# Human Factors in HCI Design

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# Pervasive Computing: Technology-Centric View

Grid computing

Security / data protection

Intelligent agents

Python-GTK

Glade

Linux

Bayesian networks

Smart rooms

3G

Bluetooth

Wi-Fi

seamless handover

Speech recognition
*[speaker (in)dependent, isolated vs continuous speech, HMMs]*

iPAQs / handhelds

Haptic Interfaces
*[force-feedback mechanisms]*

Projection / OLED displays

Mixed-reality systems

SMA5508 / MIT6.893 Student

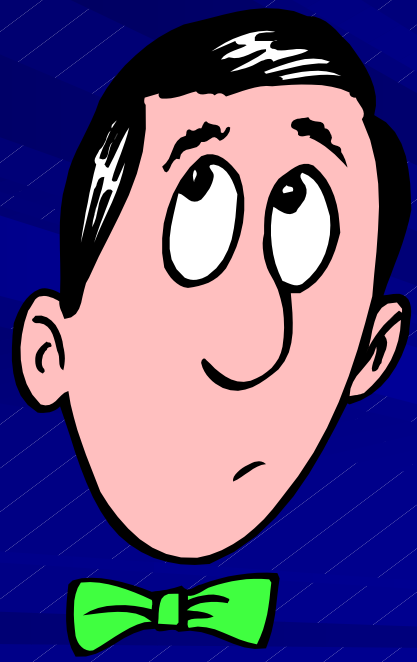
Computer vision
*[which really has nothing to do with user's visual system]*

# Pervasive Computing: Human-Centric View

Isn't that football game on now? I'd love to watch it

What's the fastest way home to get out of this traffic jam?

I'd really like to have a face-to-face conversation with Sarah in Europe, now



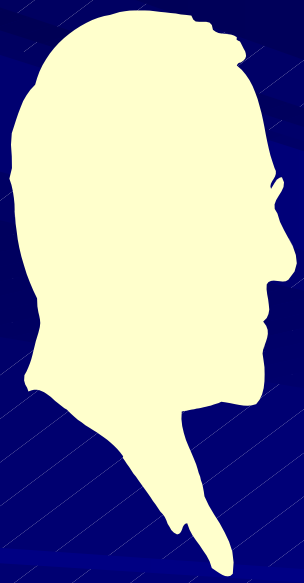
What are recent statistics of patients with the symptoms of Bob here?

When is my next appointment with John?

Heck, the pilot's down with food poisoning. How can I land this plane?!

Smith / Lim

# Human-Computer Interfacing



**Semantic Interface**

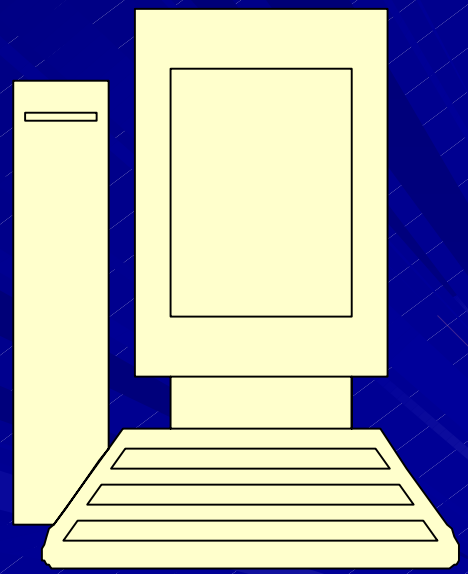
*dataflow, scientific visualization, financial accounting, remote communication*

**Syntactic Interface**

*shell commands + arguments, menus, icons, keyboard shortcuts, drag-n-drop, speech, gestures, handwriting*

**Physical Interface**

*keyboards, mice, display, stylus, device form factors, microphone*

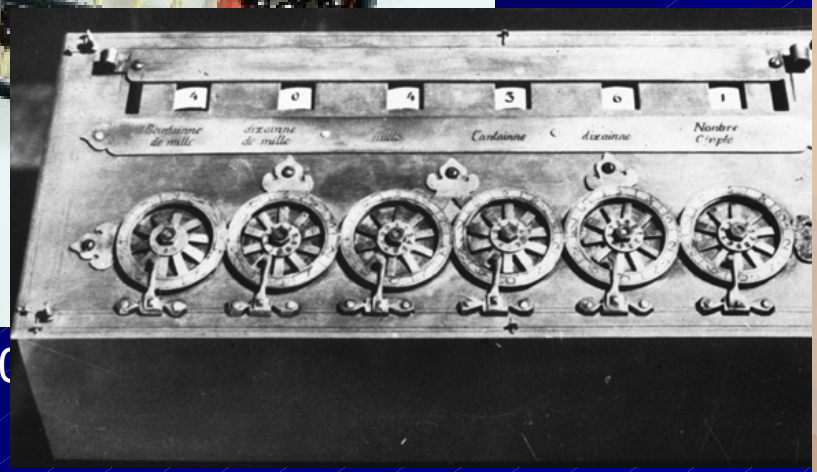


# History of Computers

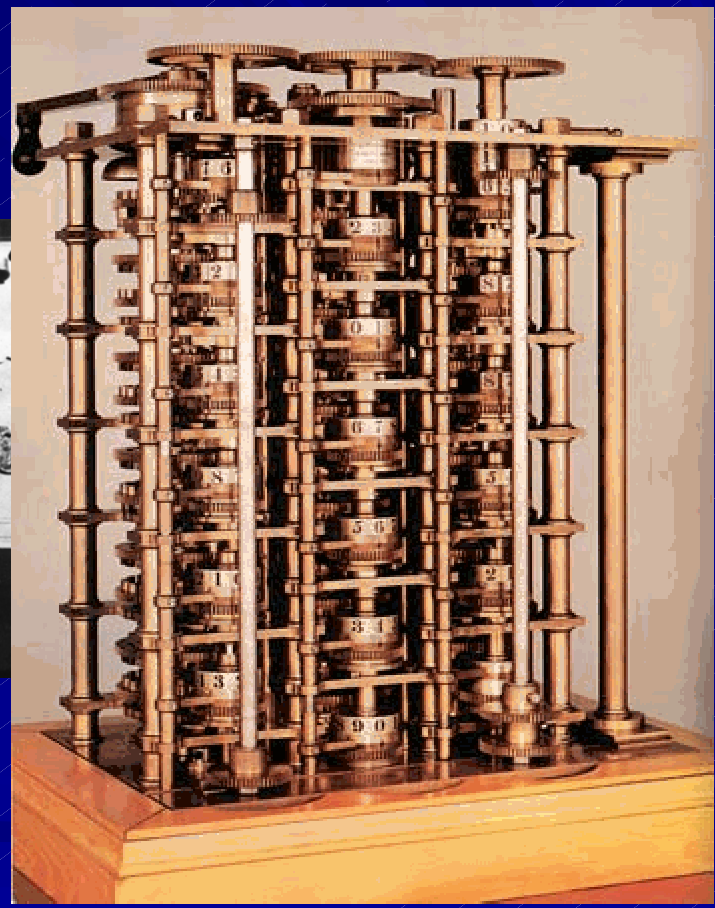
- *Not* the usual stuff
  - Number of transistors
  - Faster speeds
  - Smaller sizes
  - Power efficiency
- What about the user interfaces...

# History: Physical Interfacing 1

Abacus – 3(



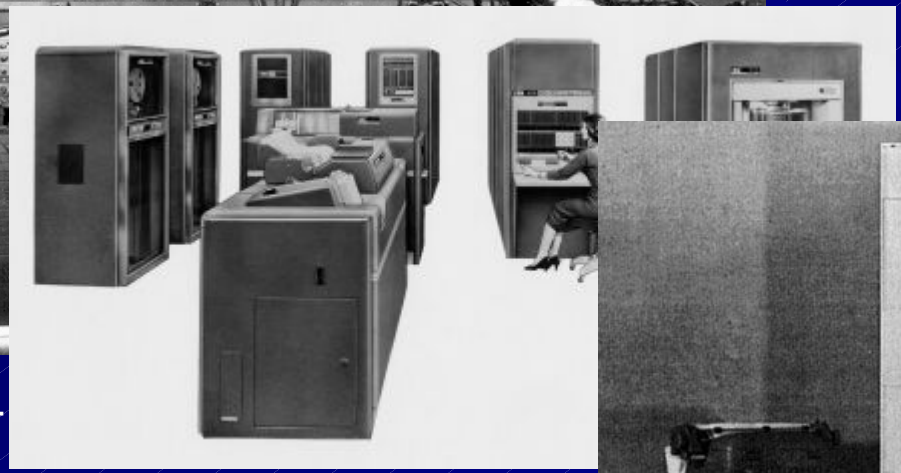

Pascalene – 1642



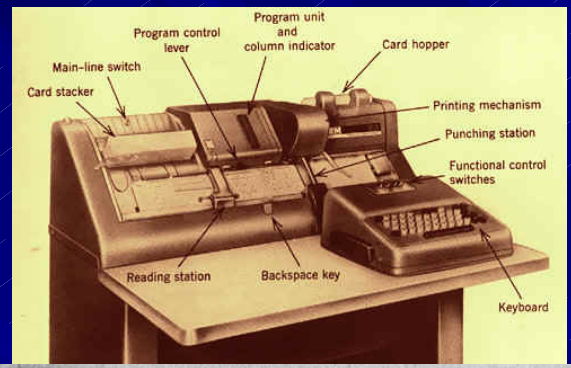
Babbage Difference Engine – 1832

# History: Physical Interfacing 2

ENIAC –



IBM 650 – 1953




DEC PDP-1 – 1960

# History: Physical Interfacing 3

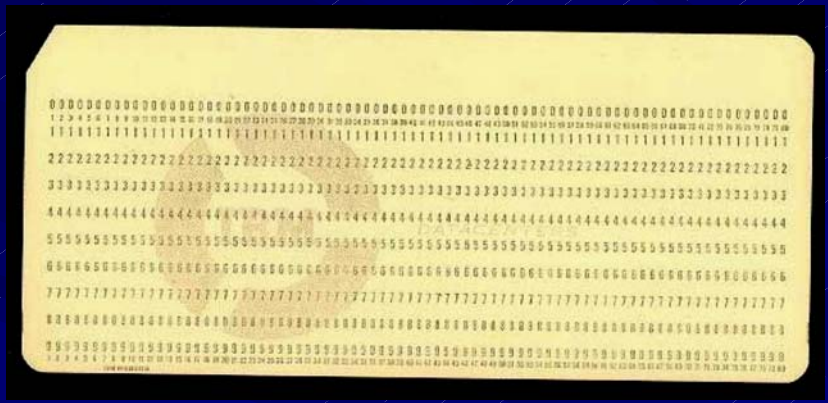
[21]

Engelbart's Workstatio

TRS-80 / Apple II– 197
IBM PC – 1981

Xerox Star -- 1979
Macintosh – 1985
New iMac – 2001

# History: Syntactic Interfacing 1

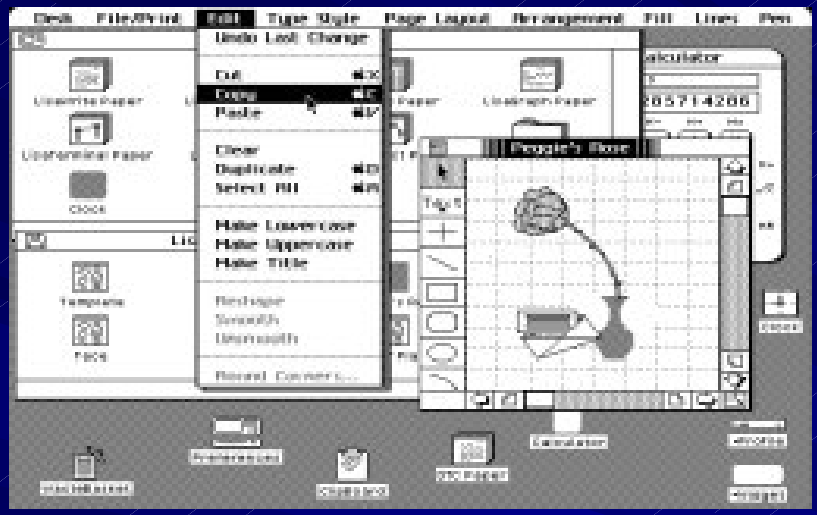


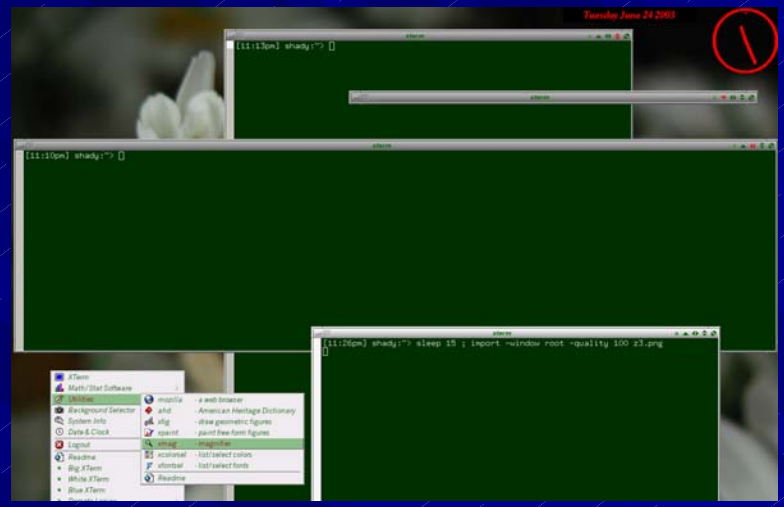
```
Microsoft DOS [Version 1.21]
(C) Copyright 1987 Microsoft Corp.
C:\>_
```

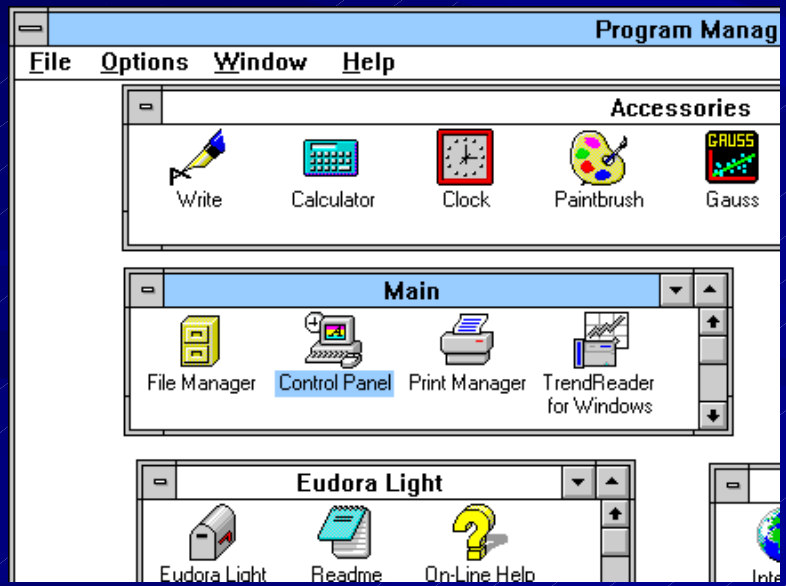
```
Command Prompt
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\astjcham>dir
 Volume in drive C is IBM_PRELOAD
 Volume Serial Number is 782A-6B36

 Directory of C:\Documents and Settings\astjcha

03/02/2004  01:33 PM    <DIR>          .
03/02/2004  01:33 PM    <DIR>          ..
03/02/2004  01:33 PM               444 .bash_h
10/02/2004  01:57 PM    <DIR>          Desktop
09/02/2004  05:06 PM    <DIR>          Favorite
16/01/2004  12:38 PM             8,867 gsview32
10/02/2004  01:02 PM    <DIR>          My Docu
07/01/2004  06:43 PM    <DIR>          Start Me
25/06/2003  11:17 PM    <DIR>          WINDOWS
               2 File(s)          9,311 bytes
               7 Dir(s)  13,503,647,744 bytes f

C:\Documents and Settings\astjcham>_
```

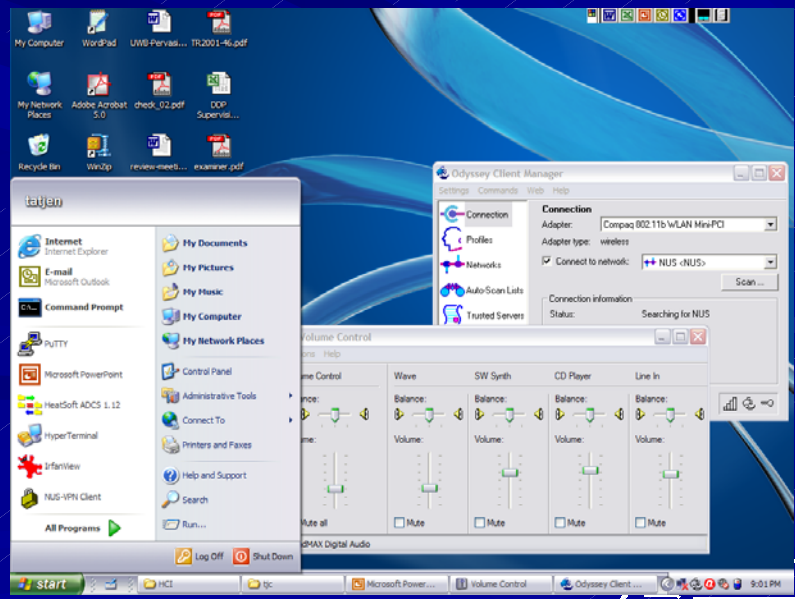
```
drwxr-xr-x   2 root     bin          512 Oct 10  2001 old
drwxr-xr-x   8 root     other        512 Oct 22  2002 openv
drwxr-xr-x   8 root     bin          512 Oct 10  2001 openwin
drwxr-xr-x   5 root     bin          512 Oct 10  2001 perl5
drwxr-xr-x  29 root     sys         1536 Aug  2  2003 platform
lrwxrwxrwx   1 root     root          15 Oct 10  2001 preserve -> ../var/prese
e
drwxr-xr-x   3 root     bin          512 Oct 10  2001 proc
lrwxrwxrwx   1 root     root          15 Oct 10  2001 pub -> ./share/lib/pub
drwxr-xr-x   9 root     bin          512 Oct 10  2001 sadm
drwxr-xr-x   6 root     bin         7168 Feb 15 01:49 sbin
drwxr-xr-x   6 root     bin          512 Jan 17  2003 sfw
drwxr-xr-x   7 root     sys          512 Jan 12  2003 share
drwxr-xr-x   6 root     bin          512 Oct 10  2001 snadm
lrwxrwxrwx   1 root     root          12 Oct 10  2001 spool -> ../var/spool
lrwxrwxrwx   1 root     root          11 Oct 10  2001 src -> ./share/src
drwxrwxr-x   7 root     sys          512 Nov  7  2001 srm
lrwxrwxrwx   1 root     root          10 Oct 10  2001 tmp -> ../var/tmp
drwxr-xr-x   4 root     bin         2048 Dec 25 15:26 ucb
drwxr-xr-x   4 root     bin          512 Oct 10  2001 ucbinclude
drwxr-xr-x   4 root     bin         1024 Aug  2  2003 ucblib
drwxr-xr-x   7 root     bin          512 Oct 10  2001 vmsys
drwxr-xr-x   5 root     bin          512 Oct 10  2001 xpg4
chamtj@sf3:/usr[378]$
```

# History: Syntactic Interfacing 2



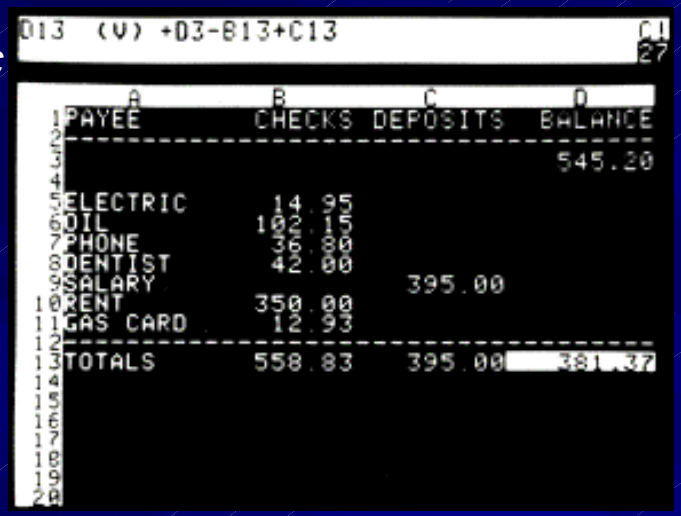




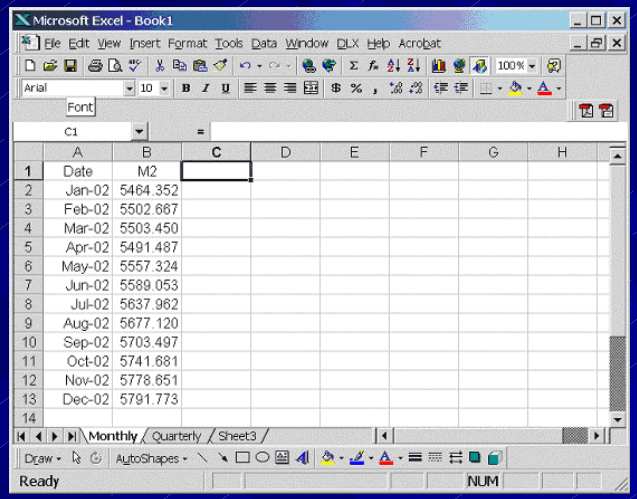



# History: Semantic Interfacing

*VisiCalc*

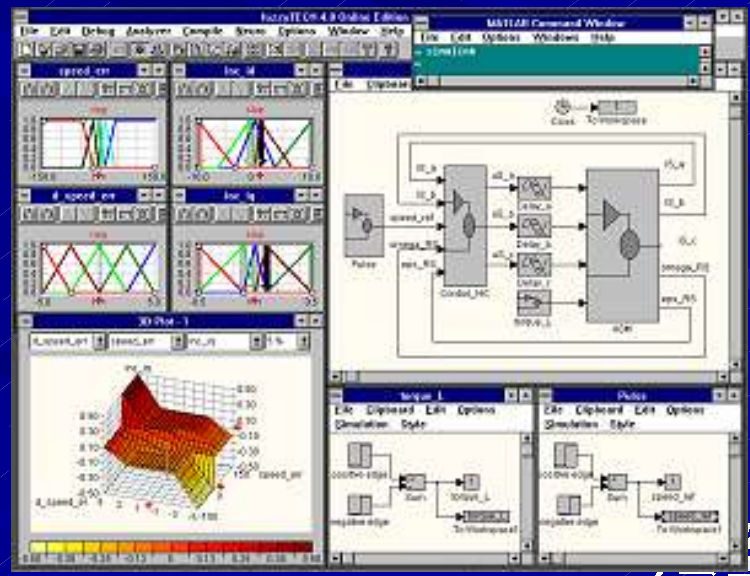



*MS Excel*

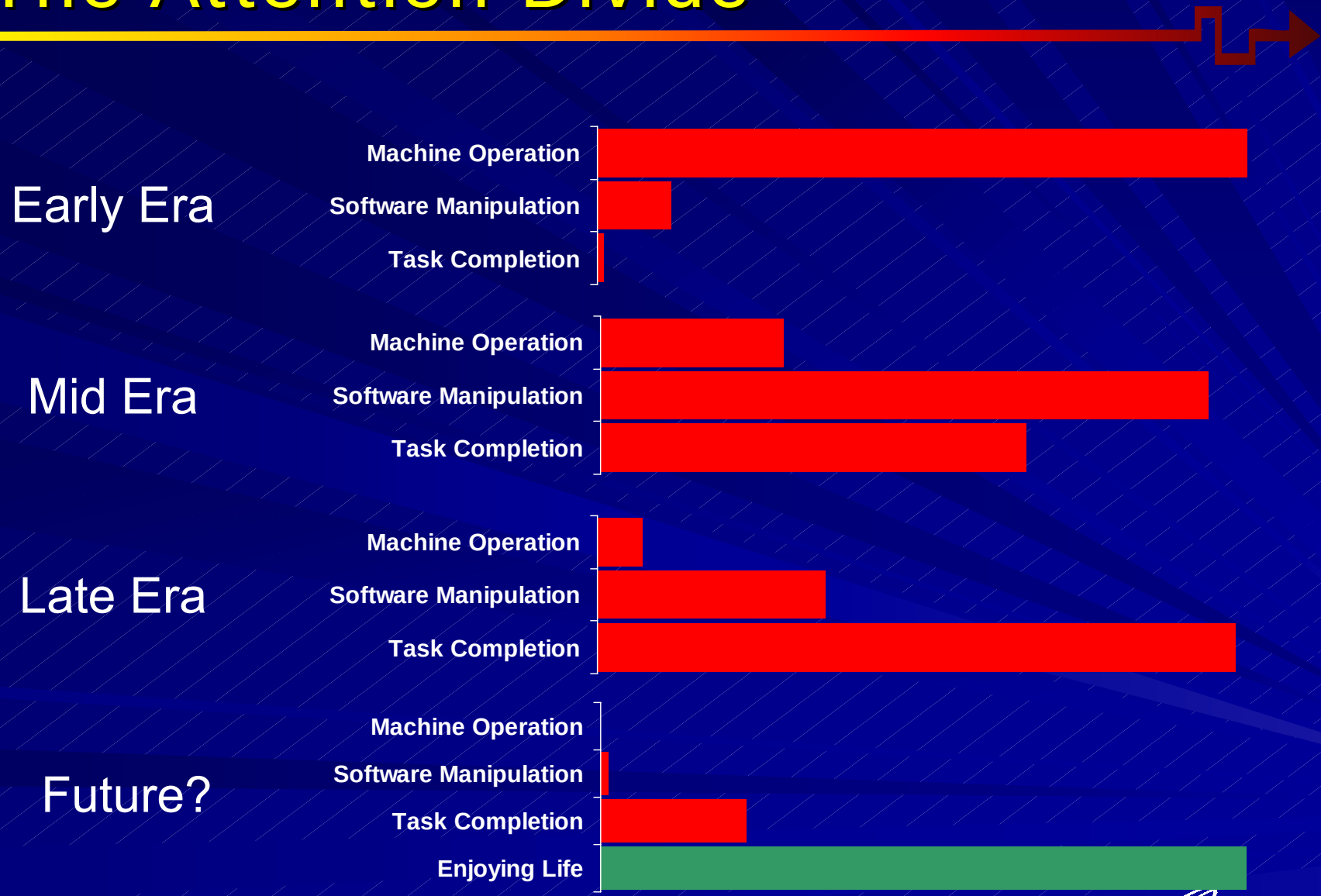



*Quicken*


*Matlab*

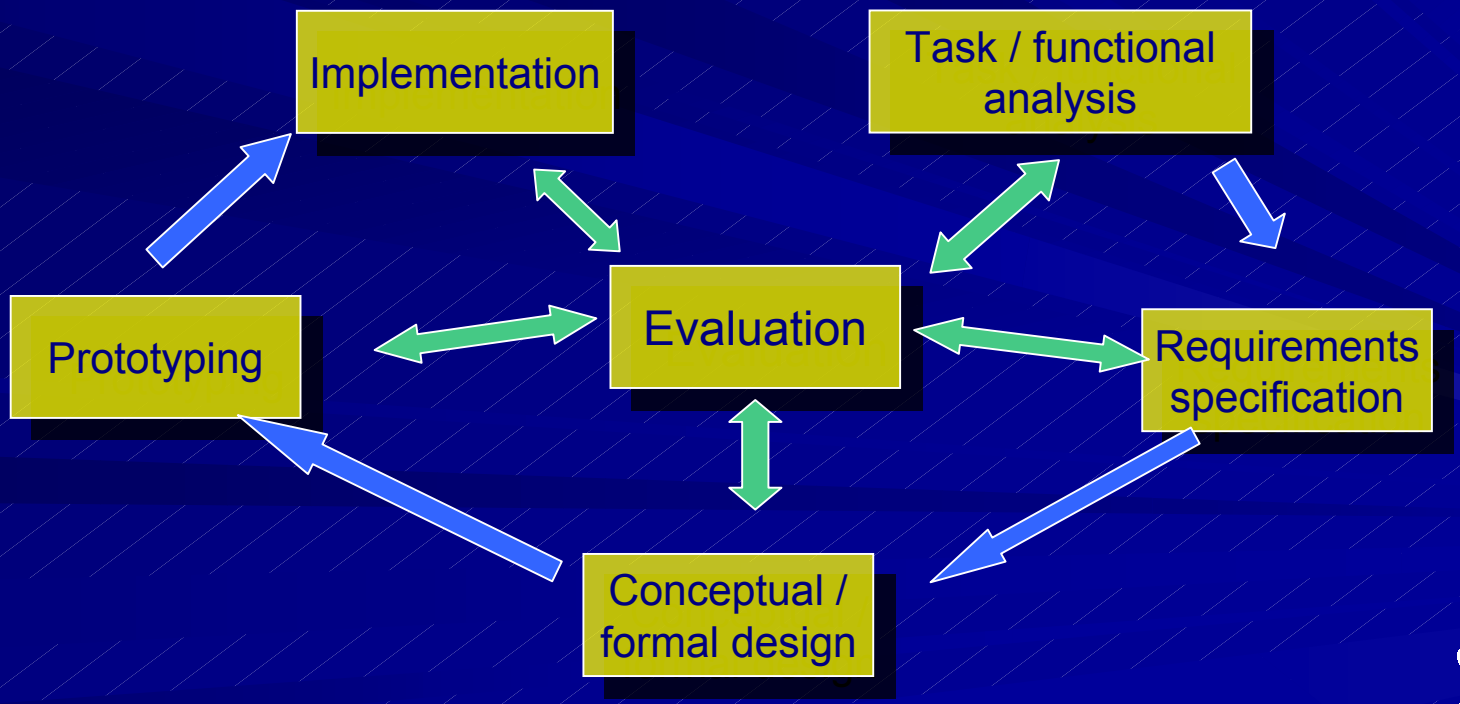


# The Attention Divide



# HCI Design – Involving the User

- Difficult to define HCI requirements specifications before-hand
  - Even harder in the pervasive computing era
- Iterative rather than open-loop development process
  - e.g. Star Model (Hartson & Hix, 1989) c.f. Waterfall Model

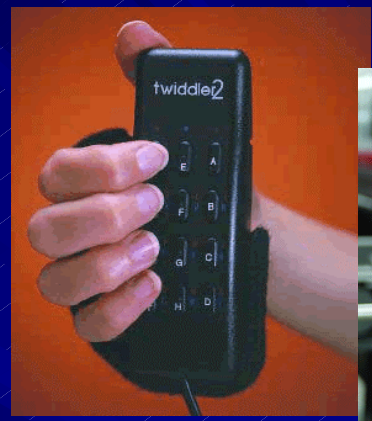


# HCI Design Guidelines

- Reflexive (Motor-Sensory)
  - Minimize brain cycles needed to use the interface (“muscle memory”)
- Cognitive
  - Allows users to harness intuitive, problem-solving skills
- Social / Organizational
  - Meet requirements for multi-person interaction

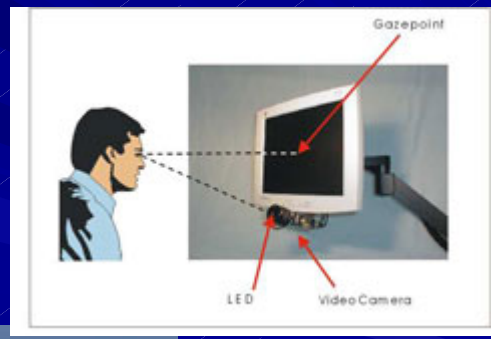
# Reflexive Considerations

- Intuition versus learning
  - simplicity versus completeness / efficiency?
- Accuracy-speed tradeoff
  - ROC curve
- User feedback
  - visual, aural, tactile
- Motor-sensory channel separation
  - e.g. is gaze cursor control a good interface?
- Ergonomics
  - Minimize physical strain on users




*Twiddler*

*HP Tablet PC*



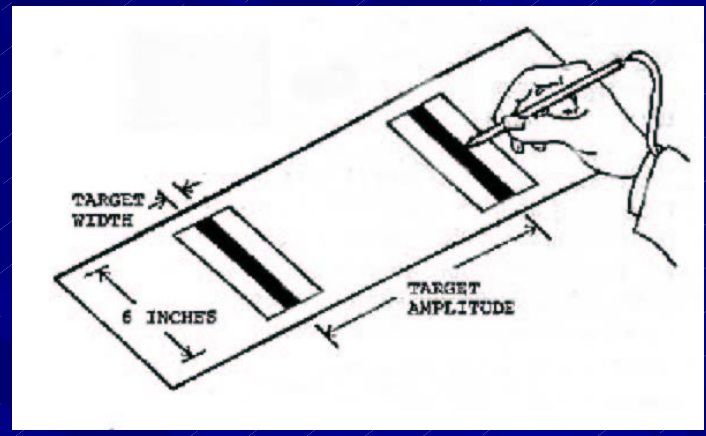

*www.eyegaze.com*

*www.5dt.com*

# Reflexive Performance Studies: Evaluation and Modeling

- Evaluations are typically based on timing experiments

*Images from Buxton 2003*

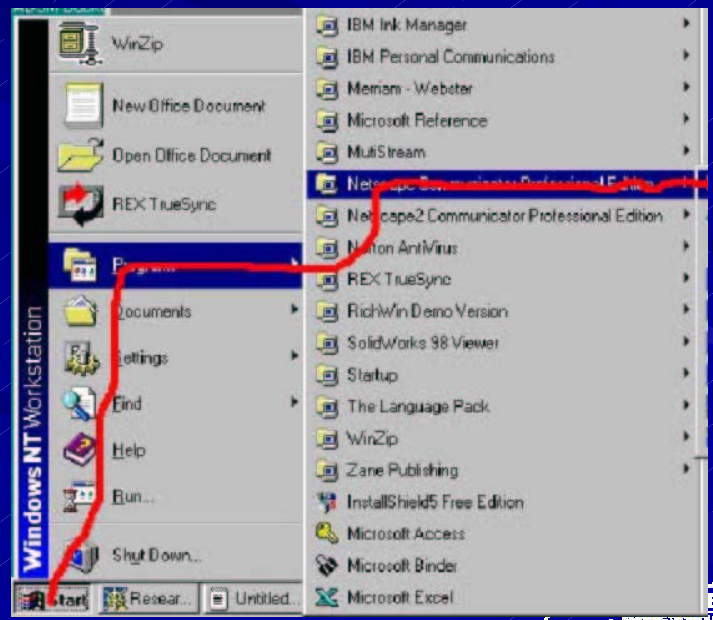



- Keystroke-Level Model
  - Card, Moran & Newell 1980
  - Task time = Σ (unit tasks time)
  - Unit tasks: Keystroking, Pointing, Homing, Drawing, Mental, Response

- Modified Fitts' Law
  - Applicable to pointing tasks

$$\frac{\text{movement}}{\text{time}} = a + b \log_2 \left( \frac{\text{distance}}{\text{target width}} + 1 \right)$$

- Steering Law (*Accot & Zhai 1997*)
  - Navigation of menus

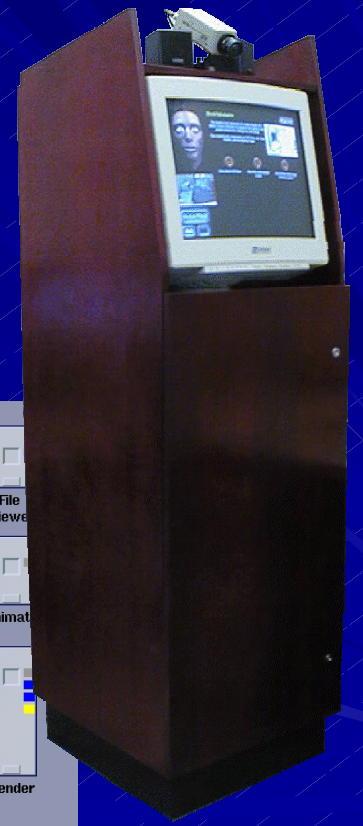


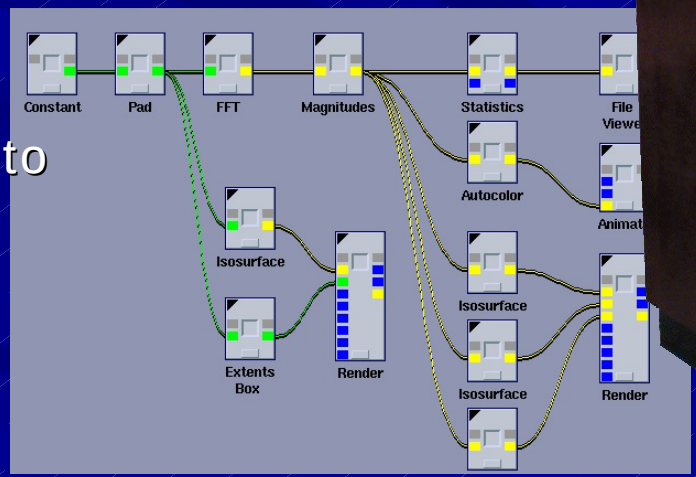
# Cognitive Considerations

- Metaphors
  - Info visualization
  - Visual programming
  - Anthropomorphism
- Cognitive load
  - Fatigue, stress of task
  - automation vs user choice
- Focus of attention
  - multi-tasking
    - how easy is it to return to a suspended task?
- User Modeling
  - Interfaces tailored to individuals

*MSR data mountain*

*HP CRL – Smart Kiosk*



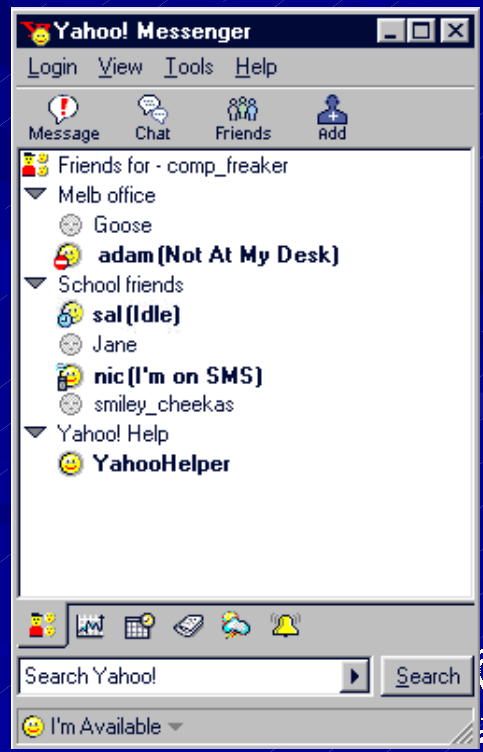



*Khoros – Cantata*

# Social and Organizational Considerations

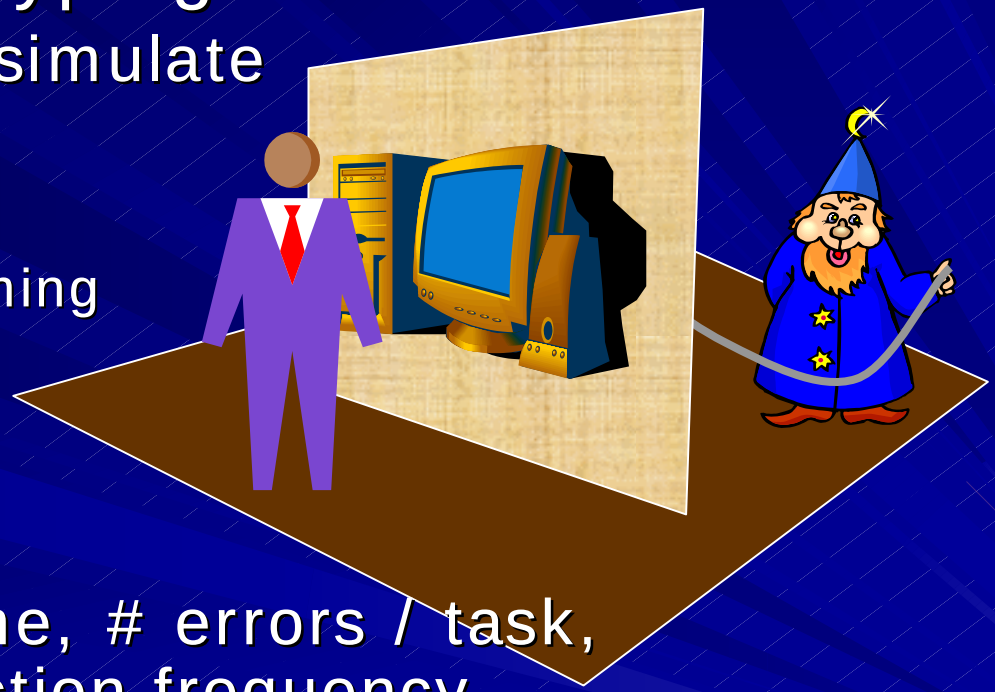
- Synchronized experience
  - Massive multiplayer games
  - ‘instant’ messaging, but typing latency?
- Organizational order
  - Online roles and process flow
  - e.g. teaching groupware have online roles for instructors, TAs and students
- Social norms
  - privacy
    - instant messaging – should online state be revealed?
    - what should default umasks be?
  - etiquette
    - taking turns during tele-collaboration
    - smileys – better or worse?

*America’s Army*



# Prototyping and Evaluation

- *Wizard of Oz* Prototyping
  - Human `wizard' to simulate machine interaction
  - Faster prototyping
    - eliminates programming overhead



- Usability Studies
  - Task completion time, # errors / task, learning curve, function frequency distribution
  - User satisfaction and feedback
  - Physiological measurements?

# Future Challenges

- As computers and computing become pervasive...
  - what are the best interfaces?
  - how do we effectively move beyond keyboards, mice, screens, WIMP? Should we?

- Interfaces that
  - combine cool technology, *and*
  - satisfy human-centric demands

# References


- Bill Buxton, *Less is More (More or Less)*, 2001
  - http://www.billbuxton.com/LessIsMore.html
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- Marc Rettig, *Interaction Design History in a Teeny Little Nutshell*, 2003
  - http://www.marcrettig.com/writings/rettig.interactionDesignHistory.2.03.pdf
- *CHI* – ACM SIGCHI Conference on Human Factors in Computing Systems