Interacção Humana com o Computador

Aula IV

Departamento de Informática
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Errors and Mental Models

Types of error

- **Slips** (deslizes/falhas/faltas)
  - Right intention, but failed to do it right
  - Causes: poor physical skill, inattention, …
  - Similar aspect but different functionality

- **Mistakes** (enganos)
  - Wrong intention
  - Cause: incorrect understanding

Humans create mental models to explain behavior.
if wrong (different from actual system) errors can occur

Errors and Mental Models

Types of error

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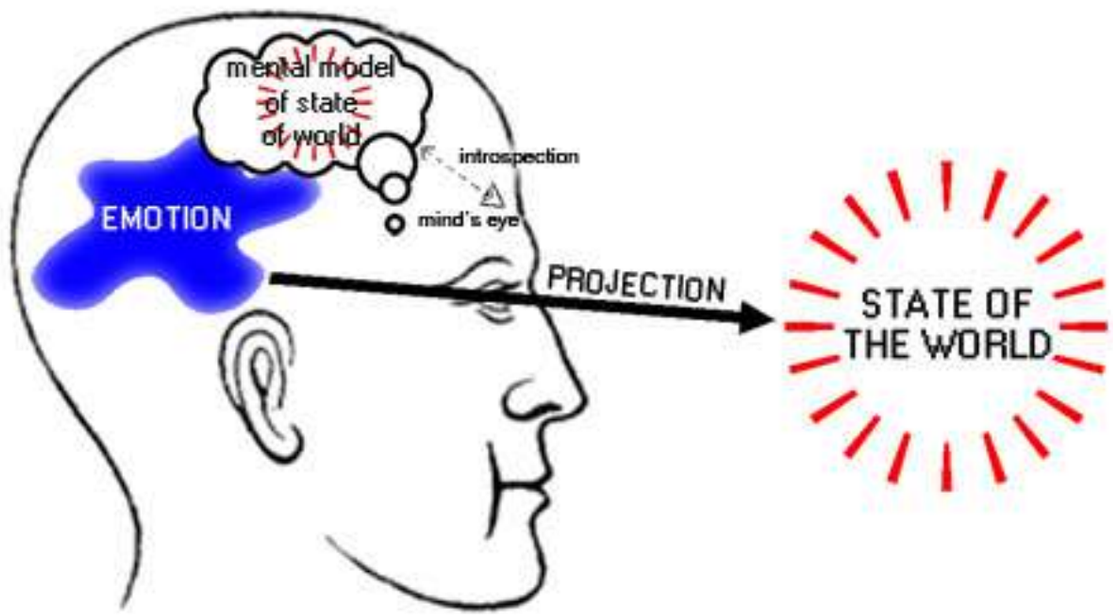
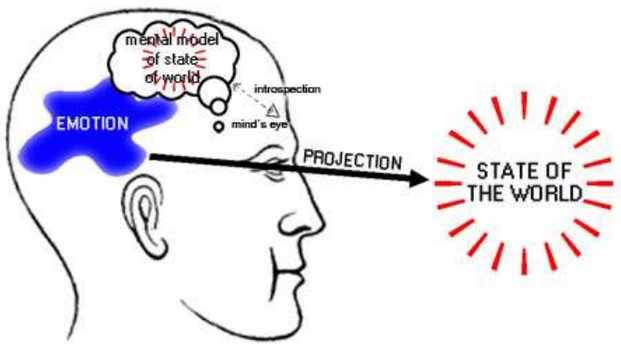


Errors and Mental Models



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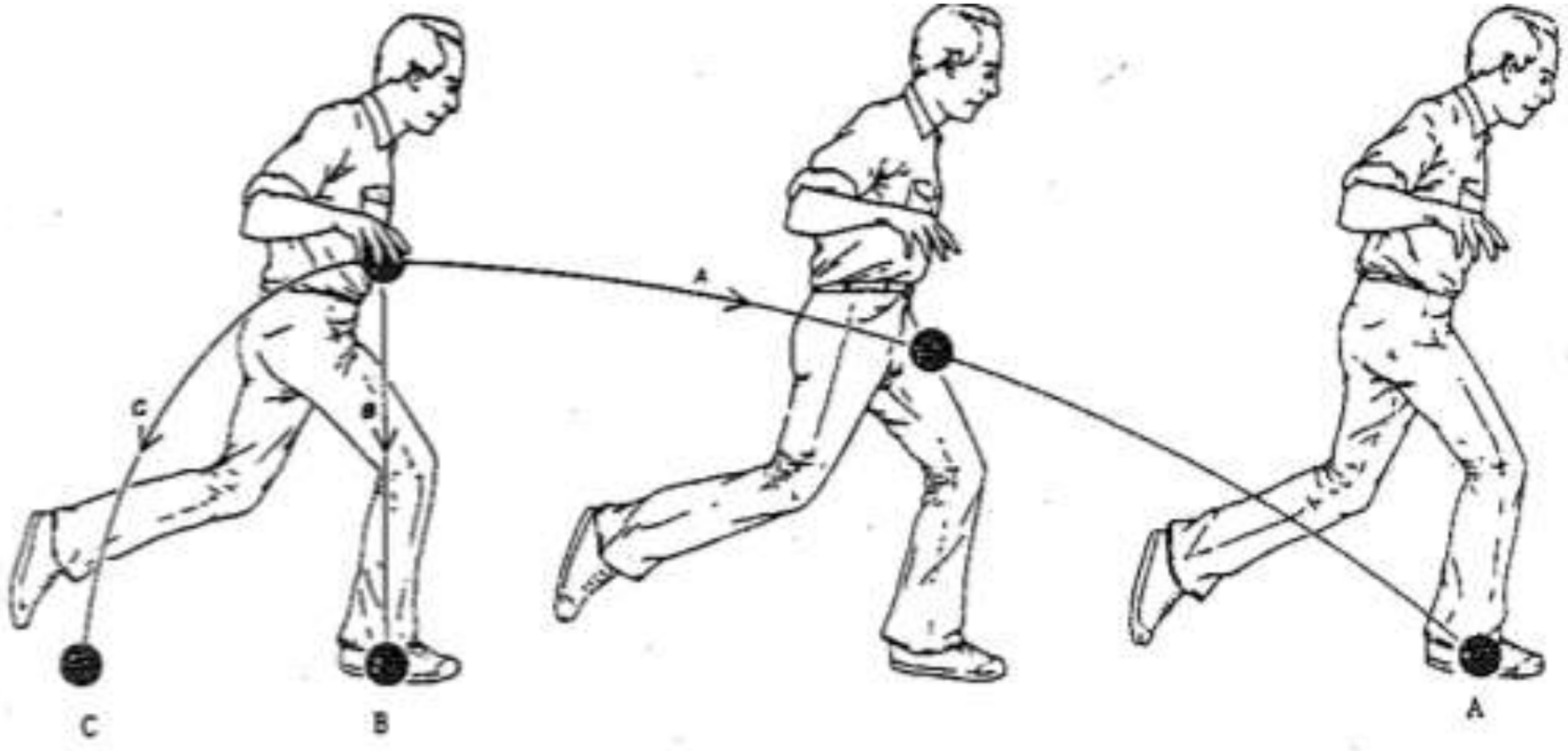


Errors and Mental Models

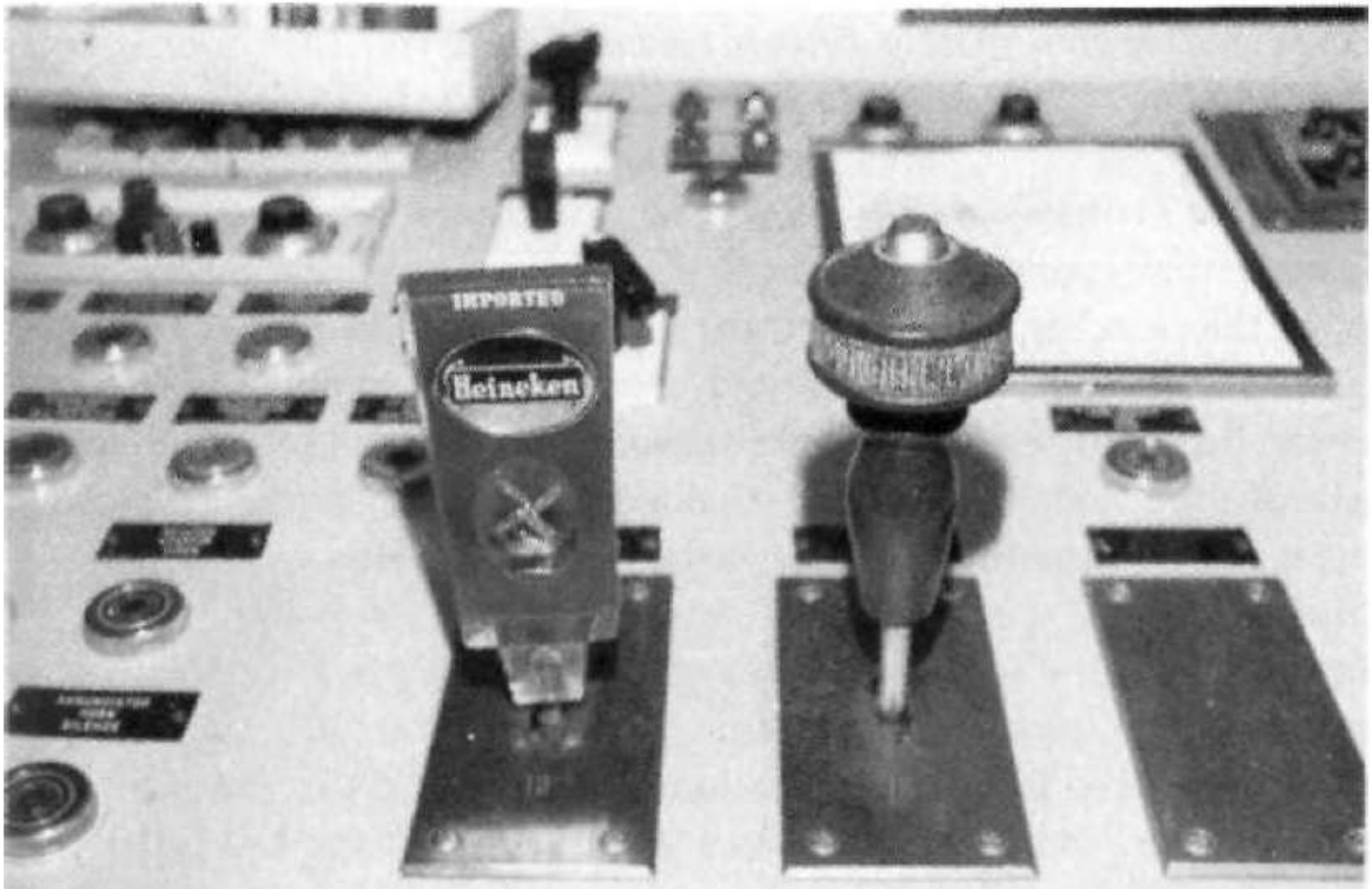
Types of error

Humans create mental models to explain behavior.
if wrong (different from actual system) errors can occur

4.5 A Clock Radio, "Human Engineered" to Simplify Operation. Note the row of identical-looking switches. (Copyright Tandy Corporation. Used with permis- sion.)

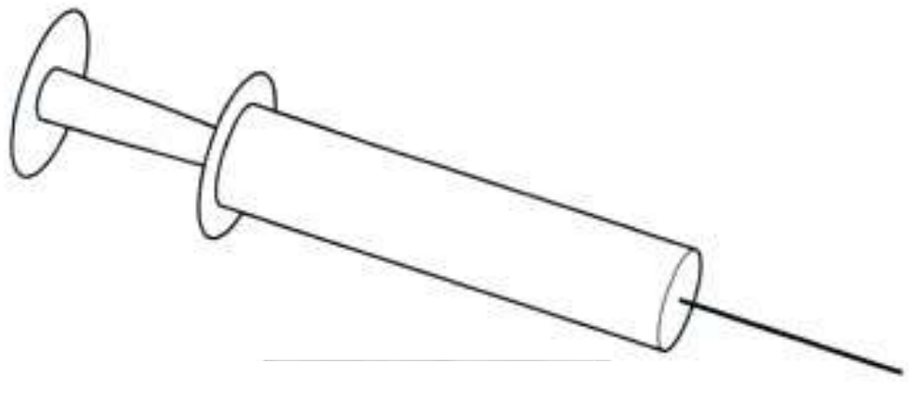
Errors and Mental Models

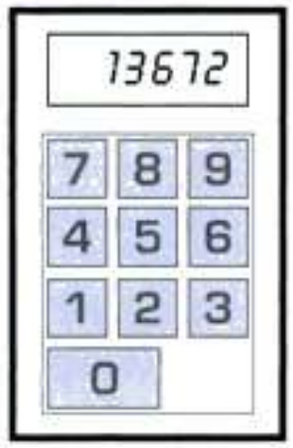
4.6 Make the Controls Look and Feel Different. The control-room operators in a nuclear power plant tried to overcome the problem of similar-looking knobs by placing beer-keg handles over them. This is good design, even if after the fact; the operators should be rewarded. (From Seminara, Gonzales, & Parsons, 1977. Photograph courtesy of Joseph L. Seminara.)



Errors and Mental Models

Controlling an electronic syringe





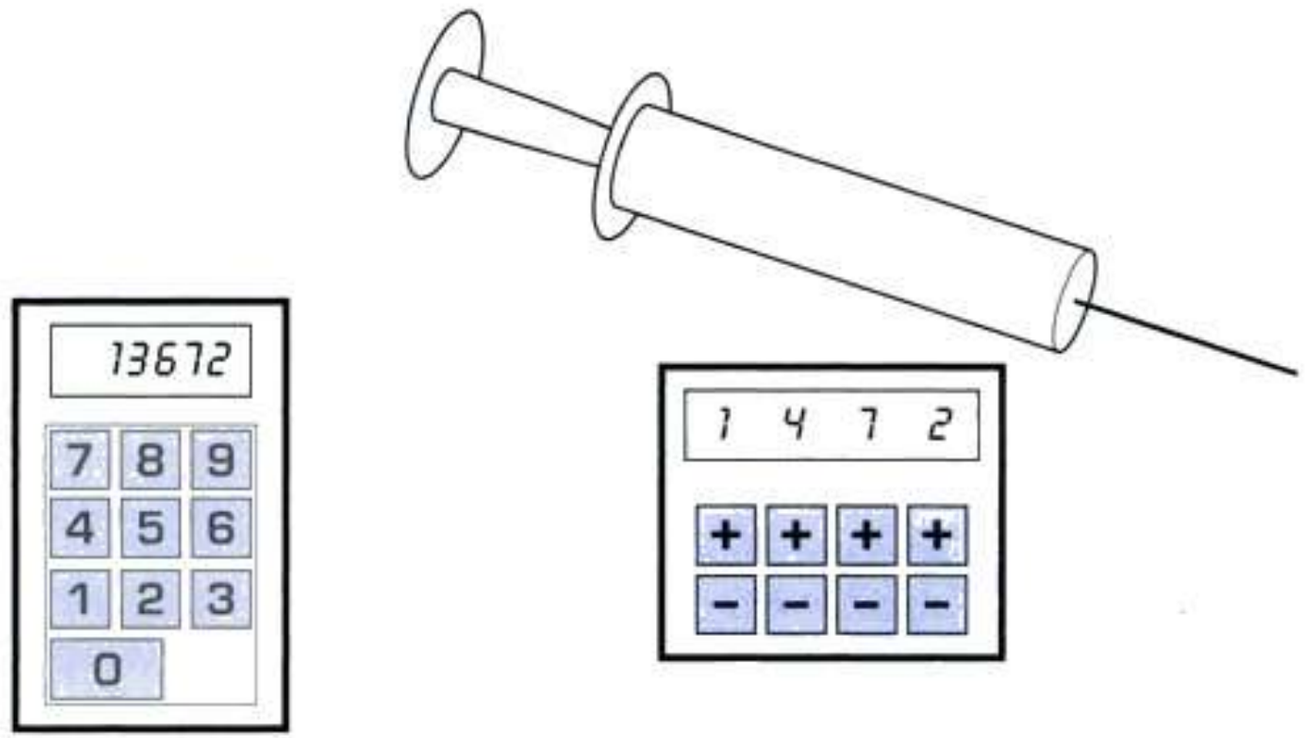
Before consulting users

Figure 0.1 Automatic syringe: setting the dose to 1372. The effect of one key slip before and after user involvement

Before **After**

Errors and Mental Models

Controlling an electronic syringe



Before consulting users

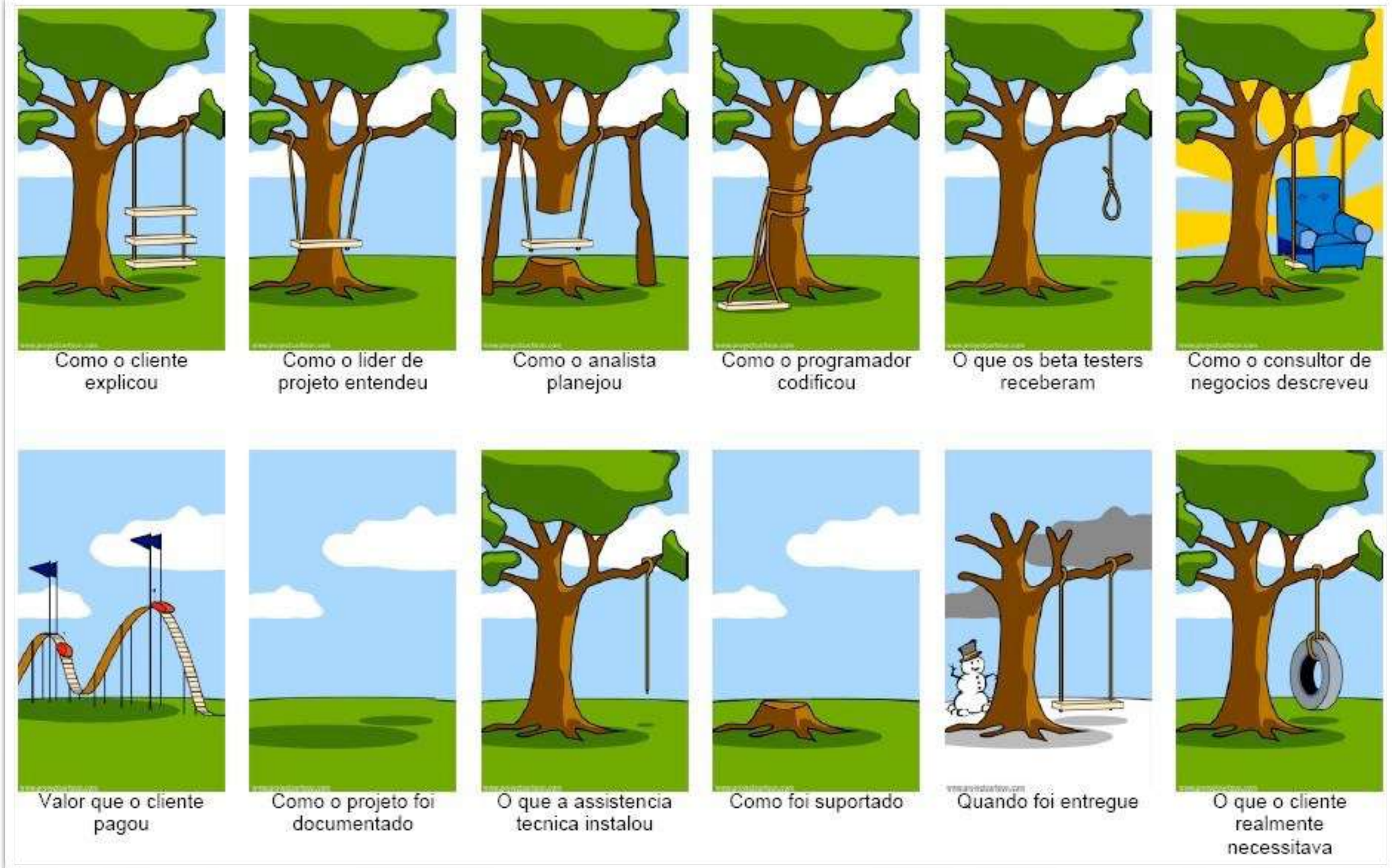
After consulting users

Figure 0.1 Automatic syringe: setting the dose to 1372. The effect of one key slip before and after user involvement

Before

After

The difficulty of software development



The Human – Emotions

- **Various theories of how emotion works**

– ***James-Lange*** (1890): emotion is our interpretation of a physiological response to a stimuli

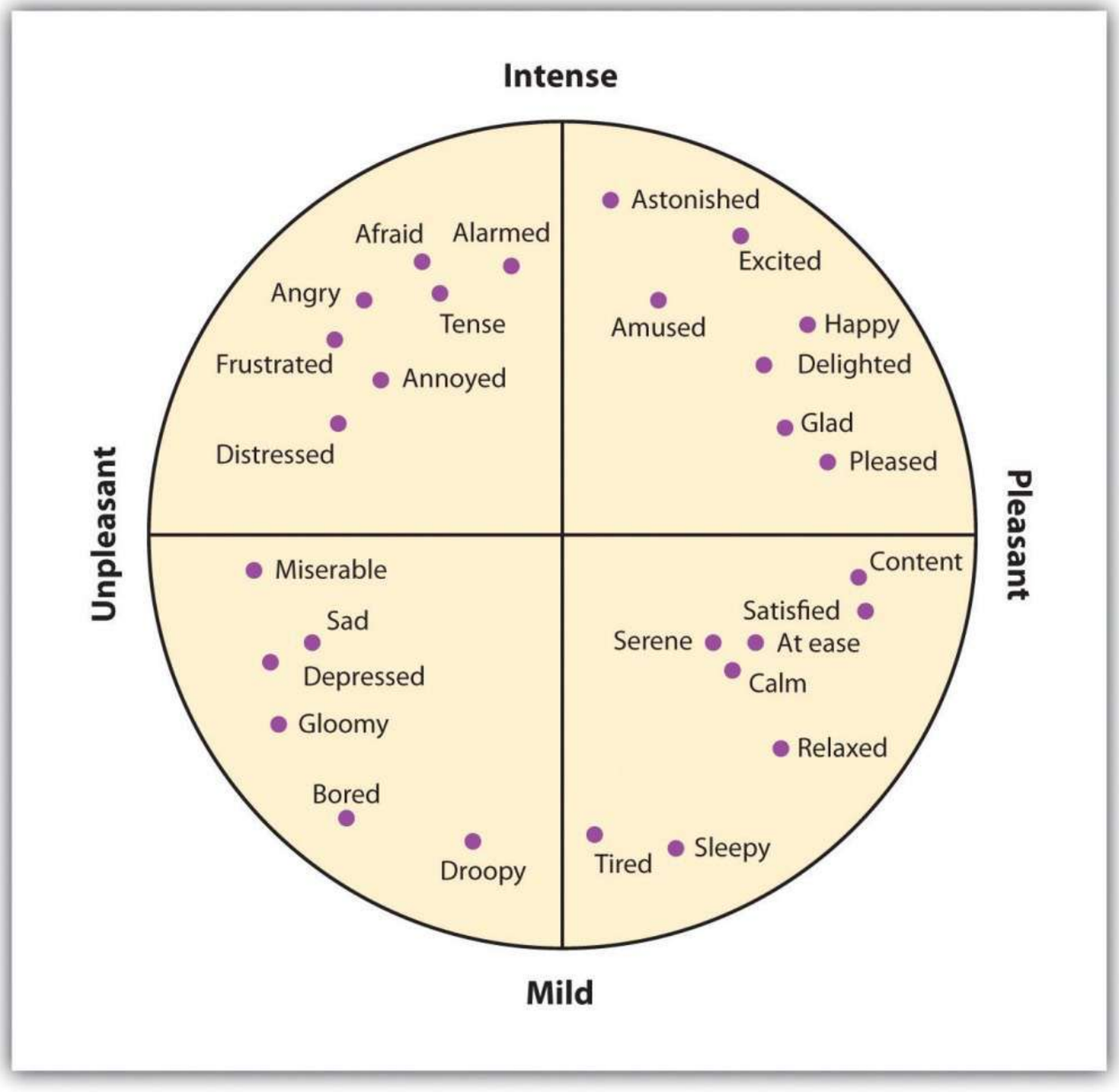
– ***Cannon*** (1929): emotion is a psychological response to a stimuli

– ***Schacter-Singer*** (1962): emotion is the result of our evaluation of our physiological responses, in the light of the whole situation we are in, e.g. +cardio ==> excited (excitement/fear?)

- Emotion clearly involves both **cognitive** and **physical** responses to stimuli

The Human — Emotions

- **The field of *sentiment analysis***
  - Several important applications, not only in HCI
  - There are some tools: Circumplex model of affect



The Human - Emotions

- The biological response to physical stimuli is called ***affect***

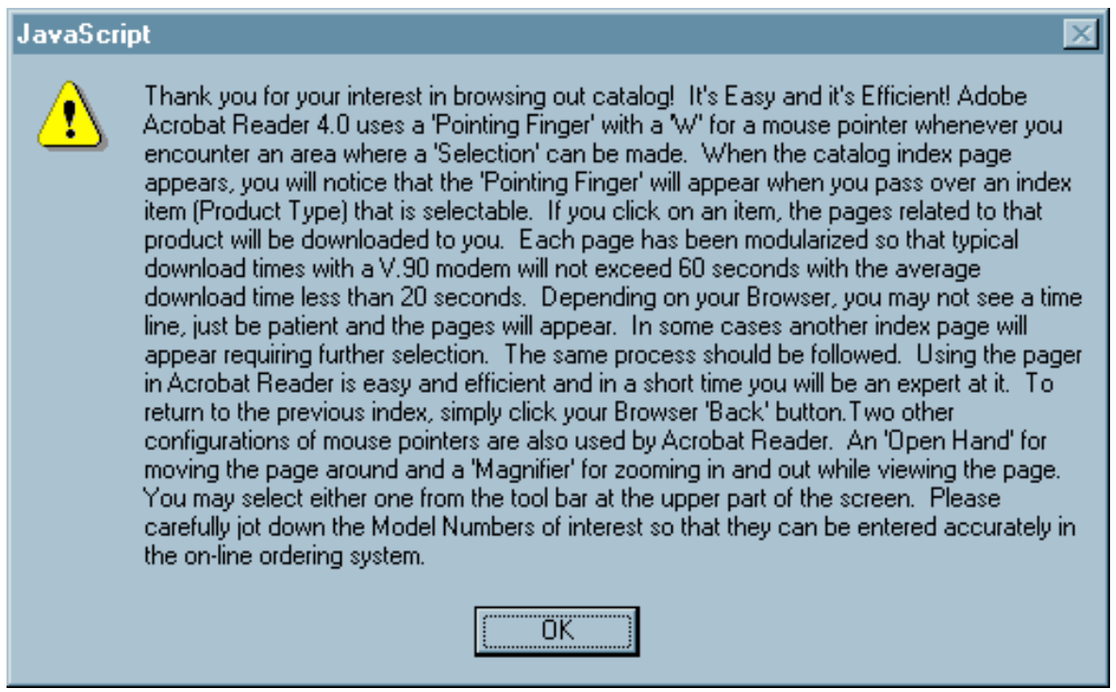
- *Affect* influences how we respond to situations
  - **positive** → creative problem solving
  - **negative** → narrow thinking

"***Negative*** *affect can make it harder to do even easy tasks;*
positive *affect can make it easier to do difficult tasks"*

(Donald Norman)

The Human - Emotions

- **Implications for interface design**
  - **Stress** increase the difficulty of problem solving
  - **Relaxed** users will be more forgiving of shortcomings in design
  - **Aesthetically** pleasing and rewarding interfaces will increase positive affect



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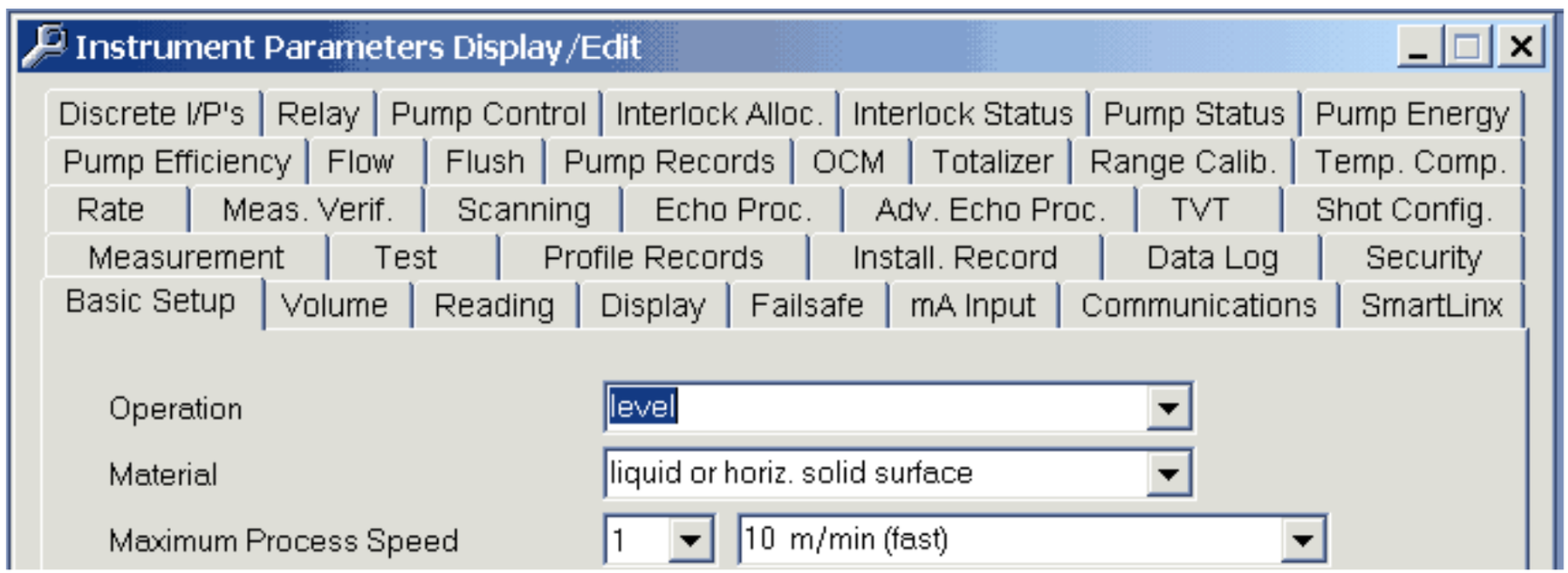

The Human - Emotions

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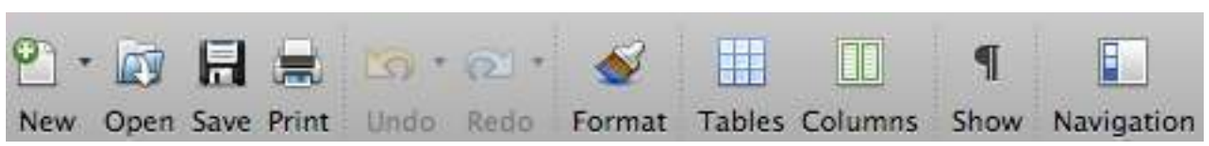
Compuserve's *WinCim 2.0*



Microsoft Office 2008

The Human - Emotions

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Individual Differences

- **Long term**
  - Gender, physical and intellectual abilities
- **Short term**
  - Effect of stress or fatigue
- **Changing**
  - Age

Ask yourself:

Will design decisions exclude sections of user population?

The Computer

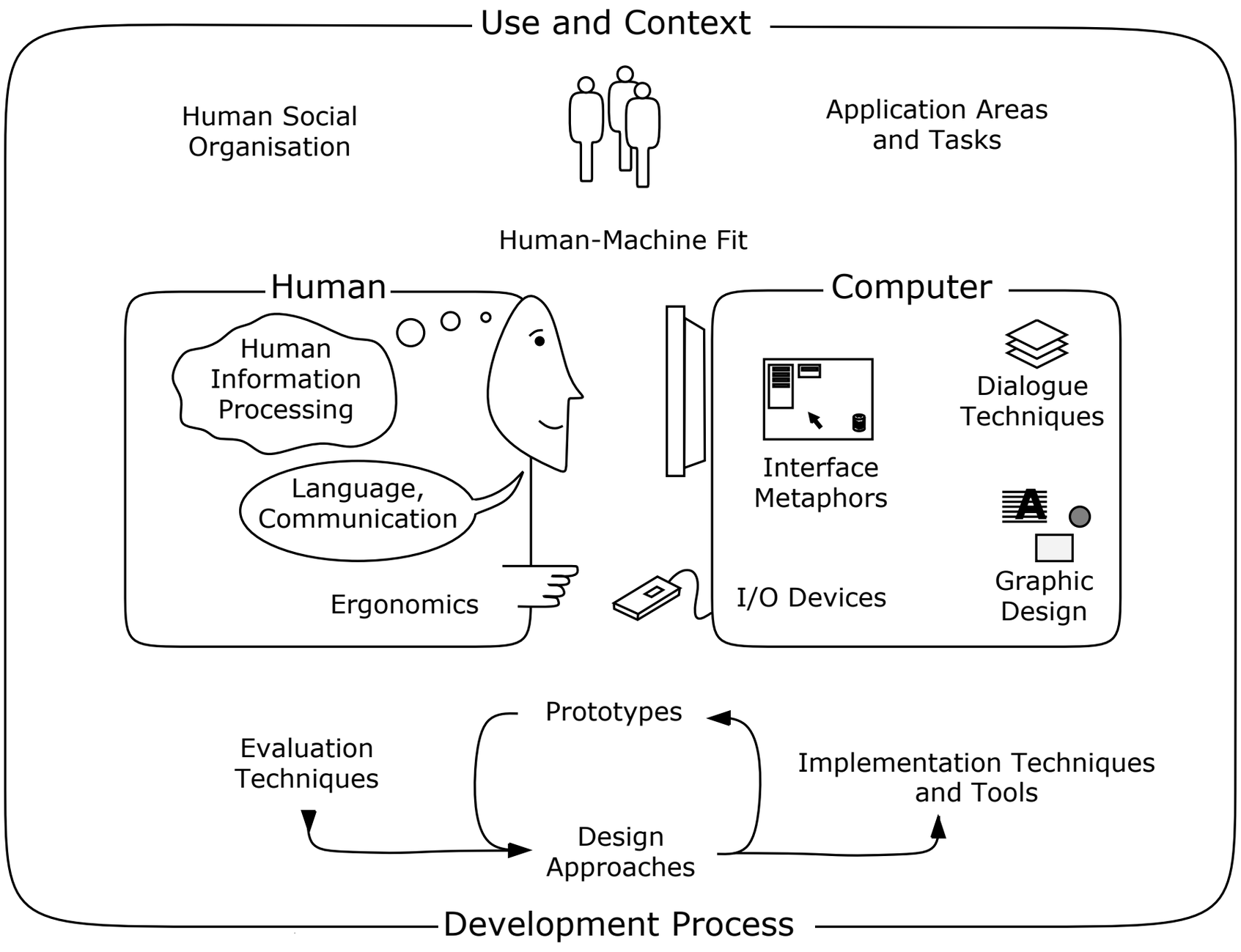


Figure 1.1: The nature of Human-Computer Interaction. Adapted from Figure 1 of the ACM SIGCHI Curricula for Human-Computer Interaction [Hewett et al., 2002]

The Computer

A computer system is made up of various elements each of these elements affects the interaction

- **Input devices:** text entry and pointing
- **Output devices:** screen (small&large), digital paper
- **Virtual reality:** special interaction and display devices
- **Physical interaction:** e.g. sound, haptic, bio-sensing
- **Paper:** as output (print) and input (scan)
- **Memory:** RAM & permanent media, capacity & access
- **Processing:** speed of processing, networks

Interacting with computers

To understand **human-*computer*** interaction
… need to understand **computers**!

What does interaction mean?

What goes **in** and **out**
devices, paper,
sensors, etc.

Sociology,
Management,
Politics,…

What can it do?
memory, processing,
networks

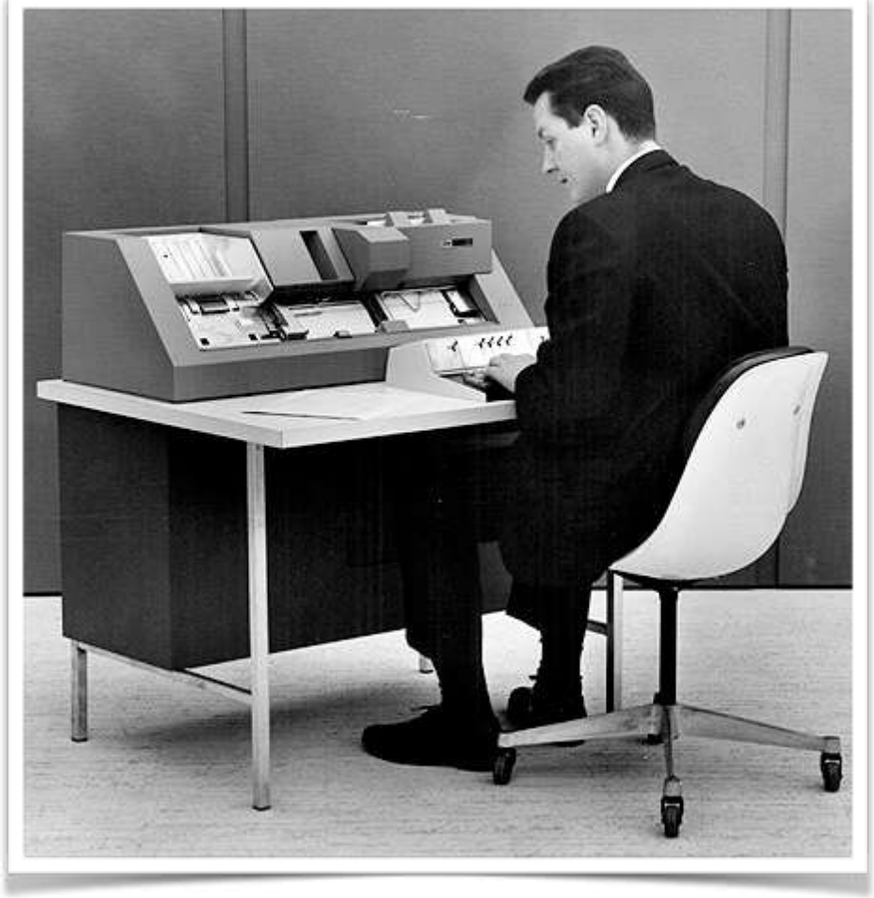
Interactivity?

"Long ago in a galaxy far away …"

***Batch* Processing**

- **Punched card** stacks or large **data files** prepared
- Long wait ….
- Line printer output

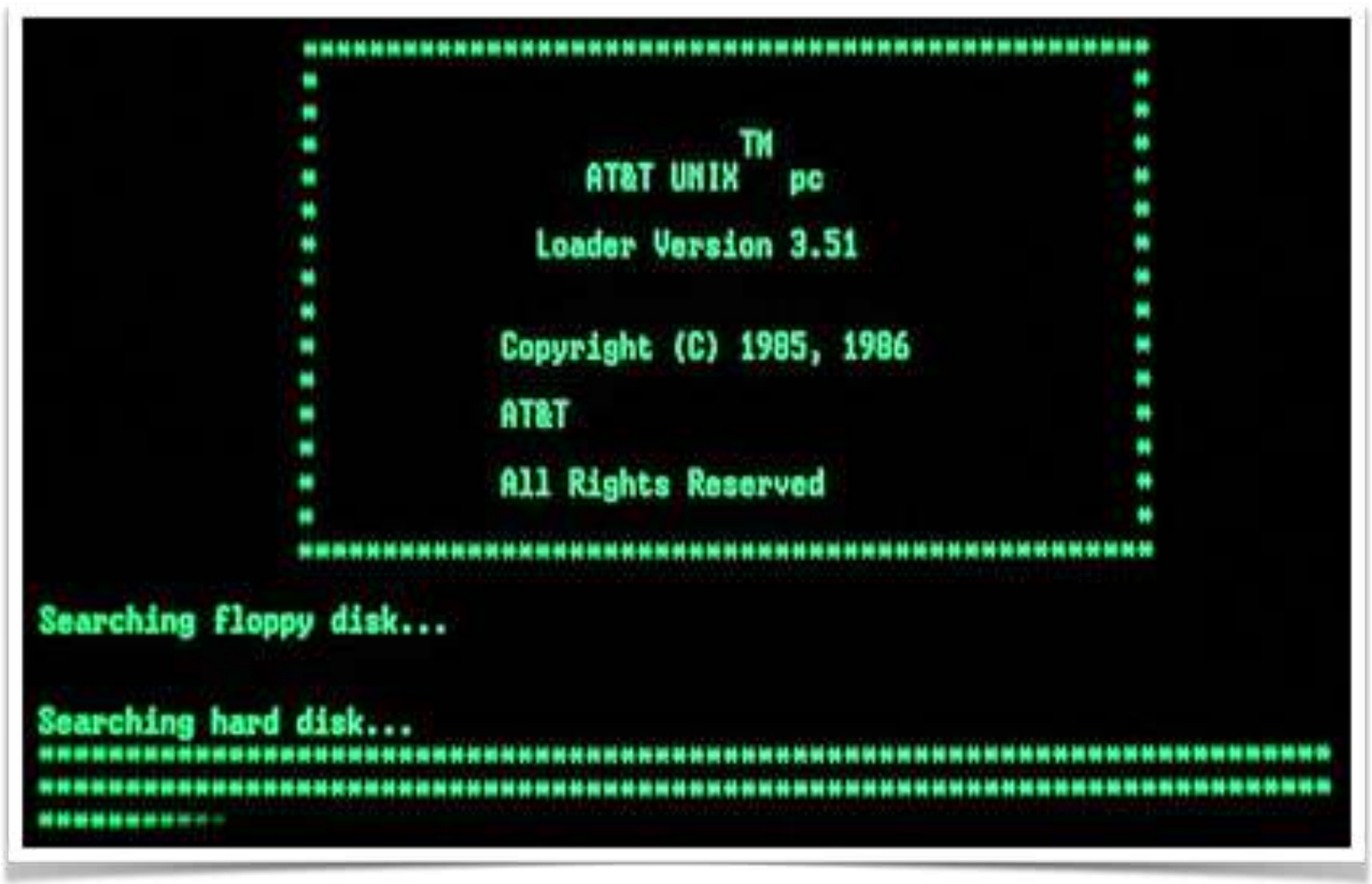
… and if it is not right …



Now most interaction is more dynamic

- Rapid feedback;
- The user is in control (most of the time);
- She is exploring/doing rather than thinking.

Command Line Interactivity



Unix Operating System

Unix PC, 1985

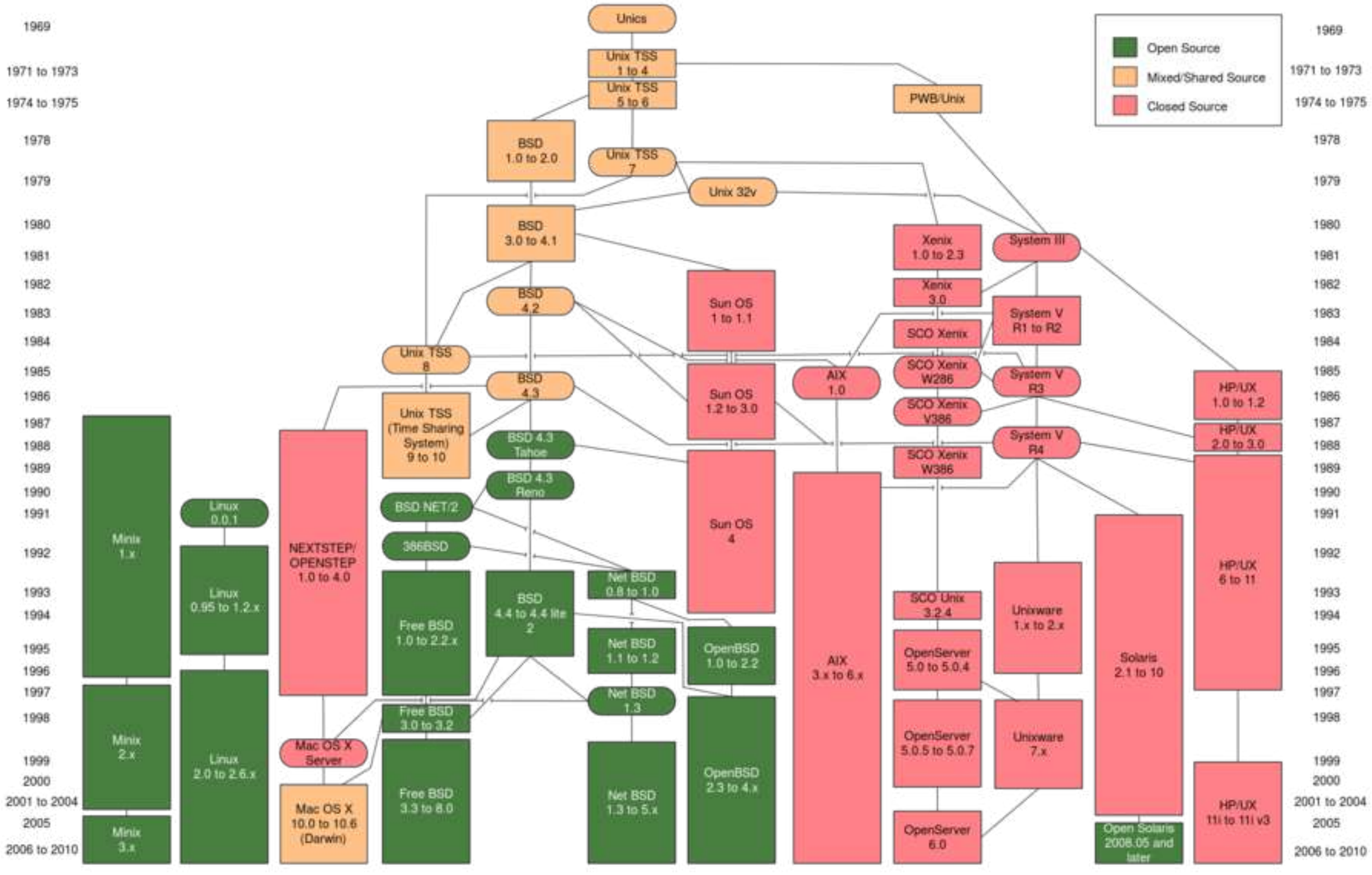
Massachusetts Institute of Technology

AT&T Bell Labs

General Electric

UNIX HISTORY

1969 – 2010



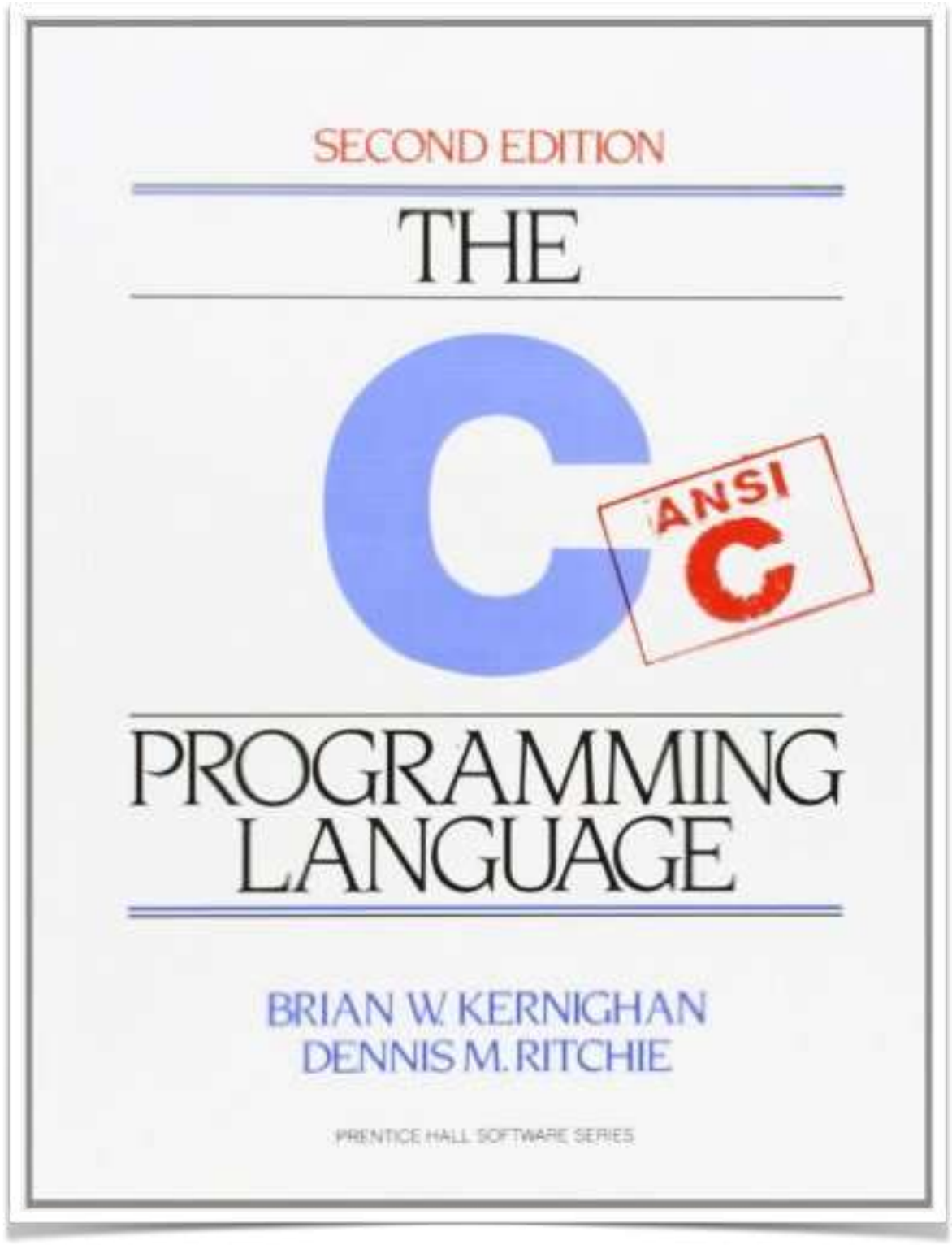
Interactivity?

PDP-11

Denis Ritchie

Ken Thompson

Interactivity?



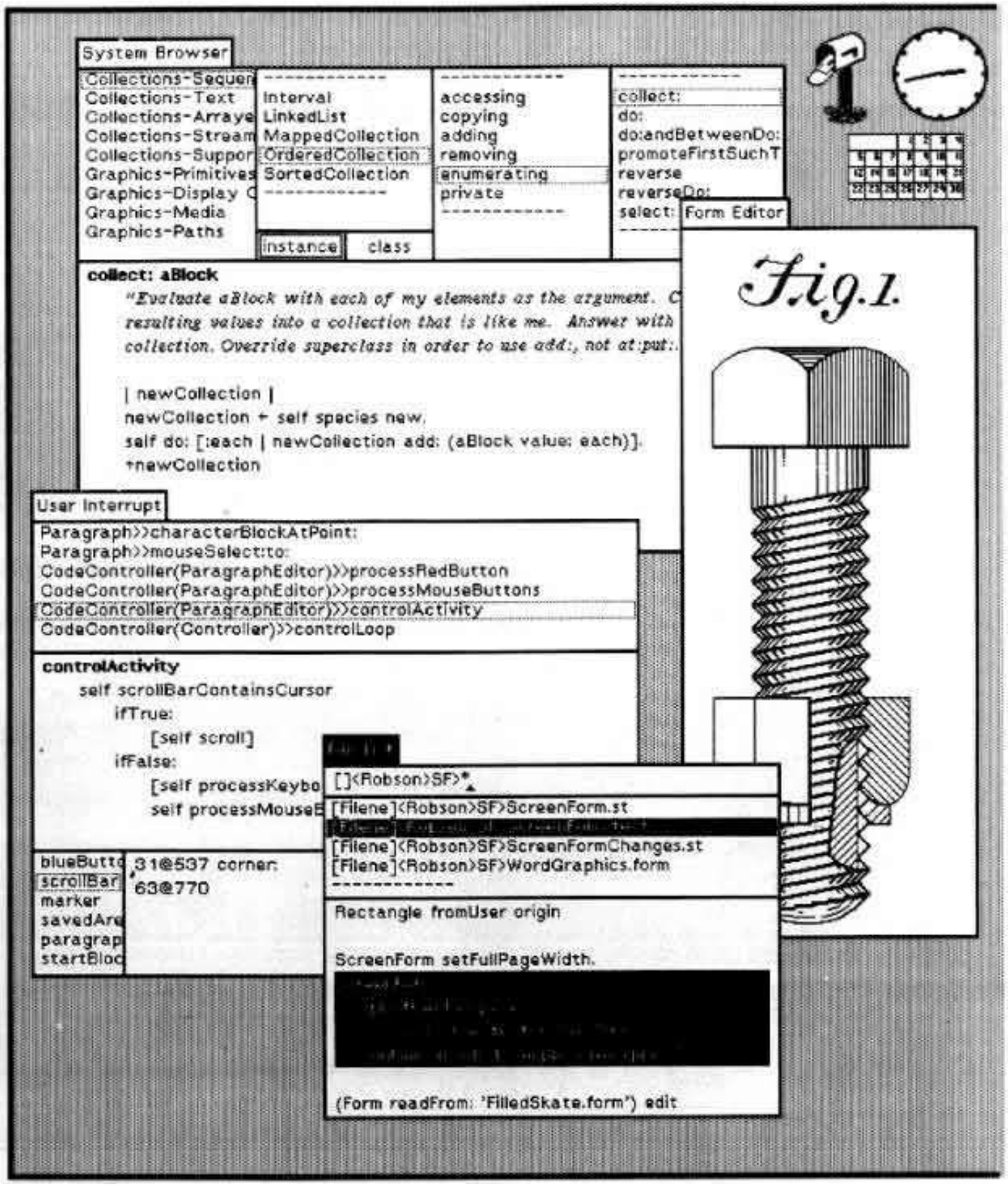
Command Line Interactivity

```
Enter today's date (m-d-y): 08-04-81

The IBM Personal Computer DOS
Version 1.00 (C)Copyright IBM Corp 1981

A>dir *.com
IBMBIO    COM        1920  07-23-81
IBMDOS    COM        6400  08-13-81
COMMAND   COM        3231  08-04-81
FORMAT    COM        2560  08-04-81
CHKDSK    COM        1395  08-04-81
SYS       COM         896  08-04-81
DISKCOPY  COM        1216  08-04-81
DISKCOMP  COM        1124  08-04-81
COMP      COM        1620  08-04-81
DATE      COM         252  08-04-81
TIME      COM         250  08-04-81
MODE      COM         860  08-04-81
EDLIN     COM        2392  08-04-81
DEBUG     COM        6049  08-04-81
BASIC     COM       10880  08-04-81
BASICA    COM       16256  08-04-81

A>_
```

MS-DOS

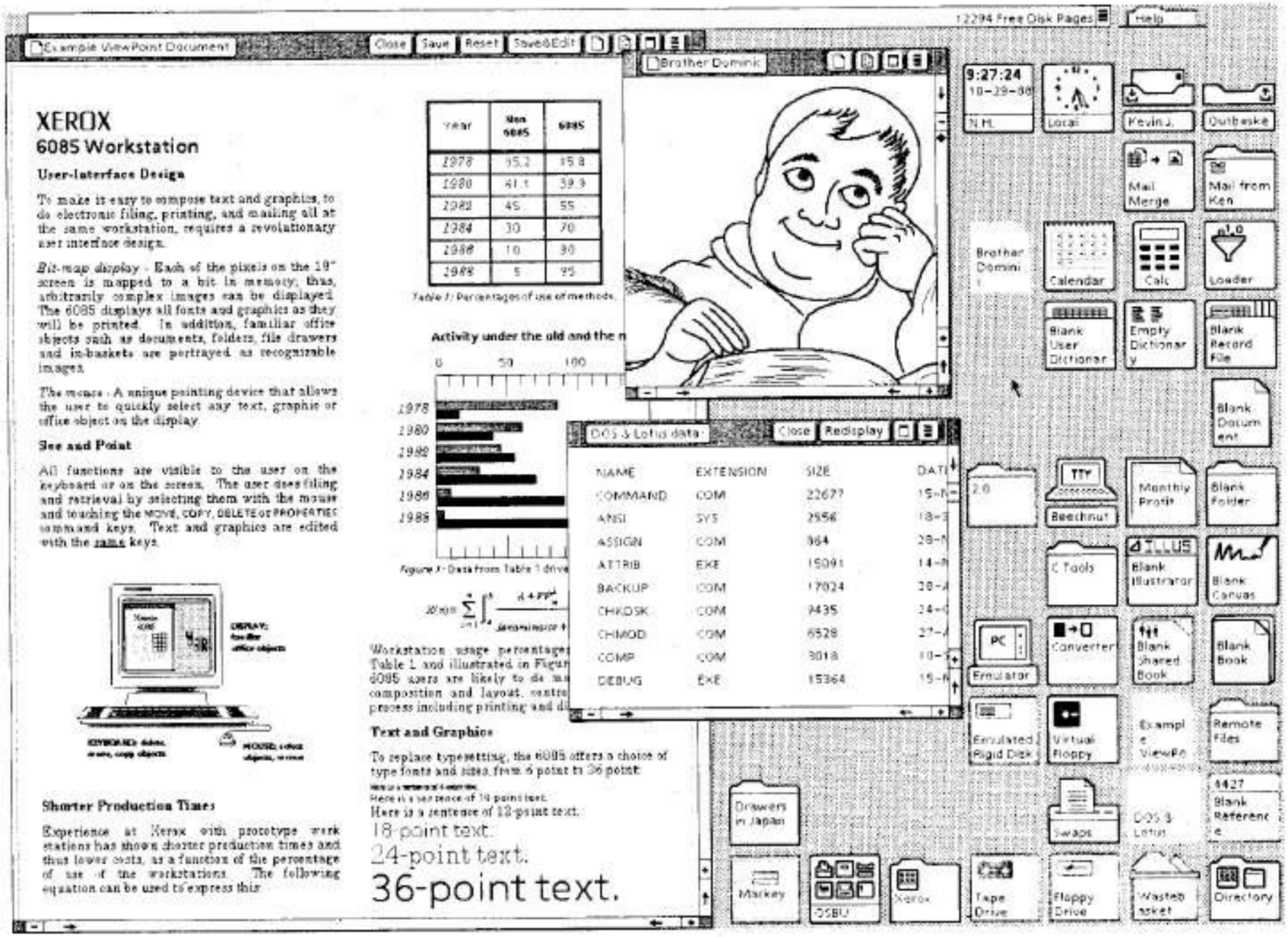
First GUI — “Xerox Alto”

March 1, 1973



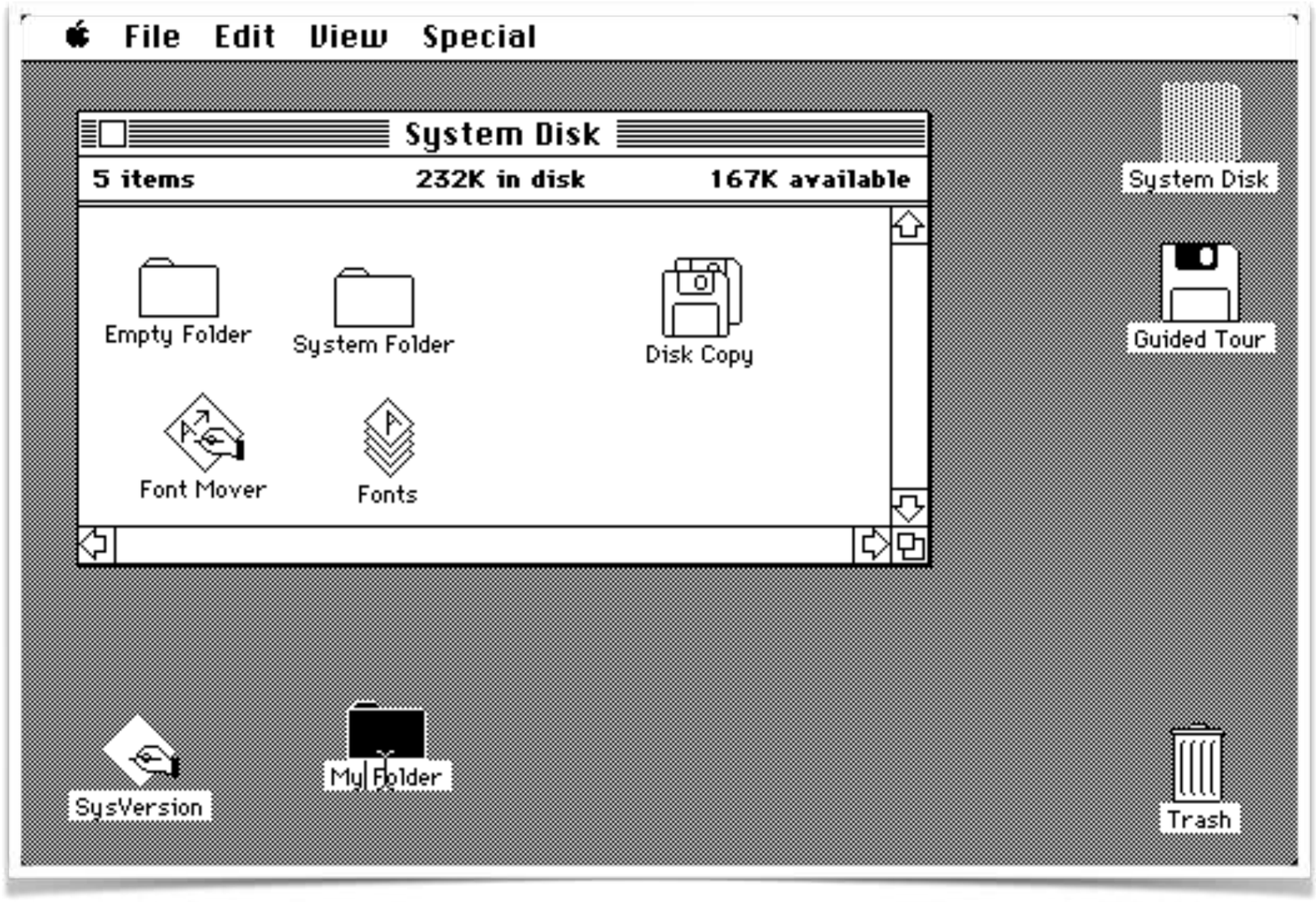
GUI — “Xerox Star”

1981



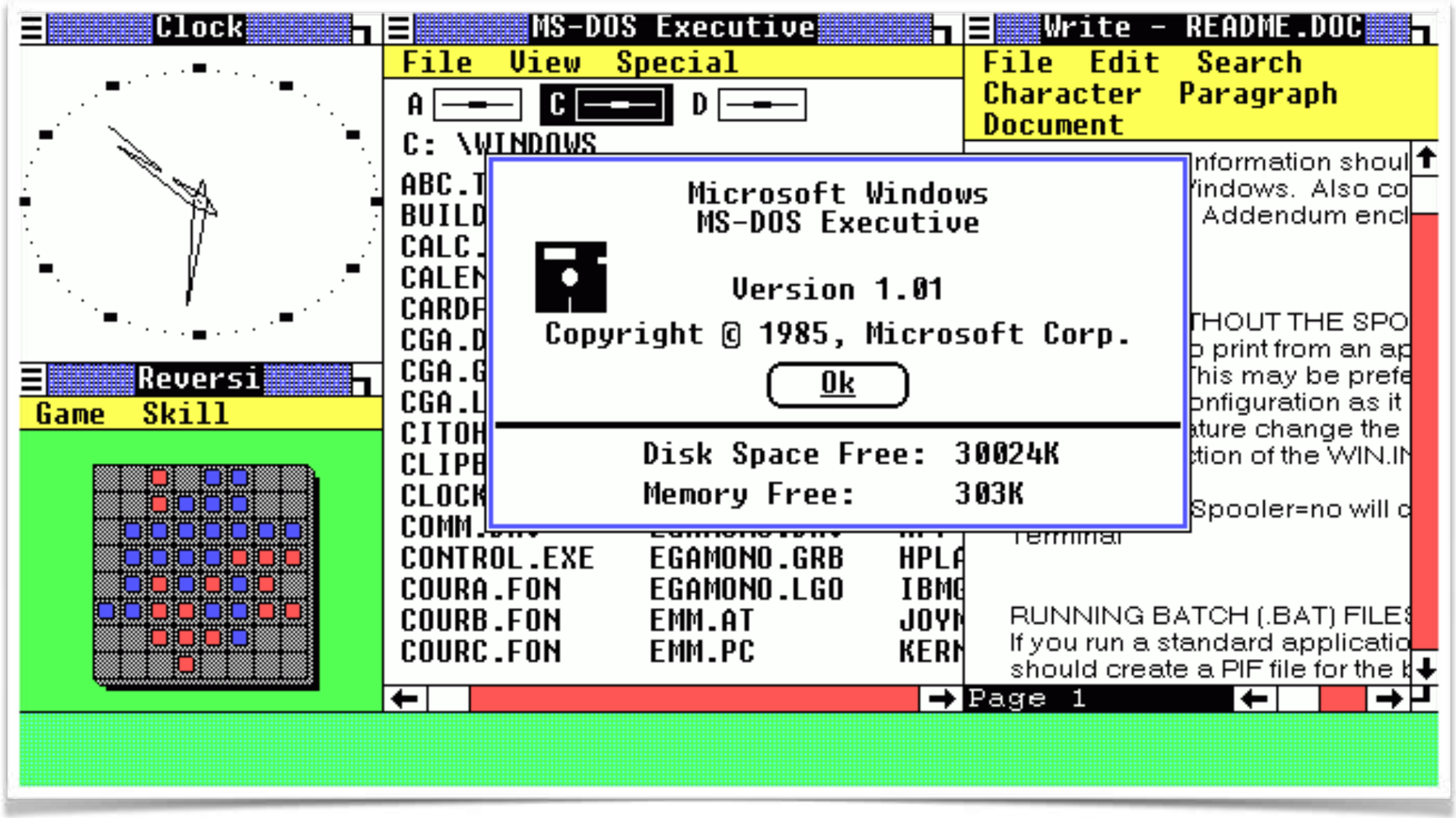
GUI — Apple Macintosh

1984

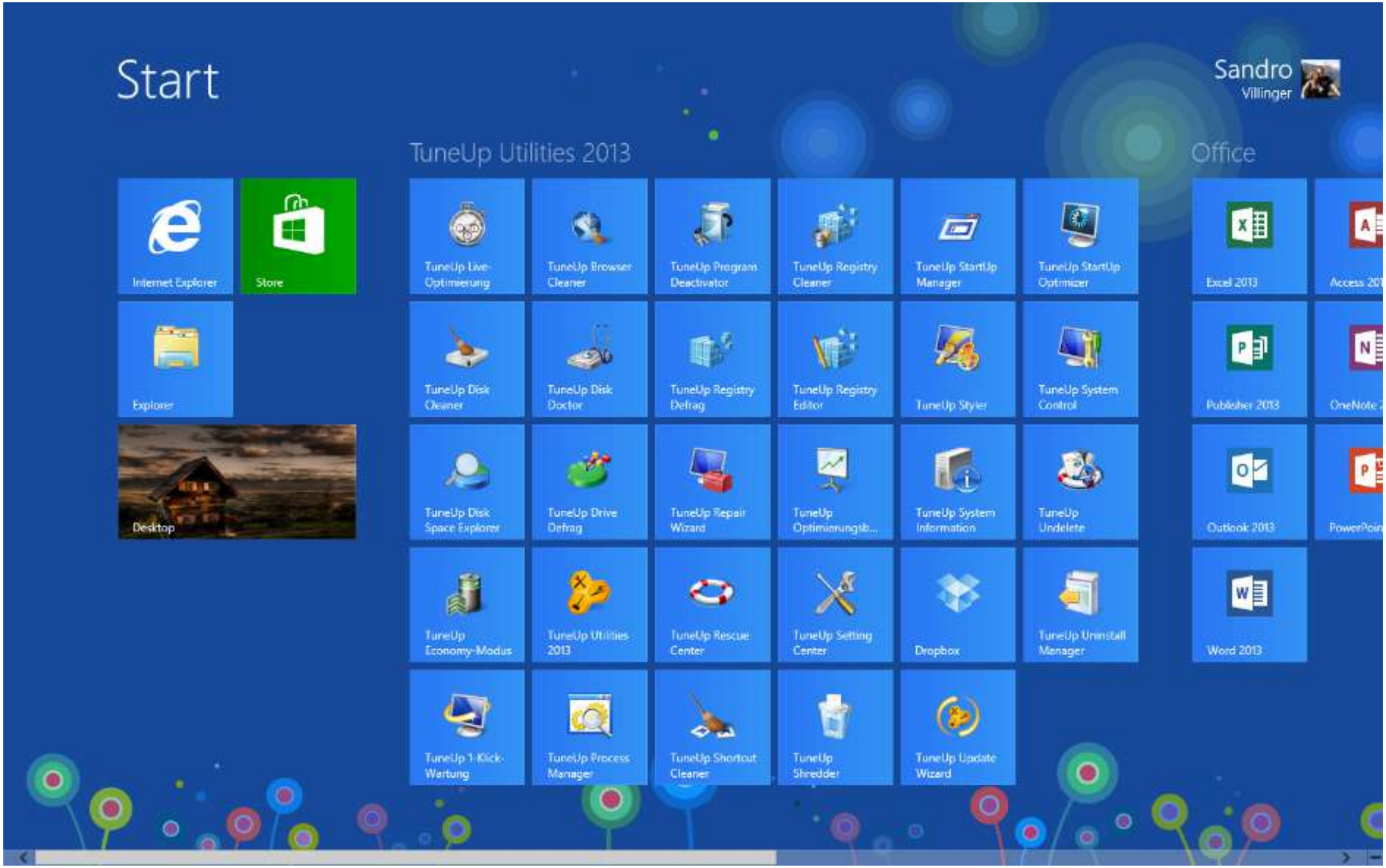


GUI — Windows 1.0

1985



Modern GUIs

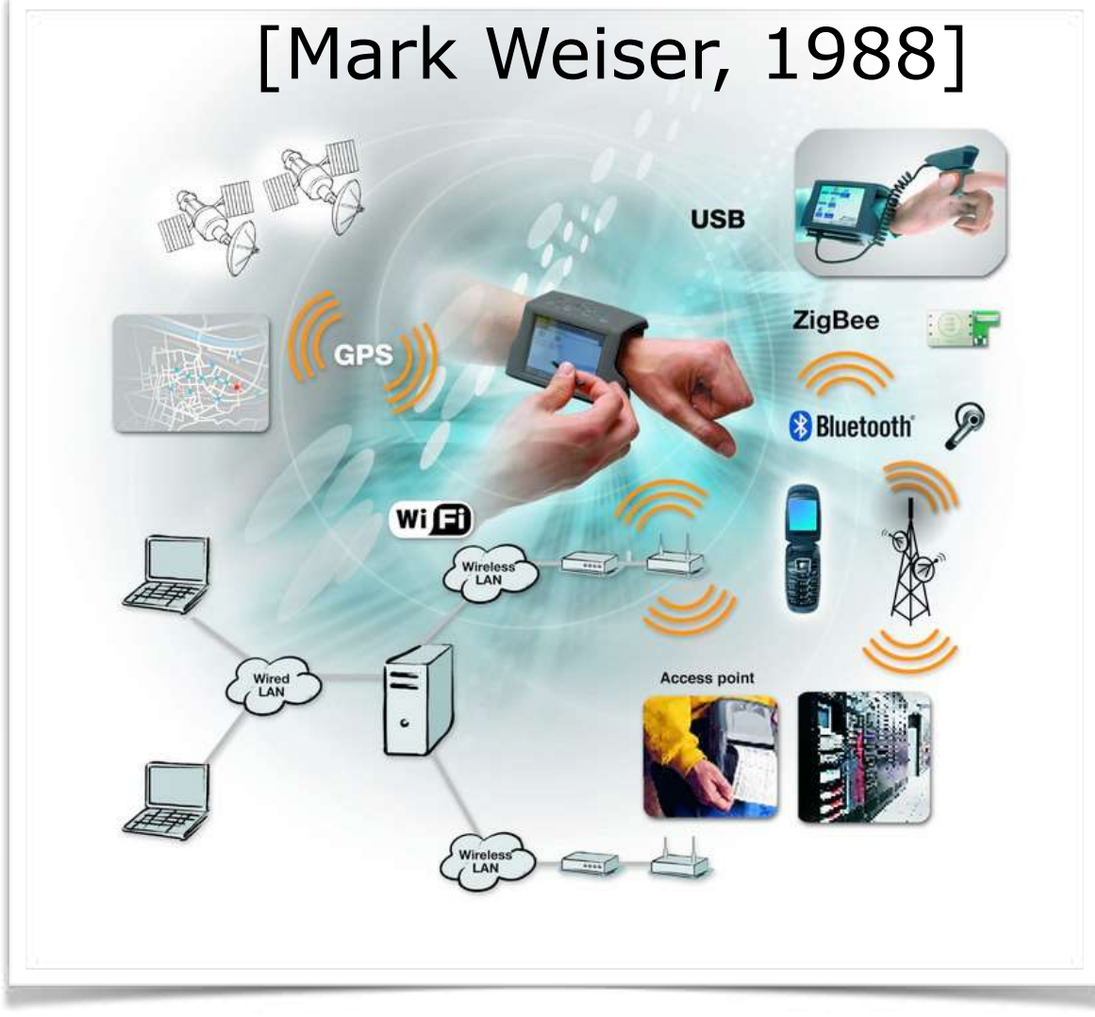

Start
Sandro
Villinger
TuneUp Utilities 2013
Office
Internet Explorer
Store
Explorer
Desktop
TuneUp Live-Optimierung
TuneUp Browser Cleaner
TuneUp Program Deactivator
TuneUp Registry Cleaner
TuneUp StartUp Manager
TuneUp StartUp Optimizer
TuneUp Disk Cleaner
TuneUp Disk Doctor
TuneUp Registry Defrag
TuneUp Registry Editor
TuneUp Styler
TuneUp System Control
TuneUp Disk Space Explorer
TuneUp Drive Defrag
TuneUp Repair Wizard
TuneUp Optimierungsb...
TuneUp System Information
TuneUp Undelete
TuneUp Economy-Modus
TuneUp Utilities 2013
TuneUp Rescue Center
TuneUp Setting Center
Dropbox
TuneUp Uninstall Manager
TuneUp 1-Klick-Wartung
TuneUp Process Manager
TuneUp Shortcut Cleaner
TuneUp Shredder
TuneUp Update Wizard
Excel 2013
Publisher 2013
Outlook 2013
Word 2013

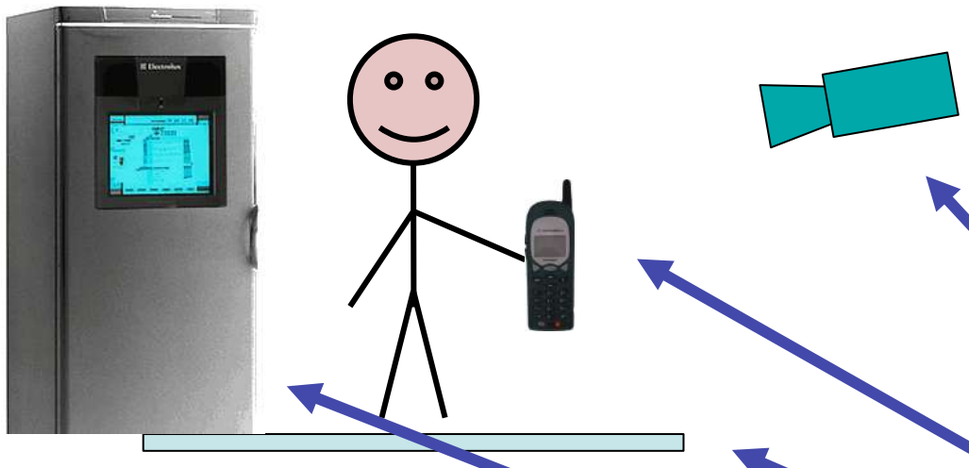
Modern GUIs

OS X

Richer interaction

Desktop computing → **Ubiquitous computing**





Sensors
and devices
everywhere

Richer interaction

Ubiquitous computing

"The most profound technologies are those that disappears"

Mark Weiser

- **Multiple smal computation devices**
  - Computers have moved out of machine room, onto the desktop and now into the pocket (Alan Dix, 2016)

Text Entry Devices

keyboards (QWERTY et al.)
chord keyboards, phone pads
handwriting, speech

Keyboards

- Them **most common** text input device
- Allows **rapid** and **precise** entry of text by experienced users
- **Keypress** closes connection, causing a character code to be sent
- Usually connected by cable, but can be wireless

layout – QWERTY

- **Standardize layout (?)**

  but …

  - non-alphanumeric keys are placed differently
  - accented symbols needed for different scripts
  - minor differences between UK and USA keyboards

- **QWERTY** arrangement **not optimal** for typing
  - layout to prevent typewriters jamming!

- Alternative designs allow faster typing but …

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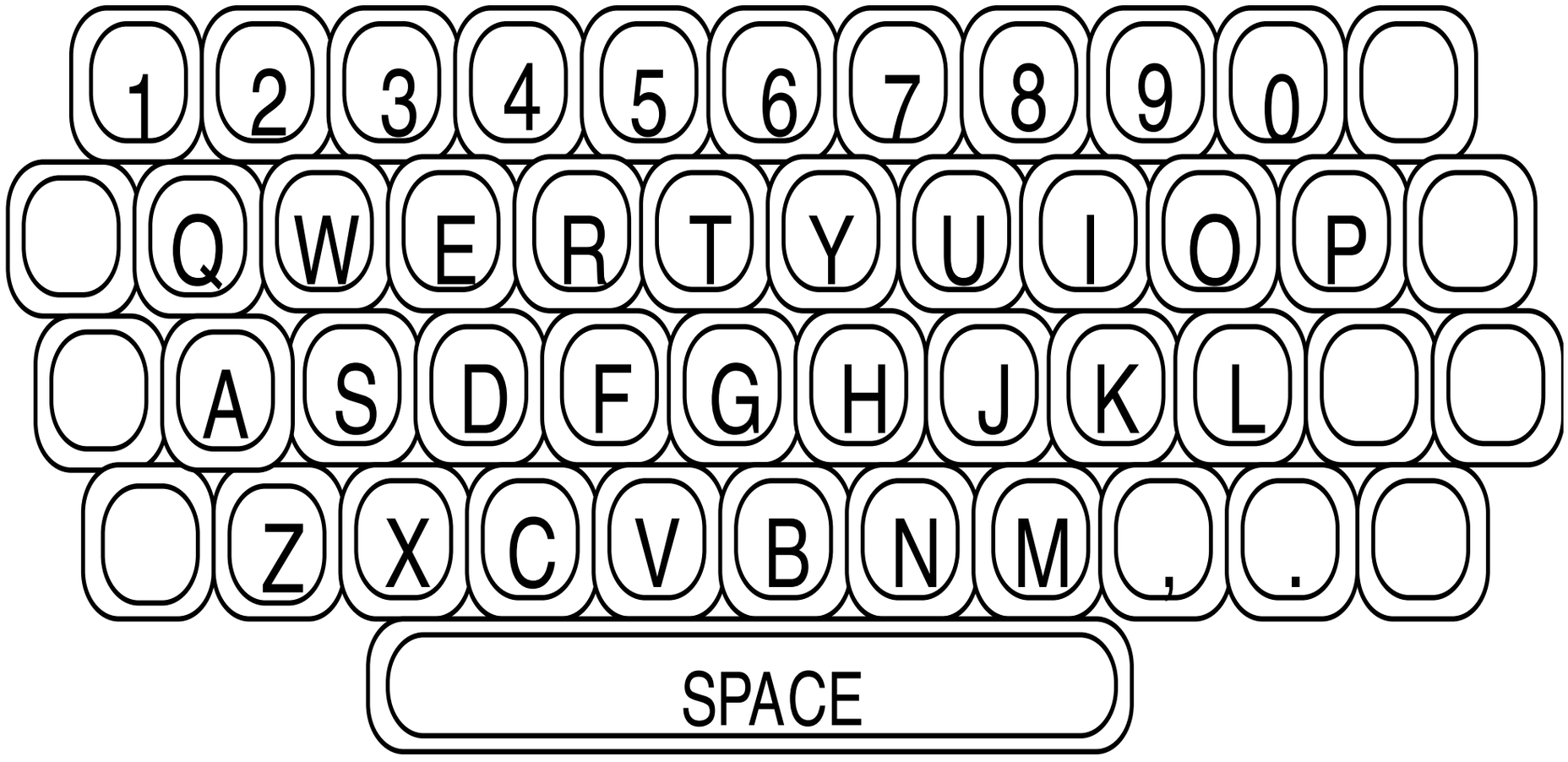
- Alternative designs allow faster typing but large social base of QWERTY typists produces **reluctance to change.**

QWERTY



The “typewriter” history

QWERTY

The “typewriter” history

QWERTY

1954

The “typewriter” history

QWERTY

1968

The “typewriter” history

Alternative keyboard layouts

Alphabetic

- Keys arranged in alphabetic order
- Not faster for trained typists
- Not faster for beginners either!

Dvorak

- Common letters under dominant fingers
- Biased towards right hand
- Common combinations of letters alternate between hands
- **10-15% improvement** in speed and reduction in fatigue
- But - large social base of QWERTY typists produce market pressures not to change

Alternative keyboard layouts

Dvorak

~ `	! 1	@ 2	# 3	$ 4	% 5	^ 6	& 7	* 8	(9	) 0	{ [	}]	← Backspace	
Tab ⇤⇥	" '	< ,	> .	P	Y	F	G	C	R	L	? /	+ =	| \	
Caps Lock Ⓐ	A	O	E	U	I	D	H	T	N	S	_ -	Enter ↵		
Shift ⇧	: ;	Q	J	K	X	B	M	W	V	Z	Shift ⇧			
Ctrl	Win Key	Alt								Alt Gr	Win Key	Menu	Ctrl	

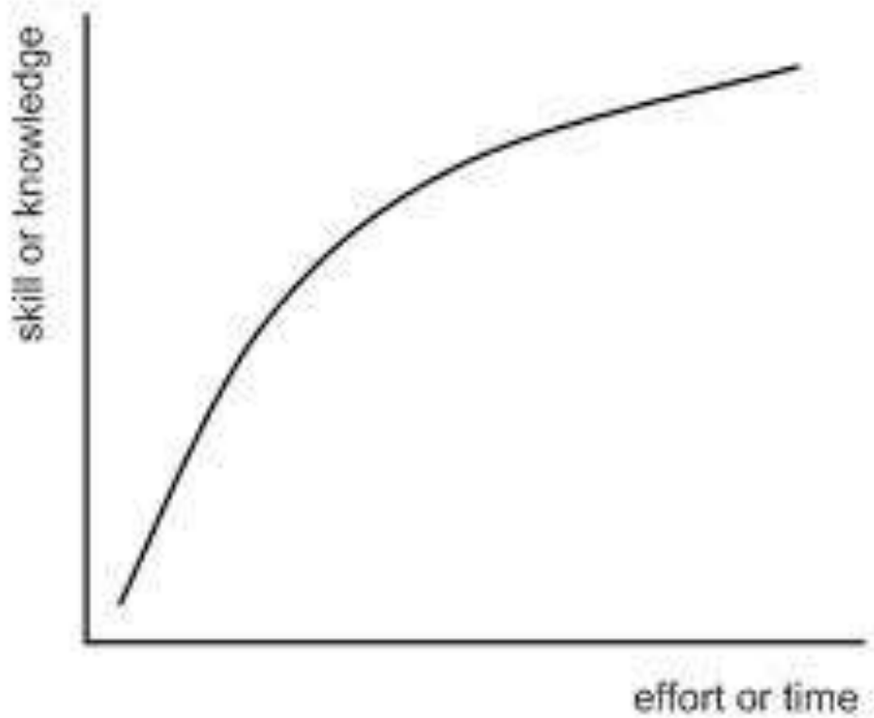
Property of Museum of History & Industry, Seattle

August Dvorak 1936

alternative keyboard layouts

Shape Writer

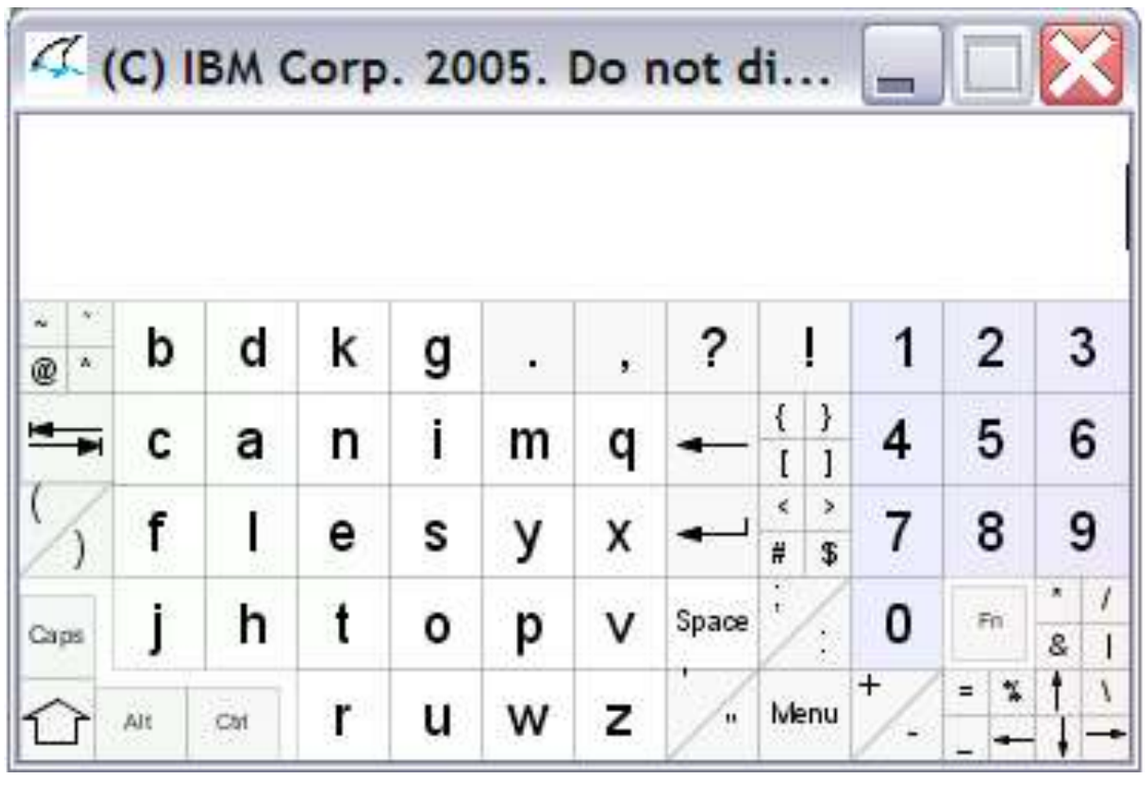
Quick learning curve



Recognize word patterns

Alternative keyboard layouts

Shape Writer



Atomic Keyboard

- Based on **Fitt's Law**

$$Mt = a + b \log_2(D/S + 1)$$

- **More Efficient**

Special keyboards for special users

- Designed to reduce fatigue for RSI
  - **RSI**: Repetitive Strain Injury
- For one handed use

  e.g. the Maltron left-handed keyboard

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Special keyboards for special users

- designs to reduce fatigue for RSI
  - **RSI**: Repetitive Strain Injury

- for impaired users in general

  e.g. the head stick keyboard

Laser Projection Keyboard

- Projects a virtual keyboard in any surface.

- User interacts with the projection.

Phone pad and T9 entry

- **Use numeric keys with multiple presses**

  2 – a b c 6 - m n o
  3 - d e f 7 - p q r s
  4 - g h i 8 - t u v
  5 - j k l 9 - w x y z

  hello = 4433555[pause]555666

  Surprisingly fast!

- **T9 predictive entry**
  - "Text on 9 keys"
  - type as if single key for each letter
  - use dictionary to 'guess' the right word
  - hello = 43556 …
  - but 26 -> menu 'am' or 'an'

Numeric keypads

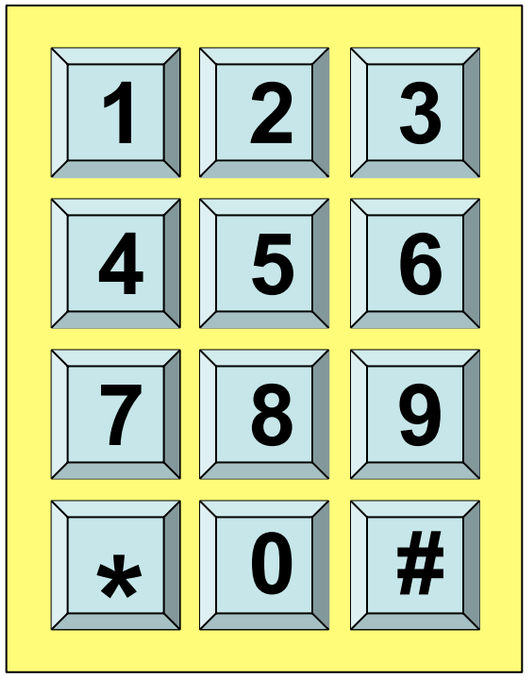
- For entering numbers quickly:
  - Calculator, PC keyboard

- For telephones

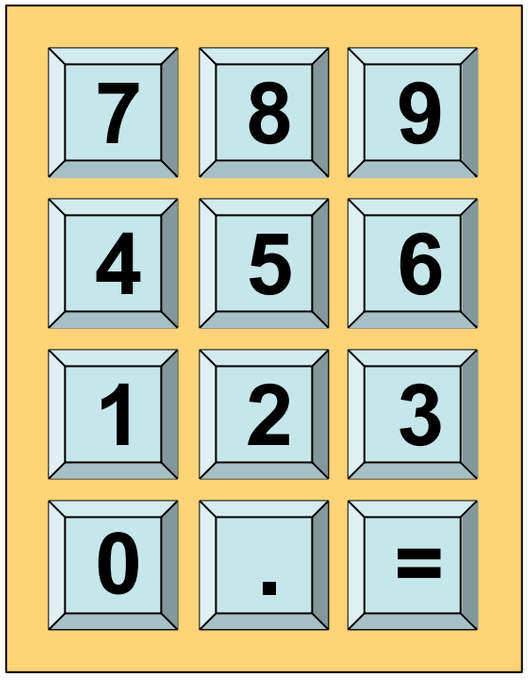
  Not the same!

  Did you noticed?

ATMs are like phones



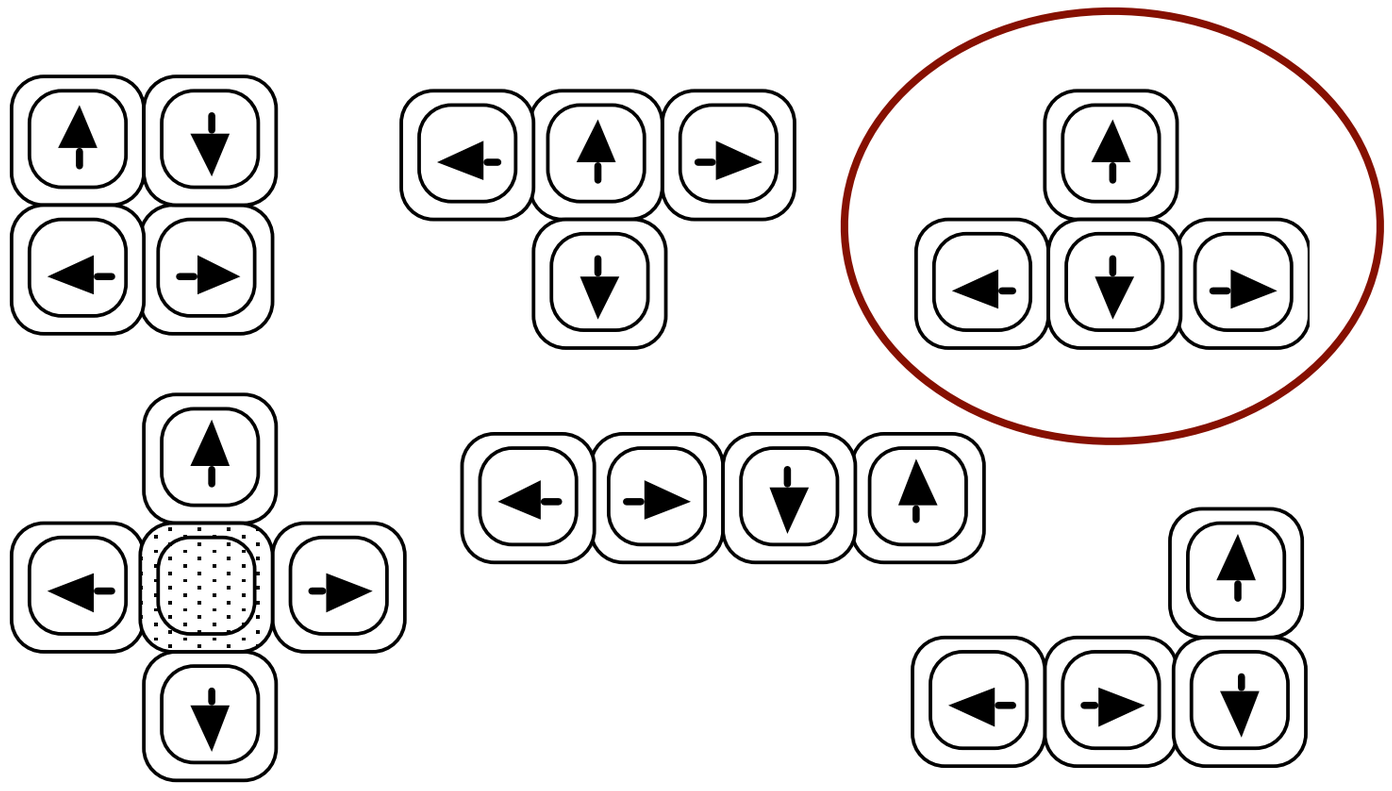
telephone



calculator

Cursor keys

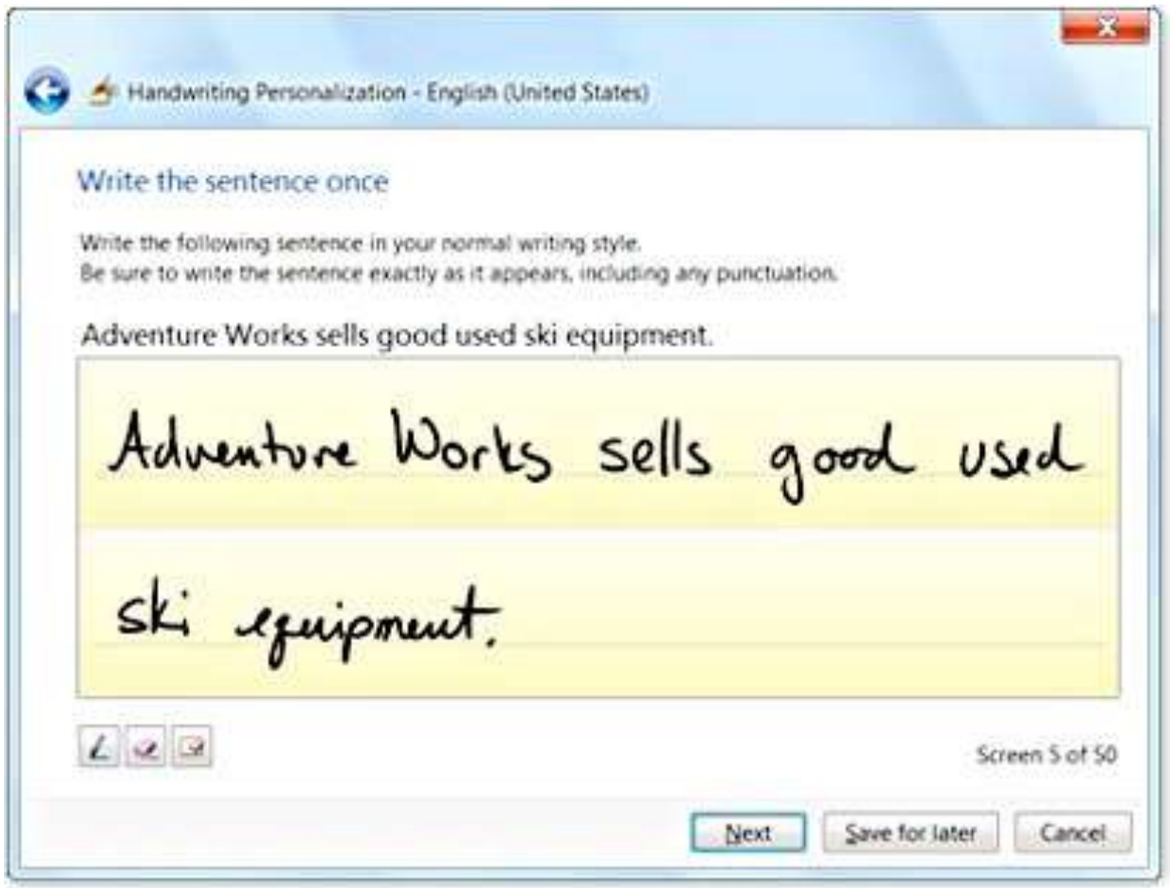
- Four keys (up, down, left, right) on keyboard.
- Very, very cheap, but slow.
- Useful for not much more than basic motion for text-editing tasks.



- No standardized layout, but inverted “T”, most common

Handwriting recognition

- **Text can be input into the computer, using a pen and a digesting tablet**
  - natural interaction



- **Technical problems:**
  - capturing all useful information - stroke path, pressure, etc. in a natural manner
  - segmenting joined up writing into individual letters
  - interpreting individual letters
  - coping with different styles of handwriting

- **But, recent improvements**

- **Used in PDAs, and tablet computers …**
  … leave the keyboard on the desk!

Apple Pencil

- **Designed to interact with the iPad Pro. Opens new interaction possibilities**

- **Key features are:**
  - Precision
  - Smoothness
  - Familiarity

Speech Recognition (NLP)

- **Improving rapidly**

- **Most successful when:**
  - Single user — with training, learns the user peculiarities;
  - Limited vocabulary systems.

- **Some challenges:**
  - External noise interference;
  - Imprecise pronunciation;
  - Large vocabularies;
  - Different speakers;
  - Accents.

  For 3% error rate = 1/30 character = 1/6 words.

Apple Siri

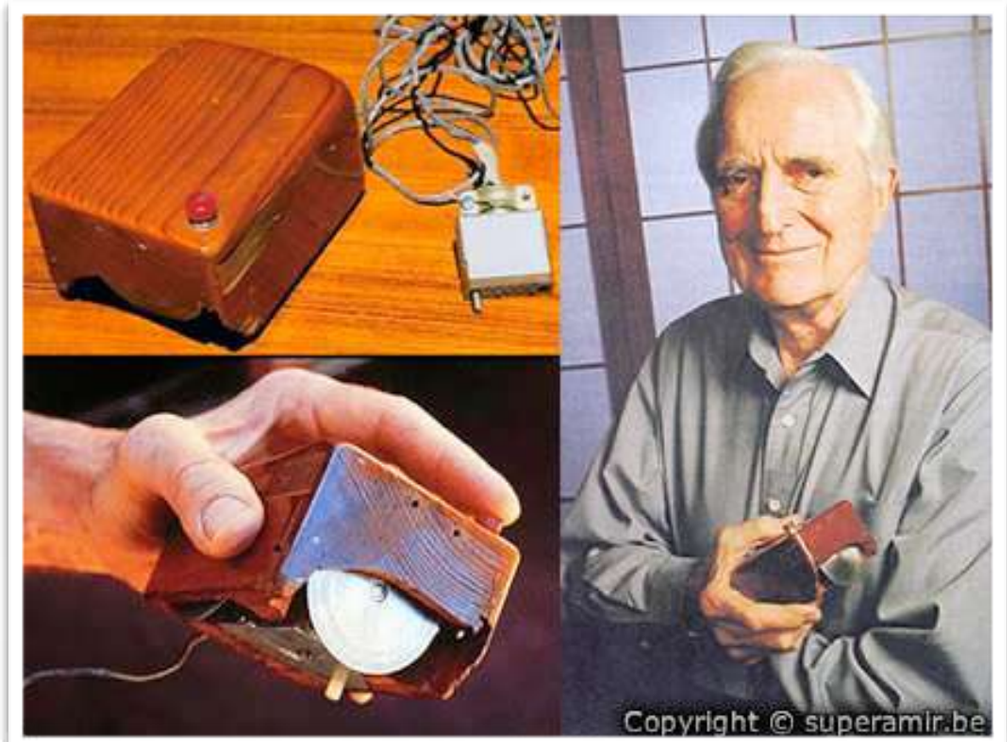
Amazon Alexa

Positioning, Pointing and Drawing

mouse, touchpad
trackballs, joysticks etc.
touch screens, tablets
eyegaze, cursors

The Mouse

- **Handheld pointing device**
  - very common
  - easy to use

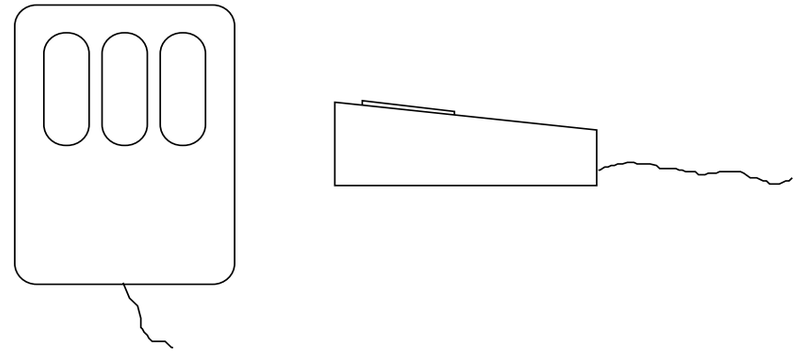


- **Two characteristics**
  - planar movement
  - buttons

    (Usually from 1 to 3 buttons on top, used for making a selection, indicating an option, or to initiate drawing etc.)

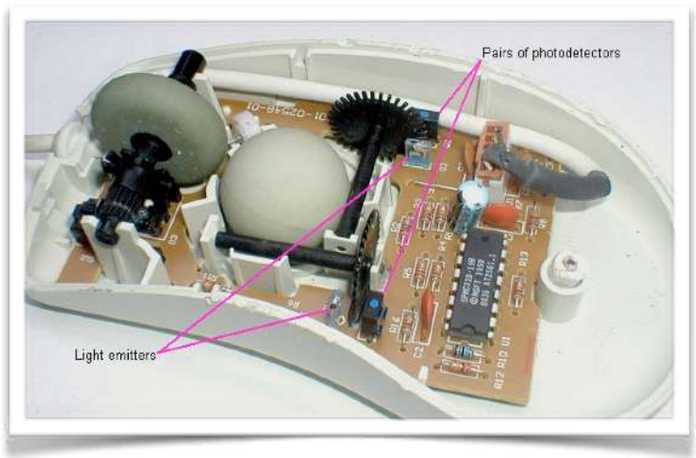
Douglas Engelbart 1964

Stanford Research Institute



How does it work?

Two methods for detecting motion

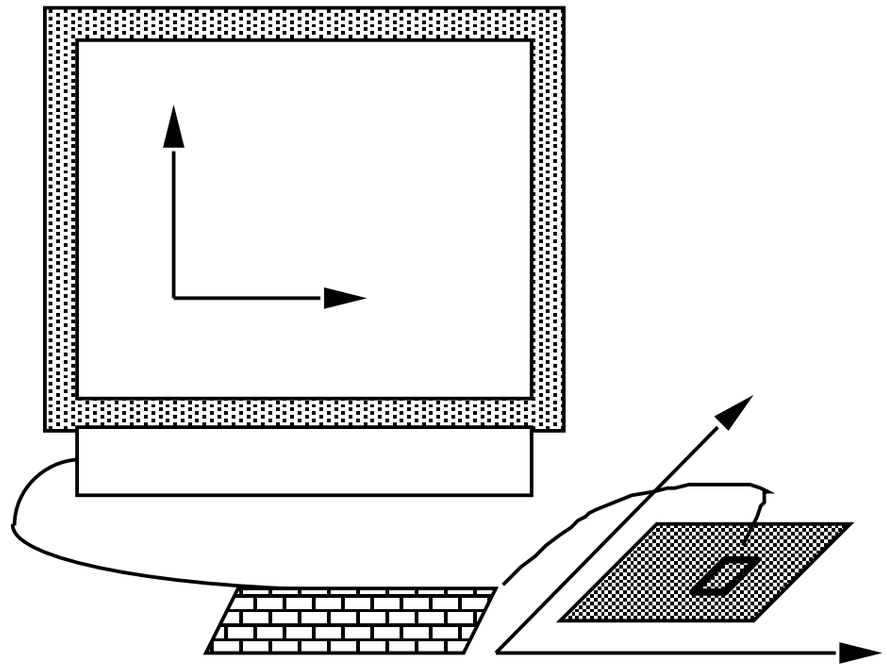


- **Mechanical**
  - Ball on underside of mouse turns as mouse is moved
  - Rotates orthogonal potentiometers
  - Can be used on almost any flat surface

- **Optical**
  - Light emitting diode on underside of mouse
  - May use special grid-like pad or just on desk
  - Less susceptible to dust and dirt
  - Detects fluctuations in reflected light intensity to calculate relative motion in (x, z) plane

The Mouse

Mouse located on desktop



- Requires physical space
- No arm fatigue

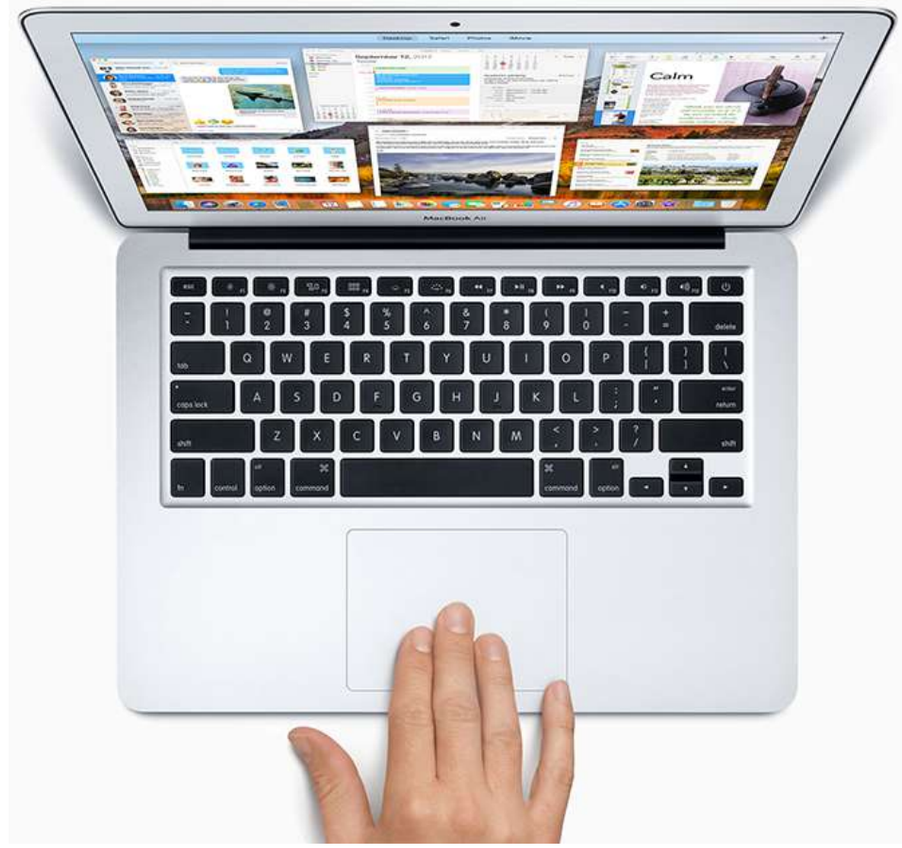
Screen cursor oriented in (x,y) plane,
mouse movement in (x,z) plane …

It is an ***indirect*** manipulation device.

- Device itself doesn't obscure screen, is accurate and fast.
- Hand-eye coordination problems for novice users

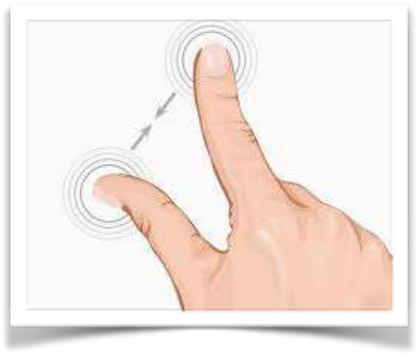
Touchpad

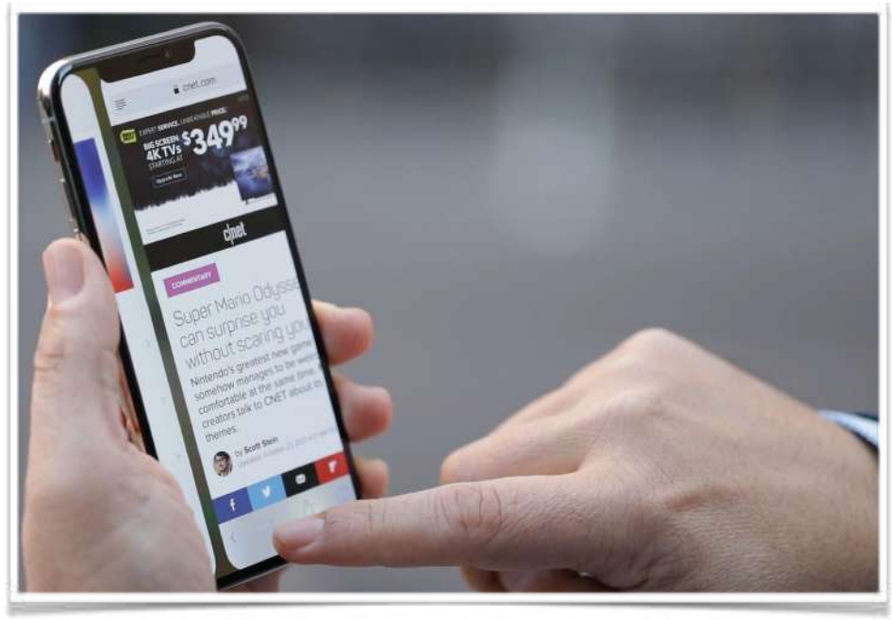
- Small touch sensitive tablets
- Stroke to move mouse pointer
- Used mainly in laptop computers
- Good “acceleration" settings are important
  - **Fast stroke**
    - lots of pixels per inch moved
    - initial movement to the target
  - **Slow stroke**
    - less pixels per inch
    - for accurate positioning
- The touch keyboard.



Direct Touch Interaction

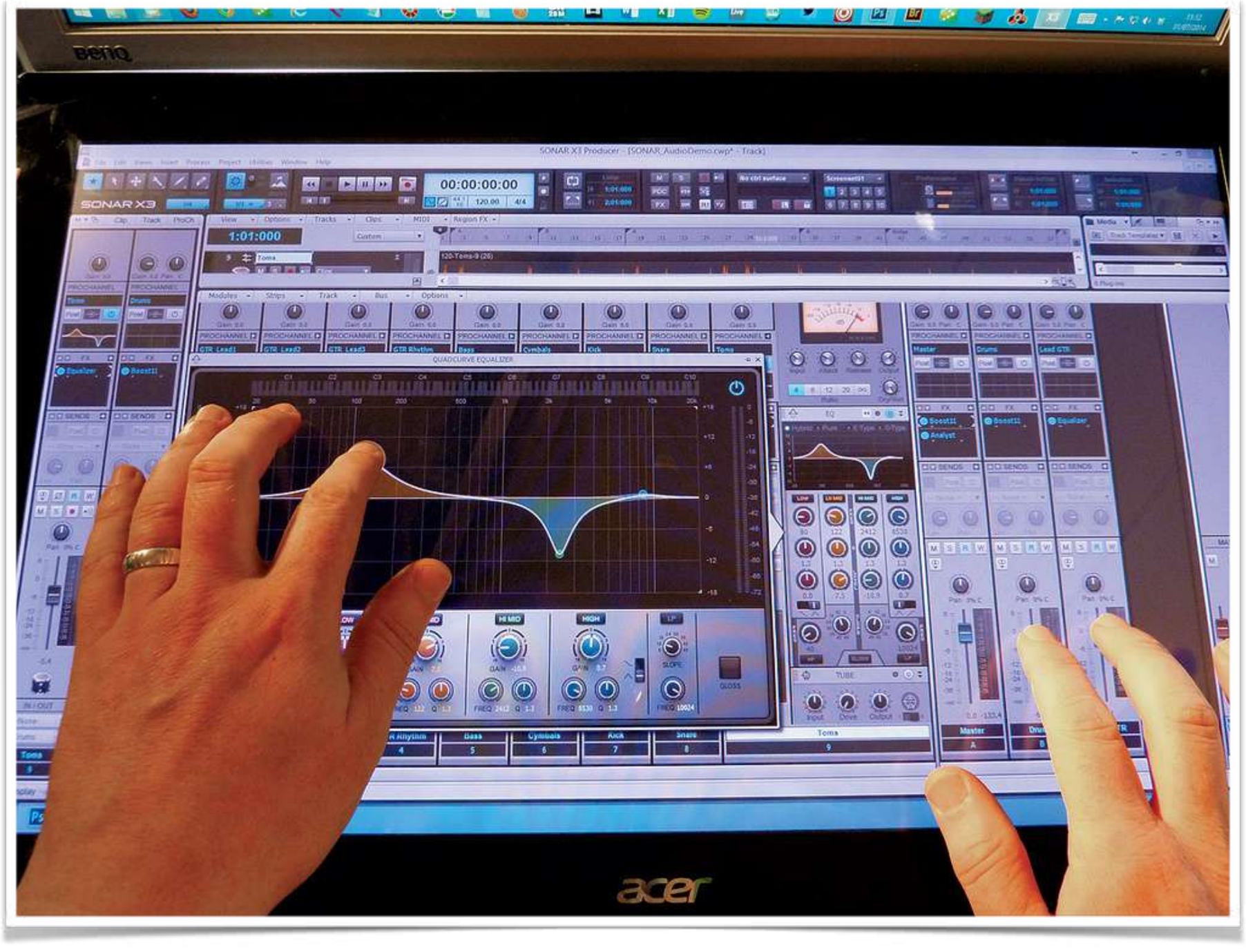
- Relatively new;
- Direct interaction;
- Multiple gestures;
- Input and output interleaved in the same space.
- Requires new interaction design: e.g. WIMP ==> PWIG





Direct Touch Interaction

Allows a complex and rich interaction



Direct Touch Interaction

Allows a complex and rich interaction

Touch-sensitive screen

- **Detect the presence of finger or stylus on the screen.**
  - works by interrupting matrix of light beams, capacitance changes or ultrasonic reflections
  - *direct* pointing device

- **Advantages:**
  - Fast, and requires no specialized pointer
  - Good for menu selection
  - Suitable for use in hostile environment: clean and safe from damage.

- **Disadvantages**:
  - Finger can mark screen
  - Imprecise (finger is a fairly blunt instrument!)
    - difficult to select small regions or perform accurate drawing
  - Lifting arm can be tiring

Multimodal Co-located Interaction

User exemplifies commands through gestures
System uses voice and image recognition