled, assure confidentiality, etc.

Test

Facilitator explains how test will work

Performs a simple task

Facilitator hands written tasks to the user

Must be clear & detailed

Facilitator keeps getting "output" from participant

"What are you thinking right now?", "Think aloud"

Observers record what happens

Avoid strong reactions:, frowning, laughing, impatience – biases the test

Designers should not lead participants

Let users figure things out themselves as much as possible

Only answer questions if user remains stuck for a long time

CONDUCTING A TEST (CONT.)

Debrief

Fill out post-evaluation questionnaire

Ask questions about parts you saw problems on

Gather impressions

Thank participants

PREPARING FOR A TEST

Select your participants

Understand background of intended users
Use a questionnaire to get the people you need
Don’t use friends or family

Prepare scenarios that are

Typical of the product during actual use
Make prototype support these (small, yet broad)

Practice running the computer to avoid “bugs”

You need every menu and dialog for the tasks
All widgets the user might press
Remember “help” and “cancel” buttons

WOZ is different from pre-built/canned functionality

WIZARD OF OZ TIPS

Rehearse your actions

Make a flowchart which is hidden from the user

Make list of legal words for a speech interface

Stay “in role”

You are a computer, and have no common sense, or ability to understand spoken English.

Facilitator can remind user of the rules/think-aloud approach if the user gets stuck

RECORD CRITICAL INCIDENTS

Critical incidents are any unusual/interesting events

Most of them are usability problems.

They may also be moments when the user

- Got stuck
- Suddenly understood something
- Said “that’s cool” etc.

USING THE RESULTS

Update task analysis and rethink design

Rate severity & ease of fixing problems

Fix both severe problems & make the easy fixes

Will thinking aloud give the right answers?

Not always

If you ask a question, people will always give an answer, even it is has nothing to do with the facts

Try to avoid leading questions