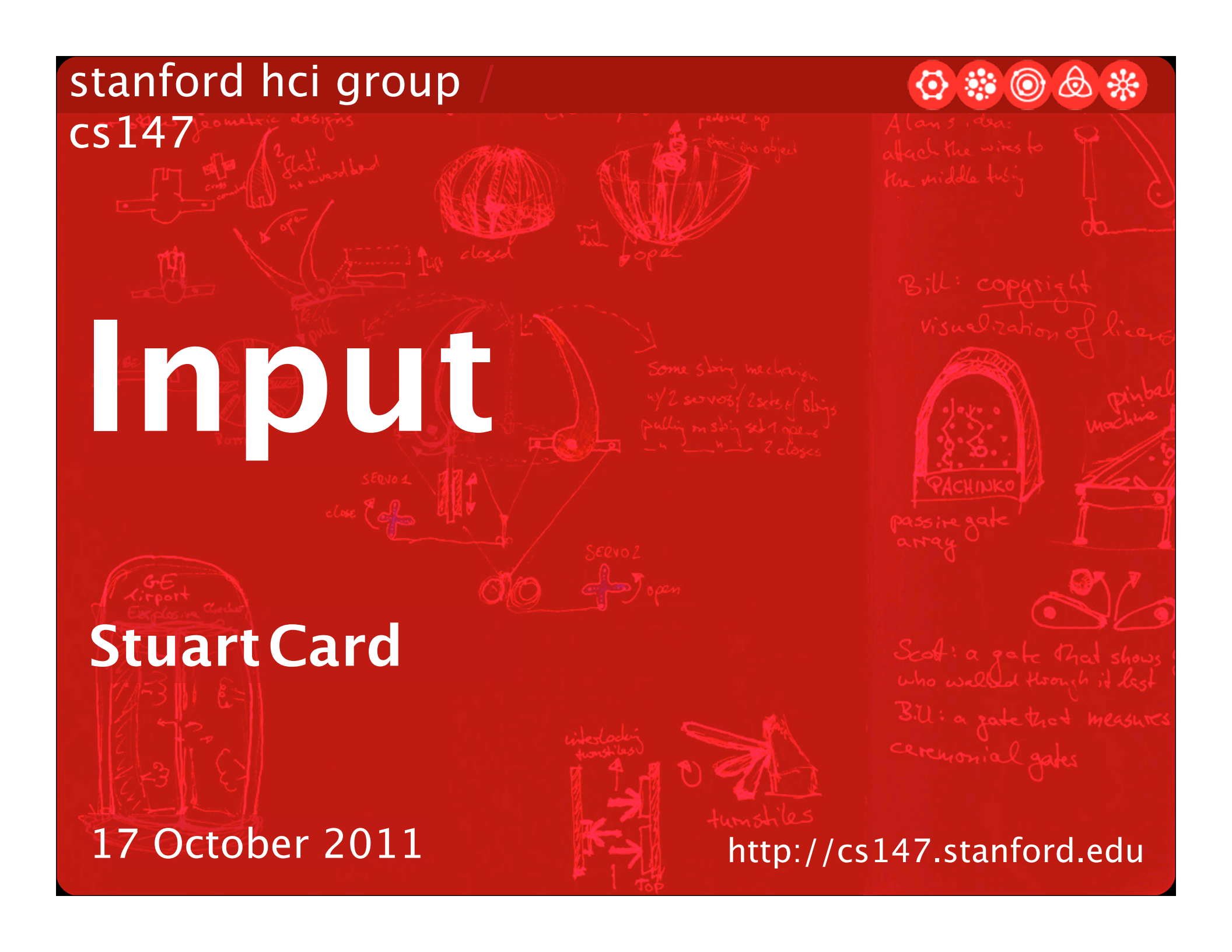
stanford hci group

cs147

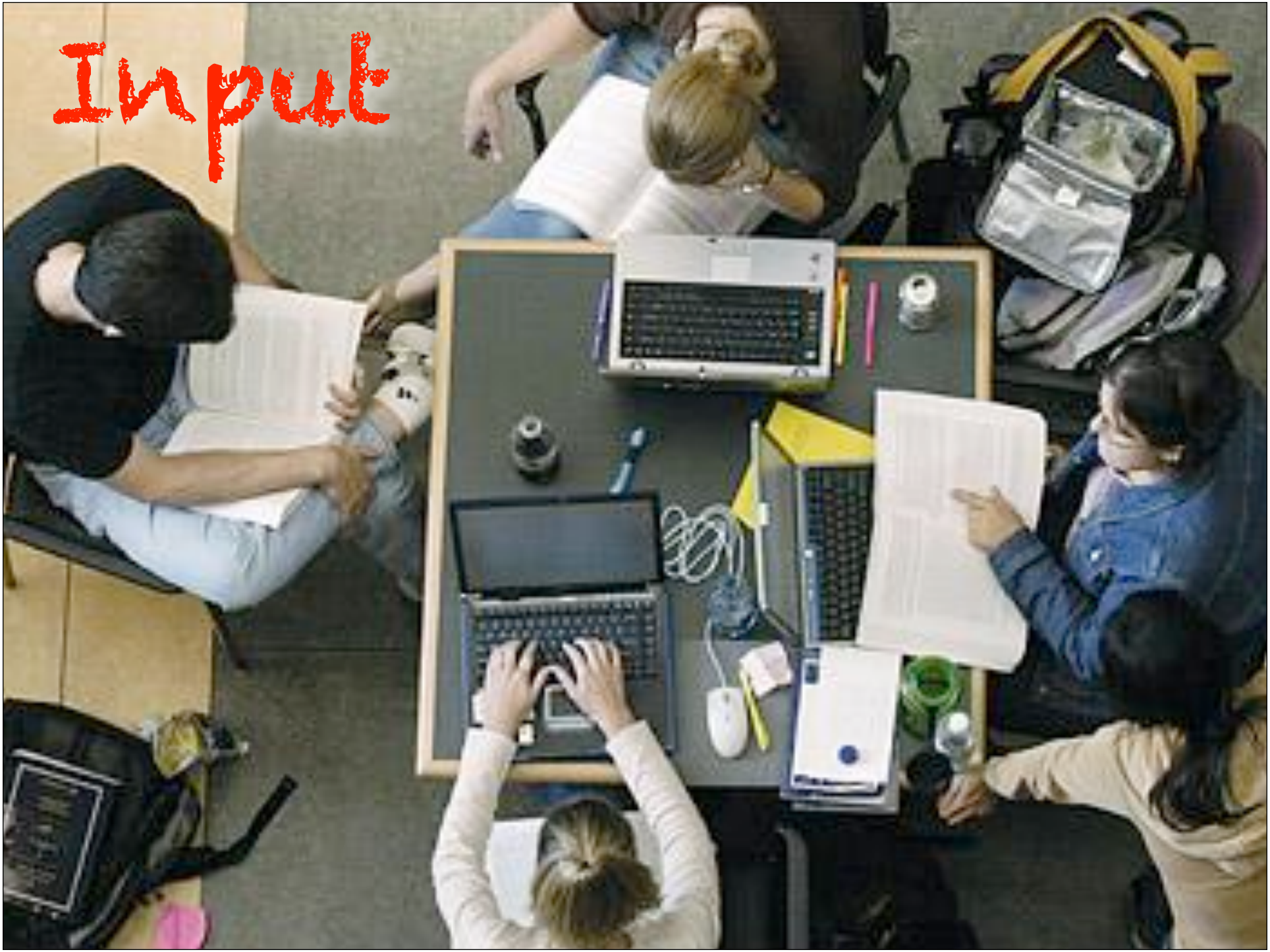


Input

Stuart Card

17 October 2011

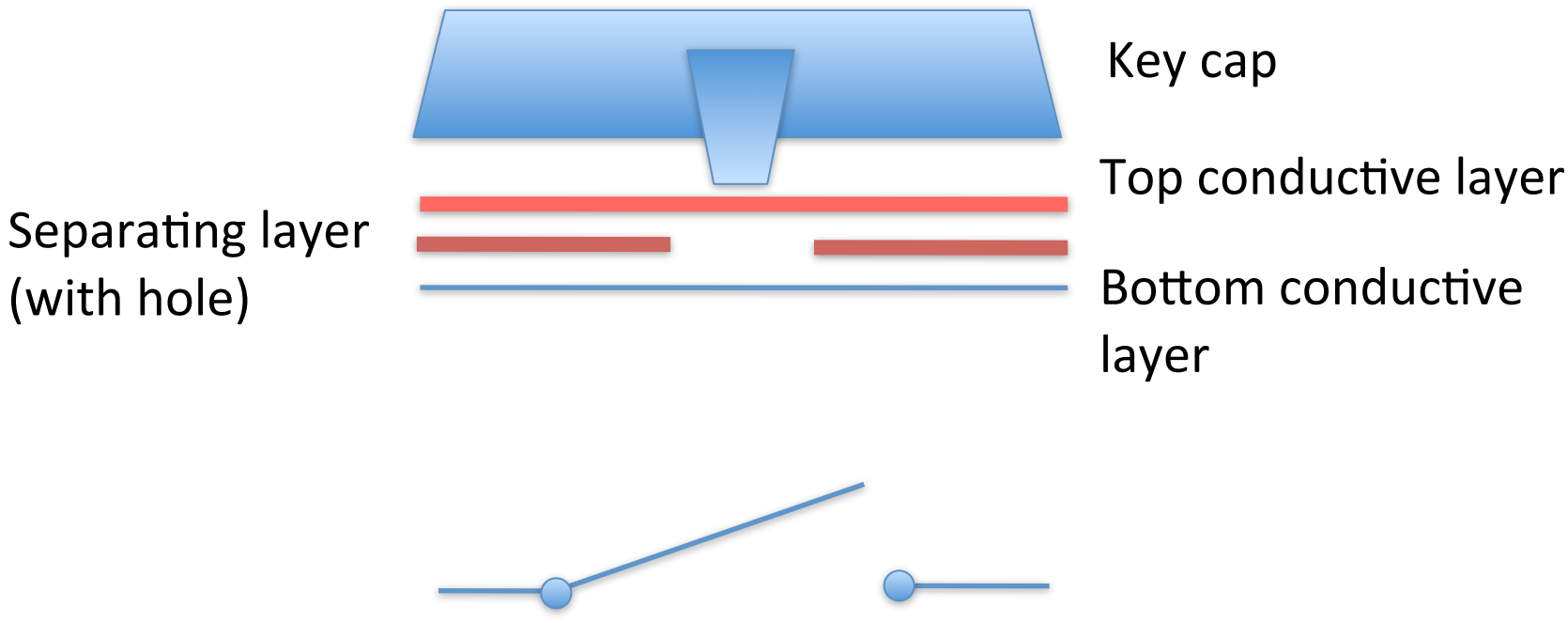
http://cs147.stanford.edu

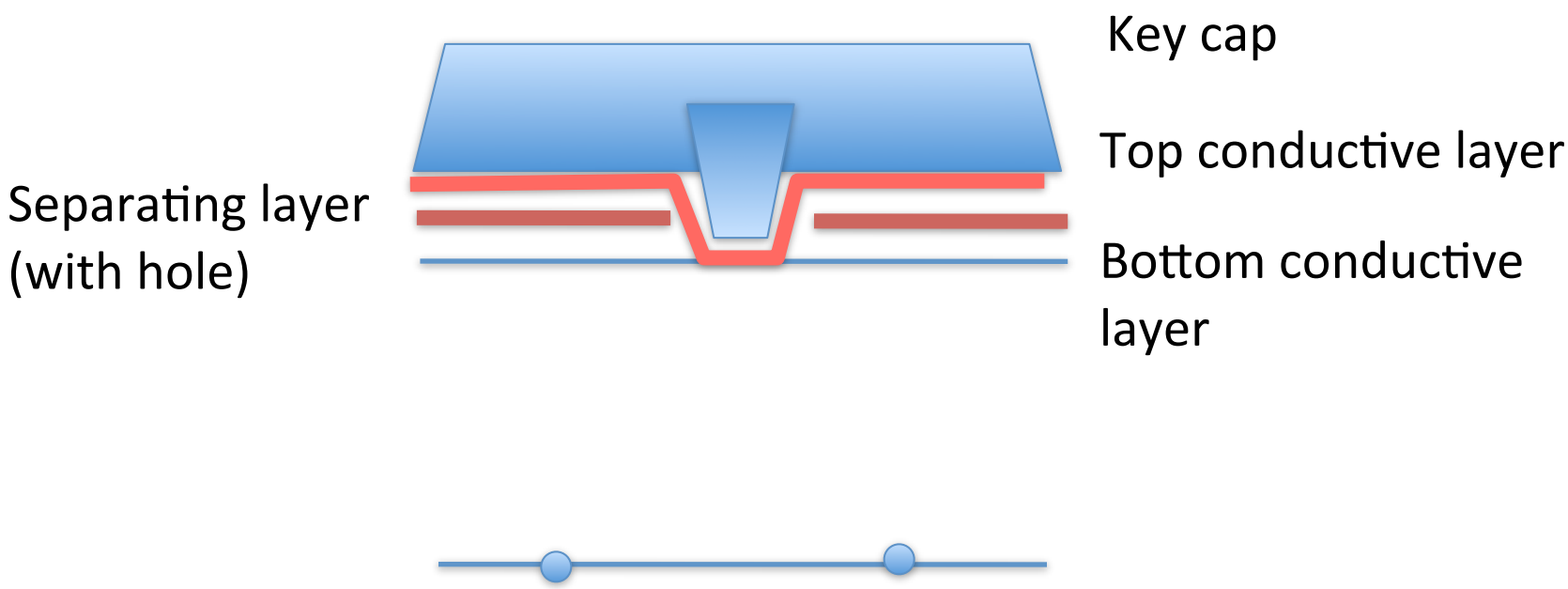

Input

Input

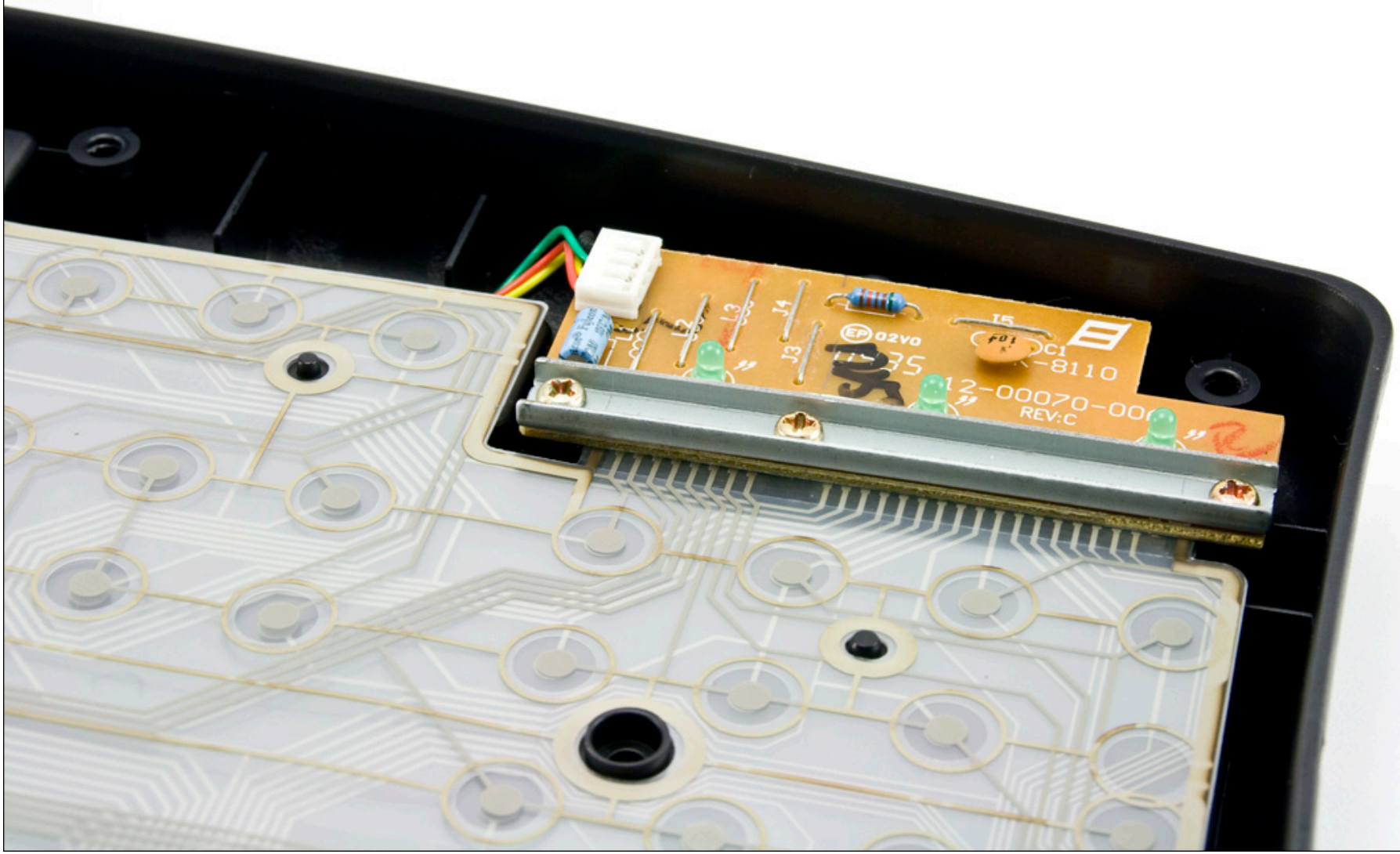
- How do these devices work for getting information into the computer?
- Some Frameworks:
  - How do input devices effect the nature of the interaction?
  - What's coming next?


DELL
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
Backspace
Enter
Shift
Ctrl
Alt
Insert
Delete
Scroll Lock


Key cap
Top conductive layer
Separating layer
(with hole)
Bottom conductive
layer


Key cap
Top conductive layer
Separating layer
(with hole)
Bottom conductive
layer

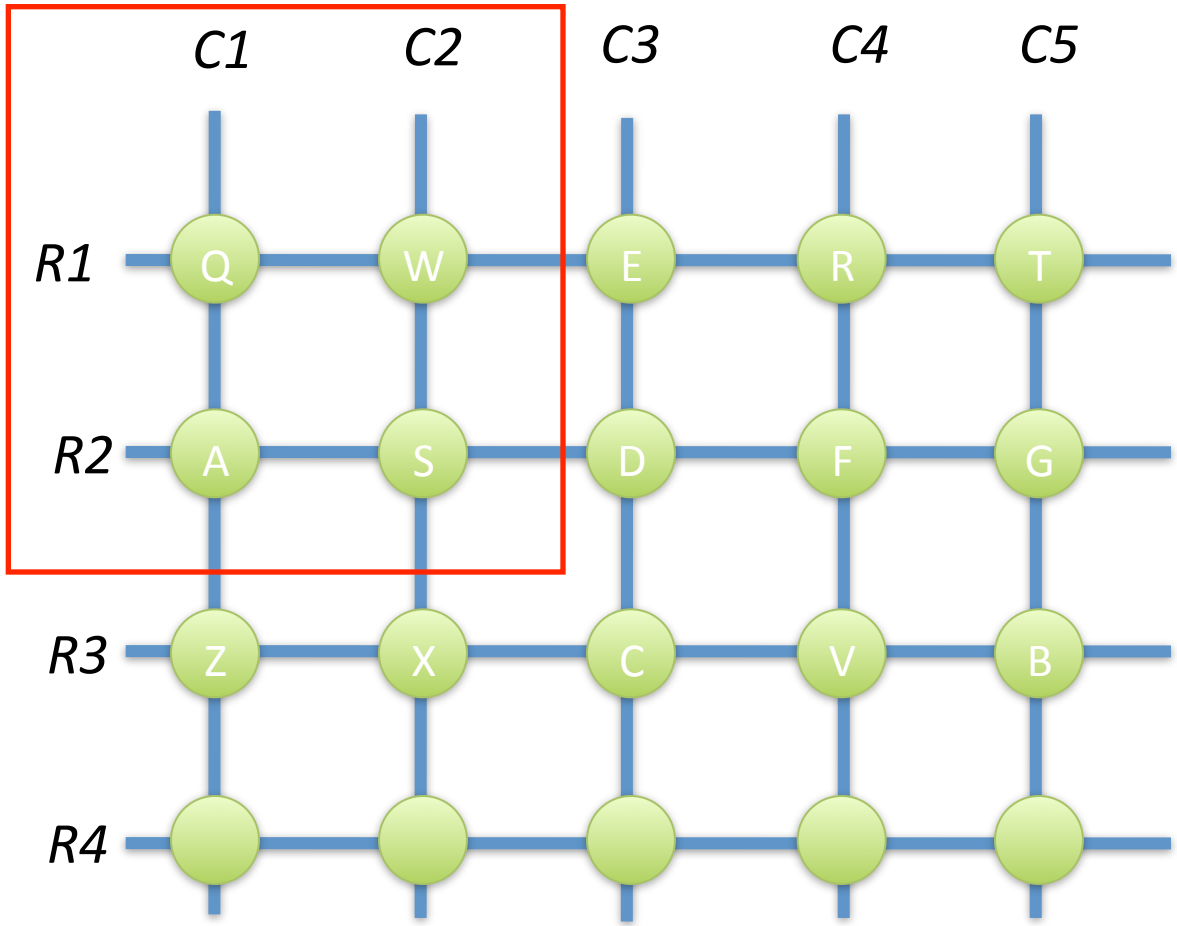
Keyboard Encoder



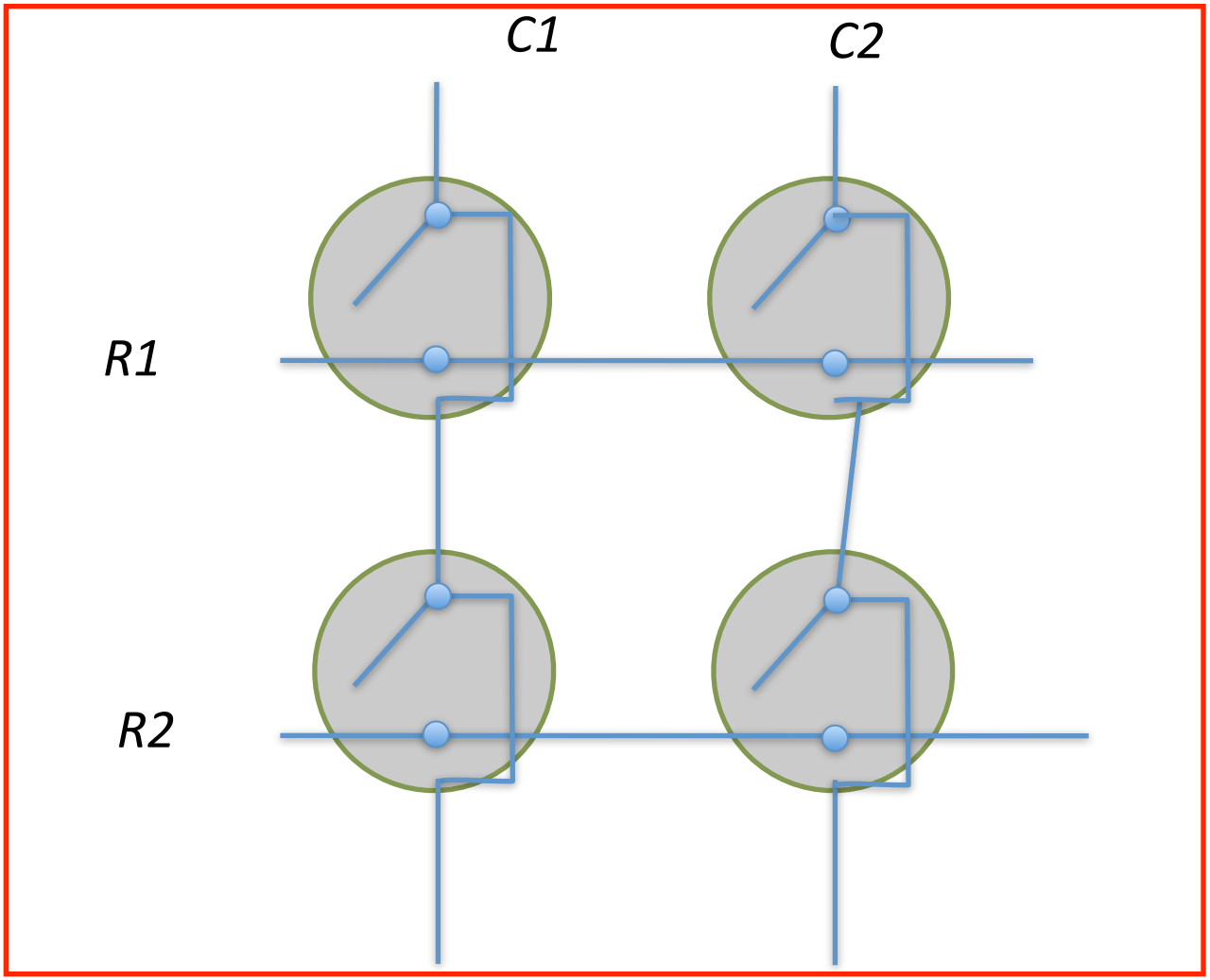
Row/Column Scanning

9 lines

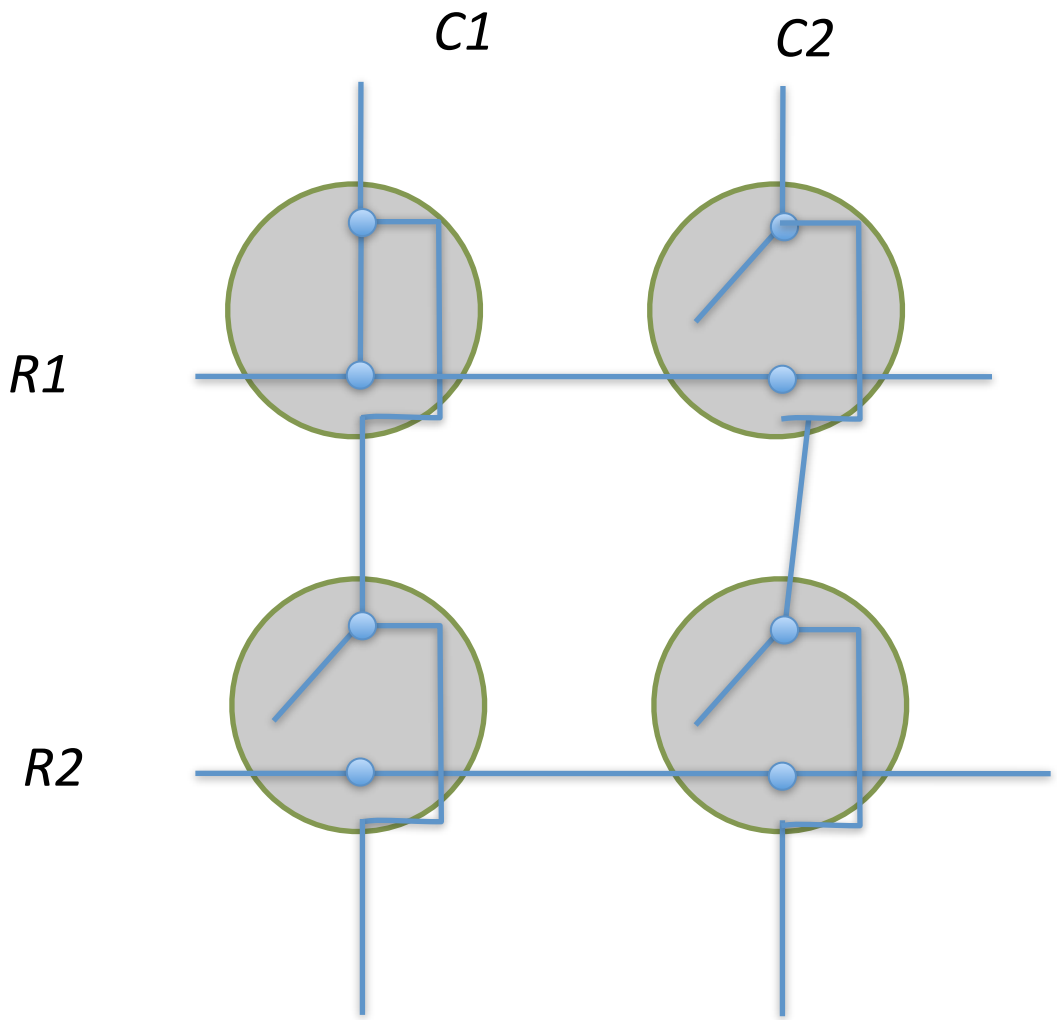
20 keys



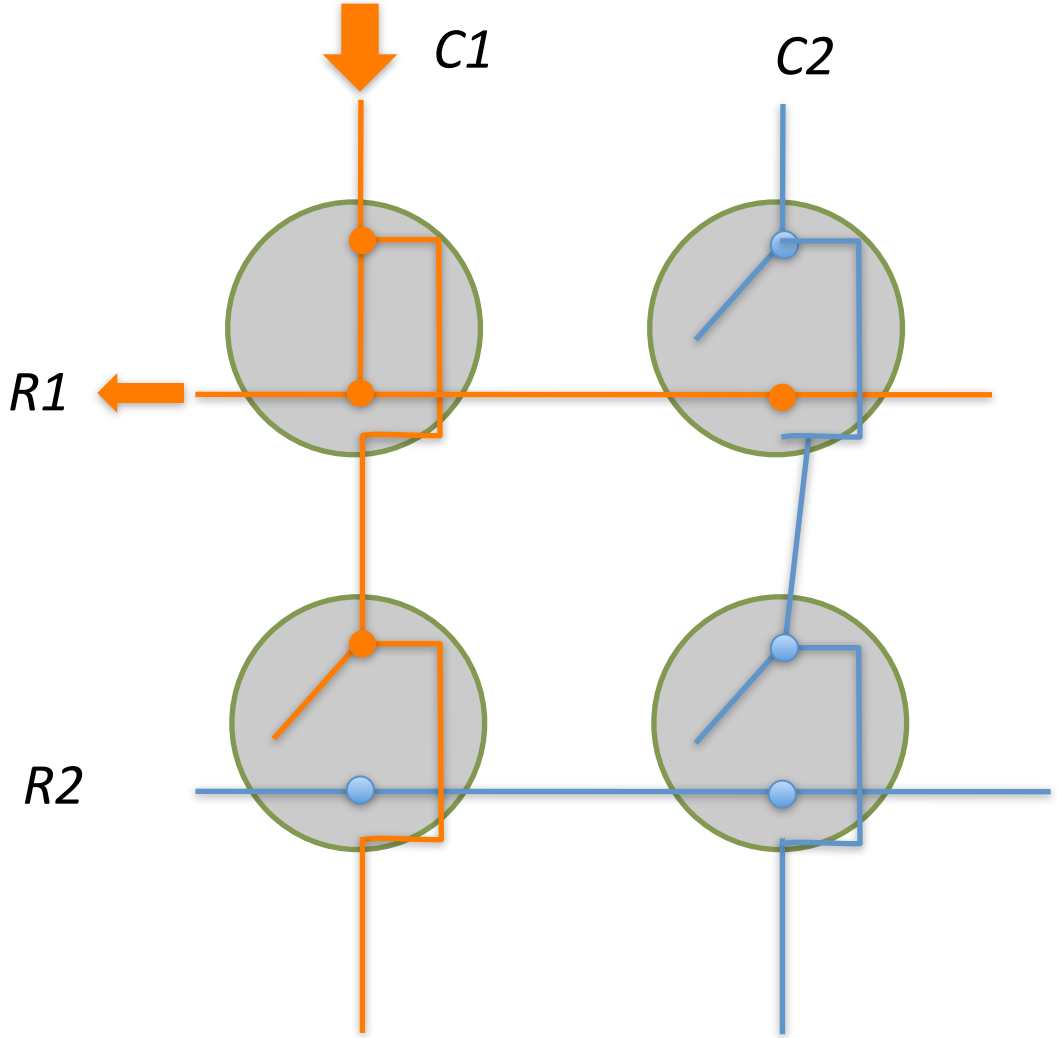
Closeup



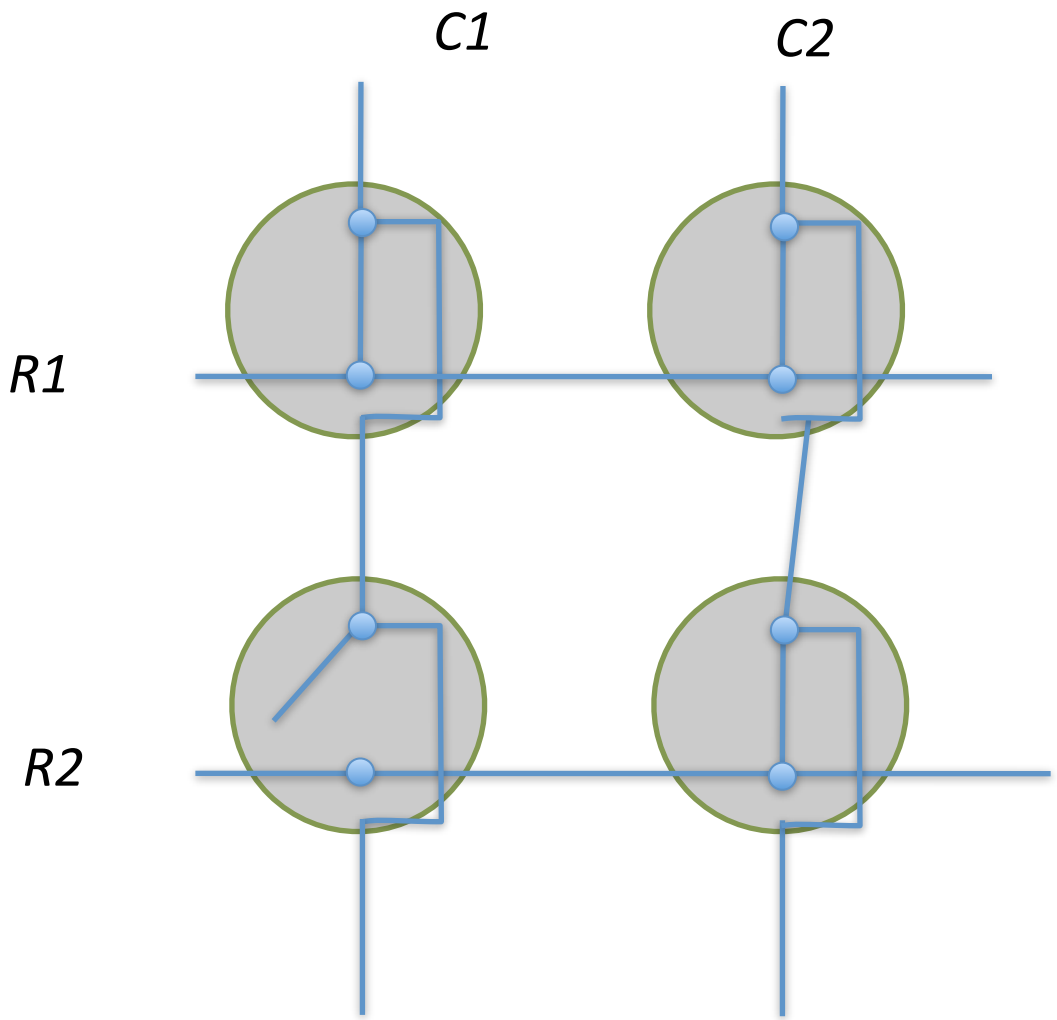
One Key Down



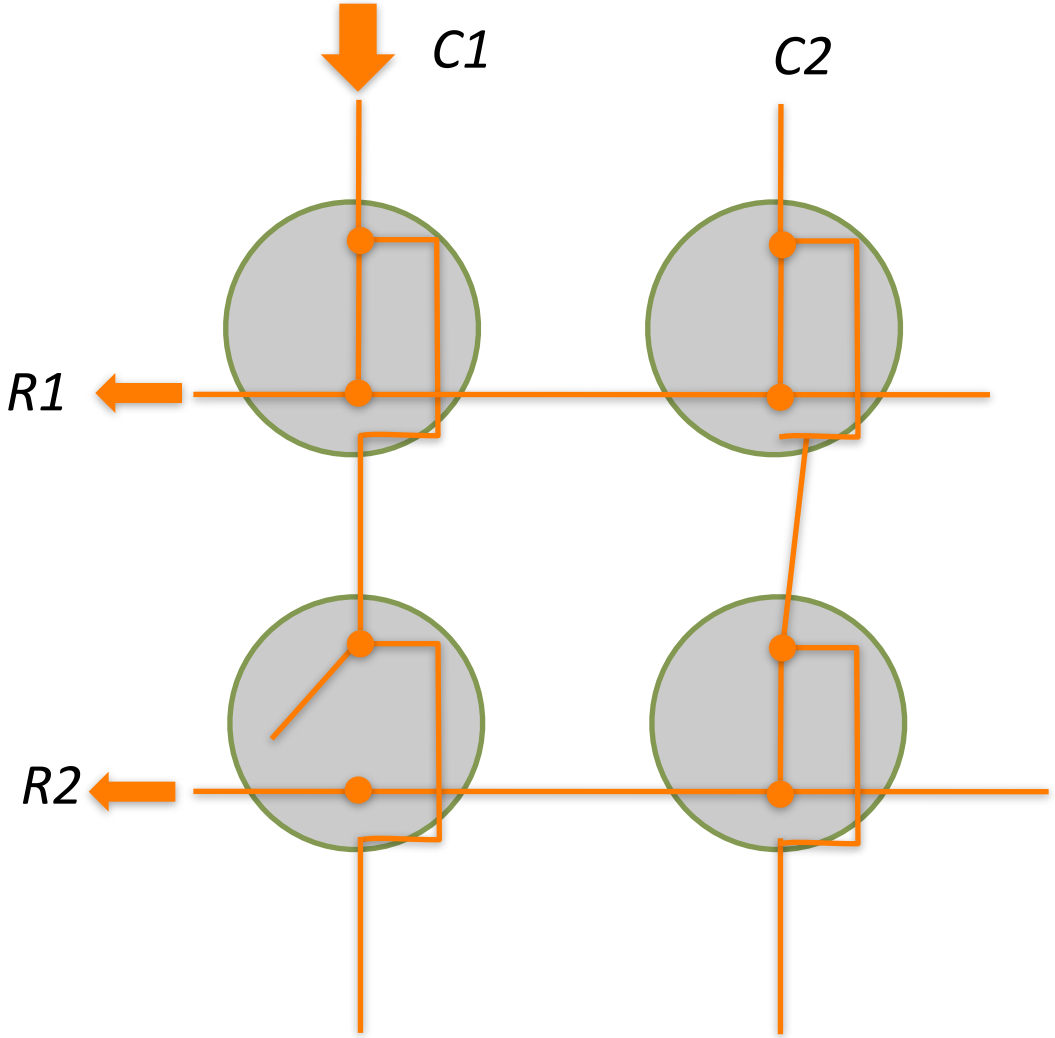
One Key Down



3 Keys Down



3 Keys Down



Keys → Scan Codes

Make (onPress) and Break (onRelease) codes

http://www.computer-engineering.org/ps2keyboard/

Keyboard Matrix (16 x 8)

16 X 8 IBM Keyboard Matrix (columns are marked 'a' to 'p' and rows are marked '1' to '8')

	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15	a16
b1			esc		F4	G	F5	H	F6	'			#0	#.	Arrow up	L Alt
b2		L Shift	Tab	Cap Lock	F3	T	Bk Space	Y	[	F7	#4	#5	#6			
b3	L Ctrl		~	F1	F2	5	F9	6	=	-	F8	Del	Ins	Page Up	Home	
b4			1	2	3	4	F10	7	8	0	9	F11	F12	Page Down	End	Prnt Scrn
b5			Q	W	E	R		U	I	P	O	#7	#8	#9	#+	Scrol Lock
b6			A	S	D	F	\	J	K	;	L	#1	#2	#3	#Enter	
b7	R Ctrl	R Shift	Z	X	C	V	Enter	M	,	\	.	#num Loc	#/	#*	Pause	
b8						B	Space	N	/			Arrow Down	Arrow Right		Arrow Left	R Alt

Standard PS/2 keyboard has 104 keys

Scan Codes

101-, 102-, and 104-key keyboards:

KEY	MAKE	BREAK	-----	KEY	MAKE	BREAK	----	KEY	MAKE	BREAK
A	1C	F0,1C		9	46	F0,46		[	54	FO,54
B	32	F0,32		`	0E	F0,0E		INSERT	E0,70	E0,F0,70
C	21	F0,21		-	4E	F0,4E		HOME	E0,6C	E0,F0,6C
D	23	F0,23		=	55	FO,55		PG UP	E0,7D	E0,F0,7D
E	24	F0,24		\	5D	F0,5D		DELETE	E0,71	E0,F0,71
F	2B	F0,2B		BKSP	66	F0,66		END	E0,69	E0,F0,69
G	34	F0,34		SPACE	29	F0,29		PG DN	E0,7A	E0,F0,7A
H	33	F0,33		TAB	0D	F0,0D		U ARROW	E0,75	E0,F0,75
I	43	F0,43		CAPS	58	F0,58		L ARROW	E0,6B	E0,F0,6B
J	3B	F0,3B		L SHFT	12	FO,12		D ARROW	E0,72	E0,F0,72
K	42	F0,42		L CTRL	14	FO,14		R ARROW	E0,74	E0,F0,74
L	4B	F0,4B		L GUI	E0,1F	E0,F0,1F		NUM	77	F0,77
M	3A	F0,3A		L ALT	11	F0,11		KP /	E0,4A	E0,F0,4A
N	31	F0,31		R SHFT	59	F0,59		KP *	7C	F0,7C
O	44	F0,44		R CTRL	E0,14	E0,F0,14		KP -	7B	F0,7B
P	4D	F0,4D		R GUI	E0,27	E0,F0,27		KP +	79	F0,79
Q	15	F0,15		R ALT	E0,11	E0,F0,11		KP EN	E0,5A	E0,F0,5A
R	2D	F0,2D		APPS	E0,2F	E0,F0,2F		KP .	71	F0,71
S	1B	F0,1B		ENTER	5A	F0,5A		KP 0	70	F0,70
T	2C	F0,2C		ESC	76	F0,76		KP 1	69	F0,69
U	3C	F0,3C		F1	05	F0,05		KP 2	72	F0,72
V	2A	F0,2A		F2	06	F0,06		KP 3	7A	F0,7A
W	1D	F0,1D		F3	04	F0,04		KP 4	6B	F0,6B
X	22	F0,22		F4	0C	F0,0C		KP 5	73	F0,73
Y	35	F0,35		F5	03	F0,03		KP 6	74	F0,74
Z	1A	F0,1A		F6	0B	F0,0B		KP 7	6C	F0,6C
0	45	F0,45		F7	83	F0,83		KP 8	75	F0,75
1	16	F0,16		F8	0A	F0,0A		KP 9	7D	F0,7D
2	1E	F0,1E		F9	01	F0,01		]	5B	F0,5B
3	26	F0,26		F10	09	F0,09		;	4C	F0,4C
4	25	F0,25		F11	78	F0,78		'	52	F0,52
5	2E	F0,2E		F12	07	F0,07		,	41	F0,41
6	36	F0,36		PRNT SCRN	E0,12, E0,7C	E0,F0, 7C,E0, F0,12		.	49	F0,49
7	3D	F0,3D		SCROLL	7E	F0,7E		/	4A	F0,4A
8	3E	F0,3E		PAUSE	E1,14,77, E1,F0,14, F0,77	-NONE-				

Keys (Scan Codes) ≠ Characters

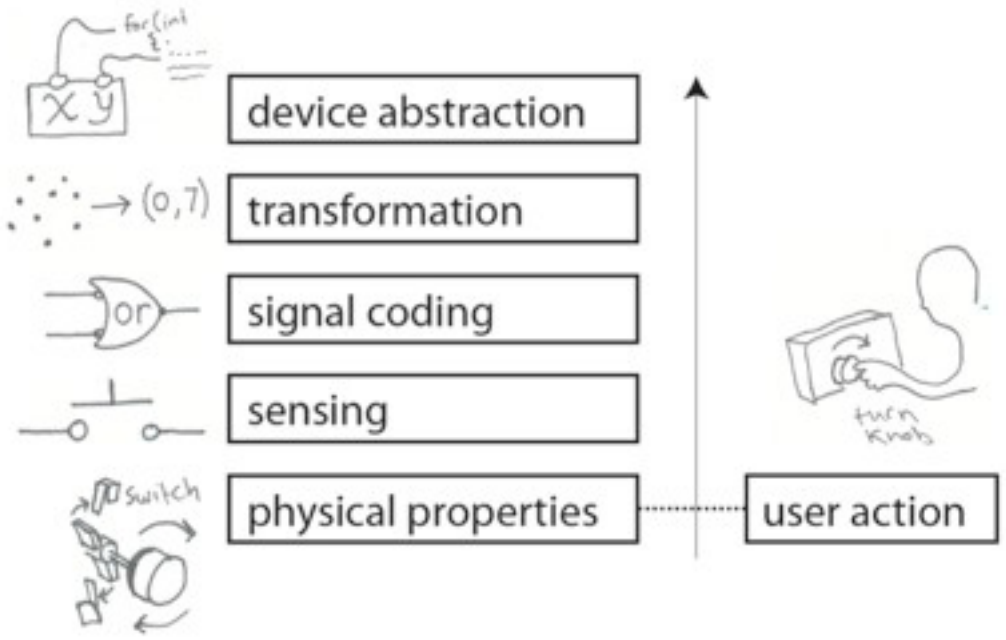
Special keys - interpreted by the OS or App

- F1, ..., F12
- Insert, Delete, Home, ...

Duplicated keys

- Numbers on keypad vs. keyboard
- Left-shift, Right-shift, Left-cmd, Right-cmd, ...

Layered Model of Input



Layered Model of Input

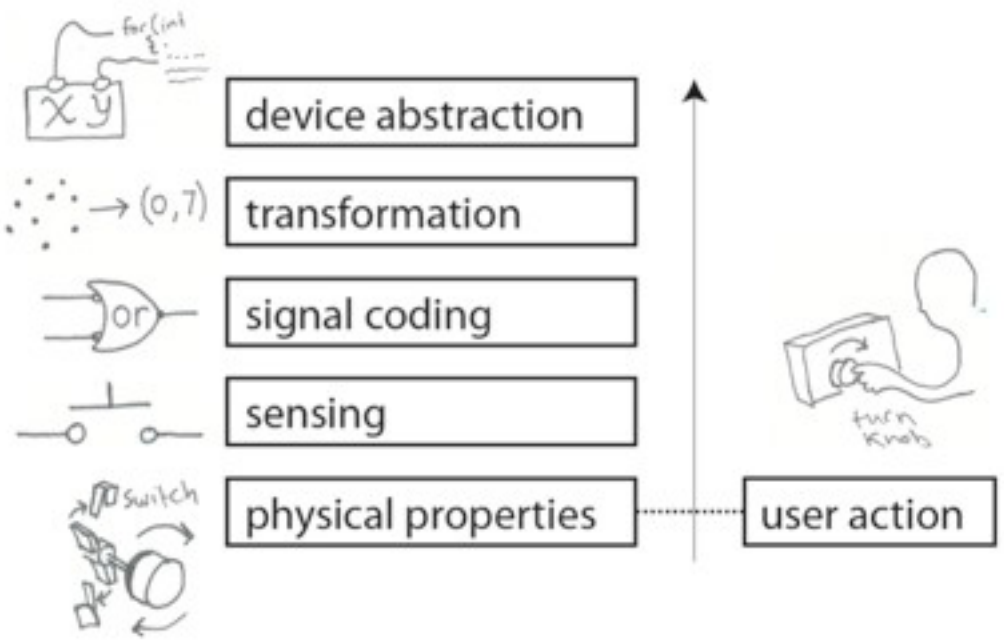
Keyboard

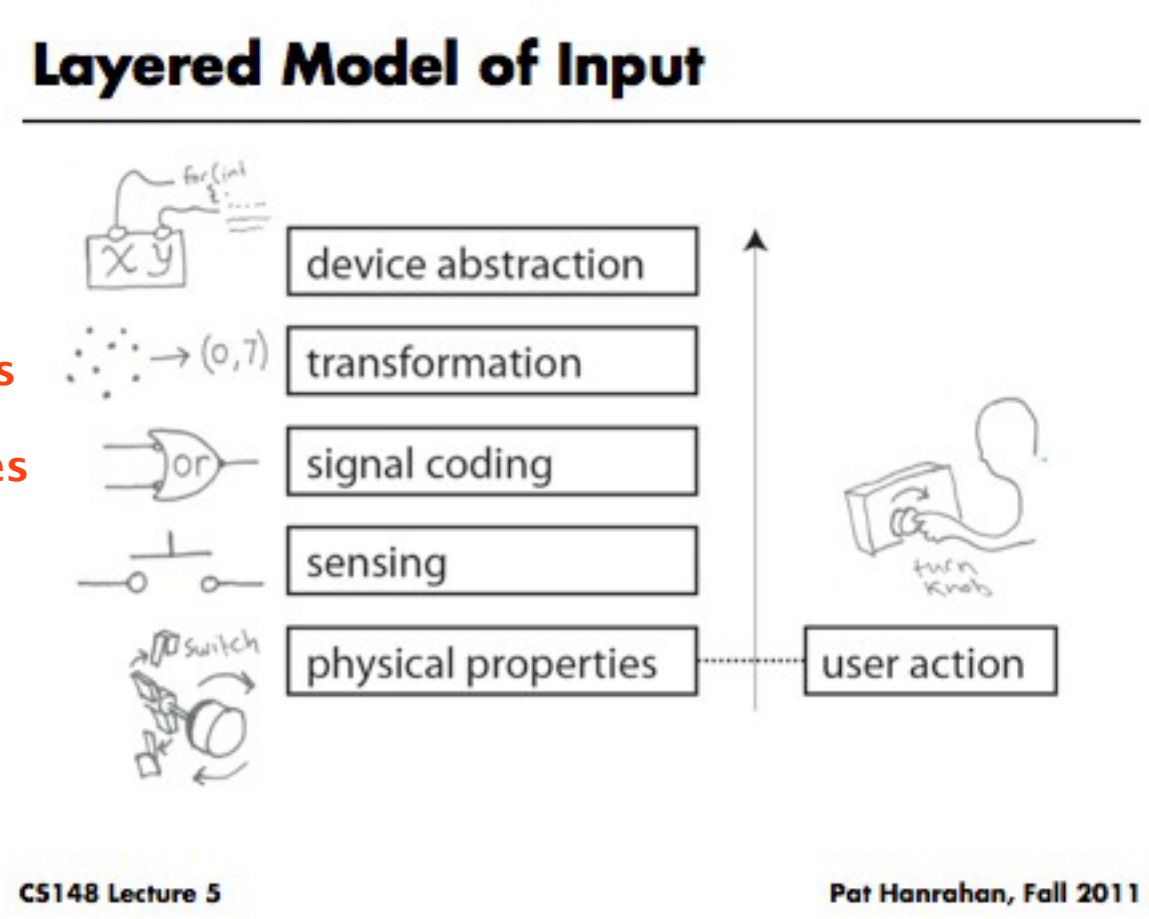
Characters

Scan Codes

Switches

Keys





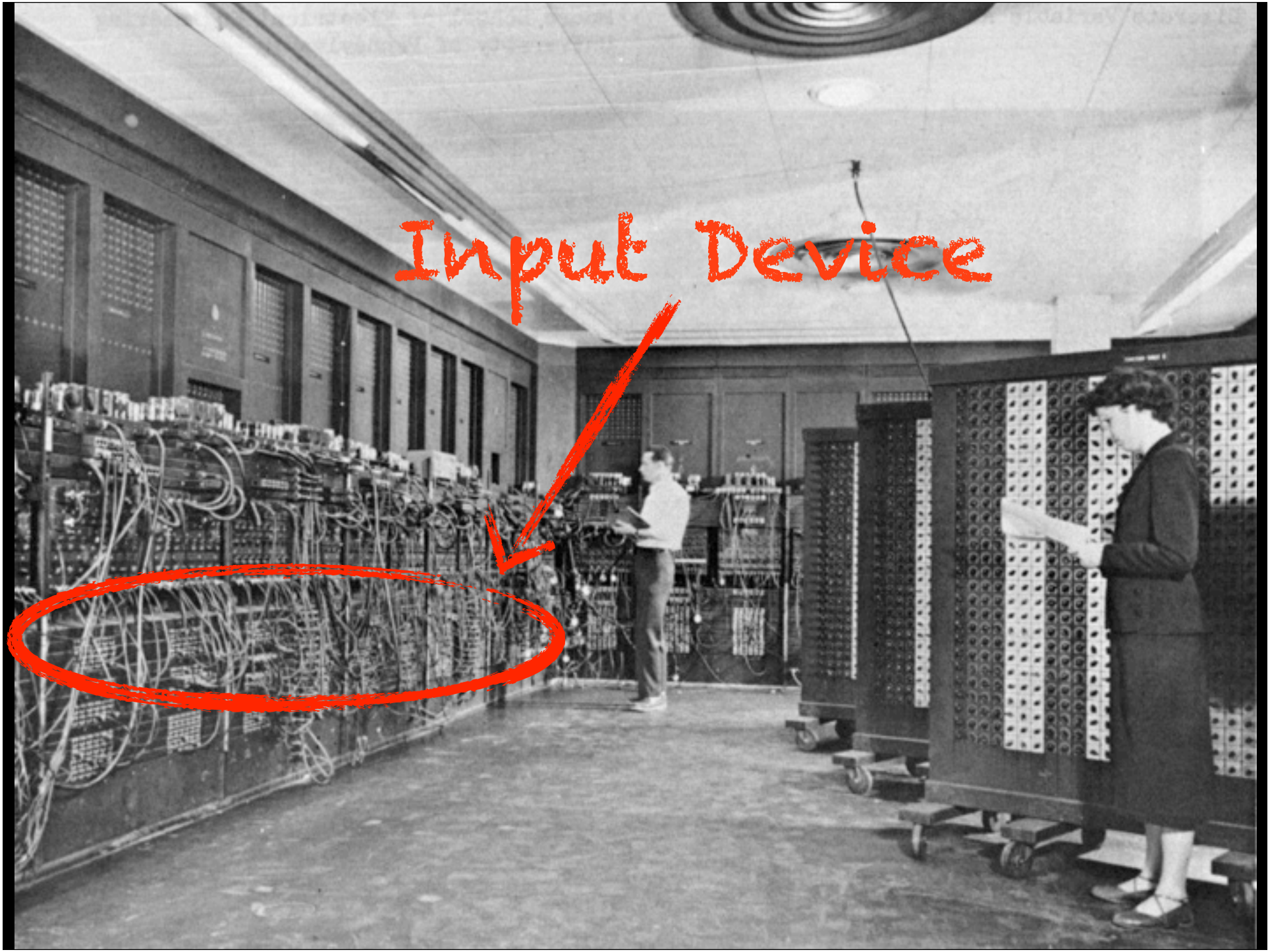
Keyboard

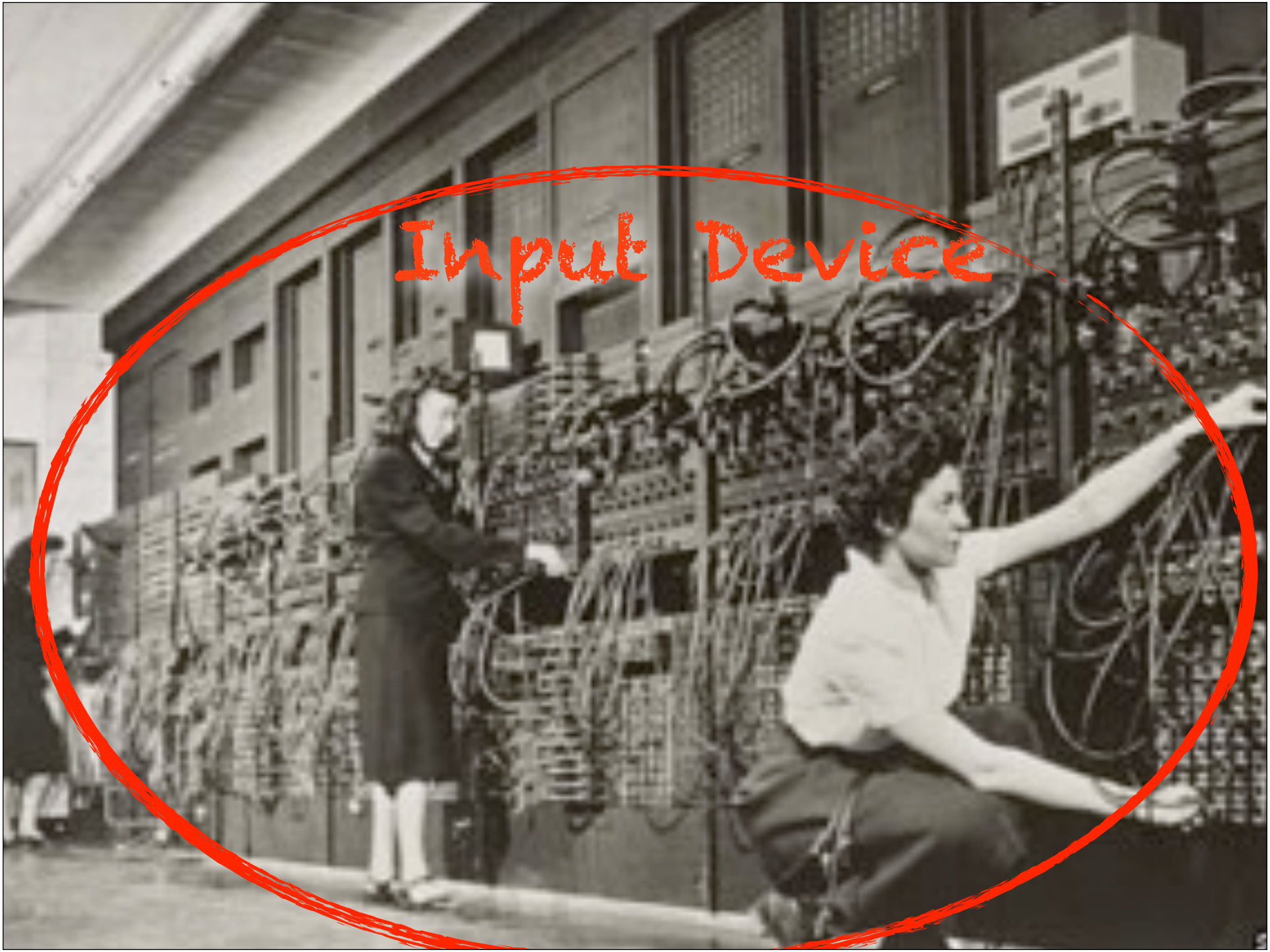
G

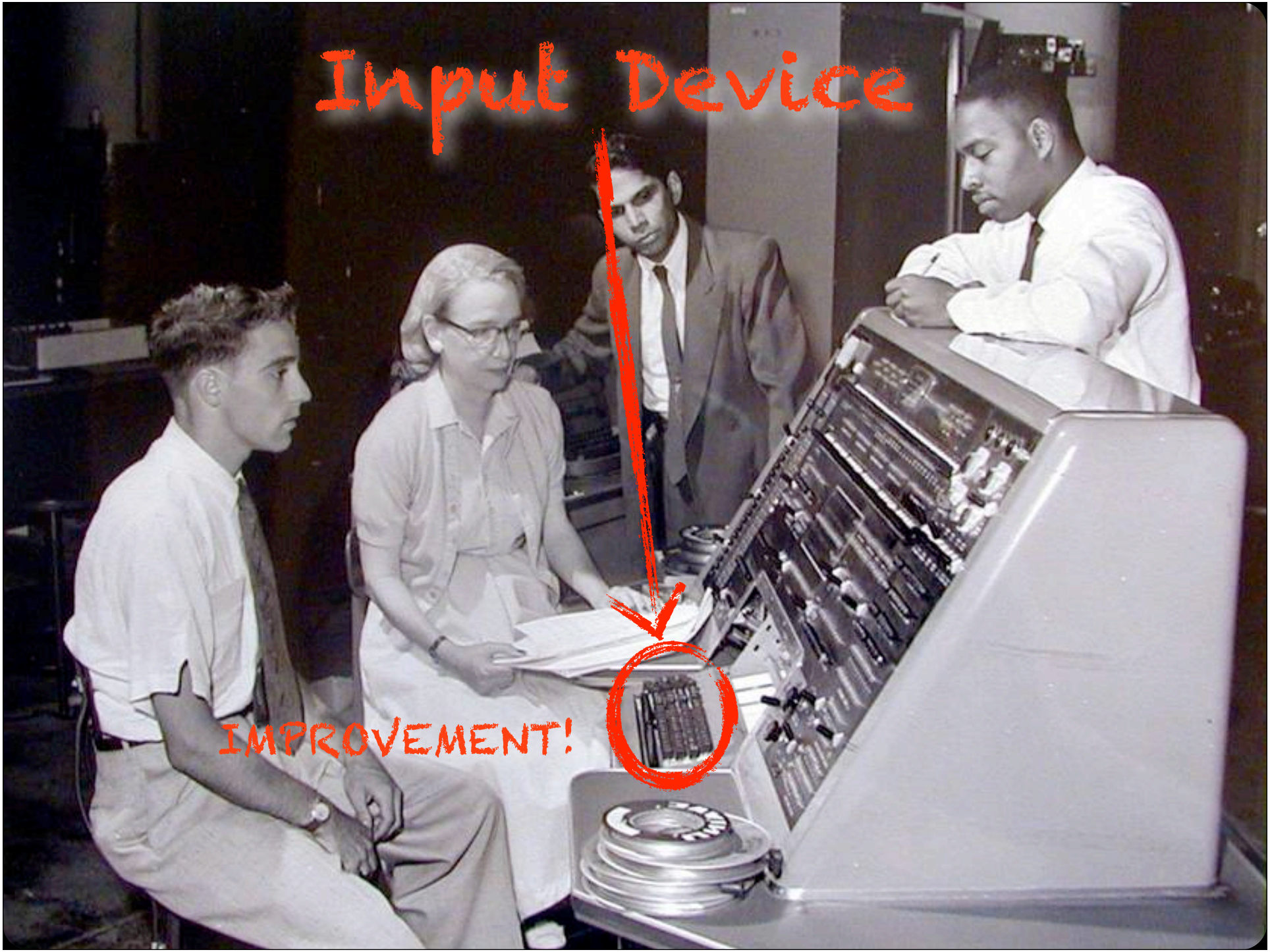
59h 34h F0h
59h F0h F12

b7a2 b1a6

SHIFT g


Input Device


Input Device

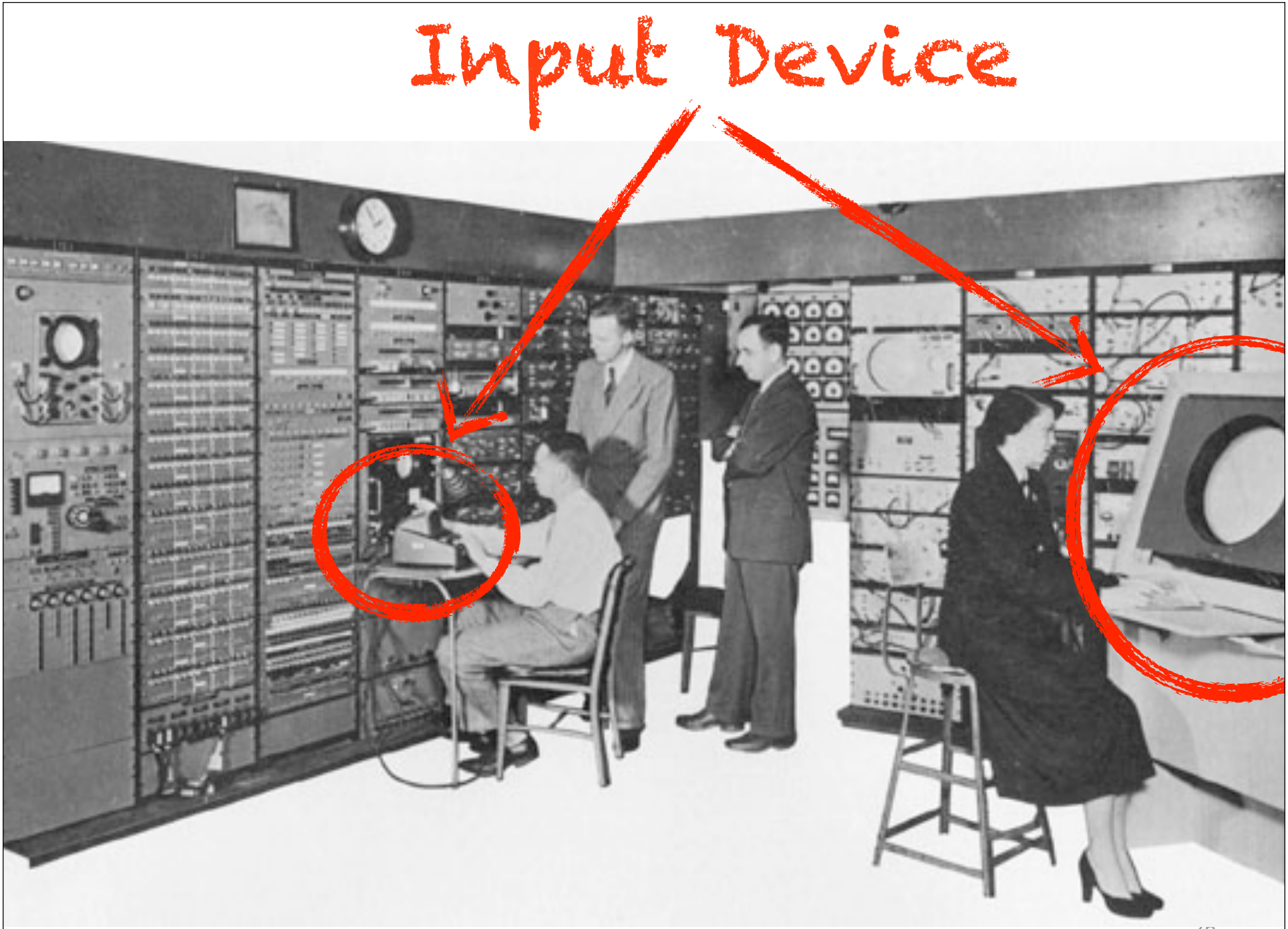

Input Device
IMPROVEMENT!

But we can do much better

The real problem:

ASYMETRY OF OUTPUT TO INPUT

Typewriter limits input speed (and expressibility)



Whirlwind (MIT, 1951)

Big Idea:

INPUT ON OUTPUT

Input on Output

SAGE

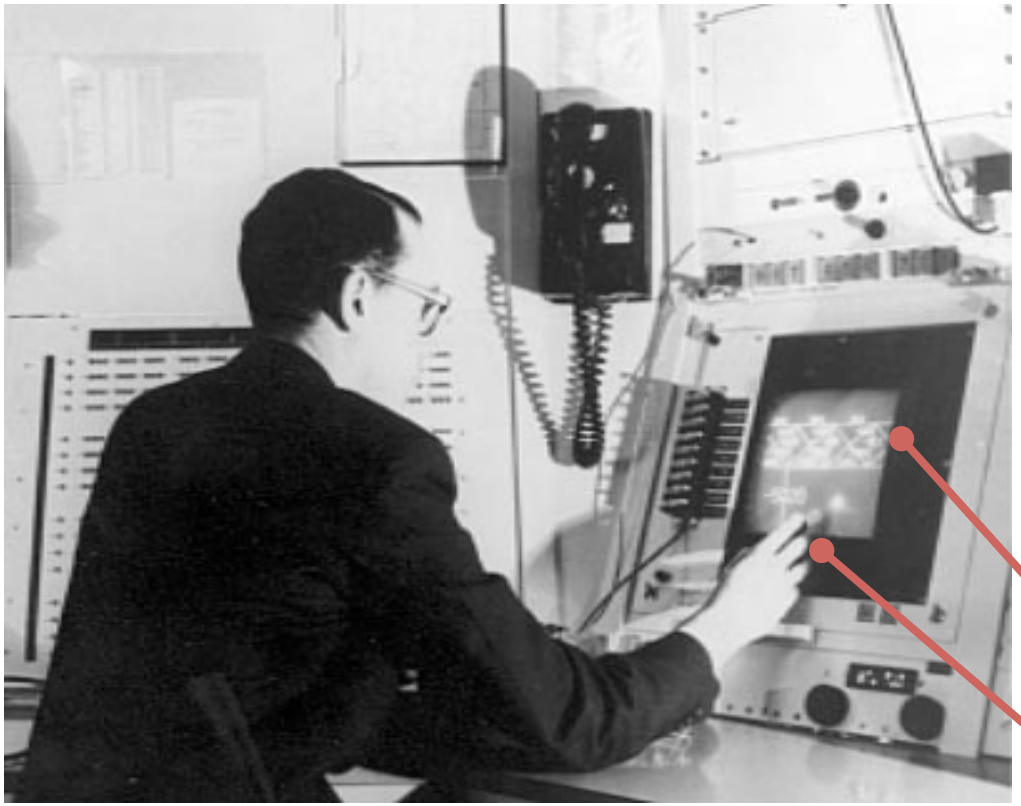
J. C. R. LICKLIDER

HUMAN-MACHINE SYMBIOSIS:

"The hope is that in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain ever thought."

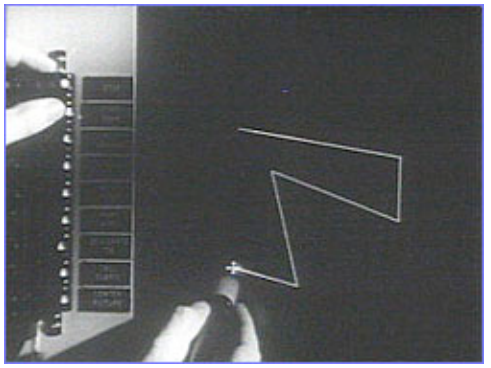
Graphical Direct Manipulation

SKETCHPAD (1963)



TX-2 (MIT, 1959)

- Direct Manipulation
- Tiled windows
- File icons
- Menus



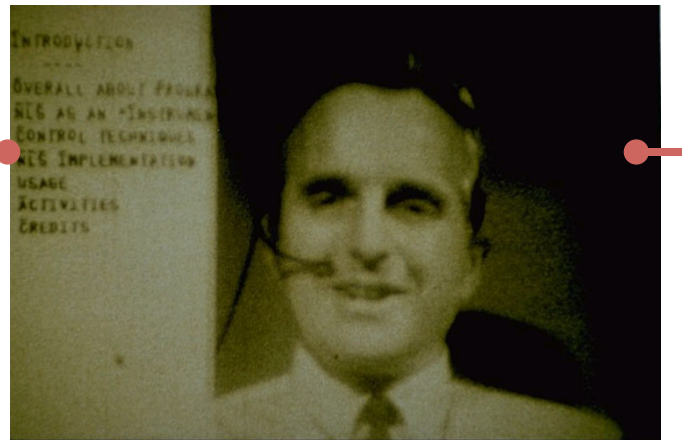
Changing visual element part of interaction loop

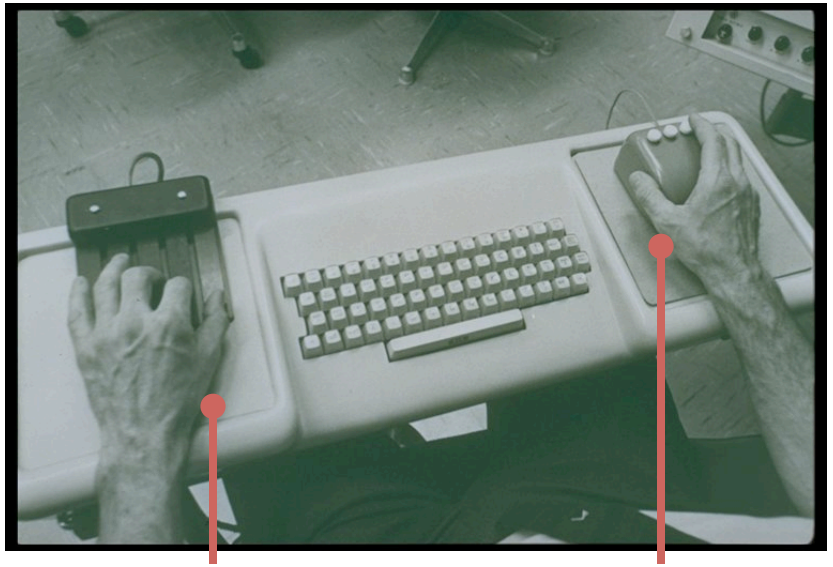
Lightpen

Point and Click, Hypertext

NLS (SRI, 1968)

- Mouse
- Point & Click editing
- Hypertext
- Rapid interaction
- Text/graphic integration





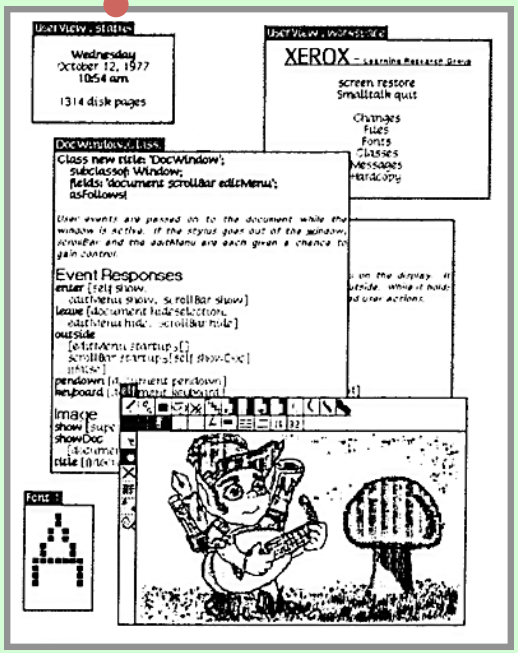
Note: Four hands are required.

Graphical UI, Windows

- Digital Mouse
- Ball mouse
- Bitmapped CRT
- Overlapped windows
- Desktop metaphor
- Object-oriented UI
- Pull-down menus
- Cut & Paste
- Icons
- Typography

Alto (Xerox, 1974)

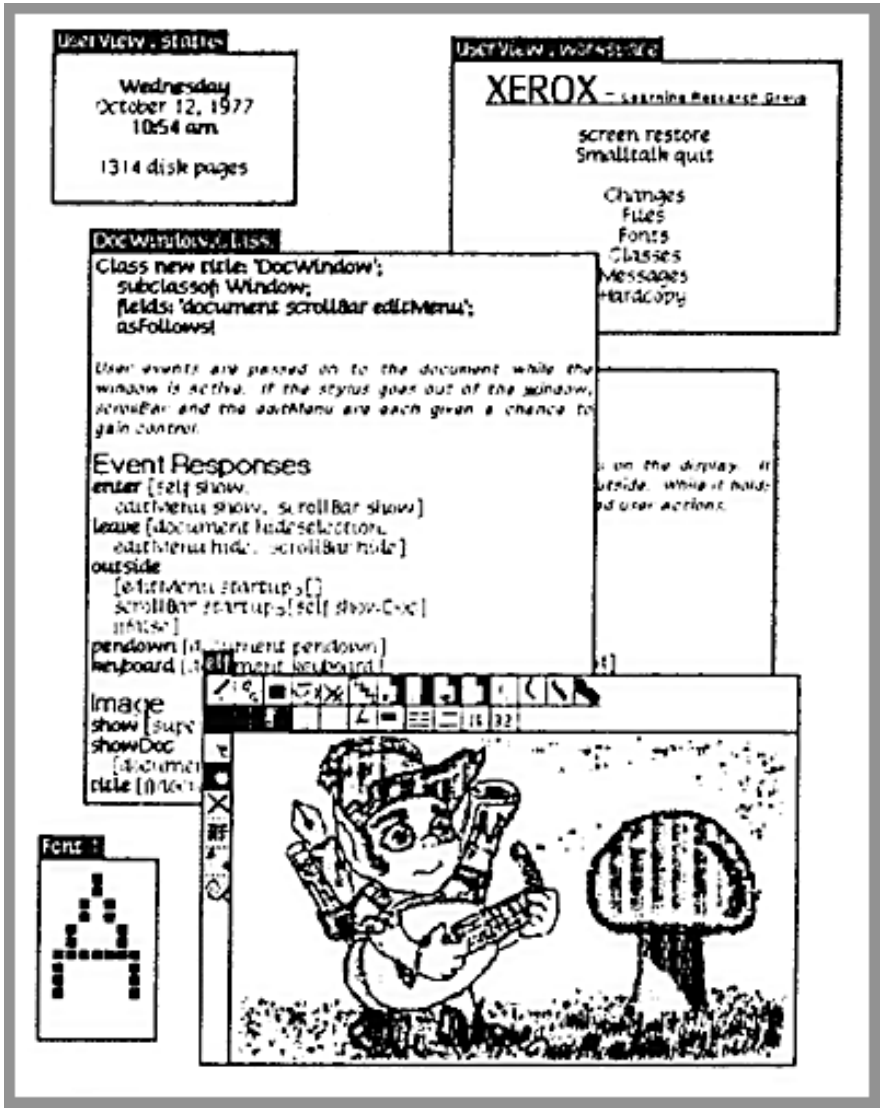
-ARCHETYPE-



Smalltalk (Xerox, 1976)

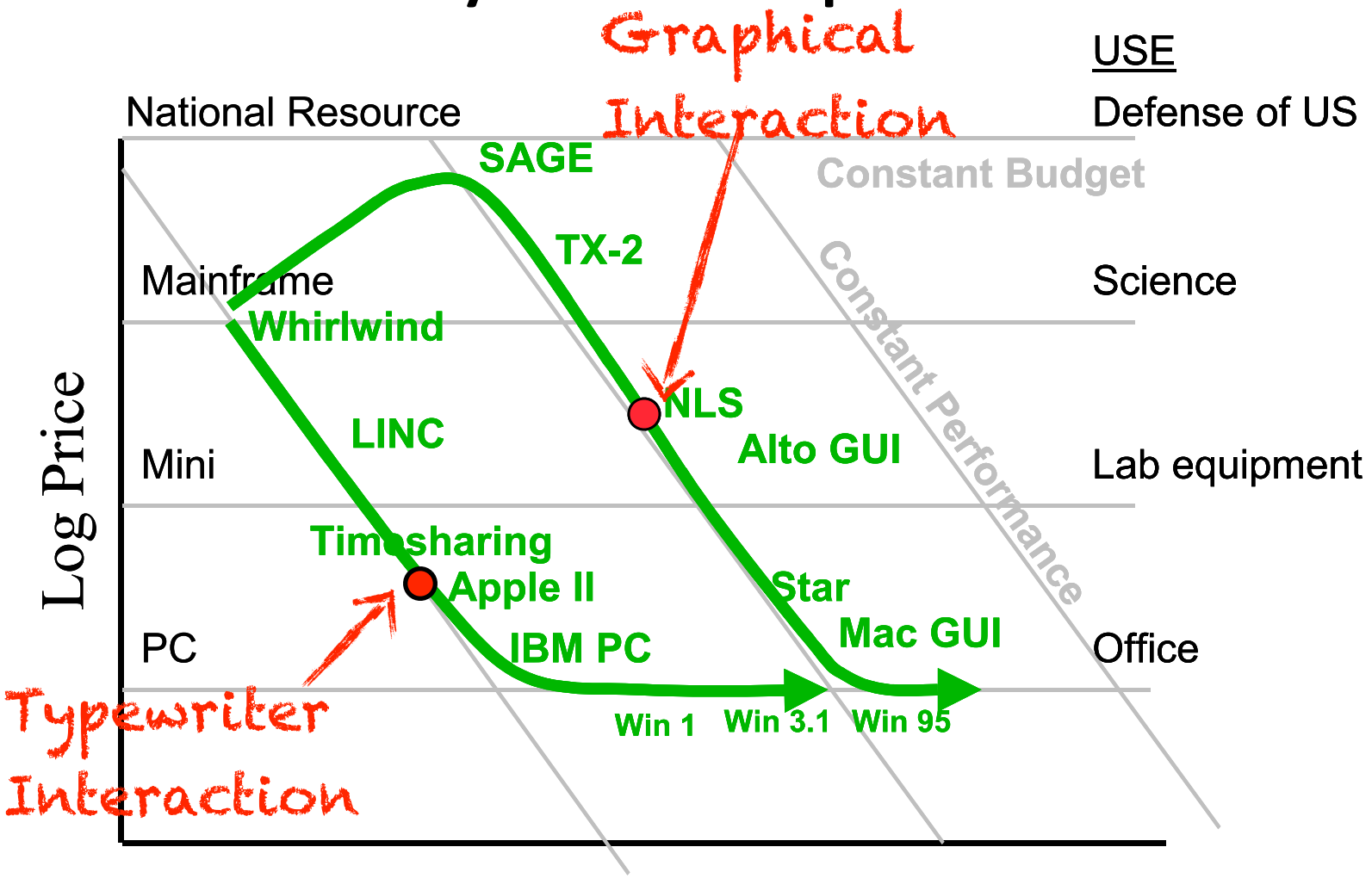
Independent information objects

Alto (Xerox, 1974)



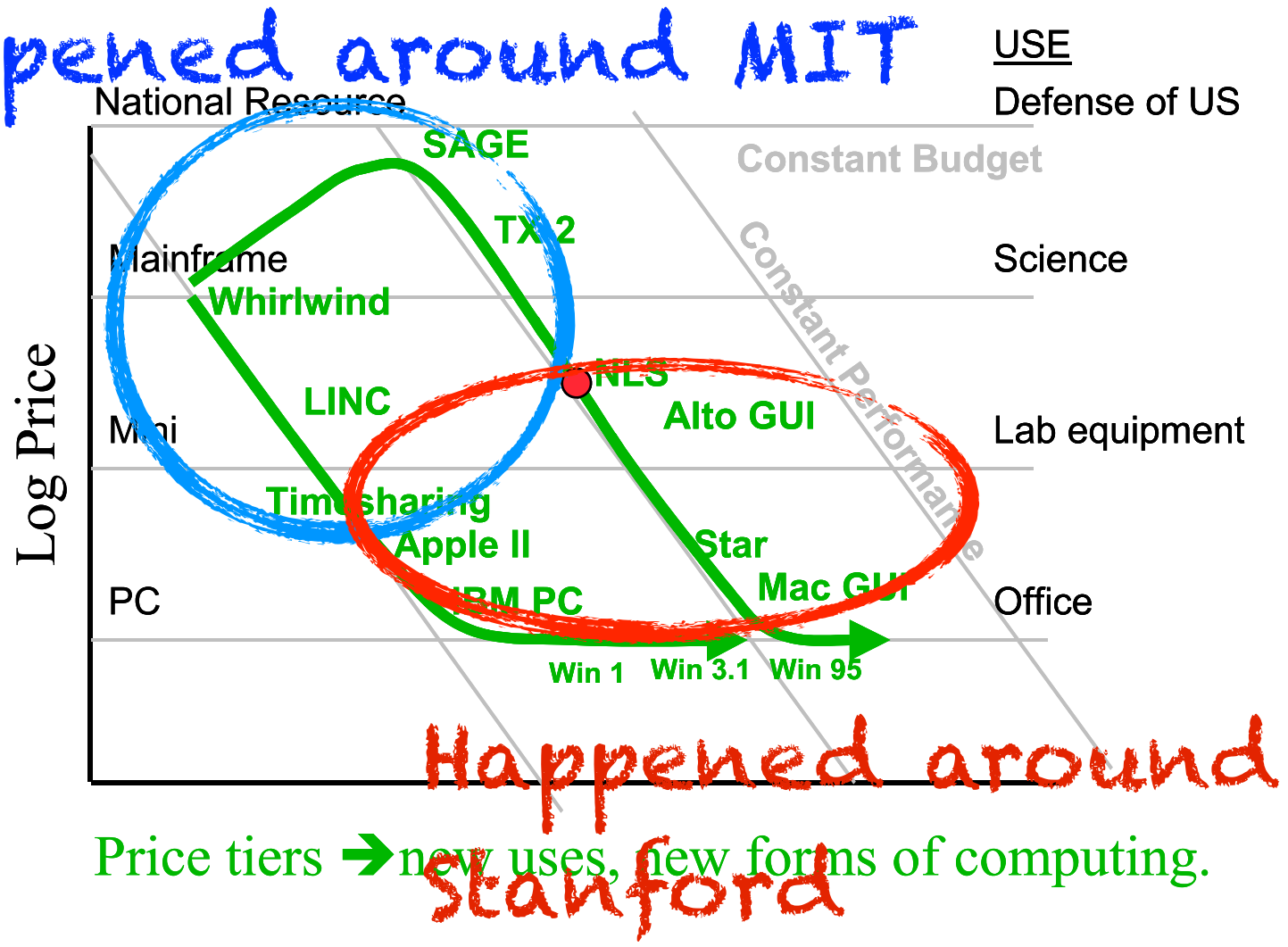
Smalltalk
(Xerox, 1976)

Bell Theory of Computer Classes

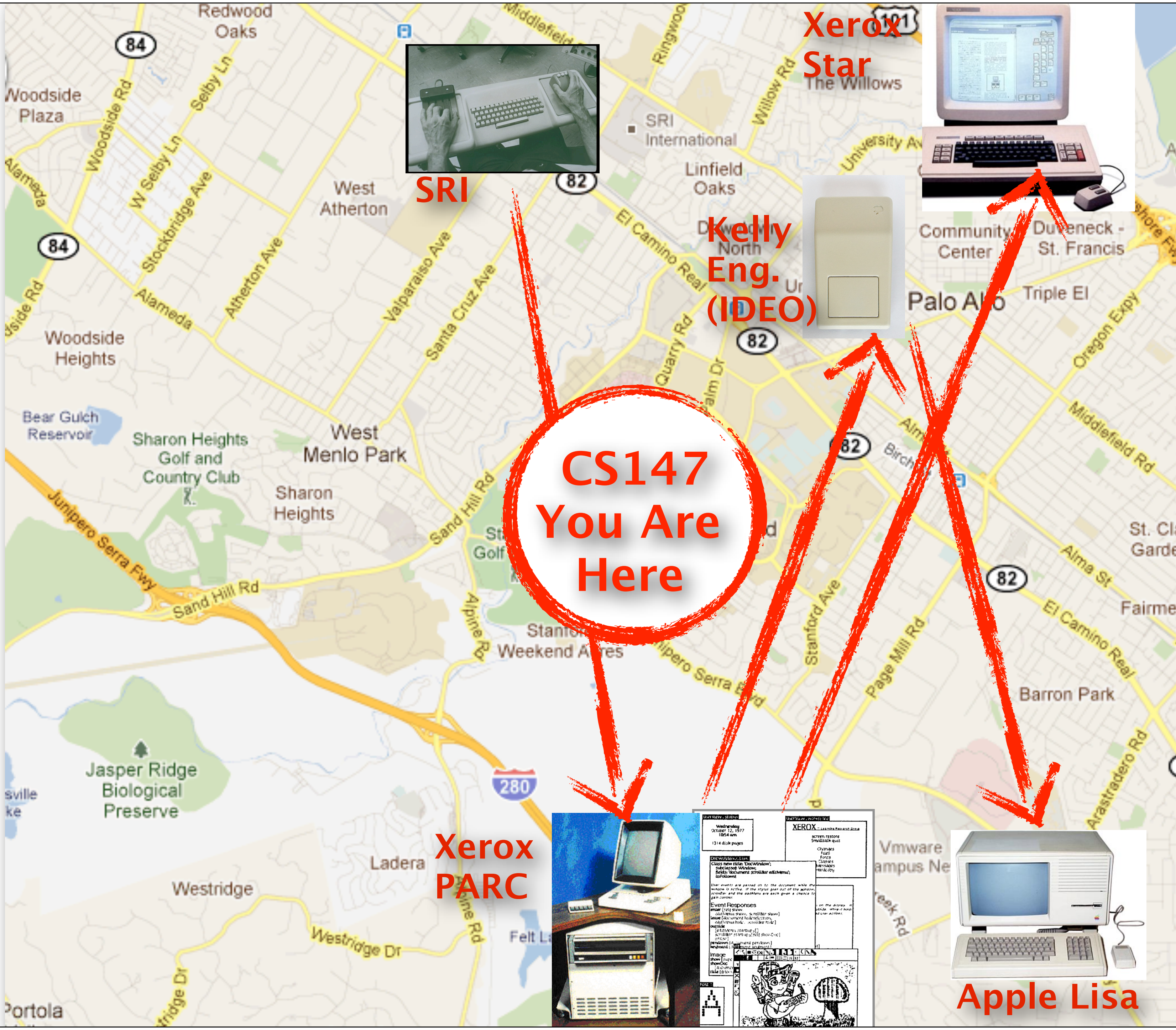


Price tiers ➔ new uses, new forms of computing.

Bell Theory of Computer Classes



Price tiers → new uses, new forms of computing.



SRI
Xerox
Star
Kelly
Eng.
(IDEO)
CS147
You Are
Here
Xerox
PARC
Apple Lisa
Redwood
Oaks
Woodside
Plaza
West
Atherton
SRI
International
Linfield
Oaks
The Willows
Community
Center
Duveneck -
St. Francis
Triple El
Woodside
Heights
Bear Gulch
Reservoir
Sharon Heights
Golf and
Country Club
West
Menlo Park
Sharon
Heights
Jasper Ridge
Biological
Preserve
Ladera
Westridge
Barron Park
Fairmea
Palo Alto

The Mouse:
Small, Cheap, Fast,
Small Targets

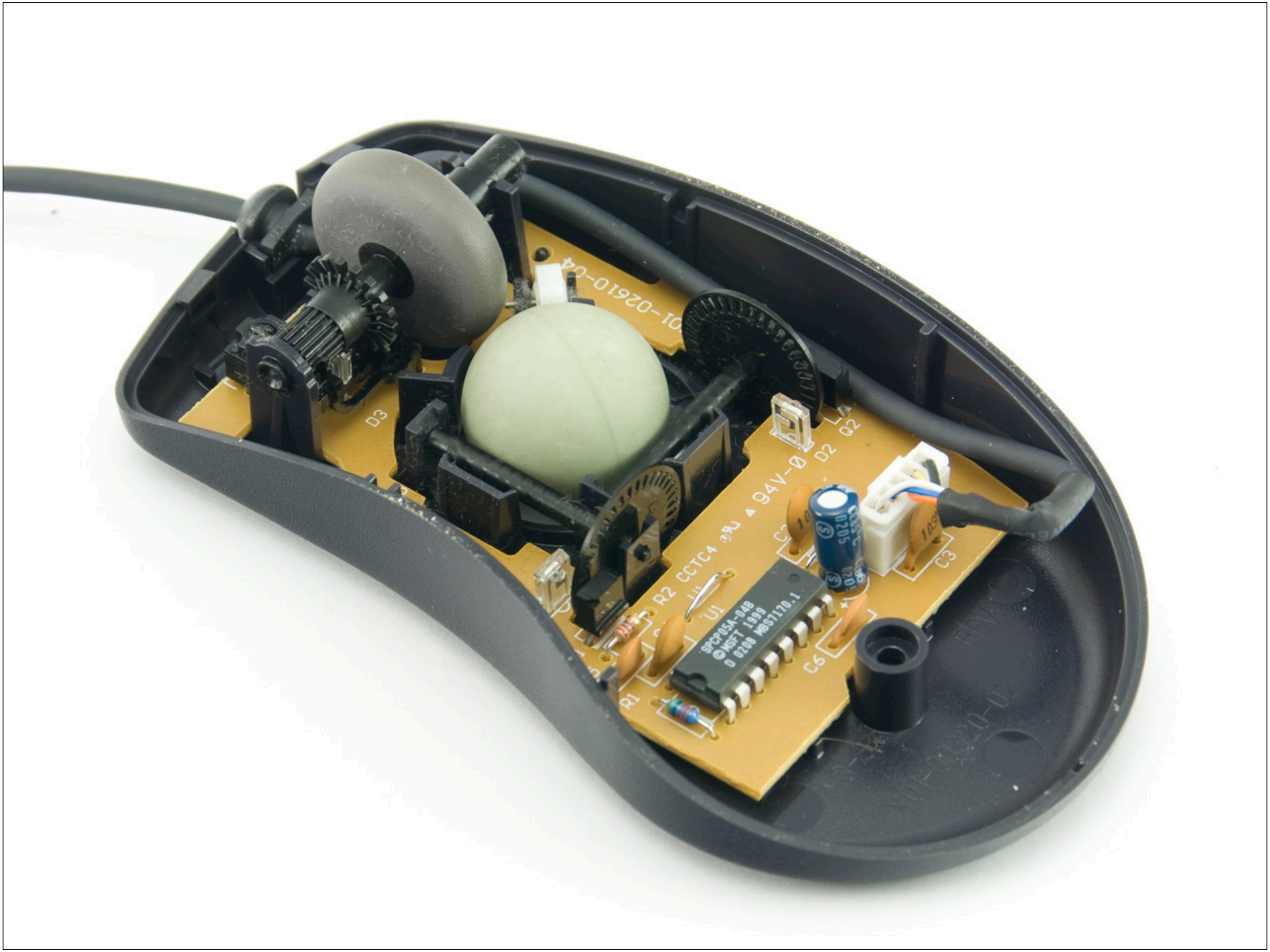

1026
33685

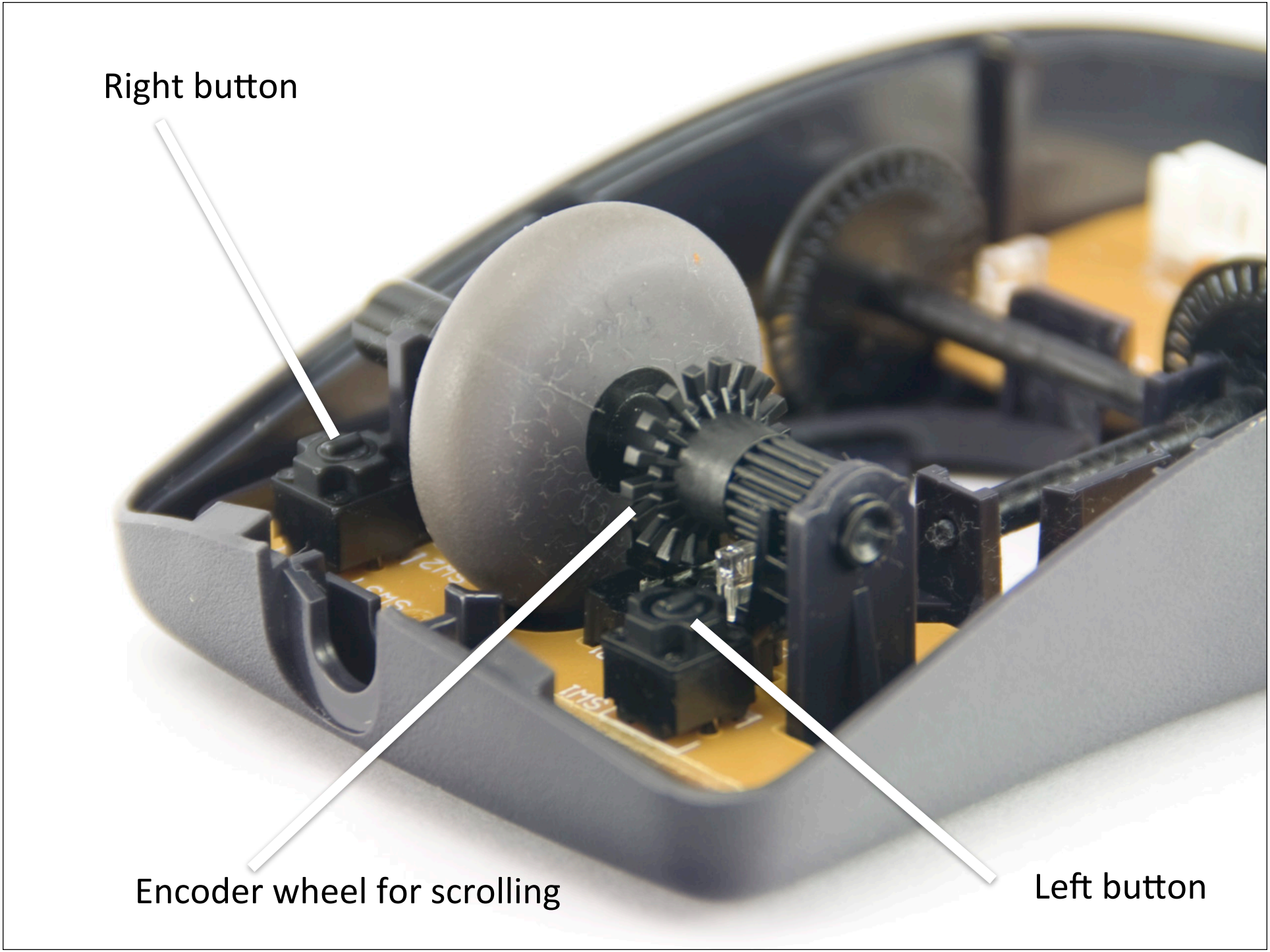
(cc) Flickr user John Chuang
http://www.flickr.com/photos/13184584@N08/1362760884/

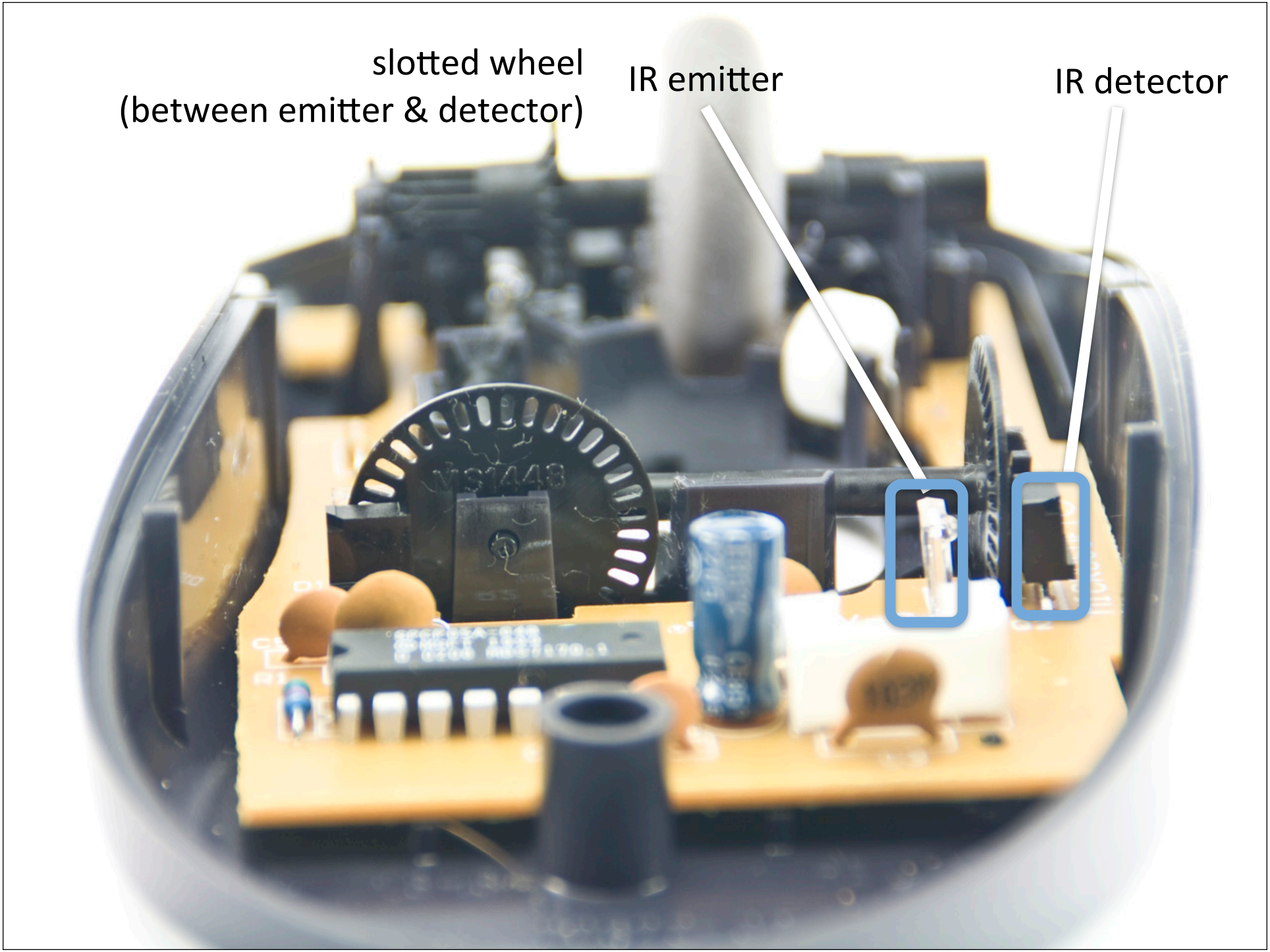
Source: Card, Stu. Lecture on Human Information Interaction. Stanford, 2007.


XEROX

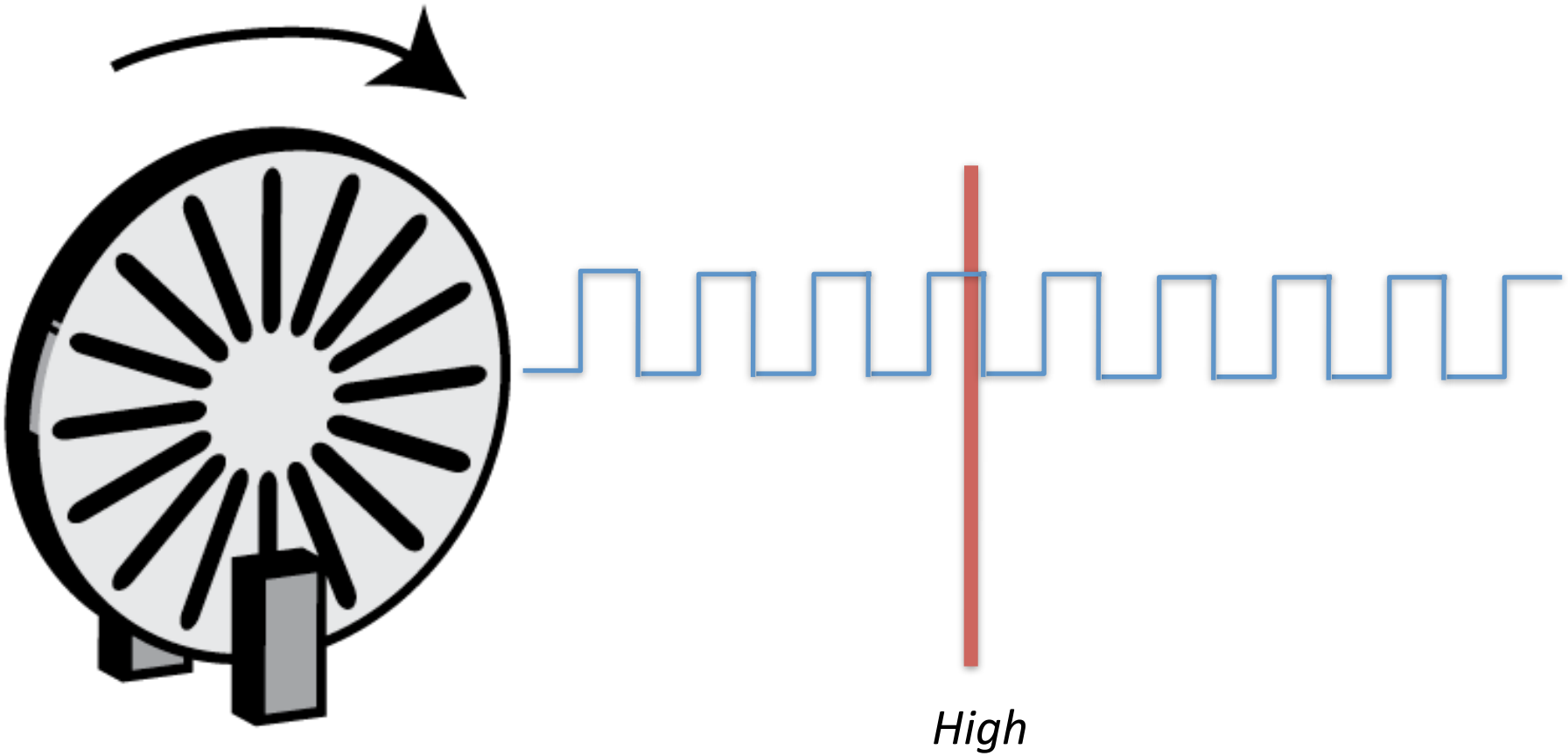

DELL
by Microsoft


D3
D2
C2
C3
C6
R1
R2
U1
94V-0

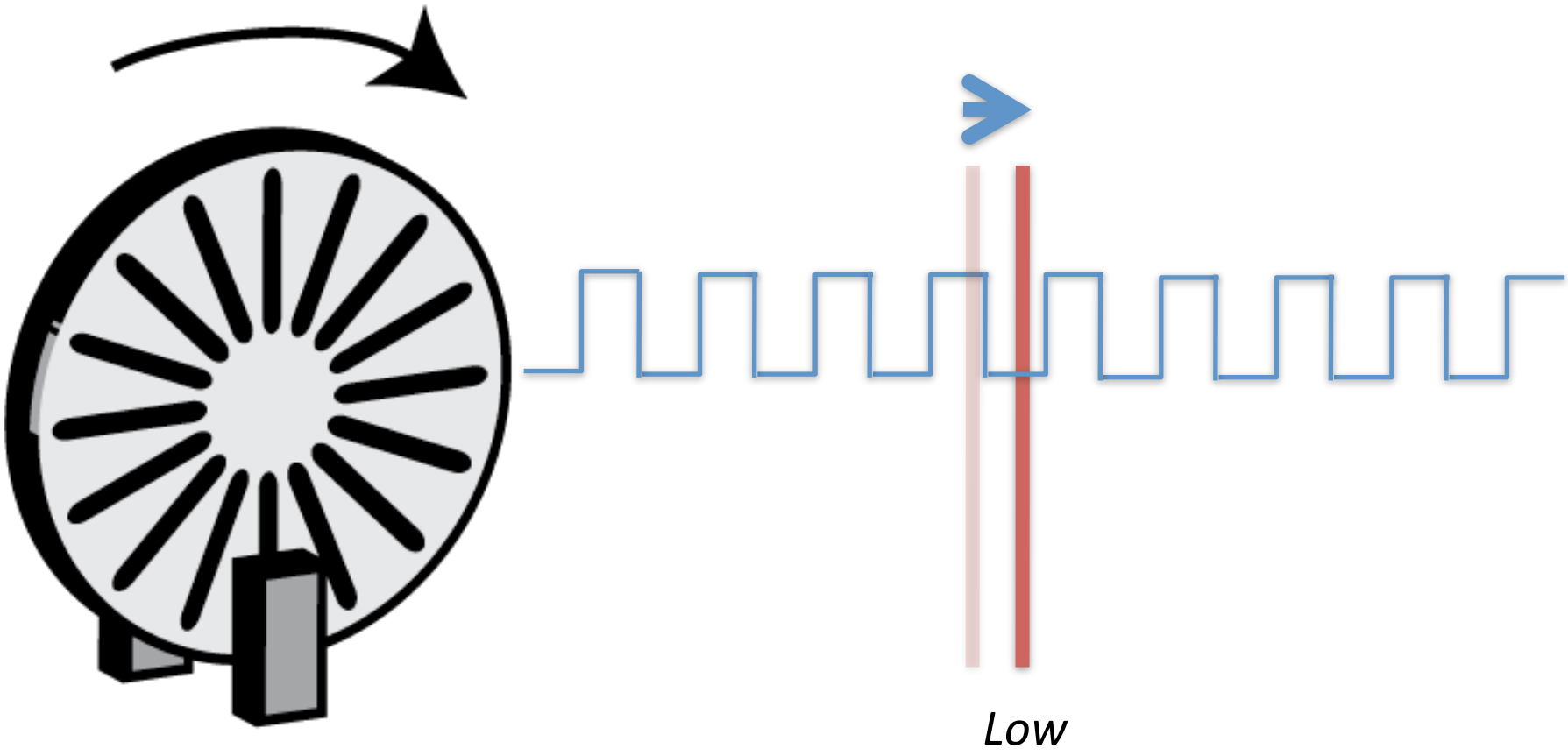

Right button
Encoder wheel for scrolling
Left button


slotted wheel
(between emitter & detector)
IR emitter
IR detector

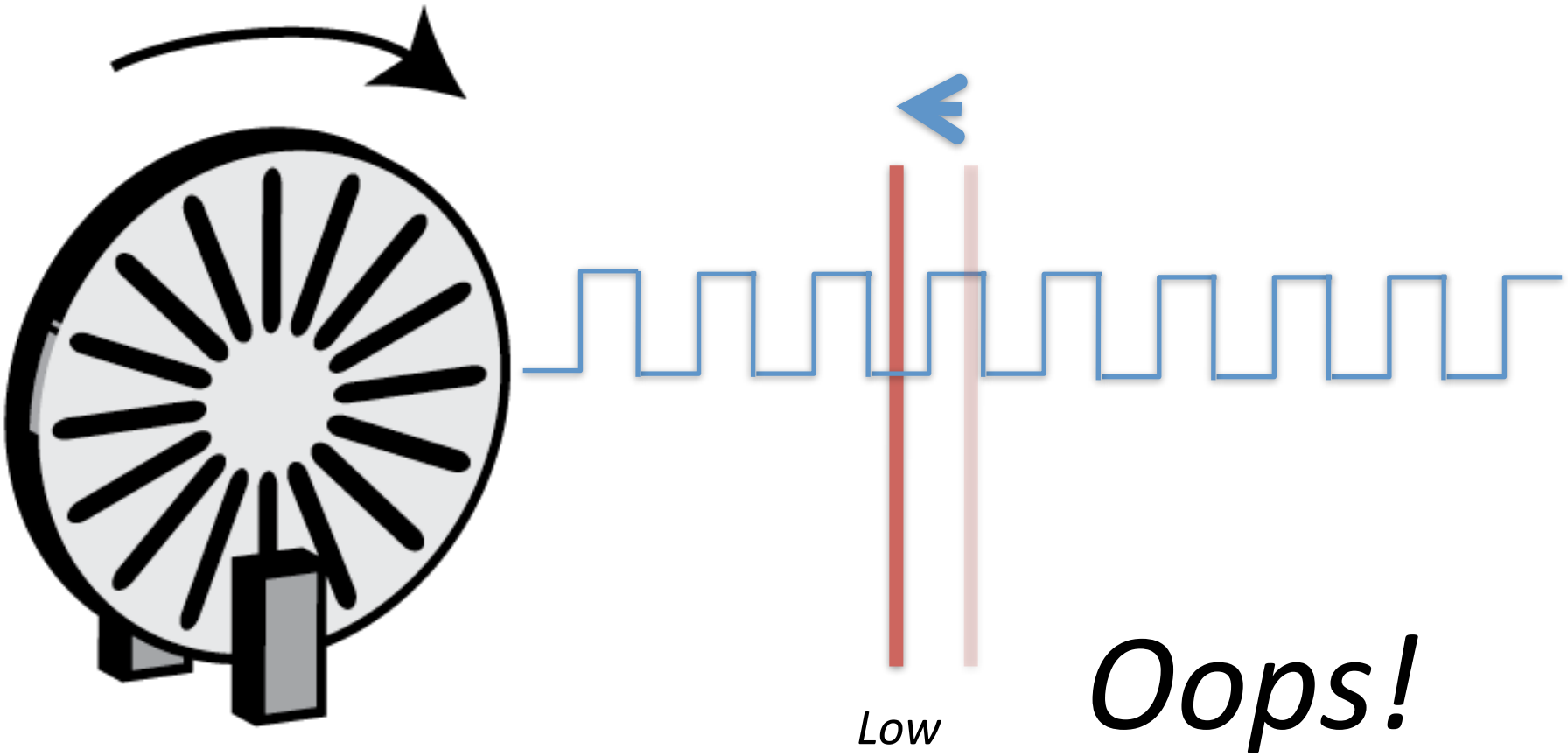
Sensing: Rotary Encoder



Sensing: Fwd Rotation

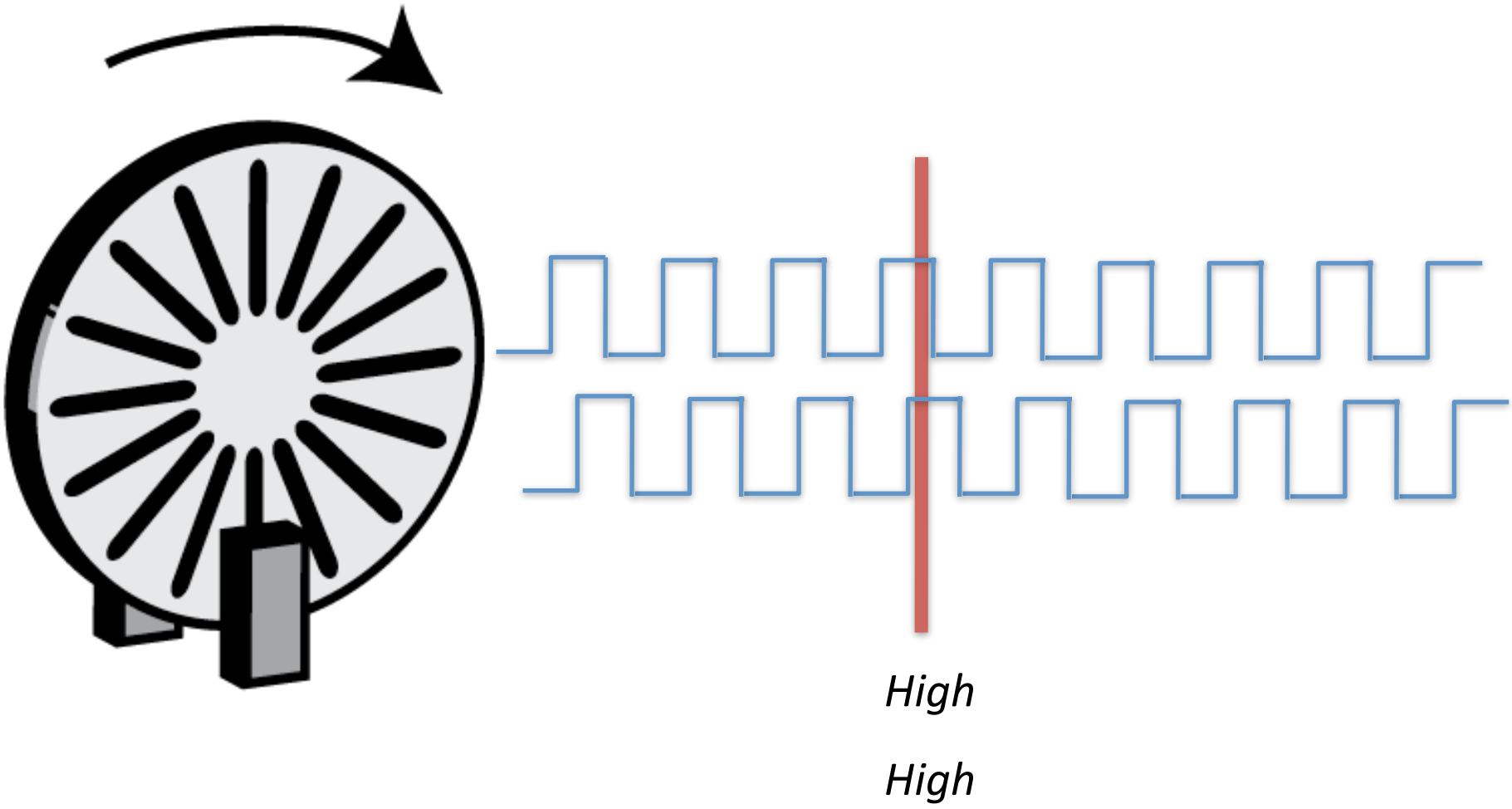


Sensing: Backwd Rotation

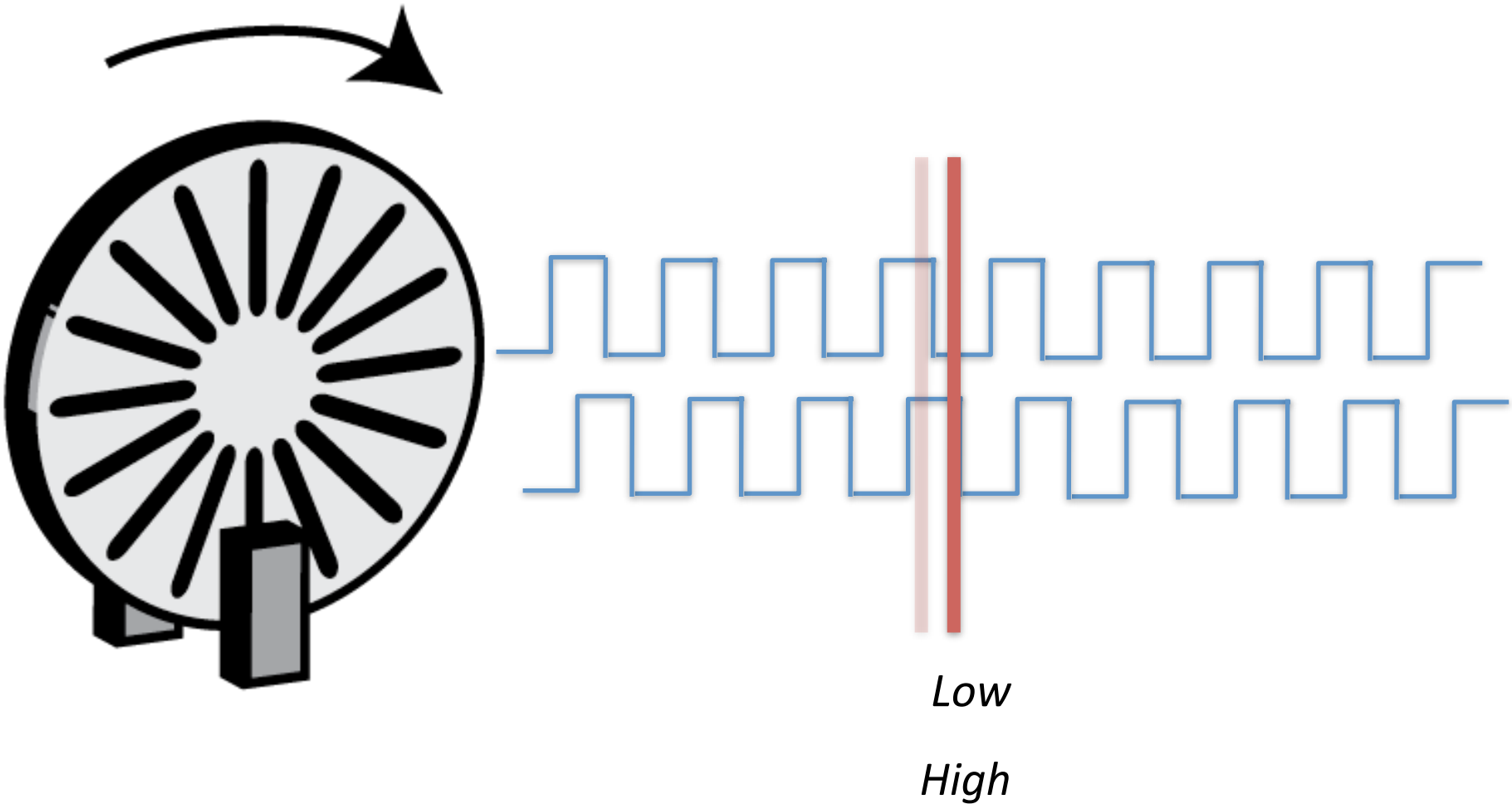


Oops!

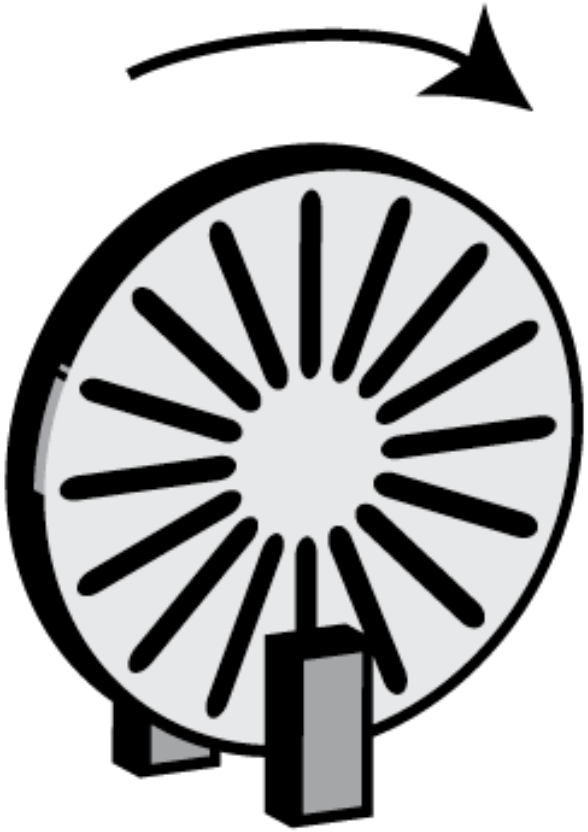
Solution: Use two out-of-phase detectors



Sensing: Rotary Encoder



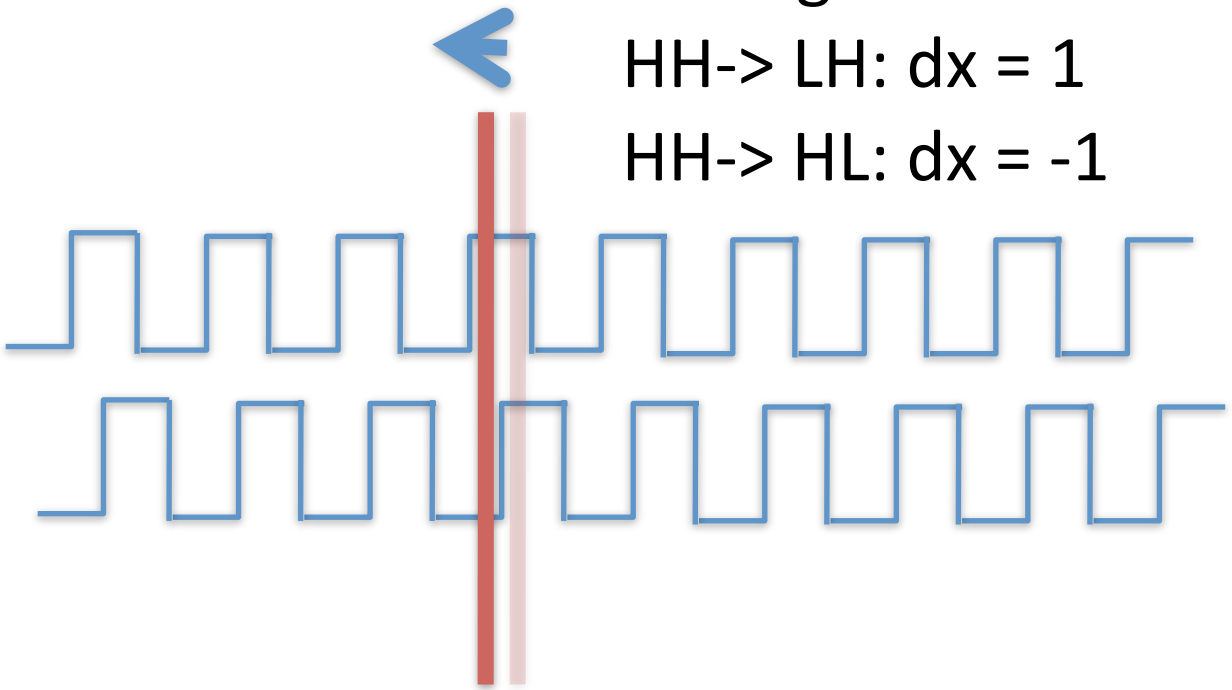
Sensing: Rotary Encoder



Coding:

HH-> LH: dx = 1

HH-> HL: dx = -1



High

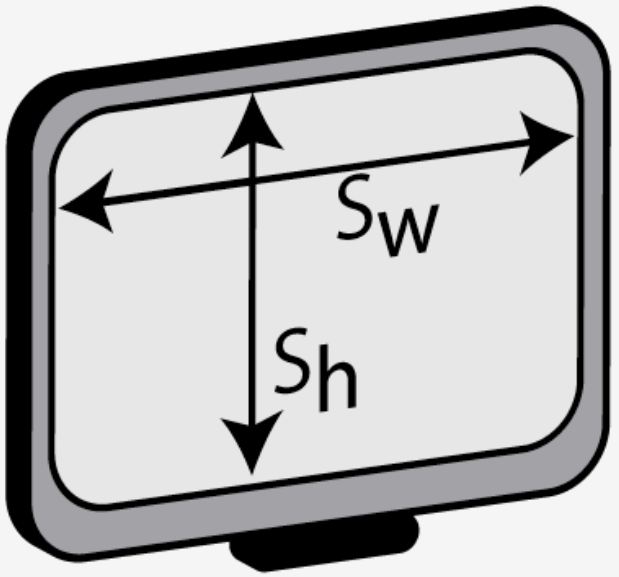
Low

Transformation

$cx_t = \max(0, \min(sw, cx_{t-1}+dx*cd))$

$cy_t = \ldots$

cx_t: cursor x position in screen coordinates at time t
dx: mouse x movement delta in mouse coordinates
sw: screen width
cd: control-display ratio



Optical Mouse

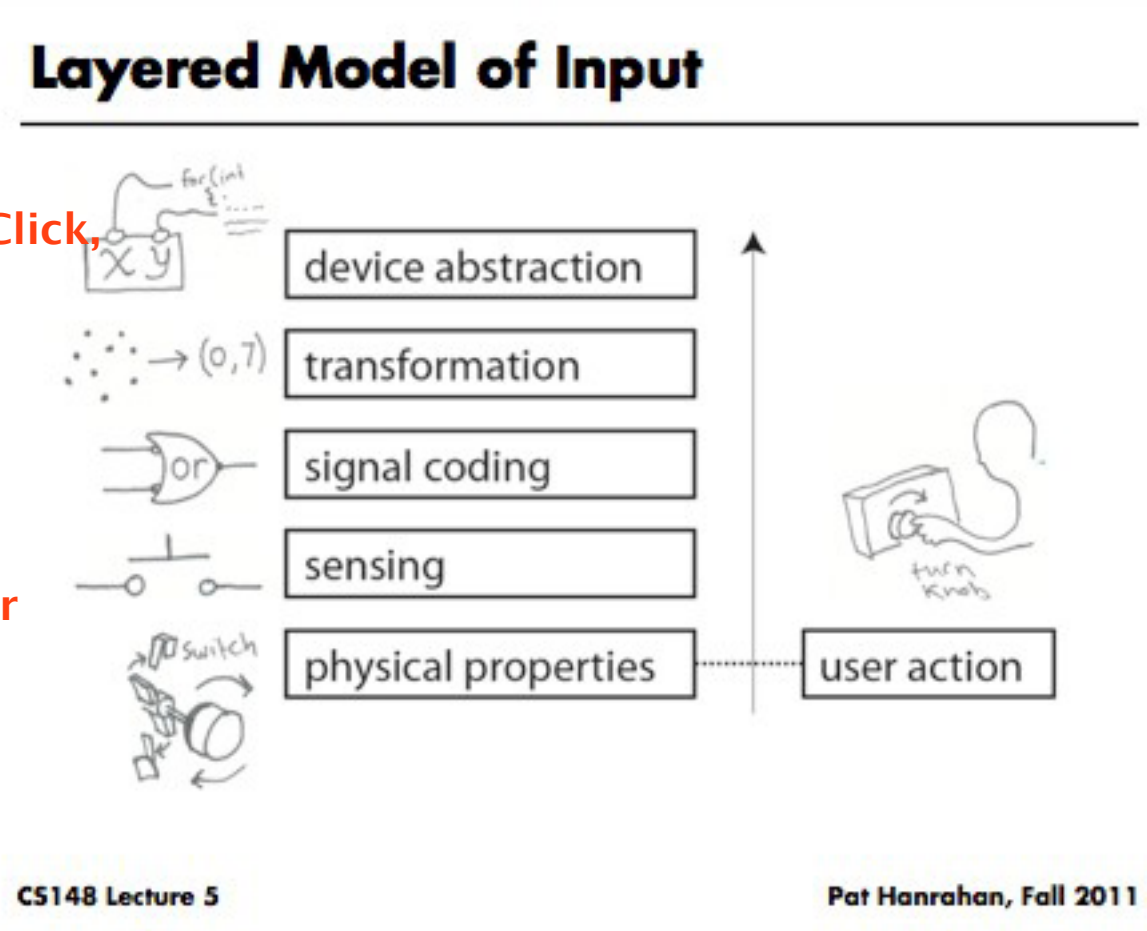
Move, DoubleClick, etc

Screen cursor Position

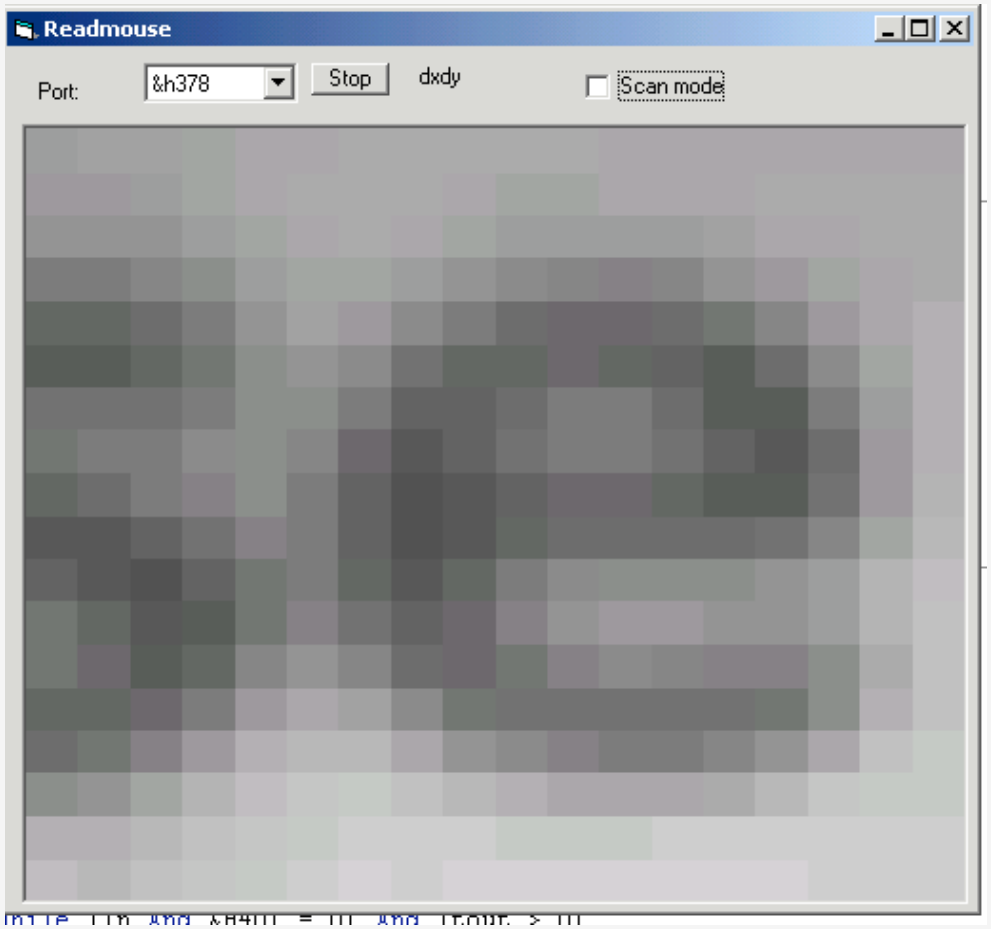
Quadrature Encoding

Rotary Encoder

Mover x,y



What about optical mice?



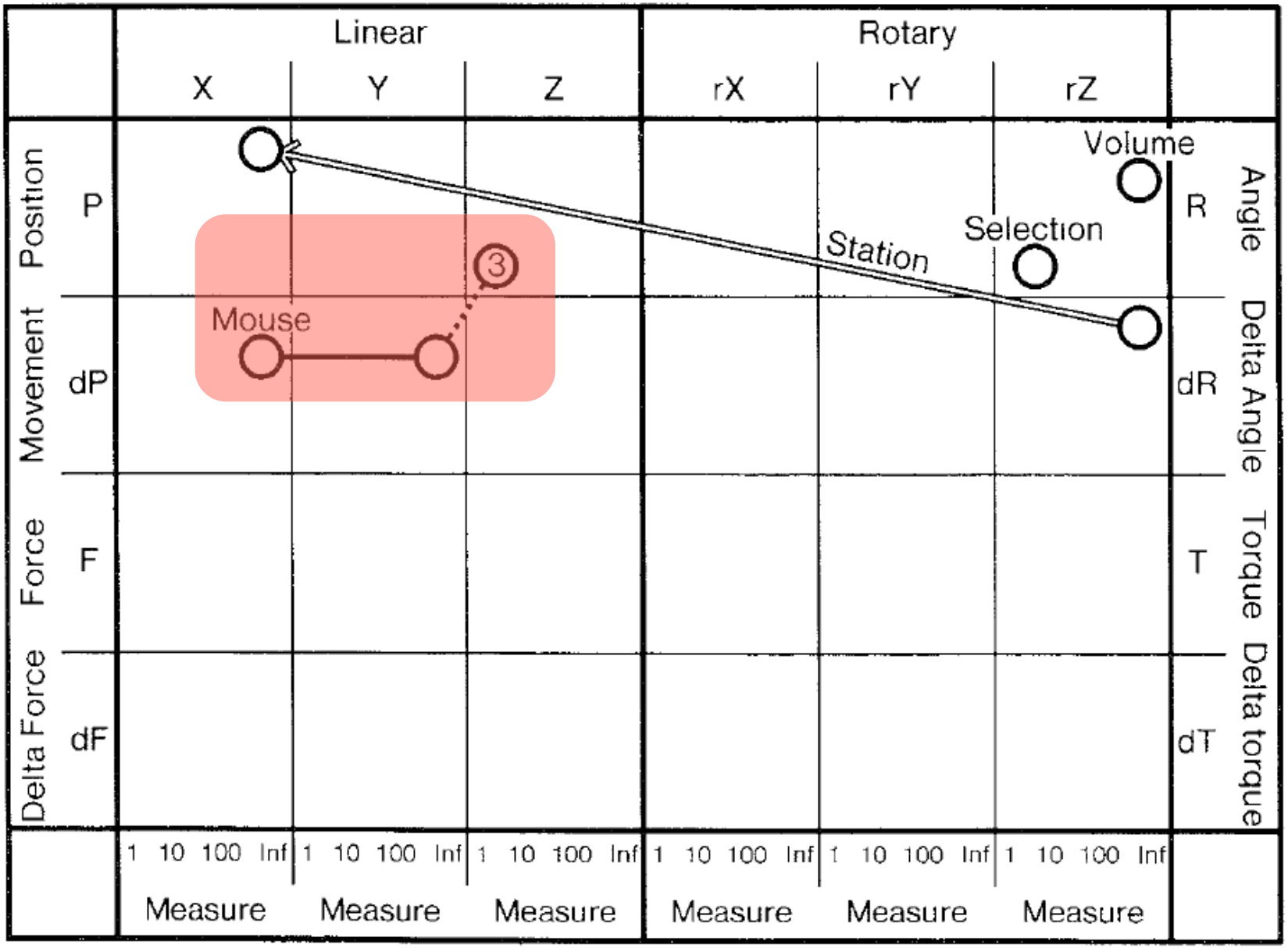
Source: http://spritesmods.com/?art=mouseeye

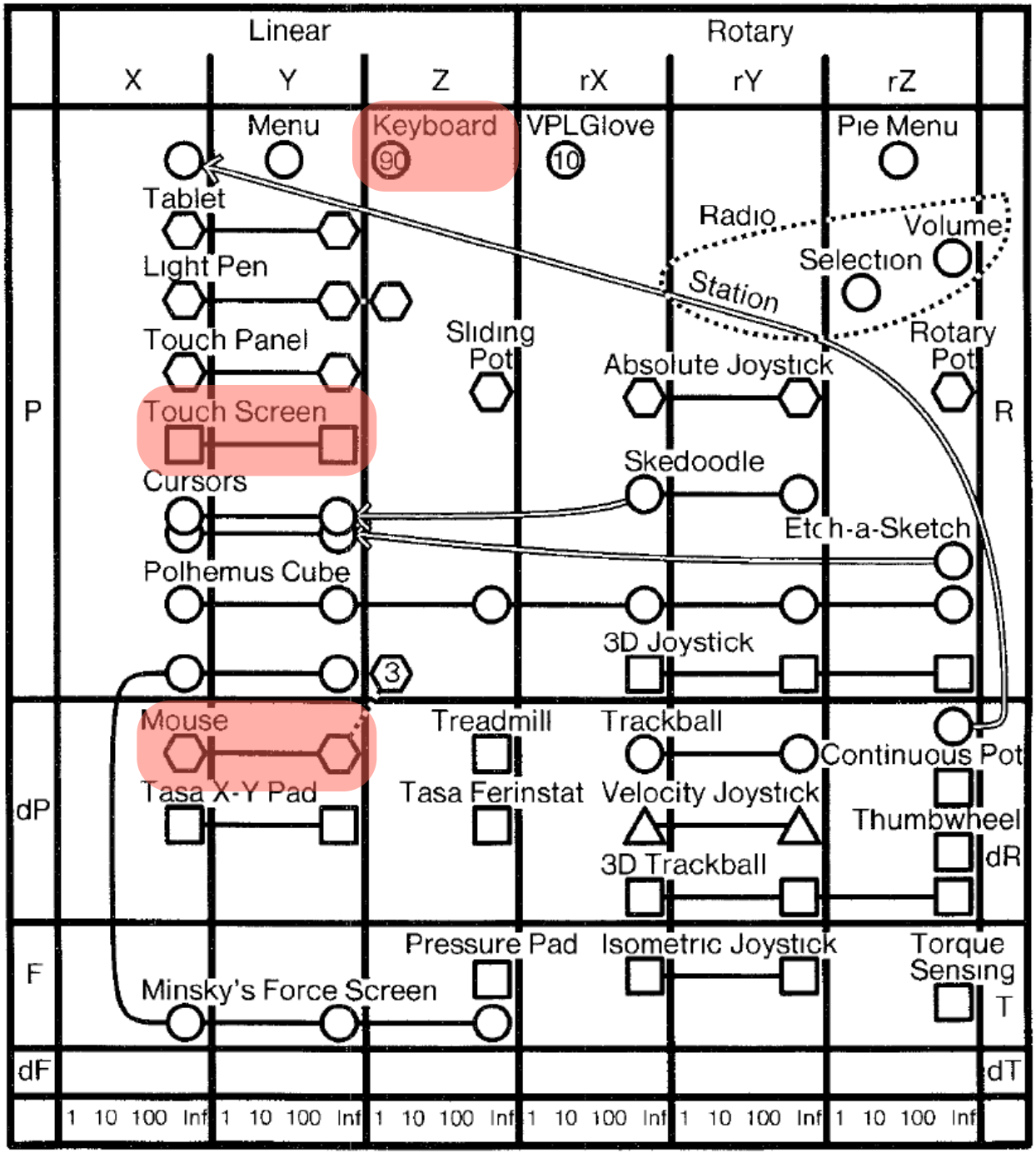
A design space of input devices…

Table I. Physical Properties Used by Input Devices

	Linear	Rotary
Position		
Absolute	Position **P**	Rotation **R**
Relative	Movement **dP**	Delta rotation **dR**
Force		
Absolute	Force **F**	Torque **T**
Relative	Delta force **dF**	Delta torque **dT**

Card, S. K., Mackinlay, J. D., and Robertson, G. G. 1991.
A morphological analysis of the design space of input devices.
ACM TOIS 9, 2 (Apr. 1991), 99-122.


Linear
Rotary
X
Y
Z
rX
rY
rZ
Position
Movement
Force
Delta Force
P
dP
F
dF
R
dR
T
dT
Angle
Delta Angle
Torque
Delta torque
Volume
Selection
Station
Mouse
3
1 10 100 Inf
Measure

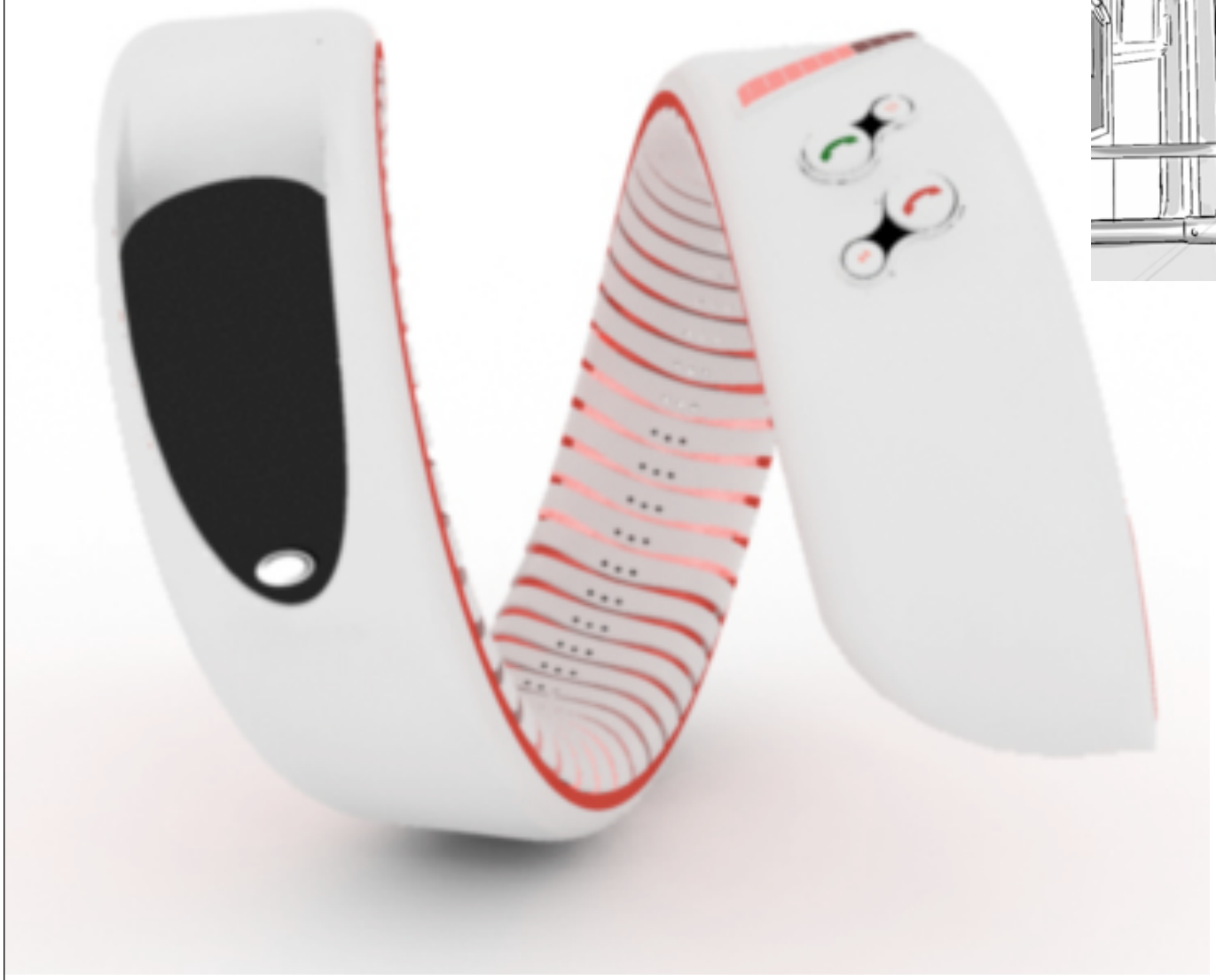

Linear
Rotary
X
Y
Z
rX
rY
rZ
Menu
Keyboard
90
VPLGlove
10
Pie Menu
Tablet
Radio
Volume
Selection
Station
Light Pen
Touch Panel
Sliding
Pot
Absolute Joystick
Rotary
Pot
P
Touch Screen
R
Skedoodle
Cursors
Etch-a-Sketch
Polhemus Cube
3D Joystick
3
Mouse
Treadmill
Trackball
Continuous Pot
Tasa X-Y Pad
Tasa Ferinstat
Velocity Joystick
Thumbwheel
dP
dR
3D Trackball
Pressure Pad
Isometric Joystick
Torque
Sensing
F
Minsky's Force Screen
T
dF
dT
1 10 100 Inf 1 10 100 Inf 1 10 100 Inf 1 10 100 Inf 1 10 100 Inf 1 10 100 Inf

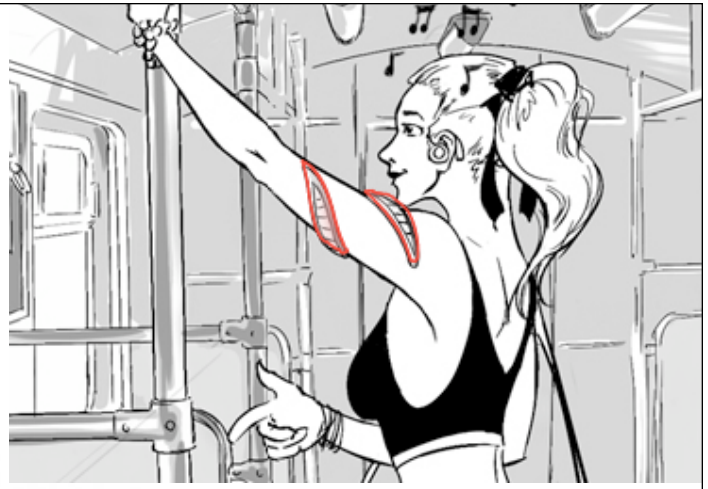
New Innovation Cycle for Input

driven by
--Small Devices
--Big screens
--New technologies

Radius from PolymerVision

Nokia concept phone by Hugo Danti





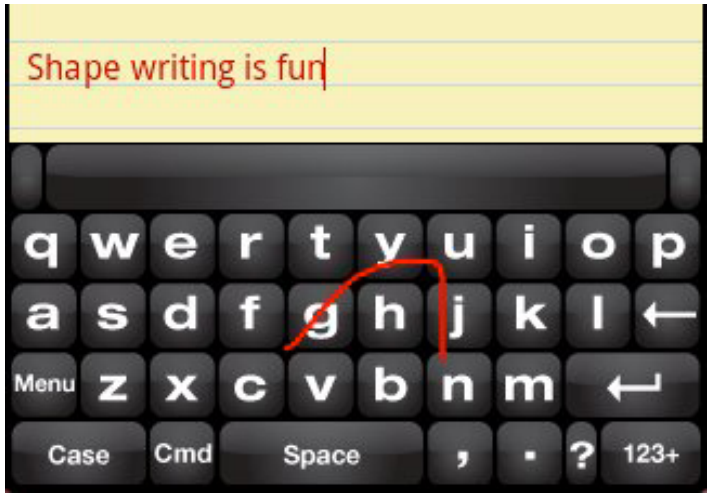
SNAKE--Product Visionaries

New Input Devices Using INPUT ON OUTPUT

courtesy Amazon.com

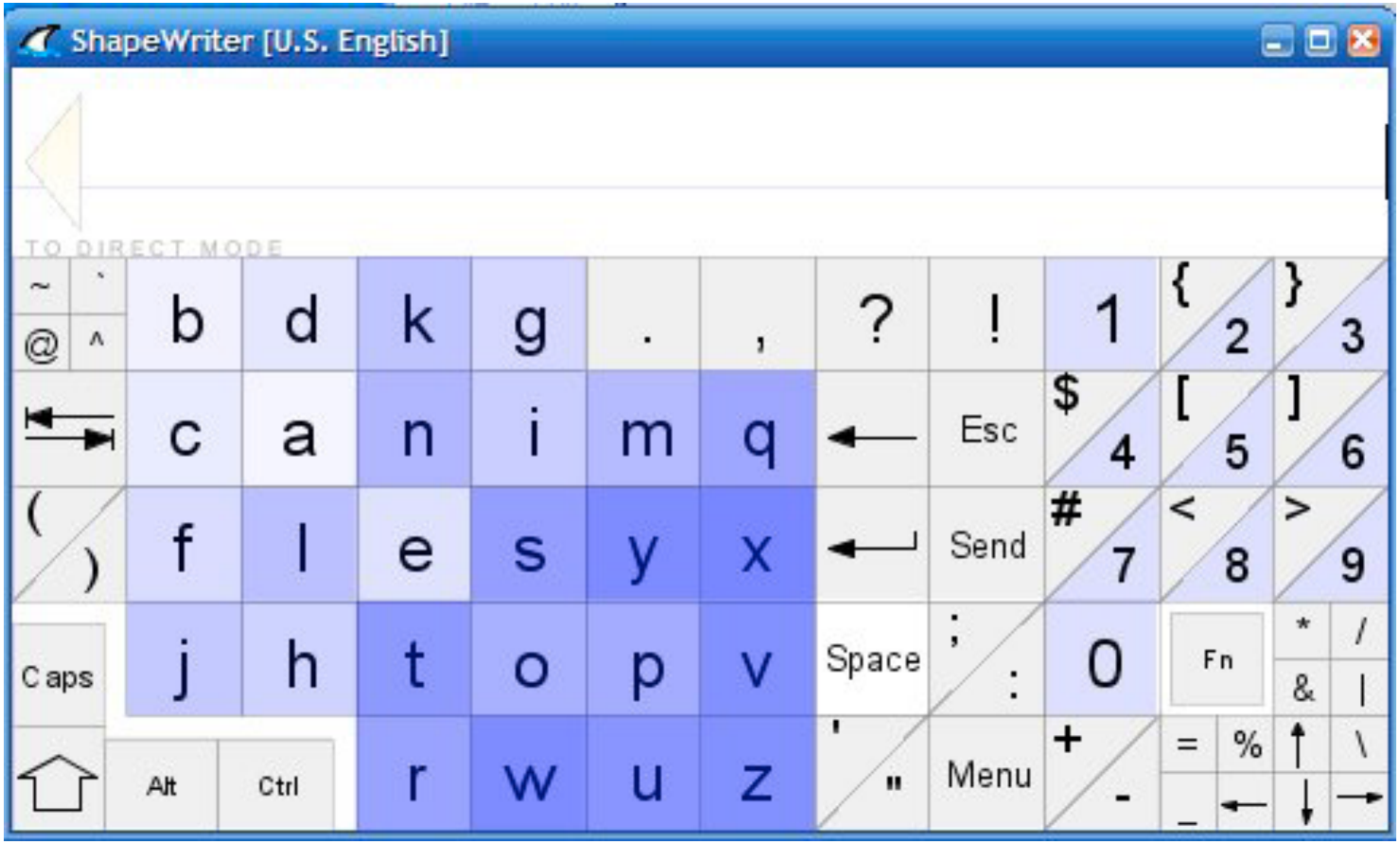
Baudisch et al., NanoTouch

ShapeWriter

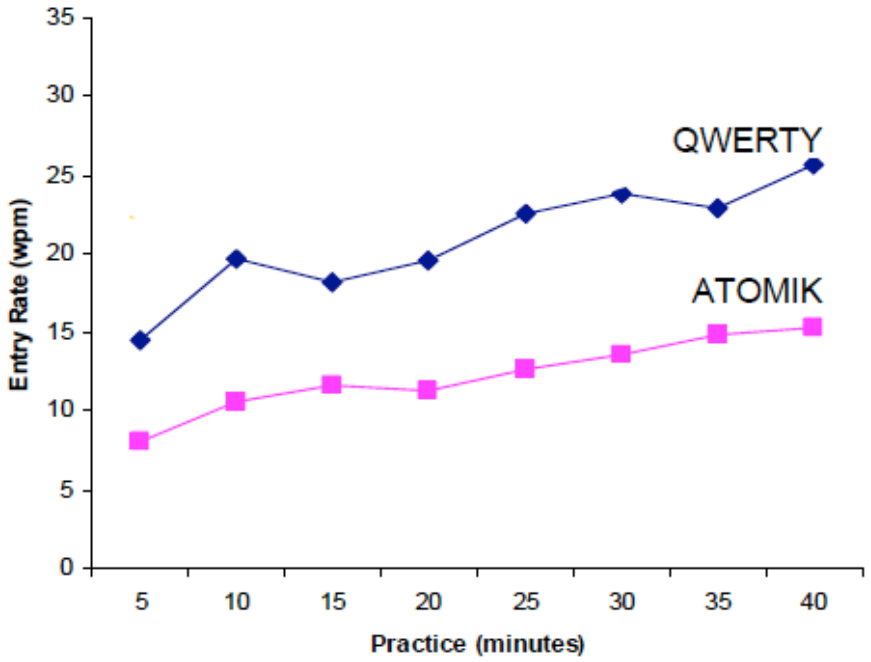


Zhai (IBM, ShapeWriter)

ShapeWriter With Optimized Key Arrangements (ATOMIK)



ShapeWriter Performance, first 40 min



- Error rate ~ 1%
- Average speed already > long term Graffiti and others.
- QWERTY faster at first, ATOMIK faster in long run.
- Experienced users can reach over 100 words/min

Shumin Zhai (IBM, ShapeWriter, Inc))

Big Idea:

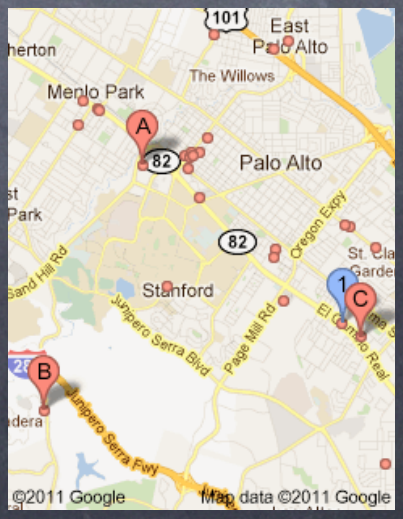
INPUT ON CONTEXT

INPUT ON CONTEXT

- **Typewriter:**
  >Find pizza in 94304
  ==> Places for pizza near 94304
  [1] California Pizza Kitchen
  [2] Round Table Pizza Menlo Park
  >Select [1]

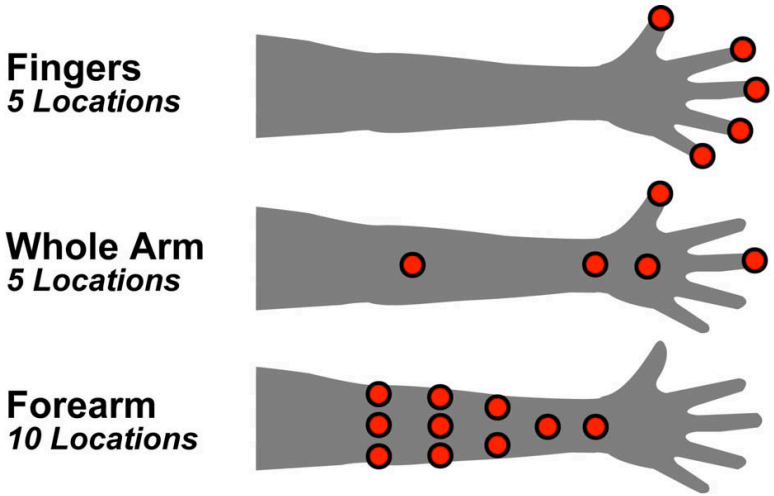
- **Input on Output:**
  >Find pizza in 94304
  <click>

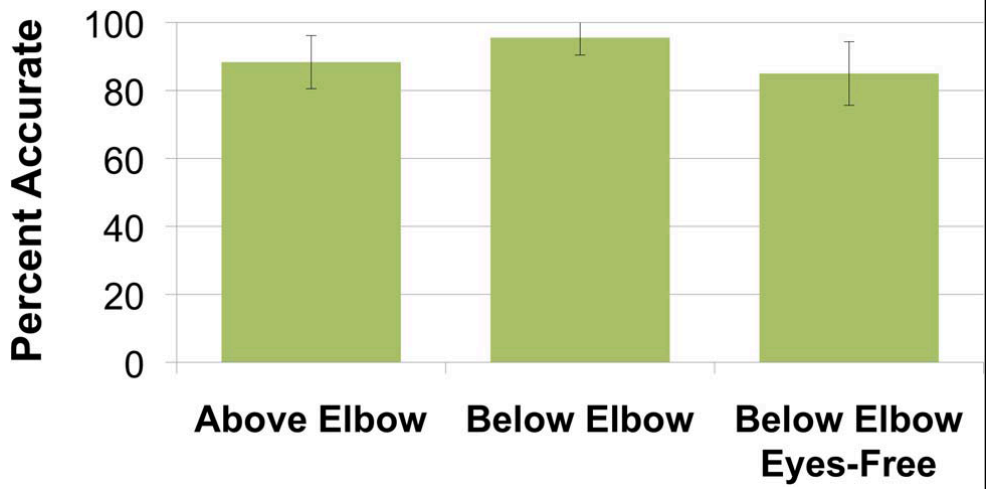
- **Input on Context (GPS):**
  > Pizza!



Suunto Watch

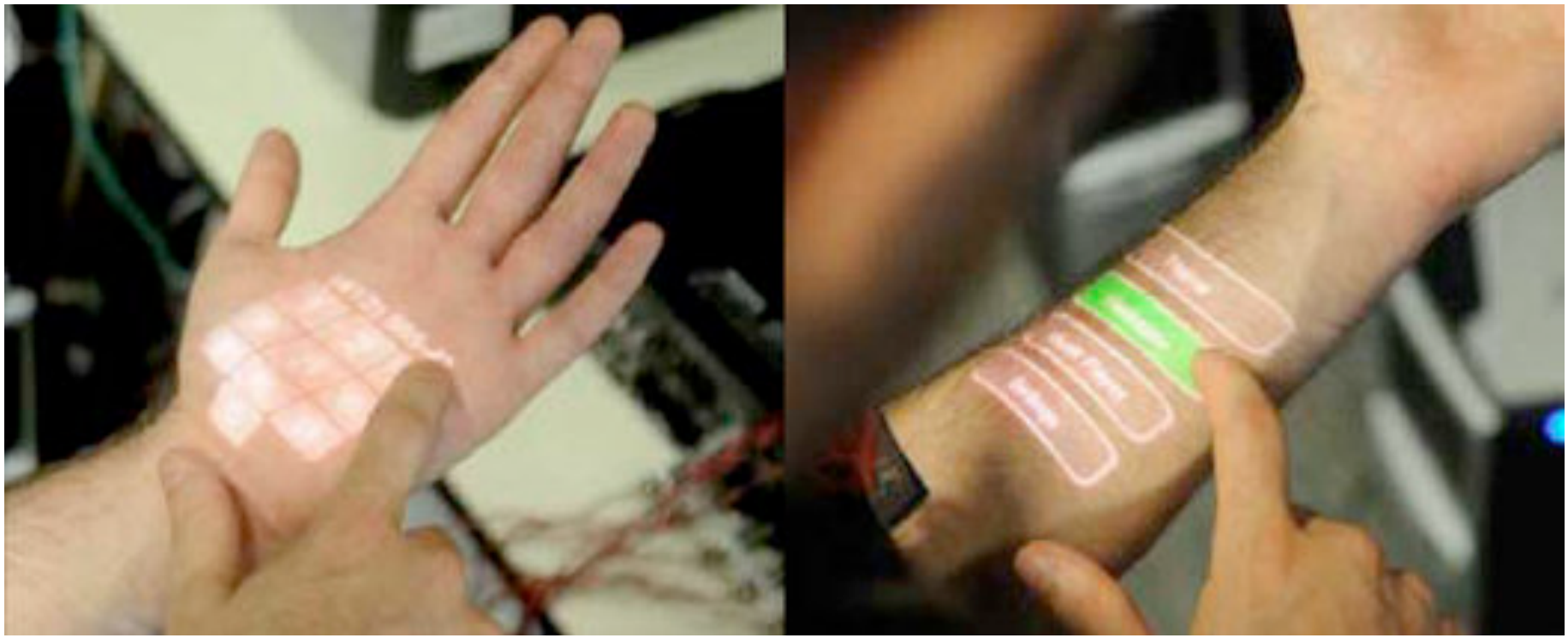
- Altitude
- Heart rate
- Calories consumed
- Lap time
- Lap number
- Accumulated oxygen deficit
- Ambient temperature


Fingers
5 Locations
Whole Arm
5 Locations
Forearm
10 Locations

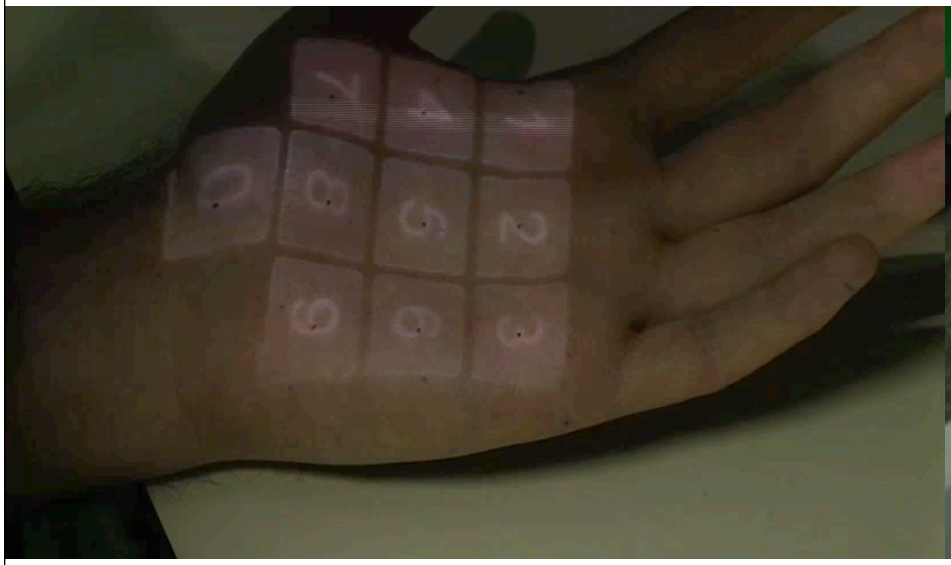

Percent Accurate
100
80
60
40
20
0
Above Elbow
Below Elbow
Below Elbow Eyes-Free

Skinput

Harrison, Tan, Morris, CMU HCII (2010)

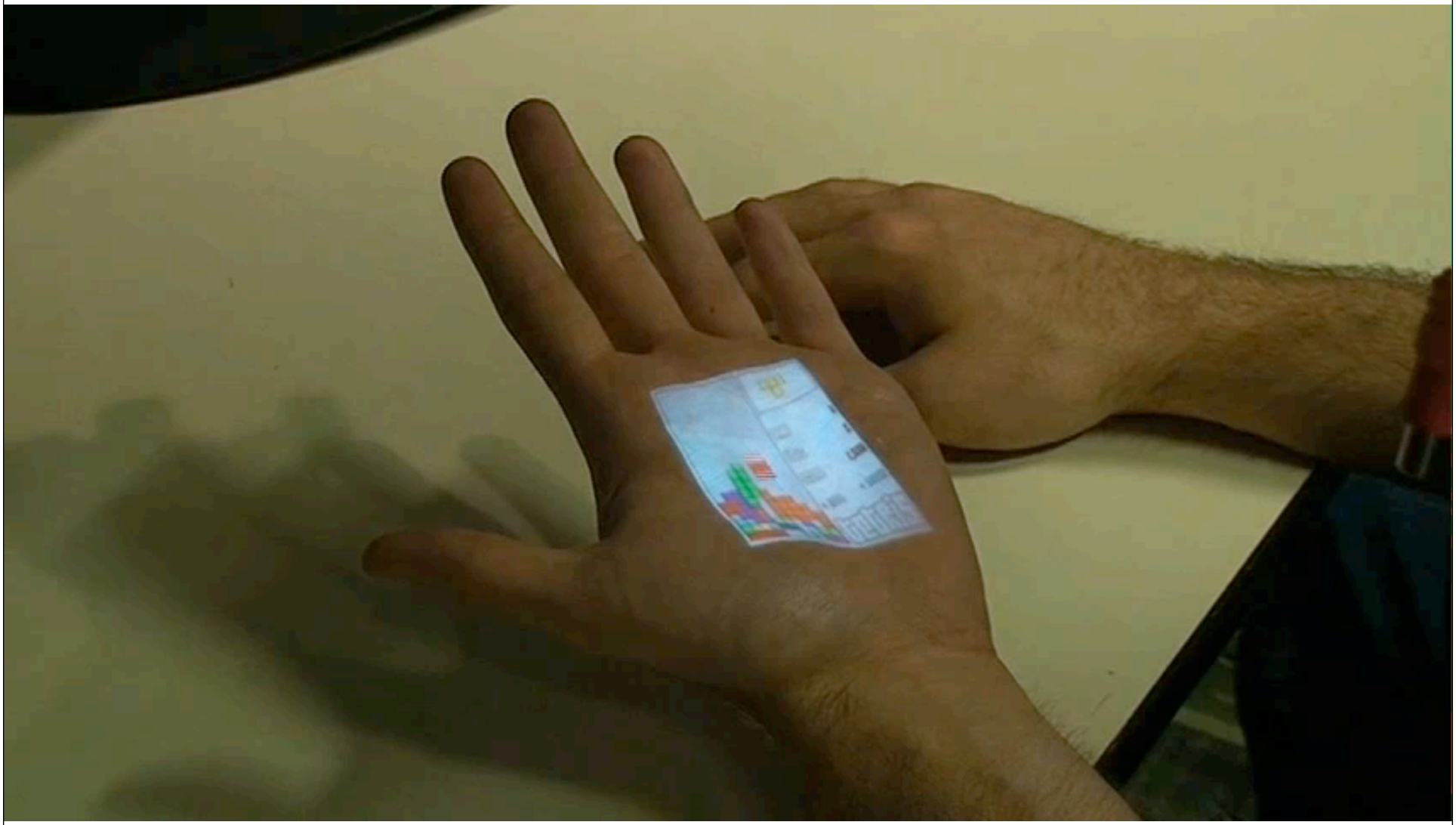


Skinput

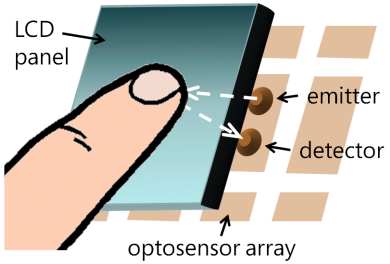


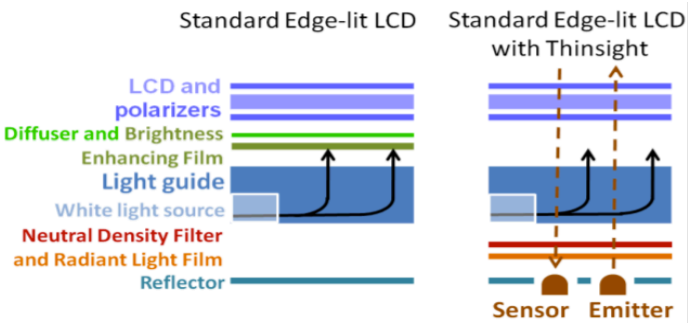
Harrisons, Tan, Morris, CMU HCII (2010)

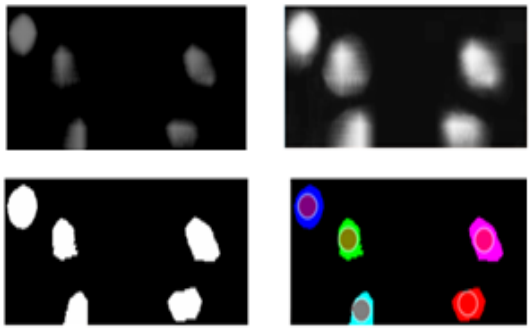
Skinput Tetris



Thinsight



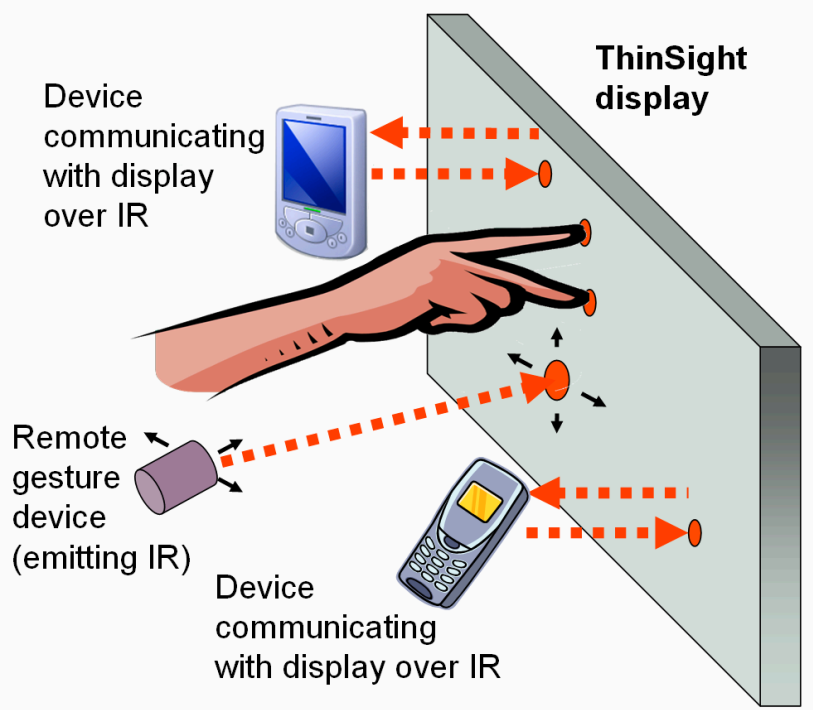




- Camera and IR light source embedded in display pixels.
- Allows multi-touch, multi object visual processing.
- Finger tips: Raw, normalized, thresholded to binary, after connected connectedness analysis.

Izadi, Hodges, Butler, West, Rrustemi, Molloy & Buxton (Microsoft Cambridge, 2009)

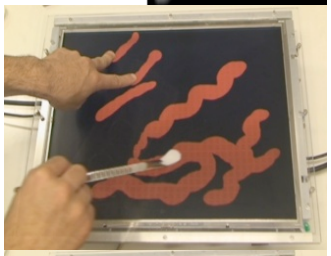
Thinsight Uses



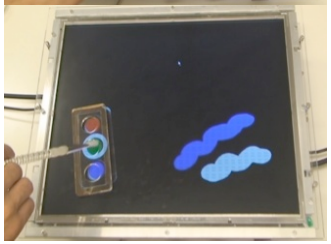
- Multi-touch photo application.

- Objects laid on display and what the camera sees.

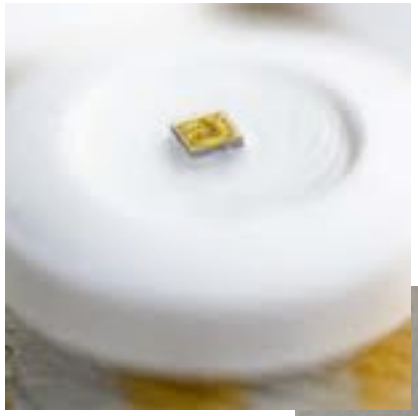
- Painting with a real brush.



- Painting with real brush, multiple fingers and tanglible palatte.



Proteus Ingestable Networked Pill



- Sensor and transmitter encapsulates pill
- Stomach acid is part of battery
- Transmits pill
  --> patch
  --> iPhone
  --> Internet

Some Summary Points

- Input devices are more than just peripherals. They enable classes of dialogues of information.
- Communication is asymmetric to humans: high-bandwidth in, slow bandwidth out.
- **Input-on-output** enables complex objects and dialogs.
- **Input-on-context** enables even more complex dialogs.
- Rapid evolution of input devices is expected in the immediate future.

But. . .
Isn't something missing?

Where's the User? The

Human-Computer Interaction

part of the story?

User → Task


Tool


User
Task
Tool

Human-Computer Interaction

Task **use and context**

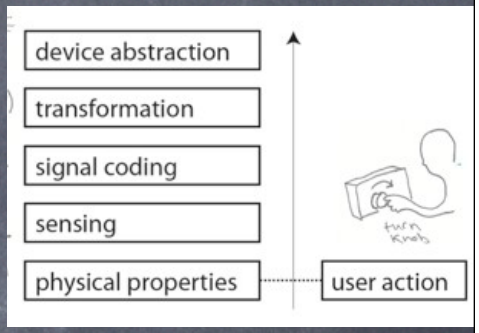
human

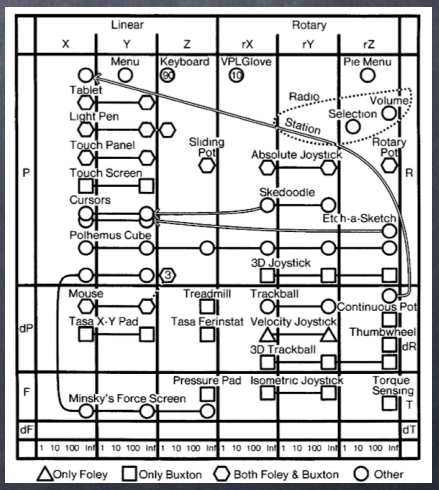
User

computer

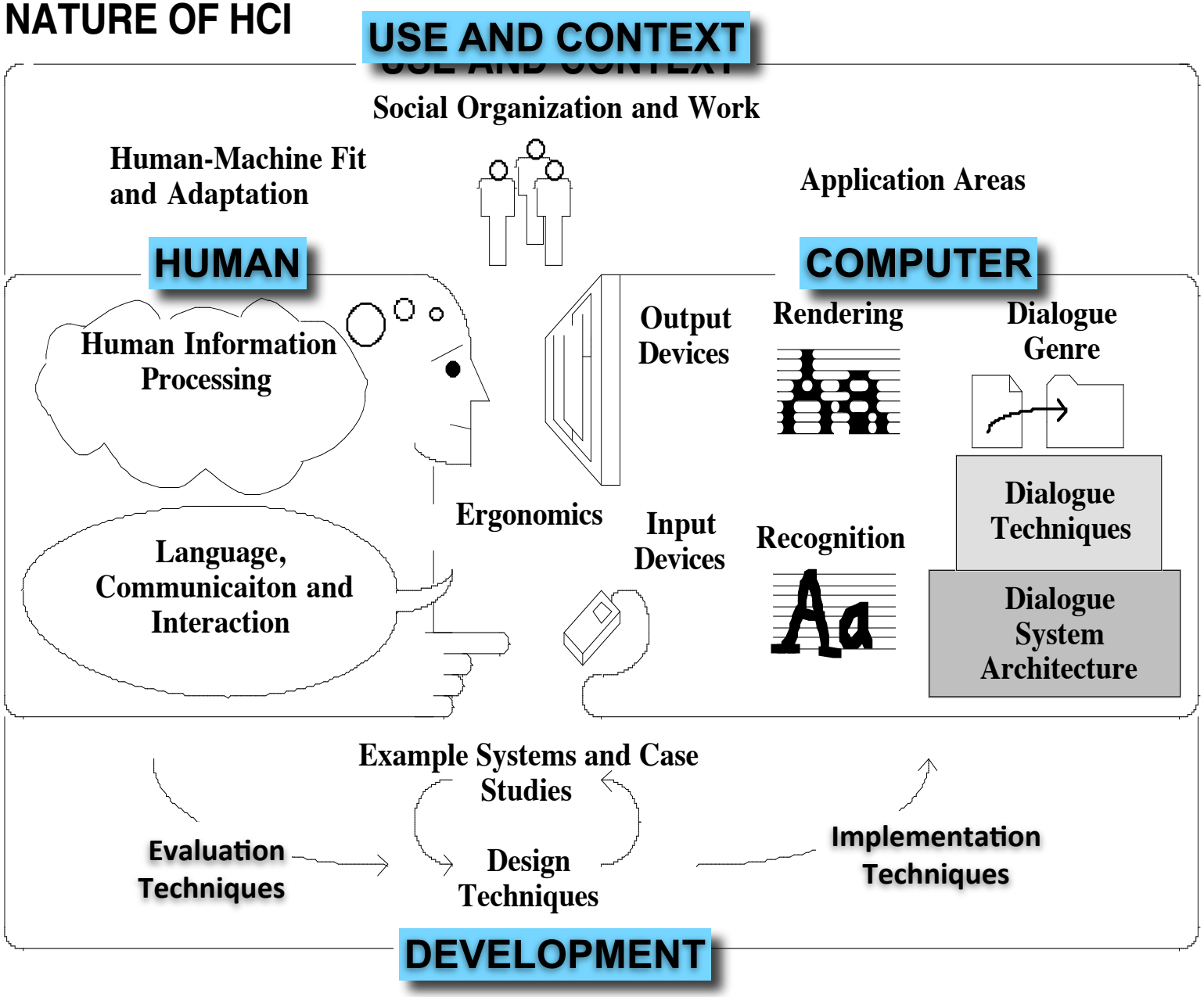
Tool

development





The Field of HCI



The Field of HCI

LECTURES FOR CS147