What is HCI?

Elements of HCI

<u>Cognitive</u> Elements

<u>I/O</u> <u>Devices</u>

Interaction
Styles

Screen Design

**Disabilities** 

Special applications

Design & Evaluation

References

# **Human-Computer Interaction**

## **Course Notes**

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# What is HCI and why should we learn about it?

- 1. A few incidents....
- 2. Consequences of bad user interfaces •
- 3. How can user interface designers determine whether a user interface will cause problems for users? •
- 4. What is HCI?



# A few incidents involving badly designed user interfaces

- A professor loses half an hour
- A professor and three staff lose two hours
- Errors are made in presidential elections
- An airliner gets shot down
- A nuclear power plant gets out of control



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#### PI Tipsheet

Instructions to Prepare and Submit a Standard Proposal

How to Prepare a SBIR/STIR Phase II Proposal

SBIR/STTR Phase
II Proposal Parts
Checklist

Frequently Asked Questions

About Proposal Preparation

<u>Help</u>

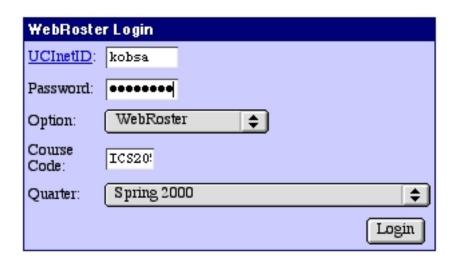
#### Proposal Preparation

Applicants preparing proposals for the International Opportunities for Scientists and Engineers Program Announcement (NSF 96-14) should use the 'Proposal Preparation (New)' system. The 'Proposal Preparation (New)' system contains the International Programs Cover Page Addendum

Login for PI or Co-PI		Login for Other Authorized Users	
Last Name:		If you are not PI or Co-PI, please enter the following in addition to Last Name Social Security# and PIN.	
Social Security#: Privacy Act	(9 digits)	Proposal ID:	(7 digits)
PIN:	(4 digits)	Proposal PIN:	(4 digits)
		Login	

If you do not know what your new PIN is or have other questions related to FastLane User Management contact your Sponsored. Research Office or equivalent.

# How can this problem be prevented?



#### Sorry..

You were able to login successfully, but you do not have permission to access the course roster for the course (ICS205) for the Spring 2000 quarter.





# Consequences of bad user interfaces

Bad interfaces may cause users to

- need more time for performing their tasks
- make more errors
- feel dissatisfied
- need more time for learning how to use the software
- not learn/use the full functionality of the software
- (if given a choice:) refrain from using the software

Good interface design therefore is important for any kind of interactive software, and of *utmost* importance in

- systems with high costs of failure (e.g., nuclear power plants, space mission control)
- systems with high demands on operators (e.g., rescue coordination centers, combat aircraft, call centers)

# How can user interface designers determine whether a user interface (element) will cause problems for users?

## 1. Analyze the interface using "common sense" (?)

- Intuitions can reveal some obvious omissions, confusing and inefficient interaction.
- Many flaws however are not "intuitively" recognizable, even with experience in user interface design.
- 2. Develop a theory of "human cognitive processing", and use it to predict problems that users will have with the interface
  - Was only successfull in limited areas so far.
- 3. Test the interface with users, and watch whether problems can be observed or are reported by users

- Tests with 5-8 users already reveal major problems
- Generalize the findings from (3) and develop guidelines of what should not be done
  - + "Usability Engineering"
- How can user interface designers determine whether a user interface (element) will *not* cause problems for users?

## What is Aim of Human-Computer Interaction?

### **Narrow definition:**

The field of Human-Computer Interaction investigates how (single) users can best interact with computers. Particular emphasis is put on

- software aspects (as opposed to the input and output devices and the physical workplace), and
- specifically on the layout and operation of the interface ("User Interface Design", "Interface Engineering").

## **Broad definition:**

The field of Human-Computer Interaction studies "the people side" in the interaction with computers, including

- users´ mental processes when interacting with computers
- work practices
- training issues

- management of computerized work processes
- collaboration in computerized workgroups
- social/organizational aspects
- health issues

+ This course focusses on user interface design issues, due to their importance and the availability of other ICS courses that focus on other aspects of HCI.

# **Elements of HCI**

- 1. What are user interfaces? •
- 2. Users are different, usage environments are different •
- 3. Factors in HCI •
- 4. Levels of analysis •
- 5. Measurable human factors •
- 6. Disciplines contributing to HCI •
- 7. Integration of usability testing into the software development process •





# What are user interfaces?

- 1. User interfaces help users interact with programs.
- 2. Users employ programs for performing their tasks.
- + User interfaces help users interact with their tasks.

A user interface should not reflect the structure of the underlying program, but the structure of the task domain and/or the task solution process. Users should not interact with the computer, but with their tasks.

## **Users are different**

- . Tasks
- Cognitive and perceptual abilities
- Personality differences
- Cultural differences
- Disabilities
- Age

# Usage environments are different

- Physical work environments
- Hardware platforms

# **Factors in HCI**

#### ORGANIZATIONAL FACTORS

training, job design, politics, roles, work organization

#### ENVIRONMENTAL FACTORS

noise, heating, lighting, ventilation

#### HEALTH AND SAFETY FACTORS

stress, headaches, musculo-skeletal disorders cognitive processes and capabilities

#### THE USER

motivation, enjoyment, satisfaction, personality, experience level COMFORT FACTORS

seating, equipment layout

#### USER INTERFACE

input devices, output displays, dialogue structures, use of colour, icons, commands, graphics, natural language, 3-D, user support materials, multi-media

#### TASK FACTORS

easy, complex, novel, task allocation, repetitive, monitoring, skills, components

#### CONSTRAINTS

costs, timescales, budgets, staff, equipment, building structure

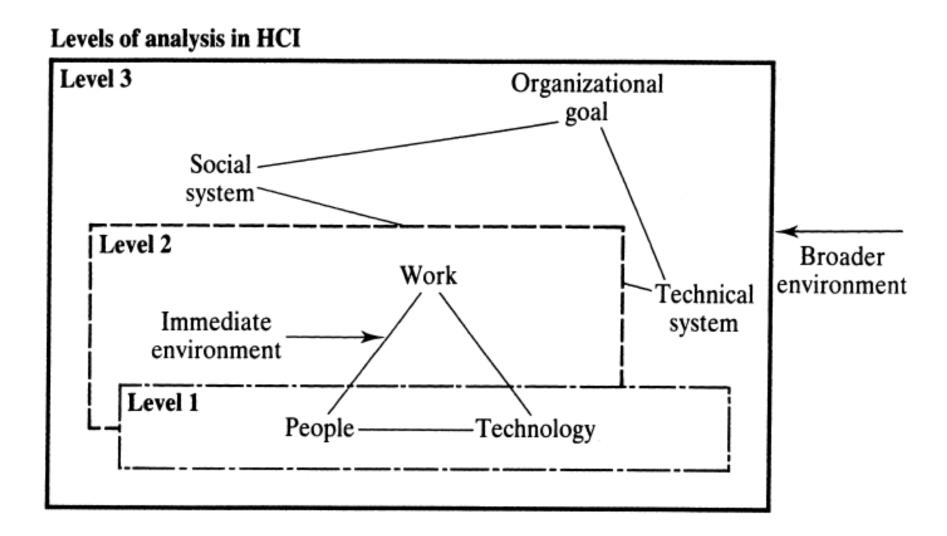
#### SYSTEM FUNCTIONALITY

hardware, software, application

#### PRODUCTIVITY FACTORS

increase output, increase quality, decrease costs, decrease errors, decrease labour requirements, decrease production time, increase creative and innovative ideas leading to new products

# Levels of Analysis in HCI



**Figure 2.4** A model of HCI (adapted from Eason, 1991).

# Central measurable human factors for user interface evaluation

### Speed of performance

How long does it take to carry out some tasks?

#### . Error/success rate

How many and what kind of errors do people make in carrying out the these tasks? How many tasks were successfully completed?

#### . Time to learn

How long does it take for users to learn what actions are required to perform their tasks?

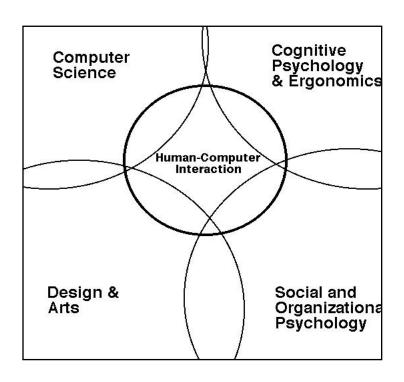
### . Retention over time

How well do users maintain their knowledge and skills over given periods of time?

### . Subjective satisfaction

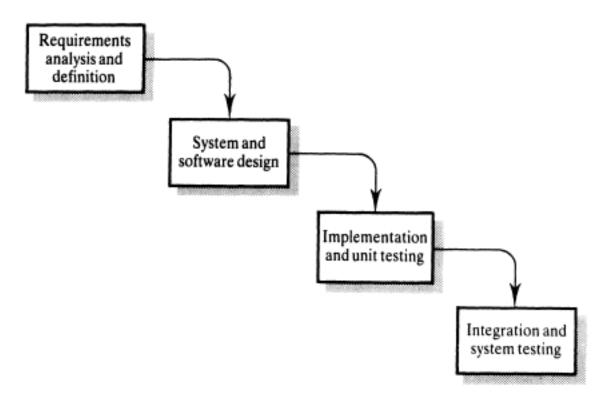
How much did users like using verious aspects of the system?

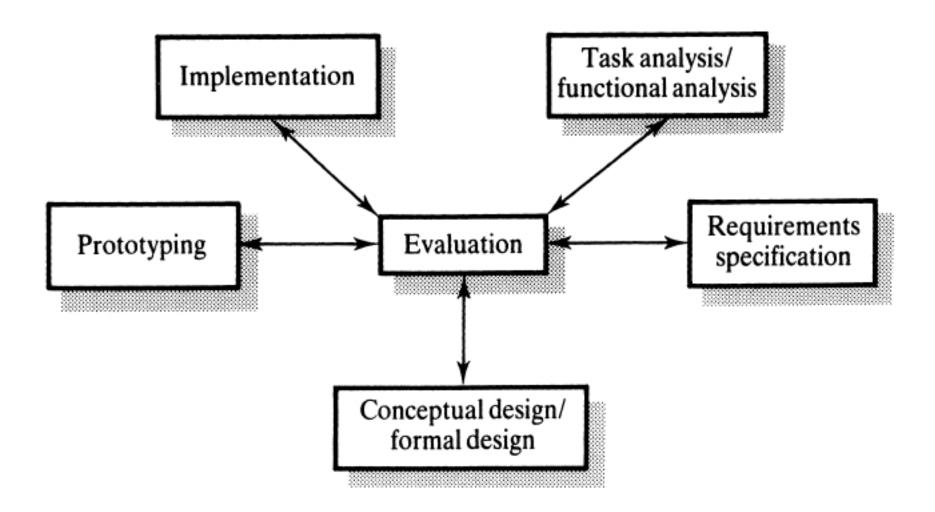
# Disciplines contributing to HCI



## Other contributing disciplines:

- Artificial intelligence
- Linguistics
- Ethnology





The star life cycle (adapted from Hix and Hartson, 1993).

# Cognitive Elements of HCI

- 1. Attentive vs. pre-attentive processing ••
- 2. Gestalt laws • •
- 3. Graphical coding •
- 4. Recognition versus recall
- 5. Mental models •
- 6. Metaphors •
- 7. Affordances •
- 8. Fitts' law (see menu interaction)
- 9. Color vision (see color)

# **Preattentive Visual Properties (Healey 97)**

- Length
- Width
- Size
- Curvature
- Number
- Terminators
- Intersection
- Closure
- Colour
- Intensity
- Flicker
- Direction of motion
- Binocular lustre
- Stereoscopic depth
- 3-D depth cues

Lighting direction

## **Gestalt Laws**

Gestalt laws describe regularities of human perception (but do not explain them!)

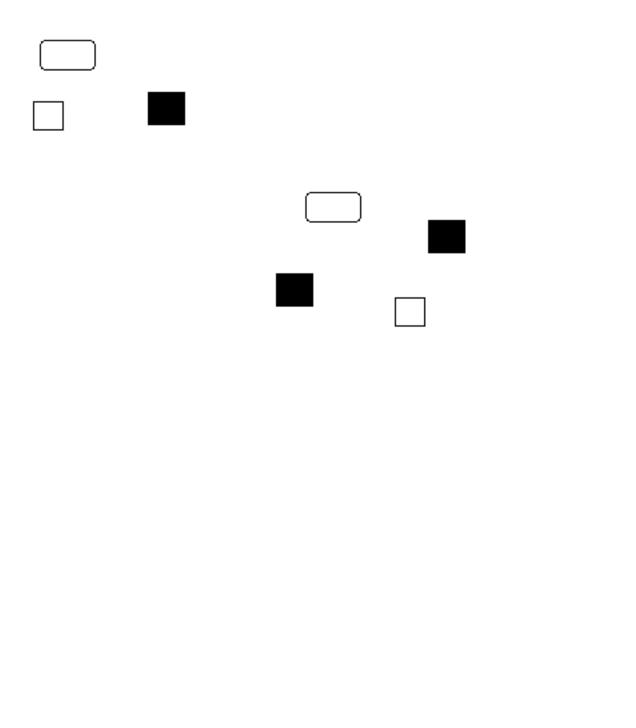
Proximity: objects that are close to each other tend to be seen as a group •

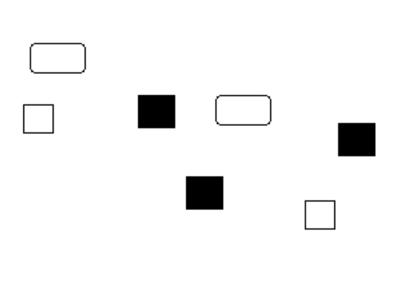
**Similarity**: objects of the same shape or color are seen as belonging together •

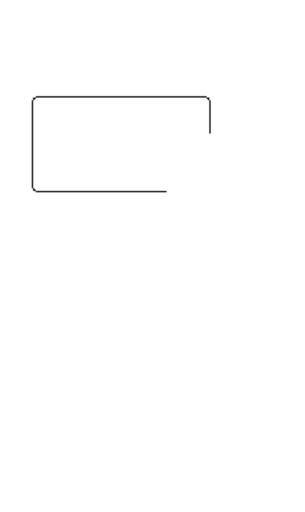
Closure: Missing parts of an object are filled in to complete it, so that it appears as a whole. •

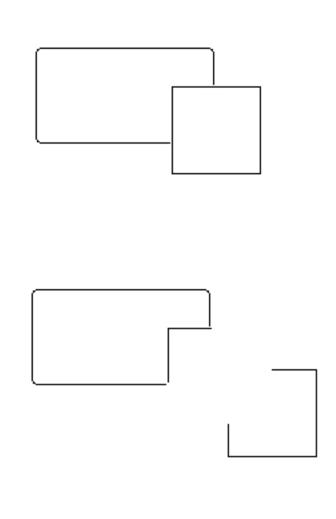
Continuity: lines tend to be seen as continuous, even if they are interrupted ◆ ◆ ◆

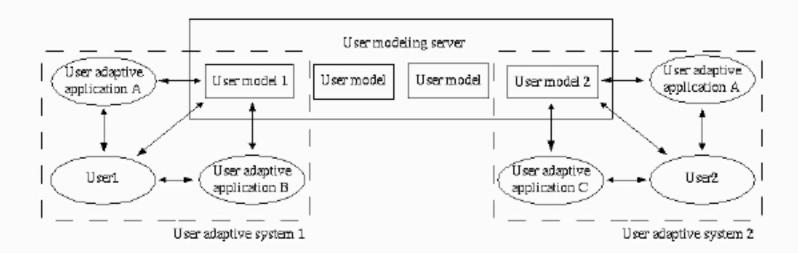
**Symmetry**: regions bounded by symmetrical borders tend to be perceived as coherent figures •

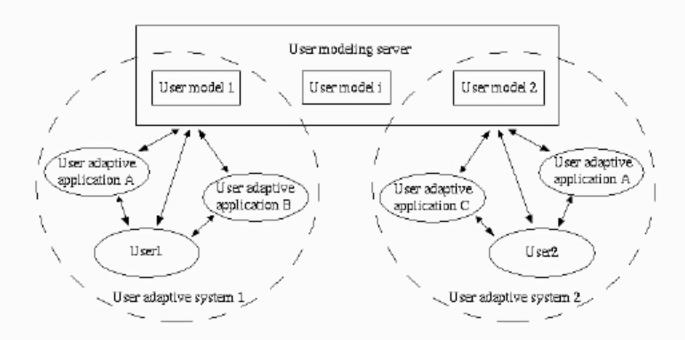


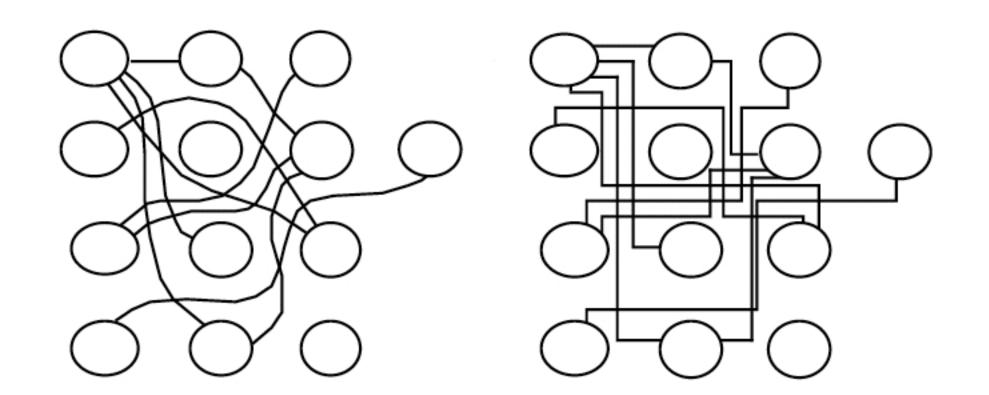


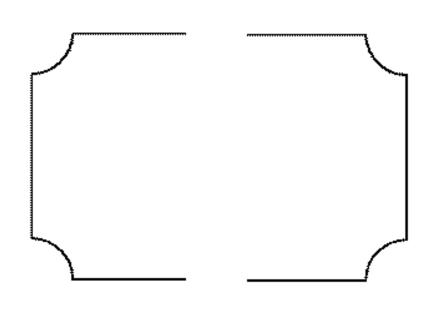


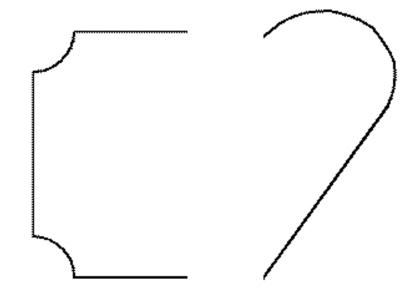


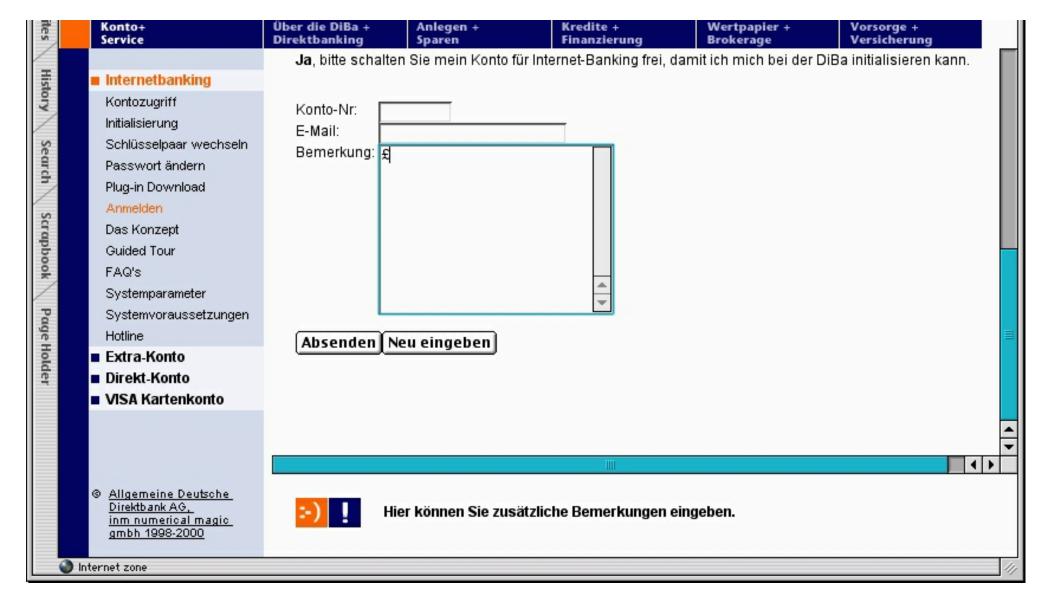












# Example for the Application of Gestalt Laws

Please answer the following questions based solely on Gestalt laws, the upper-case words in the leftmost box and the proper names in the picture.

- 1. How many ballots are there?
- 2. Can George Bush and Art Olivier together be elected for president and vice president?
- 3. Name all people who can be elected for president and vice president.

## Comparison of coding methods (Maguire, 1987)

Coding method	Maximum number of codes	Comments
Alphanumerics	Unlimited	Highly versatile. Meaning can be self-evident. Location time may be longer than for graphic code.
Shapes	10-20	Very effective if code matches object or operation represented
Color	4-11	Attractive and efficient. Excessive use confusing. Limited value for the color-blind.
Line angle	8-11	Good in special cases, for example, wind direction.
Line length	3-4	Good. Can clutter display if many codes displayed.
Line width	2-3	Good
Line style	5-9	Good
Object size	3-5	Fair. Can take up considerable space. Location time longer than for shape and color
Brightness	2-4	Can be fatiguing, especially if screen contrast is poor
Blink	2-4	Good for getting attention but should be suppressible afterwards.  Annoying if overused. Limit to small fields.
Reverse video	No data	Effective for making data stand out. If large area is in reverse video, flicker is more easily perceived.
Underlining	No data	Useful but can reduce text legibility.
Combination of codes	Unlimited	Can reinforce coding but complex combinations can be confusing

#### Mental models

Mental models are representations of the function and/or structure of objects in peoples' minds.

- may be incorrect or incomplete
- can be "executed"
- are analogical representations, or a combination of analogical and propositional representations
- are dynamically constructed when required

#### Two main types:

- Functional models (good for everyday use)
- Structural models (good for breakdown situations; difficult to acquire from usage experience only)
- \* Computer systems should be designed in such a way that users can quickly acquire a good functional model of the system which is in accordance with their task model.

# Important interaction metaphors

Interface metaphors evoke an *initial* mental model in users of the system's structure and operation. Metaphors should relate to users' past experiences and should be consistent.

- (Typewriter metaphor): Evoked easily due to physical similarities. Should be avoided
- Desktop metaphor: Currently the predominant metaphor.
- Book metaphor: For <u>hypertext</u>, hypertext-like online documentation.
- Filing cabinets: For online documentation, <u>subdivisions</u> in web offerings, <u>system settings</u>.
- . Office metaphor: For collections of documents
- Library metaphor: For large collections of documents
- Building metaphors, city metaphors, etc.: for virtual worlds
- Animated agent metaphor: for guidance and recommendation

#### . Composite metaphors

Combine 2 or more metaphors (like office, file cabinet and desktop)

The learning and retention of a system's functionality is considerably facilitated by meaningful and consistent metaphors.

## ICS 205

Winter 2001



home flights hotels cars

cruises deals

maps



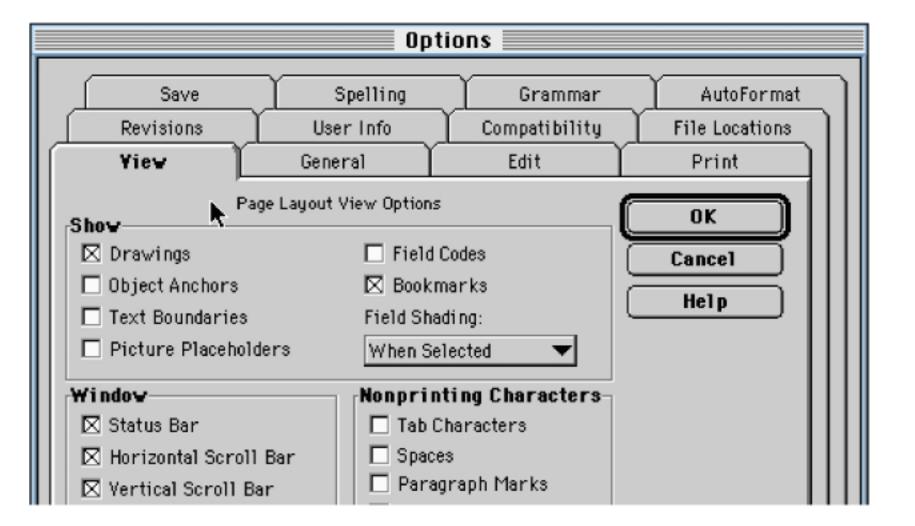


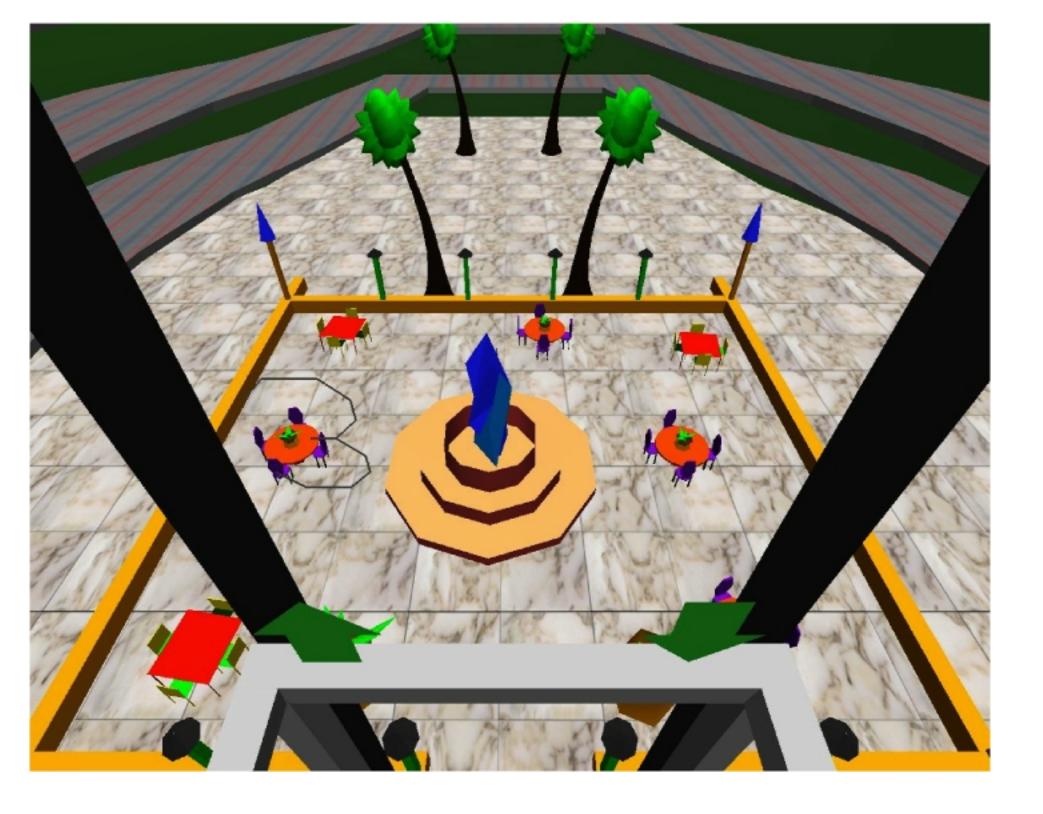












# City metaphor





To use the calculator:

- Enter your zip code
- Click on one of the three tabs (Home/Mobile Home Owner, Tenant, Condominium Owner).
- 3. If prompted, input any additional information

NOTE: Do Not Press Enter after you input the zip code; it will reset the Calculator.

Carefully review the available earthquake coverages before you complete the premium calculation.

Home / Mobile Home Owner Tenant Condominium Owner

Zip Code:

## Affordances

"term that refers to the properties of objects -- what sorts of operations and manipulations can be done to a particular object" (D. A. Norman 1988, The Psychology of everyday things).

- A door affords opening
- A chair affords support

"perceived affordance": the extent to which objects suggest their affordance.

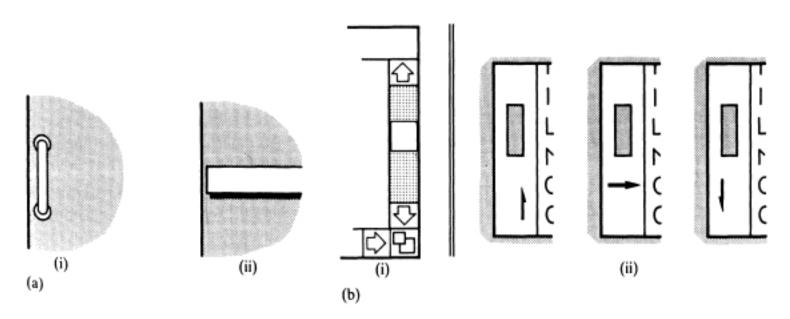


Figure 4.5 The affordance of objects (Gaver, 1991). (a) Door handles; (b) scroll bars (© 1991, Association for Computing Machinery, Inc. reprinted by permission).

## **Input and Output Devices**

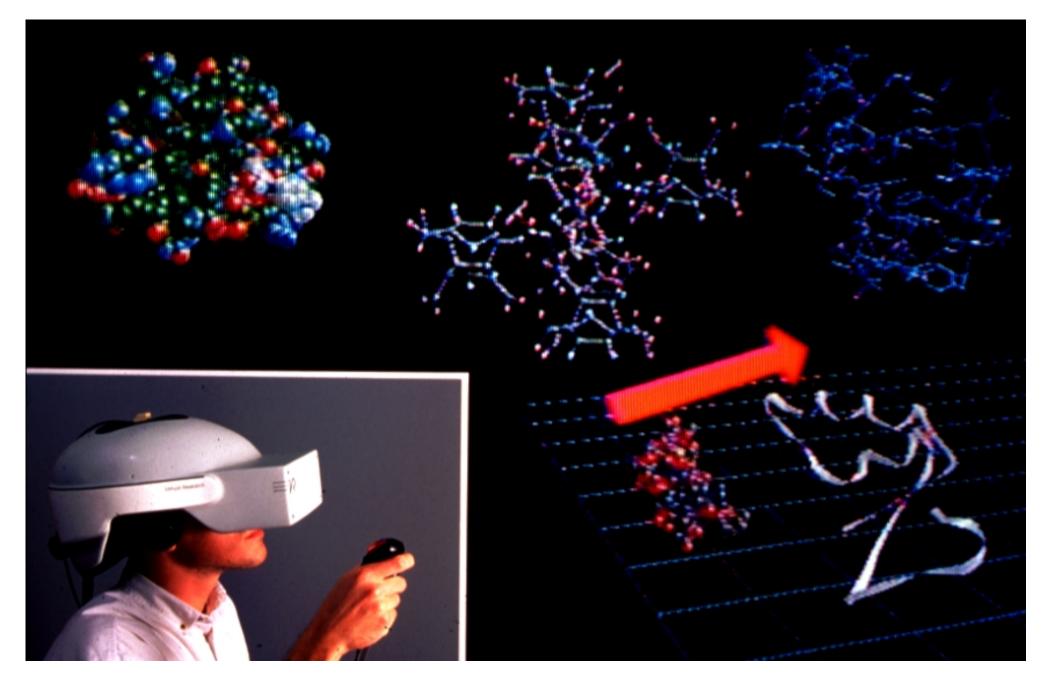
- 1. Output devices •
- 2. Input devices •
- 3. Requirements for input and output devices •

#### Output devices

- Desk-bound displays (CRT, LCD, Plasma)
- Portable displays
- Displays in helmets

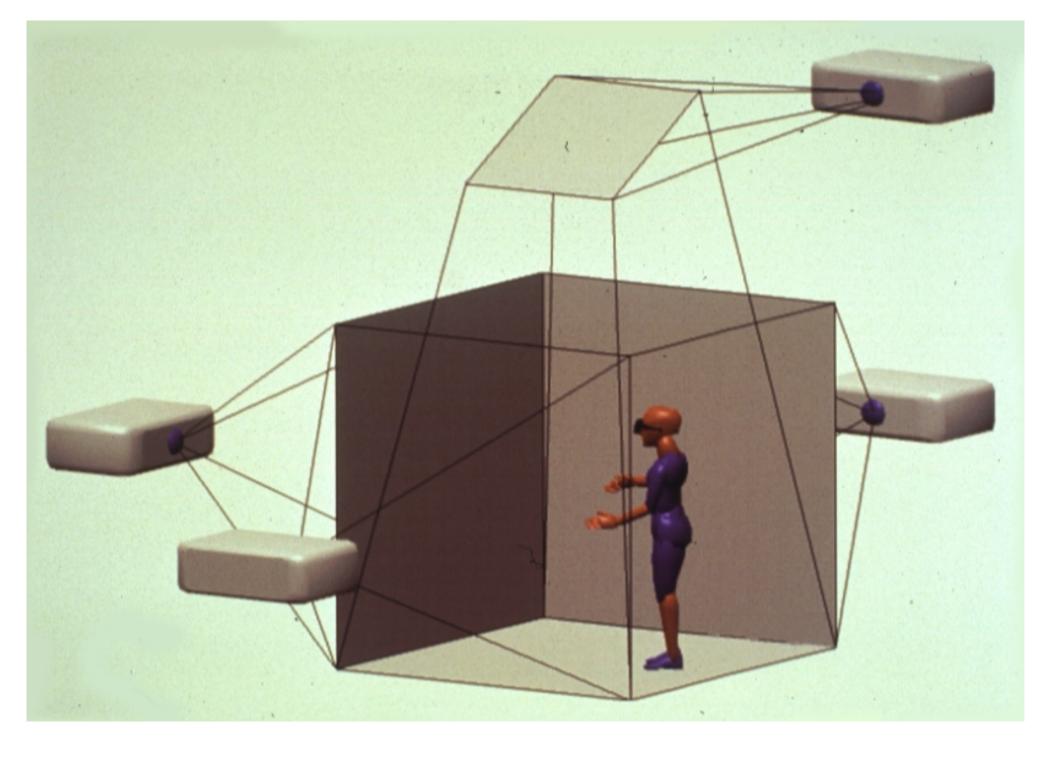
   eye glasses
   projections onto retina
- Wall-mounted displays (projections

   ), whiteboards
- Speech Audio
- Non-Speech Audio
- Force output
- Special output devices for people with disabilities (Braille display\*, speech, etc.)
- Olfactorial output
- + Cater to variety of possible output devices

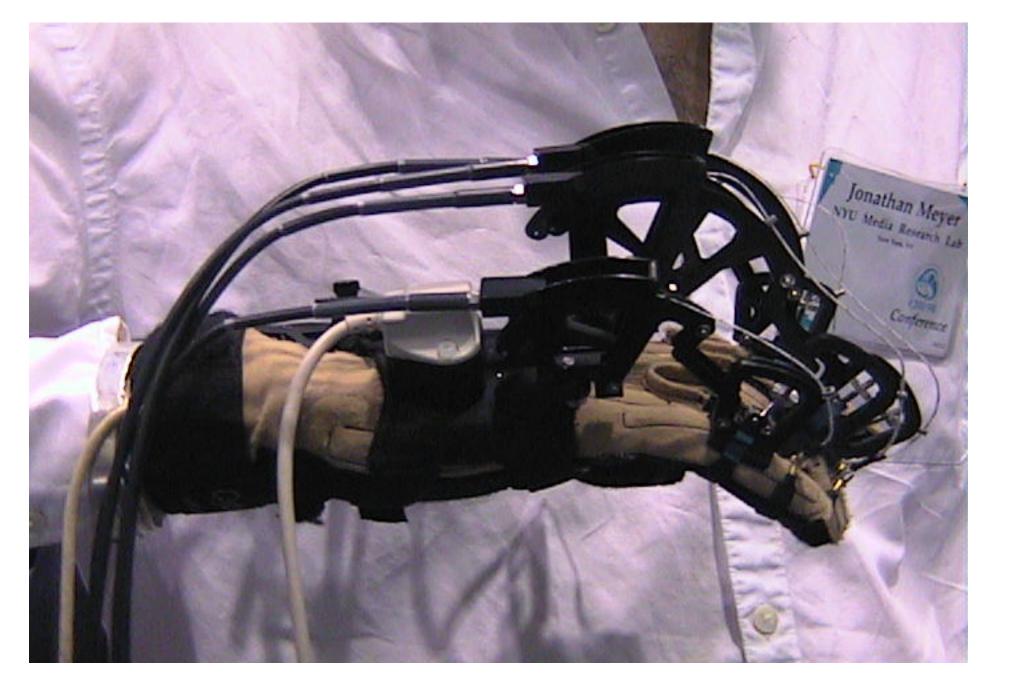
















#### Input devices

- Keyboards
   ◆ (QUERTY, Dvorak
   ◆ , chord
   • , numeric)
- Cursor keys
- mouse (1-3 keys)
- trackballs, trackpads, joystick, 3D-mouse
- Touch screens
- Speech input
- "Graffiti"

   handwriting, gestures
- Data gloves
   →, data suits, 3D trackers
- Gaze
- Special input devices for people with disabilities (e.g., foot mouse, head mouse, lip readers, etc.)
  - + Cater to variety

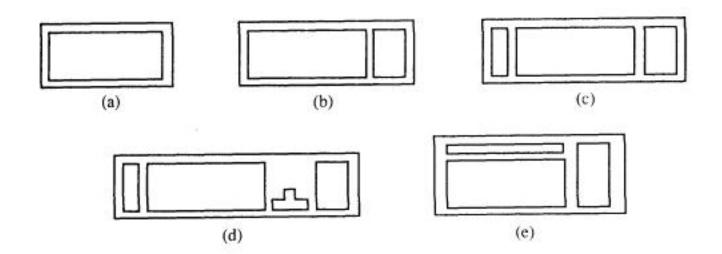
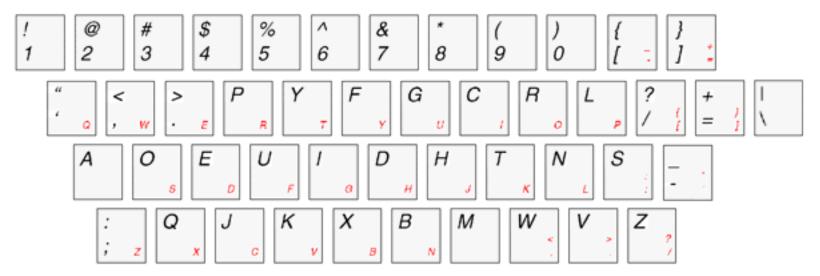


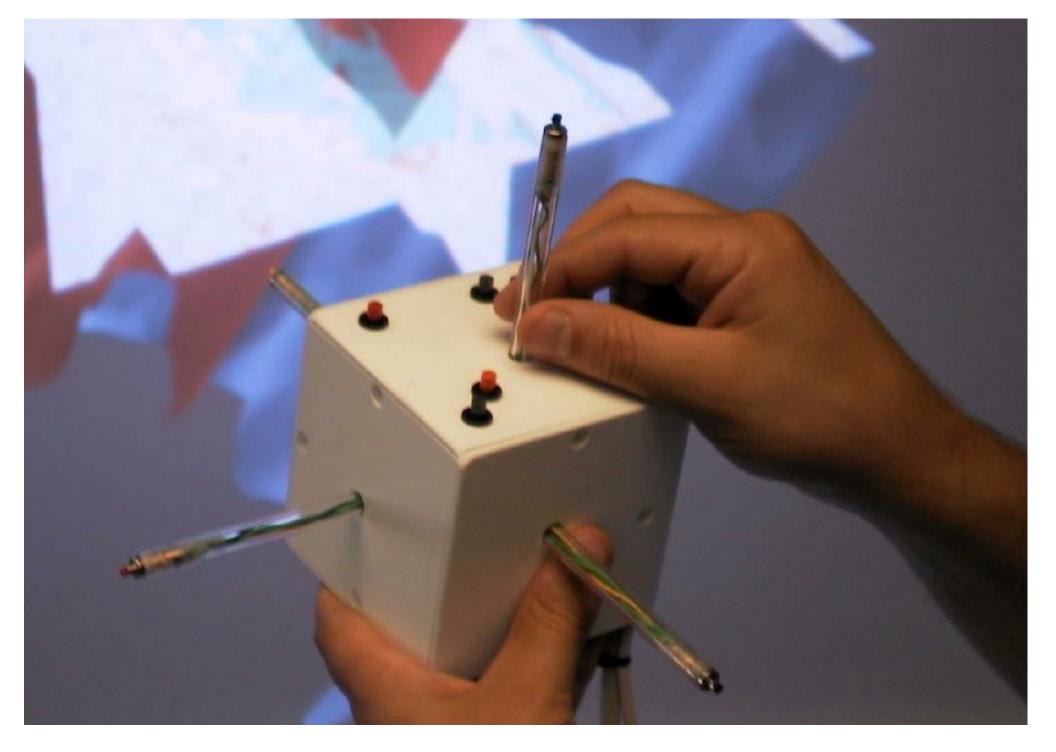
Figure 2.1 A range of keyboard layouts:

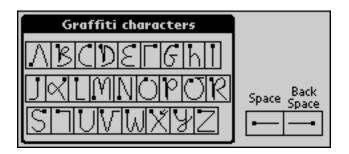
- (a) neither function keys nor numeric keypad (Macintosh Plus)
- (b) no function keys (Macintosh SE standard keyboard)
- (c) function keys and numeric keypad (IBM PC)
- (d) function keys at left, cursor keypad
- (e) function keys at top

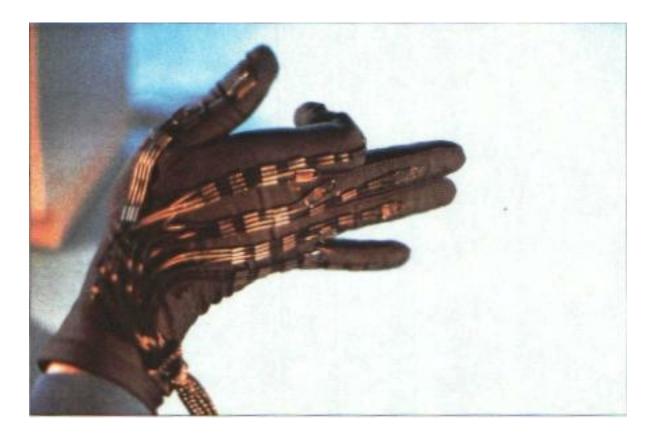


Dvorak Keyboard Layout













### Requirements for I/O Devices

- Must match the physiological and psychological characteristics of users, their training and their expertise (consider age, impairments, and computer skills)
- Must be appropriate for the user's tasks
- Must be suitable for the intended work environment.

# Interaction Styles and HCI Guidelines

- Interaction Styles •
- 2. Interaction style independent design principles •
- 3. Command interfaces •
- 4. Menu-based interfaces •
- Direct-manipulative interaction •
- 6. Form Fills ♦

# Interaction styles

## Command entry

Difficult to learn and to retain

Can be very efficient for trained users

+ Recommended for frequent users only (and for work under time pressure)

#### Menus

Easy to learn and to retain Slows experienced users down

+ Recommended for all users when complemented by menu commands

### Direct manipulation

Relatively easy to learn, easy to retain Restricted in scope

+ Recommended for all users when icons are labeled and when

direct manipulation is complemented by other interaction style(s)

(Form fill-in)
Limited in scope

(Natural-language interaction)
Technical limitations

## Interaction-style independent design principles

- Strive for consistency (constancy is a special type)
  - internal;
  - external with metaphor, and other software thereby conformity with user expectations
- Provide advance information •
- Provide immediate feedback
- Permit easy reversal of actions (undo)
- Prevent errors; offer help in case of errors
- Reduce short-term memory load
- (Let the user be in control)
- Cater to user diversity; allow for personalization ◆
- . Provide shortcuts for experienced users

- . Provide online help •
- . Provide learning aids •

# **Advance information**

- informs users about what is possible and what is not
- informs users about what will happen
- give users cues as to what action/input is correct
- indicates forseeable inconveniences for the user

Aim: prevent users from performing actions that would lead to errors or otherwise unexpected results.

Form: Advance information should be given through visual indicators rather than text.

#### **Examples**:

- Menu entries which currently cannot be selected should be visually distinguished from entries that can be activated.
- Objects in direct-interactive interfaces that currently cannot be accessed should be visually distinguished from objects that can be activated.
- The shape of the mouse symbol should indicate the action that

- will occur if the user clicks the mouse button. •
- Submenus should be shown when the mouse moves over the superordinate items.
- Required formats of keyboard entries should be indicated.
- Long duration of actions should be indicated, and users' permission requested.

# **Feedback**

Any action of the user should lead to an immediate reaction of the system (ideally after not later than 0.1 seconds)

#### **Examples:**

- Menu entries, object icons, etc. should become highlighted when being touched by the cursor.
- Selected items in menus should be marked.
- Path selection in navigation hierarchy should be visualized.



- Errors in user input should be reported immediately.
- System should inform the user about the status with status indicators (e.g., clock with rotating hands) ◆ and even better with progress indicators (e.g., bar that progressivly indicates task completion).



- Feedback can be visual, auditory and tactile.
   (Users should be able to turn off auditory output).
- \* System reactions should always have about the same latency.

# **UNDO**

The UNDO function allows for the last user action(s) to be "undone". The presence of an UNDO functions encourages users to explore the functionality of a system.

### **Guidelines:**

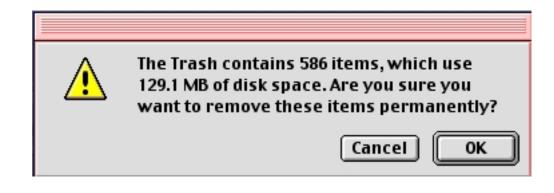
- Even when a general UNDO function is available, special UNDO functions should nevertheless be preserved (such as delete left, delete right, second click on selected menu items to undo the selection). They can be activated more quickly and already became a convention.
- If an UNDO function is available, everything should be undoable, if possible
  - It is difficult for users to understand that some actions in a program that have local effects only (like saving a document to the harddisk, or overwriting a document) cannot be undone.

- o [In contrast, users understand easily that actions that have external effects (like sending an email message) cannot be undone.]
- Multiple UNDOs should be possible
- . UNDO of UNDO:
  - Toggle UNDO: easy for beginners
  - Linear sequence of UNDOs and REDOs

## **Error handling**

#### **Error** avoidance

- Provide lots of + advance information
- Keep dangerous items/icons away from frequently used commands.
- Warn users if actions have irreversible effects. Request confirmation (which should not be the default option).



 Options that increase safety should be "on" by default (e.g., checkpoint files, UNDO).  Errors should be recognized and reacted to as soon as possible.

#### **Error messages**

- Should explain
  - what the problem is
  - what the user can do to solve the problem (at least by examples)
- Should be formulated in terms of the users' task
- Should be polite; the word "unfortunately" should be avoided ◆◆

#### **Program errors**

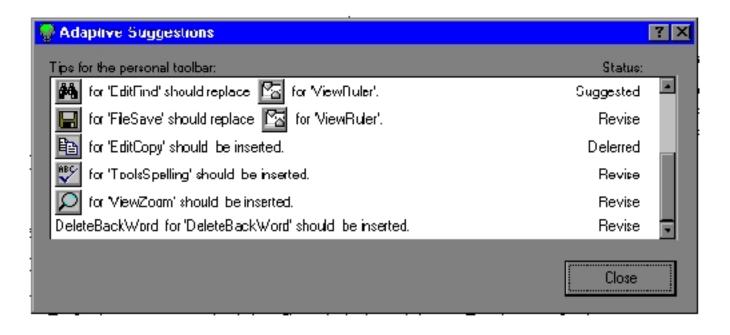
- In the case of a program crash, give users the opportunity to save their files, or save (checkpoint) files automatically.
- Allow users to abort programs, and to relaunch them.

## Guidelines for adaptable and adaptive menus

- Experienced users (and system administrators) should have the possibility to make changes to the menus, to cater to user needs (= "adaptable menus"):
  - introduce/change shortcut codes
  - hide/delete redundant menu items
  - move/duplicate menu items into other menus
  - o create links between menus
- It does not seem advisable to allow for completely automatic positional changes in menus, like re-ordering or hierarchical repositioning of menu items based on usage frequency (= "adaptive menus")
  - violates the constancy principle
  - negative experimental results by Shneiderman
- It seems o.k. to perform positional changes under the control of the user.



#### Example toolbar



Recommendations for changes in a Word 97 "Personal Toolbar", based on usage frequency (Spasovsky/Fink/Kobsa 1997)

# Online Help

- Indispensible for beginners and occasional users, useful even for experienced users.
- Should address the 6 most frequent user questions:

```
"What is this for?"
"How can I...?"
"What happens if...?"
"Why is now...?"
"Why is ... not...?"
"Where am I now?"
```

- Should be availabe for *all* system functions in a consistent manner (F1 key ◆, Alt-H, Ctrl-H, permanent help menu item, dedicated help key).
- If help is not available for one or more functions, this should be pointed out.
- Users should know that help is available, and how.
- Help texts should be situation-sensitive and as concrete as possible.
- Should be written in terms of users' task (preferably by technical authors and not by the programmers).
- Should not be written in the style of the user manual, but rather

- offer short and concise information with lots of examples.
- Users should also be able to request help for options that are currently not available. The help text should include an explanation of their unavailability.
- Help windows should not hide the part of the computer screen that is being explained. They should be movable.
- Users should be able to leave a help message quickly if it is not relevant.
- Initial help texts should be short. More details upon request only.
- Initial work on user modeling and context recognition to supply more relevant help.
- + Give "implicit advice" through good interface design so that the need for explicit help does not arise.

# Learning aids

### **Guided Tours**

- Should only explain the most important concepts
- Maximum duration: 20-30 minutes
- Users should be engaged (selections, quizzes,...)
- Users should be directly addressed
- Should give examples
- Numerous guidelines available

## **User Manuals**

- Important source of information when everything else fails
- Should not be written by the programmers
- Numerous guidelines available

# Command interface style

kobsa@igor% ls ICS205-Spring00-notes/ ICS205-Spring00.html kobsa@igor% ls ICS205-Spring00-notes 5-human-factors.htm bad-ifs.htm chord-keuboard.htm contr-disciplines.htm contr-disciplines.jpg kobsa@igor% kobsa@igor% kobsa@igor% kobsa@igor% kobsa@igor% kobsa@igor% kobsa@igor% kobsaRigor% 📕

find-problems.htm input-devices.htm

metaphors.htm nsf-new.jpg

nsf-old.jpg

courses.html

output-devices.htm twiddler.gif users-are-diff.htm what-are-ifs.htm whatishei.htm

#### **Command interfaces**

#### **Advantages:**

- Hands remain on the keyboard
- Fast input
- Powerful language constructs possible ("print file1 file2 file3", wildcards, pipes, ...)

#### **Disadvantages:**

- Difficult to learn
- Difficult to retain

#### **Guidelines:**

- Use action-oriented command names that come in the first place, i.e. <command>
   <arg1> <arg2>...
  - (e.g., "move a b" rather than "a move b" or "location a b")
- Use congruent names for antagonistic commands (Carroll 1982)
- Use consistent order of arguments
- Specifiy direct object in first argument (Barnard et al., 1982)
- Allow natural/consistent abbreviations for command names (e.g., "mv" for "move"; cf. Shneiderman 1998)
- Allow for variations in the syntax; tolerate spurious words (e.g., "mv a to b")
- Allow for the definition of aliases

- Provide command history
- Allow for the editing and re-entry of the last few commands
- If possible, allow multiple parameters and wildcards
- If possible, allow macro definition and programming

#### Menu-based interfaces

- Overview •
- Guidelines for menu items •
- Guidelines for menu length and item order •
- Guidelines for menu dynamics •
- Guidelines for menu hierarchies •
- Guidelines for graphical menus •
- Guidelines for adaptable and adaptive menus •

# Menu-based Interaction --Overview

#### 3 basic activities:

- Navigation (in menu hierarchy, information resource, etc.)
- Selection (of data, parameters, etc.)
- Activation (of programs, documents, etc.)

**Selection made** through mouse, number/character keys, function keys, cursor keys plus return key, rotating cursor symbol plus return key, touching on the screen, etc.

Special case: "analog" menus

## Types of menus •

Textual menus

- Graphical menus (icons)
- Combination of text and graphics
- Linear menus
- Menus with spatial layout
  - 4
- Static menus (e.g., menu bar)
- Pull-down menus
- Pop-up menus
- Isolated menus
- Connected menus (mostly hierarchical menus) ◆ ◆
- Pie menus ◆

# **Guidelines for menu items**

- The menu should have a short meaningful headline, preferably centered, in upper/lower case; unneccessary emphasis/embellishment should be avoided.
- Menus should show
  - the menu items that can be selected
  - the menu items that currently cannot be selected (deemphasized)
  - the menu items that have already been selected
  - the presence of submenus
  - if applicable: the code/key to select the menu item
  - if applicable: the shortcut that can be used to select the item, in addition to the mouse
  - if applicable: short and polite instructions on how to select items, formulated in terms of the user's task.
- Entries should be in upper/lower case; avoid unneccessary emphasis/embellishment.

- The difference of each entry to all other entries must be very clear (Schwartz & Norman, 1986).
- If the name of an item consists of more than one word, the most significant word should come first.
- If letter codes are being used, the code should correspond to the first letter of the first word. If this is not possible, numeric codes should be used (Pellman, 1984) ◆.
- To achieve external consistency with earlier versions or competitive products, menu items should be *lexically* identical (least there won't be a transfer effect; Foltz et al., 1988). Addition and ommission of menu entries is o.k.
- In non-tabular menus, the error rate for items with text and icons combined is 50% less than for mere textual items (Muter and Mayson, 1986).

Example of poor menu design • Example of better menu design •

# Guidelines for menu length and item order in linear menus

- For beginners, menus should be kept short. If item names are longer than one word, menus should not contain more than 5-8 items.
- Longer menus are possible if items are grouped or have a natural sequence (numbers, dates, etc.)
- Items should be grouped according to rules of the task domain, and separated by whitespace or horizontal lines (Parkinson et al., 1985).
- For beginners: menu items that will be frequently used by most users should go to the top of the menu \*
- If multiple selections are possible, then frequently-selected combinations of items should be kept closely together (or otherwise increased in size) •
- "Dangerous" items should not be collocated with frequently used items.
- (As a final rule): use alphabetic, chronological or numerical order, or group according to similarity of items (e.g., position "save as"

- next to "save") •
- Possibly use pie menus, which are superior to pull-down menus for beginners.

# Menu dynamics

- The menu item that is currently being touched by the cursor symbol should be highlighted.
- Submenus of the currently touched menu item should be shown (30% less search time and 50% less errors for beginning users, Snowberry et al., 1985).
- Selected options in the menu should remain checked.
- It must be possible to leave the menu without selecting any item (since users may have erronously launched the menu, or just want to explore the system)
- Positional constancy in menu entries is important. If an item is not available at the moment, it must nevertheless remain in the menu, but should be made less prominent (e.g., grey color)
- Menus should be easily visible against all possible backgrounds.

### **Guidelines for menu hierarchies**

- Submenus of the currently touched menu item should be automatically shown (30% less search time and 50% less errors for beginning users, Snowberry et al., 1985).
- Menus should not be deeply nested (2-3 levels only).
- The menu lenght should not exceed 3-12 items. Menus may be longer if they are grouped or if items have a natural sequence.
- On the top level and particularly on the bottom ("leaf") level, menus should be longer than in the middle of the hierarchy (Norman & Chin, 1988).
- Longer menus are better when working under time pressure (Wallace, 1988)
- The total number of different menus in a hierarchy should be low (Norman 1991). If possible, combine two or more intermediate menus into a single one and deactivate those menu items that do not occur in the respective navigation path.
- All entries of the same level should fit on a screen (no scrolling should be necessary).
- The hierarchy should be constructed thematically. Sometimes

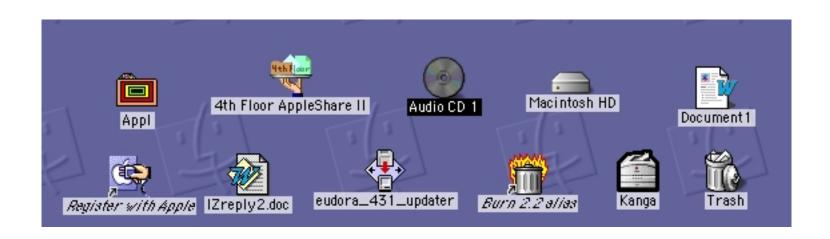
menu hierarchies can be constructed based on which items are frequently selected together.

- Constructing hierarchies top-down or bottom-up? (Chin, 1986):
  - Top-down approach yields broader trees (more menu entries on the top level) and deeper trees. The emphasis lies on the discrimination of the differences between items.
  - Bottom-up approach yields narrower trees with broad lowermost level. The emphasis lies on the clustering of related items.
    - \* Use a combined approach.
- Consider menu shortcuts to deeper hierarchy levels.
- External consistency (with previous program versions or competitive programs): changing the hierarchical position of menu entries is o.k., as long as lexical identity is preserved (Foltz et al., 1988).

## Guidelines for graphical menus •

- Menu items (= "icons") should be recognizable and distinguishable within the normal viewing distance, under different light conditions.
- Should be esthetically pleasing.
- Global properties (like form, color or size) are much more important than local properties (like details to increase likeness):
  - Abstract icons become much faster selected than concrete icons.
  - The selection speed for abstract items seems to be less dependent on the number of icons than is the case for concrete and textual items ("parallel search").
- Similar objects/functions should be assigned similar icons.
- Users should be able to easily understand the intended meaning of icons, or at least be able to learn it quickly.
- The addition of textual labels makes it easier for beginning users to learn, and for infrequent users to recognize, the graphical menu items.

# Direct-manipulative interaction style



## **Characteristics**

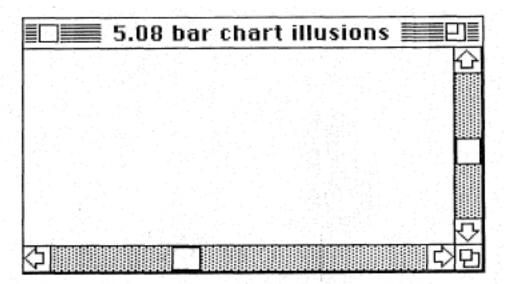
- Graphical interface objects that represent task objects/functions, or objects in the user's work environment.
- Selection and manipulation of interface objects through pointing device.
- One or more metaphors presented, of which most interface

- objects form part.
- Operations on task objects is performed through "congruent" operations on the interface objects.
- All options are normally available all the time.

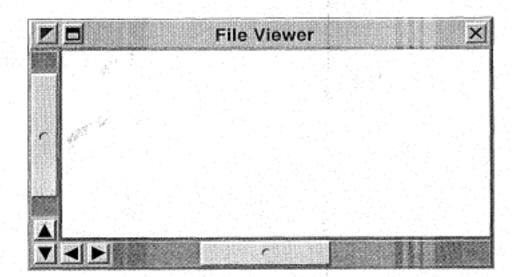
## Important design requirements

- Consistent metaphor(s)
- Immediate feedback
- Icons should be clearly distinguishible through overall shape and color.
- The form of the interfaces objects (and the form of the mouse icon when hoovering above interfaces objects) indicate the operations that can be performed ("look and feel") ◆ ◆ ◆ ◆

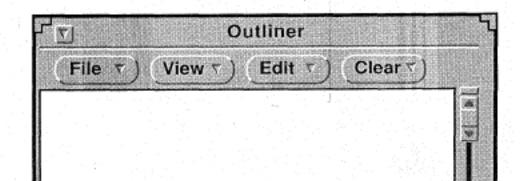




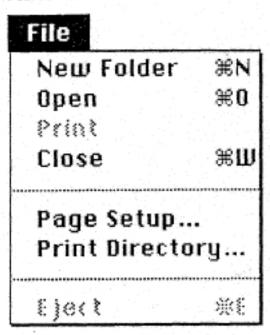
#### NextStep



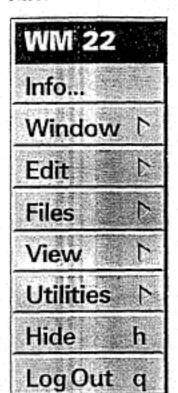
#### OPEN LOOK



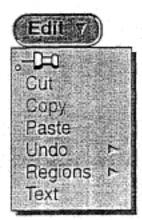




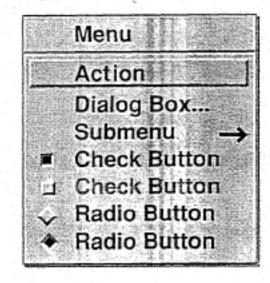
#### NeXT



#### OPEN LOOK



#### Motif

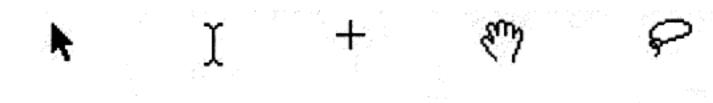


#### MS Windows

File	
Open	Enter
Print	
Move	F7
Delete	Del
Select All	Ctrl+/
Exit	

#### Presentation Manager

File	
Open	Enter
Print	ShiftPrtSet
Move	F7
Delete	Delete
Select All	Ctrl+/
Exit	F3



## Macintosh software











X Window System

Figure 9.3 Various cursors

## Form-fills

- Useful for entering large amounts of data
- Consist of tables and label/data fields

#### **Guidelines**

- Switch at most once between tables and label/data fields.
- Left-align labels, data fields, and columns of tables.
- Alphabetical listings should be arranged vertically, possibly in several parallel columns.
- Use meaningful labels
- If user enters data from a paper document, its layout should be mirrored by the screen layout.
- Allow for a space of at least two characters between columns, and one character between data and surrounding frame.
- Insert a blank line after about every fifth line of data.
- Split long alphanumeric codes in groups of 2-4 characters.

- If a specific format of the user input is required, communicate this to the user:
  - Use underscores, periods etc. to indicate the exact or maximum input length.
  - Units (like \$, ft., mph) and separators (like "-", "/") should be part of the form.
  - Use add-ons like "dd/mm/yy" or "(example: 12/\_8/59)".
- Mark fields where entry is required (e.g., by "\_", "." or color), or group such fields separately. 
   Hitting the return or tab key should bring the user to the next required entry field.
- Fill in data fields with default values or with the most recently entered value.
- Enter field values automatically if they can be inferred from other user input.
- Allow for abreviated entries which can be expanded by hitting a single key (automatic expansion is difficult for beginners). If the result is not unique, show available alternatives.
- Automatically entered values should however never have dangerous effects.

# Example •

### **Field Organization**

Our eyes naturally or culturally move from top to bottom, left to right. Place fields to take advantage of this standard, and move the cursor accordingly. For example, arrange related fields across the screen as in

Resource: \_\_\_\_ Task: \_\_\_ Duration (Days): \_\_\_

or down it, as in

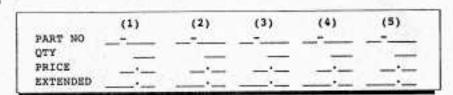
Resource: \_\_\_ Task: \_\_\_ Duration (Days): \_\_\_

but not in a zigzag pattern:

Resource: \_\_\_\_\_ Task: \_\_\_\_ Duration (Days): \_\_\_\_

Use columns for repetitive information, since they complement natural eye movement. Note how part number, quantity, price, and extended price flow from left to right in

rather than



PRICE \_:\_ \_:\_ \_:\_ \_:\_

An exception occurs with paired groups of fields. For instance, if your application has "sold to" and "ship to" address information, arrange the fields as

	SOLD TO		SHIP TO	
Name:	VINE AND	Name :		17
Addr1: _		Addr1:		V
Addr2:		Addr2:		_
Citys		City:		77
Sti	Zip:	St:	zin	_

Name:	
Title:	
Rank:	
Name:	
Title:	
Rank:	
Telephone number:	
Name:	
Title:	
Rank:	
Telephone number:	
Name	
relephone number:	

# Organize lists vertically like this:

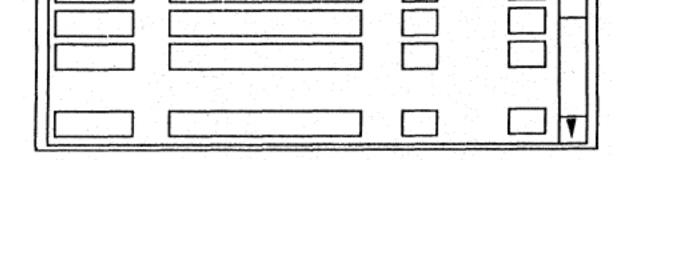
Adrian Charles
Agrippa Glenda
Basil Dana
Beverly Douglas
Caine Edith
Cary Eliot

Fatima
Florence
Gordon
Hanna
Henry
Hope

# Rather than horizontally like this:

Adrian	n's	Agrippa		Basil
Beverly		Caine		Cary
Charles	• .	Glenda	, ,	Dana
Douglas		Edith		Eliot
Fatima		Florence		Gordon
Hanna		Henry		Hope

Name:	] Co. co.	Major_	Year	r: Status:
ID: Number	Title Co-op	Track:	Section	n Sequen
			H	H
		5.5	H	H
			님	
			Ш	
	J25"			
mproved				
mproved	•	REGISTRA	TION	
mproved	STUDENT	REGISTRA	TION	
mproved	STUDENT		TION	Year:
mproved Name:	STUDENT	TUDENT	TION	Year: Status:
Name:	STUDENT	TUDENT	TION	-
Name:	STUDENT	TUDENT  *Major:    Track:	FION	-



7/1/89	JONAH'S FISHING EXPEDITIONS	SCREEN
11:15 am	NEW EMPLOYEE ENTRY	1 OF 2
REQUIRED DA	ГÀ	. :
EMPLOYEE NO	O: SSN:	
EMPLOYEE NAMI	B:	• • •
ADDRESS	1:	• • •
ADDRESS	2:	• • •
CIT	Yı ST: ZIF	P:
DIVISION	Code: dept code:	
section	code:	
OPTIONAL DAT	ΓA	
SEX (M/F	): . BIRTHDATE (MM/DD/YY):	.//
SALARY (	GRADE:	1.
MONTHLY SI	ALARY: \$	
F1-Help F3-1	Add Employee PgDn-Benefit Plans E	Ssc-Cancel

Figure 4-12. Using dots to indicate field length.

```
Optional Data:
SEX (M/F): BIRTHDATE (MM/DD/YY): ../../..
SALARY GRADE: ...
MONTHLY SALARY: $ ....0.00

F1-Help F2-Next Screen F3-Add Employee Esc-Cancel
```

Figure 4-13. Using dots with numeric data.

7/1/89 11:15 am	JUNAH'S FISHING EXPEDITIONS NEW EMPLOYEE ENTRY	SCREEN 1 OF Z
REQUIRED DA	)TA:	· · · · · · · · · · · · · · · · · · ·
EMPLOYEE 1 EMPLOYEE MAN ADDRESS ADDRESS CII	IE:	
DIVISION SECTION		
SALARY MONTHLY S	): BIRTHDATE (MM/DD/YY): GRADE:	

Figure 4-14. Using colors to indicate field length,

7/1/89 JONAH'S FISHING EXPEDITIONS SCREEN 11:15 am NEW EMPLOYEE ENTRY 1 OF 2
EMPLOYEE NO: 00000000 SSN: 000-00-0000 EMPLOYEE NAME: 7
 ADDRESS1: 7
ADDRESS2: SI: ?_ ZIP: 00000
SEX (M/F): _ BIRTHDATE (MM/DD/YY):/
DIVISION CODE: 000 DEPT CODE: 0000 SECTION CODE: 0000
MONTHLY SALARY: \$
F1-Help F2-Next Screen F3-Add Employee Esc-Cancel

Figure 4-9. Filling fields to show required entries.

7/1/89 JONAH'S FISHING EXPEDITIONS 11:15 am NEW EMPLOYEE ENTRY	SCREEN 1 OF 2
REQUIRED DATA:	
EMPLOYEE NO: SSN: EMPLOYEE NAME:	
ADDRESSZ: SI: ZIP:	Base Surveyor
DIVISION CODE: DEPT CODE:	
 OPTIONAL DATA:	
SEX (M/F): _ BIRTHDATE (MM/DD/YY):/_	/
SALARY GRADE:	
 F1-Help F2-Next Screen F3-Add Employee Esc-	Cancel

Figure 4-11. Separating required data from optional data.

9/9/91	VIDEOLAND RENTALS UPDATE VIDEO INVENTORY	12:44 pm
VIDEOTAPE NO: MOVIE TITLE:		
QTY:		
F1-Help	F3-Update Quantity	Esc-Cancel

Figure 4-18. Finding an entry when the complete title is not known.

9/9/91	VIDEOLAND UPDATE VIDEO		12:44 pm	
	1	#		
VIDEOTAPE MOVIE TIT	NO: 4032 LE: Casablanc	a.		:.
	mv • 2			

QTY: 2

Enter quantity or press <PgDn> for next title (

F1-Help

F3-Update Quantity

Esc-Cancel

Figure 4-19. Showing the first record matching user input.

9/9/91	VIDEOLAND RENTALS UPDATE VIDEO INVENTORY	12:44 pm
VIDEOTAPE MOVIE TI		
	Casablanca Casino Royale Cast a Giant Shadow Castle Keep	
Enter qua	ntity or press <pgdn> for ne</pgdn>	ext title (
F1-Help	F3-Update Quantity	Esc-Cancel

Figure 4-20. Popup window showing possible choices.

Name	
Add1	
Add2	
City	
st:_	
Zip:	교회 이 교통을 하는데 이 사람들이 가입니다 하는데 되었다. 나는 그 그 그래 없다고 싶다.
	그리는 의 이 시청하는 것 같아 그리고 있다. 아름없다
	그리는 의 이 시청하는 것 같아 그리고 있다. 아름없다
	: Code2:
	Call Date:
Code	Call Date: Enrollment Date:
	Call Date:
	Call Date: Enrollment Date:

Figure 3-14. Initial screen design for Famous Surgeons'
Mailing List Program.

FAMOUS	SURGEONS' CORRESPONDENCE SCHOOL STUDENT ADD SCREEN
Last Name: Address 1: Address 2:	First:
City: Phone:	St: Zip: Primary: ()
	Emergency: () Use
	sired Enrollment: _/_/_ MM/DD/YY Application Sent: _/_/_
	edical Experience (Y/N): _ Method (C)ash (I)nstallment: _
F1:Help F10	):Add Student Esc:Cancel 12:13 pm

Figure 4-25. Revised screen design for Famous Surgeons' Mailing List Program.

Name:		1 "		<u> </u>	- A	_413 (a)	
Address		4,					
Address City:	2: _	<u> </u>	<del>- 11, 111 j</del>	<del></del>	St:	Zip:	
CICY:	-				30		7
					in and		
Phone:	Pr	imary:					
	En	mergency	y:				
	<u> </u>						
Inquiry	Date						
Desired			Date: _				
Applicat	ion S	Sent: _	******				1.
Medical	Exper	rience	(Y/N):			200	
Payment	Metho	od:					

Figure 3-15. Improved screen design for Famous Surgeons' Mailing List Program.

st Name: dress 1:	First:
dress 2: City:	St:_ Zip:
Phone:	Primary: () Emergency: ()
Des	DD/YY) Inquiry: _/_/_ ired Enrollment: _/_/_ pplication Sent: ///
Me	dical Experience (Y/N): _ Method (C)ash (I)nstallment:

Figure 4-26. Alternative screen design for Famous Surgeons' Mailing List Program.

# Selected elements of screen designs

- 1. General screen layout •
- 2. Interaction-style independent design principles •
- 3. Text ••
- 4. Color •
- 5. Windows •





# Guidelines for general screen layout

- The layout should reflect the structure of the task or the task solution process, and not the structure of the underlying program.
- All information that is necessary to solve a coherent sub-task should be visible on the same screen.
- The screen should not contain information that is never relevant for the user.
- The screen should contain a minimum of 60% (and ideally 85%)
   whitespace.
- The upper and the lower half of the screen should roughly contain the same amount of whitespace.
- The screen layout should be more or less vertically symmetric.
- All information that belongs together should be grouped together in clearly visually separated unit that is always presented at the same place.
  - Proximity/distance is mostly good enough for grouping;
  - o if not, use lines, differently colored background, or boxes.
- Users should be able to enter and correct data in arbitrary order.

- If connecting screens have to be used,
  - the same headlines should be used
  - information units needed in two or more screens should be presented on allscreens, at the same location.
- Users should always be able to find information on
  - o how to get to the previous screen
  - optional: how to exit the subtask or the whole program
  - how to obtain help
- Unnecessary colors and embellishments should be avoided.
- Emphasis should only be used if really necessary, and only with necessary prominence:
  - o low: different font, underlining, upper case, spacing out
  - medium: different size, color or density, inverse video, framing
  - blinking, acoustic signals

# Special screen areas

### Title line

- centered in the upper part of the screen
- separated by whitespace
- possibly marked out by larger font, bold face, inverse

## Lowermost screen part:

- Good place for status information
- explanation of available secondary menu options (help, exit, special function keys)
- dynamic explanation of items that are touched by the mouse symbol
- warnings and error messages (possibly with an acoustic signal that can optionally be turned off)

Logos: should go into the left or right upper corner

Clocks: should not show seconds and should not tick

### **Example** •

#### Univers

This illustration shows different typographic styles. Type style is an important design consideration and helps give an overall look to the document.

#### Garamond

This illustration shows different typographic styles. Type style is an important design consideration and helps give an overall look to the document.

#### Bookman

This illustration shows different typographic styles. Type style is an important design consideration and helps give an overall look to the document.

#### Helvetica

This illustration shows different typographic styles. Type style is an important design consideration and helps give an overall look to the document.

#### Courier

This illustration shows different typographic styles. Type style is an important design consideration and helps give an overall look to the document.

### Palatino

This illustration shows different typographic styles. Type style is an important design consideration and helps give an overall look to the document.

### Futura

This illustration shows different typographic styles. Type style

### Times

This illustration shows different typographic styles. Type style is

# **Text**

- Text in upper/lower case will be read about 12% faster than text in upper case only (Rehe, 1974).
- Serif fonts are more easily readable than sans serif fonts.
- Proportional fonts are more easily readible than fixed-width fonts.
- Do not use more than 1-3 different fonts and 1-3 different font sizes.
- Lines should not be longer than 40 characters.
- 1 1/2 spaced text can be read 10% faster than single-spaced text.
- Justified text has no advantages over left-aligned text. If lines are short, the reading speed of justified text is 12% shorter due to the larger spacing between words.
- Information units, particularly in help and error messages, should not be longer than 12-14 lines (plus possibly a figure). Use "more..." links for more detailed information.
- Emphasis should not be used very frequently.

# Color

- 1. Human vision •
- 2. Color perceptions depend on context •
- 3. Colors have different cultural associations •
- Guidelines based on physiology
- 5. Guidelines based on user satisfaction and designers' experience • •
- 6. More guidelines... •
- 7. Recommended usages for color •

# Windows

# Very useful interface objects for

- distinguishing between different applications
- within an application, for distinguishing different types of information that is being conveyed to the user or requested from the user
- for interrupting users with warnings and confirmation requests

### **Guidelines:**

- While tiled windows are more easy for beginners to understand and manipulate, overlapping windows are far more flexible.
- It is important to signal to the user which window is on top and which window is below.
  - Partial occlusion already does a good job in this respect (text in windows should be surrounded by whitespace that is at least one character broad).
  - Additional support through 3D effects (e.g., slanted edges, brighter and darker sides, shadows, delayed expansion and shrinking)

# HCI for special applications

- 1. Hypermedia •
- 2. Virtual reality applications •
- 3. CSCW systems •
- 4. Handheld devices •















Apply Now - 0% INTRO VISA

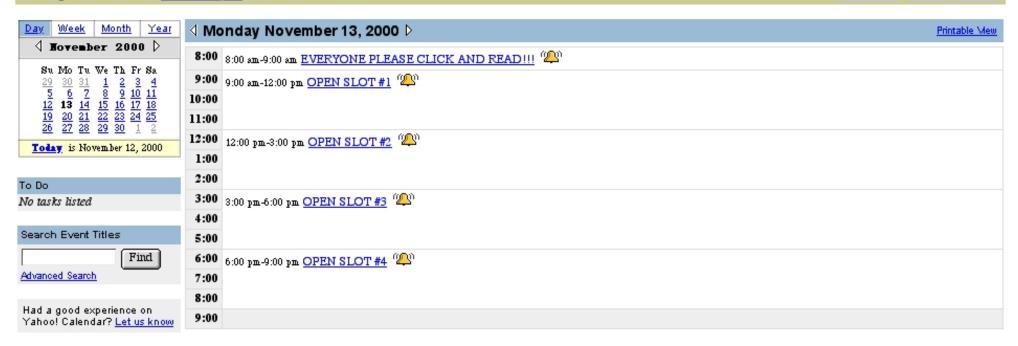
#### Viewing the calendar of ics105project

COHA

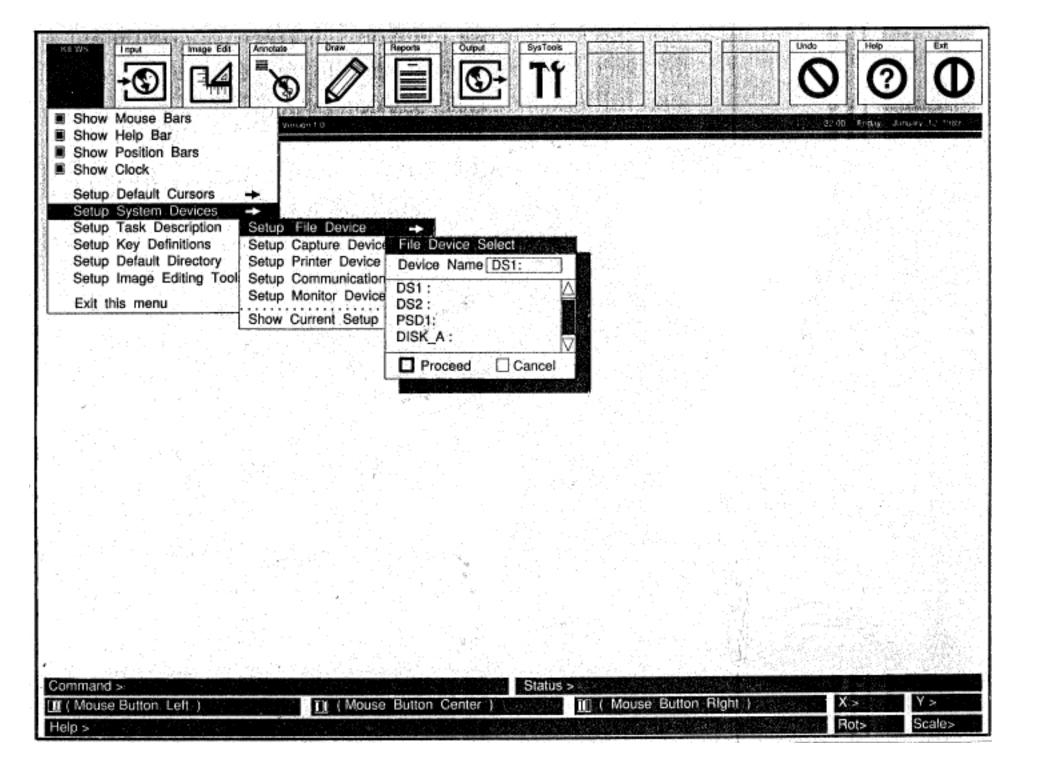
Calendar

Welcome Guest

What's New? - Go to My Calendar



Address Book - Alerts - Auctions - Bill Pay - Bookmarks - Briefcase - Broadcast - Calendar - Chat - Classifieds - Clubs - Companion - Experts - Games - Greetings - Home Pages - Invites - Mail - Maps - Member Directory - Messenger - My Yahoo! - News - PayDirect - People Search - Personals - Photos - Shopping - Sports - Stock Quotes - TV - Travel - Weather - Yahooligans - Yellow Pages - more...





### File

New

...nsq0

Close

Save

Save As...

Page Setup..

Print...

Quit

# Style

√Plain Text	Ж₽
Bold	ЖB
Italic	<b>%</b> I
<u>Underline</u>	₩U
Outline	₩0
Shadow	₩\$
Superscript	жH
Subscript	921

9 Point

10 Point

√12 Point

14 Point

18 Point

24 Point

# Format

Insert Ruler Show Rulers

### Open Header

Open footer
Remove Headers
Display Footers
Set Page #...
Insert Page Break
Title Page

Align Left #N
Align Center #M
Align Right #R
Justify #J
Use Ruler #D



Please Wait.

Hertz #1 Club Gold<sup>®</sup>
Enrollment Agreement
& Terms & Conditions
Now Loading...

This may take several minutes.

### Poor Error Message

- ERROR 56 OPENING FILE.
- JOB ABORTED! FILENAME ILLEGAL.
- WRONG CHOICE.
- 4. YOU IDIOT, YOU MADE A STUPID MISTAKE ON CARD # 2. YOU PUNCHED 211 INSTEAD OF 112.
- 5. THE LOCK MANAGER CANNOT PROCESS YOUR REQUEST NOW. PLEASE RETYPE YOUR REQUEST AFTER 6 pm.
- 6. RETYPE THE NODE NAME AS SPECIFIED IN THE NETWORK MAP.
- LOCKED FILE.

### Improved Error Message

The filename you typed cannot be found. Press F2 to list valid names.

Retype filename. For example, REPORT.DOC

Type an option from the menu.

Card # 2 contains a 211 when 112 was expected.

Print requests of more than 50 pages cannot be run before 6 pm. Reenter your request at that time.

Retype the node name as either SI01 or SI02.

The file you requested, RE-PORT.DOC, is locked. Before you request the file again,

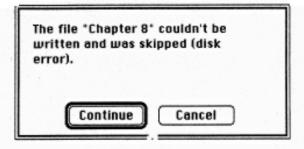


Figure 13.13 Error: file write failure

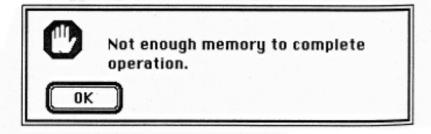


Figure 13.15 Error: insufficient memory

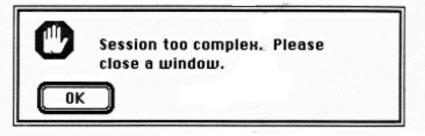


Figure 13.14 Error: too many documents are open

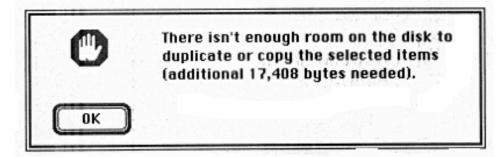


Figure 13.12 Error: disk is full



business travel

programs

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#### **Location Guide**

US Airport and Near Airport Locations

Neighborhood Locations

Locations outside the US

### tell us about your trip \*Required Fields

# Country of Residence? \* United States

#### Pickup / Dropoff Location

Enter one ONLY: city, state, country or a 3-letter airport code (for example, Fort Lauderdale or Florida or United States or FLL.)

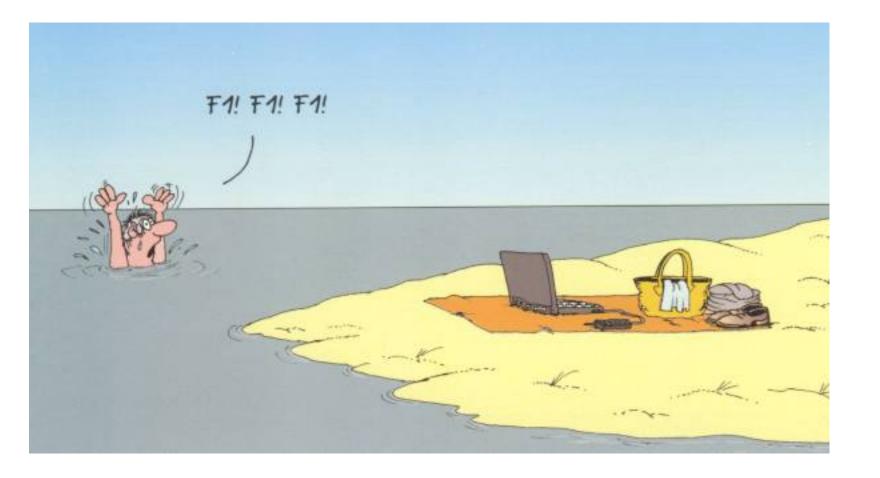
The pickup location 'Irvine, CA' could not be found. Please enter another pickup location. If you need help finding an Alamo location, click in the pickup location field and then use the Location guide that appears to the left of the screen.

Pickup Location *	
Irvine, CA	
Pickup Date *	Pickup Time *
OCT-2001   \$ 21   \$	1:00 PM 🛊



"It's the latest innovation in office safety.

When your computer crashes, an air bag is activated so you won't bang your head in frustration."



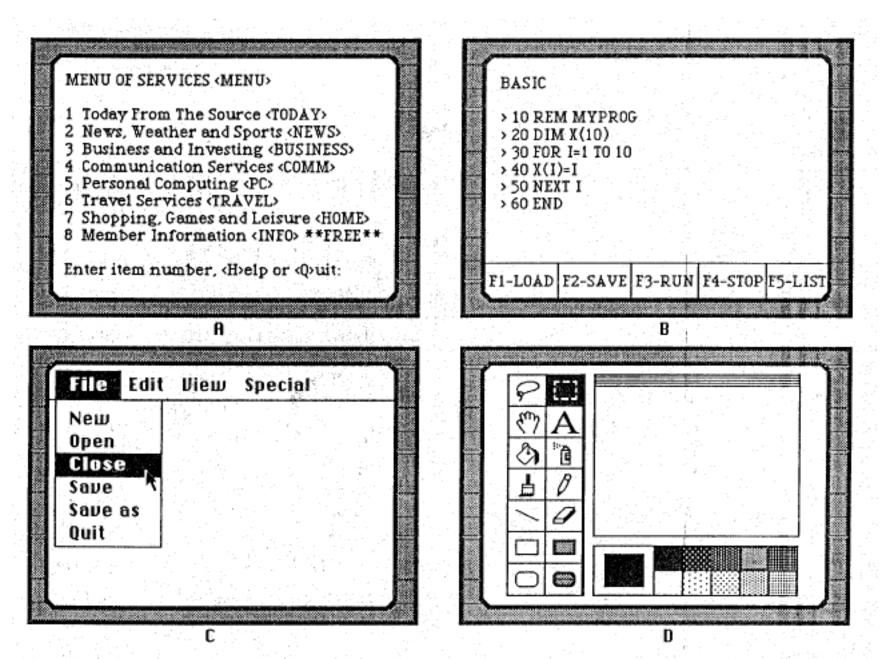
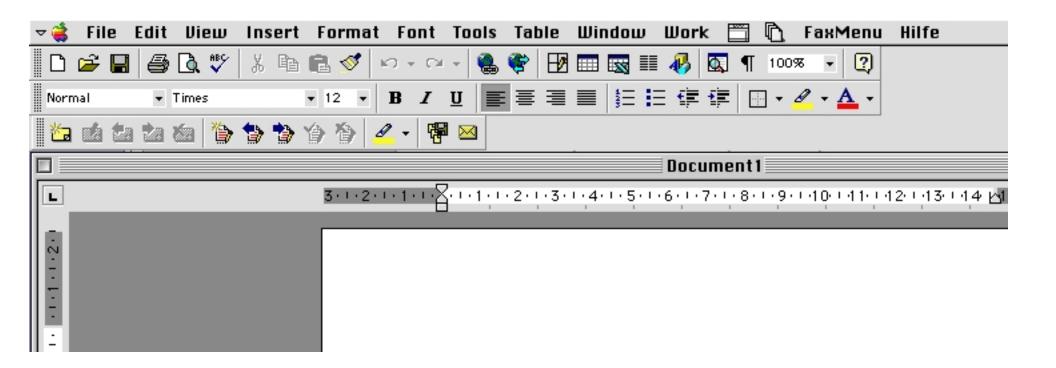


Figure 1.1. Examples of the current variety of menu selection types. Portions of menus from (a) The Source™ time-sharing network, (b) a Basic interpreter on the IBM-PC, (c) the Macintosh™ Finder menu, and (d) the MacPaint® tool palette.



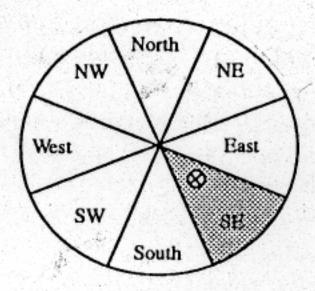
Start Clock 00:00:00 Observer: Phyll Group: TSC Session: T082291 1813 Cynthia Jack Mary Fred Evaluation Information Flow Action To All Procedural Praise Elaboration Idea-Content Agree Case\_History Metaphor/Analogy Presentation/Affect Disagree S Probabilistic\_Reasoning Assured Criticize Done R Self-Disclosure Position Statistical Information Ε Uncertain Clarify\_Question Joking/Laughing Е Solicits\_Suggestions/Openness Adversarial Ν Restruct\_Info\_Builds\_on\_Idea Reset Attentive Interrupts Nods Laughs **Smiles** Yawns Types Description: Sarah Burt Emma Carl

Action	Brush	Color
Draw	•	Black
Type	•	Red
Graph	⊗	Green

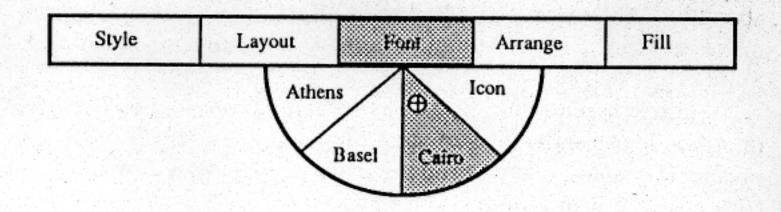
Action	Size	Face
Draw	9 pt	Normal
Type	10 pt	Bold
Graph	12 pt	Italics

Action	Туре	Axes
Draw	Bar	Grid
Type	Line	Tics
Graph		None

A simple set of cycling softkeys with commands and parameters



Pop-up pie menu



Pull-down pie menu

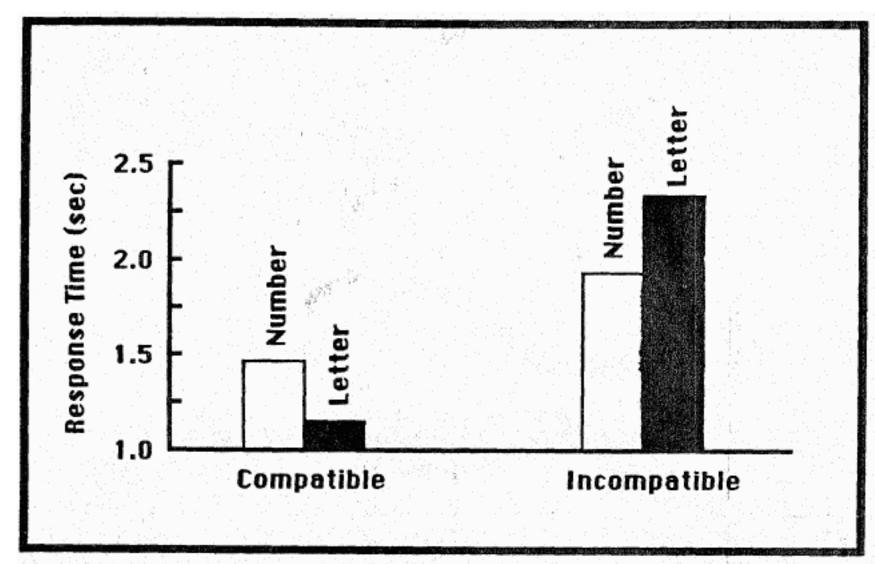


Figure 6.12. Response selection time as a function of the response-option compatibility.

# Example of poorly designed menu

### \*\*MENU

- A PROJECT ADDITION
- **B** PROJECT INFO UPDATE
- C DELETE RECORD
- **D** PROJECT INFO DISPLAY
- **E** REPORT
- F REPORT CHANGES

KEY:

# Improved design

## Update project descriptions

### Options:

- 1. Add project
- 2. Update project
- 3. Display project
- 4. Delete project
- 5. Project report
- 6. Changes over previous report
- 7. Return to previous menu

Please enter selection by

pressing key 1 - 7: \_ (Type H for help)

# Selection time for menu items

The time necessary to select an item i from a menu of length n is composed of the **search time S** plus

- in the case of selection via a keyboard code: the time necessary to press the key(s);
- in the case of selection with a pointing time: the positioning time
   P, plus the activation time (e.g. the mouse click).

### 1. Search time S

### 1.1 Beginning users:

- If the label of the item is unknown, all items must be inspected at least once. S is therefore proportional to n.
- If the label of the item is known, there are three possible search strategies
  - (1) Serial inspection
  - (2) Random inspection without repeat (implausible)

(3) Random inspection with repeat

In all three cases, S is proportional to n. In case (3), both the expected means and the variance is higher than in (2) and (1).

### 1.2 Advanced users:

Advanced users remember the approximate position of frequently used items fairly well. The search time S then is nearly constant (i.e., independent of n). •

\* The length of a menu influences the search time only when the user is a beginner.

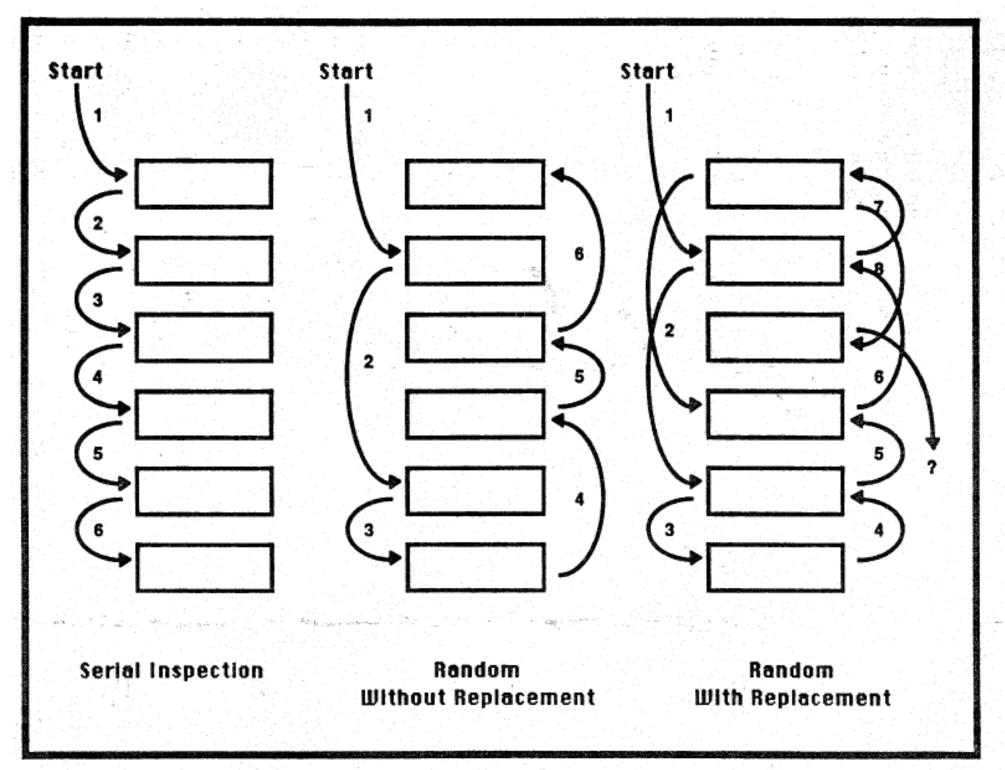


Figure 4.3. Three models of visual search of menu lists.

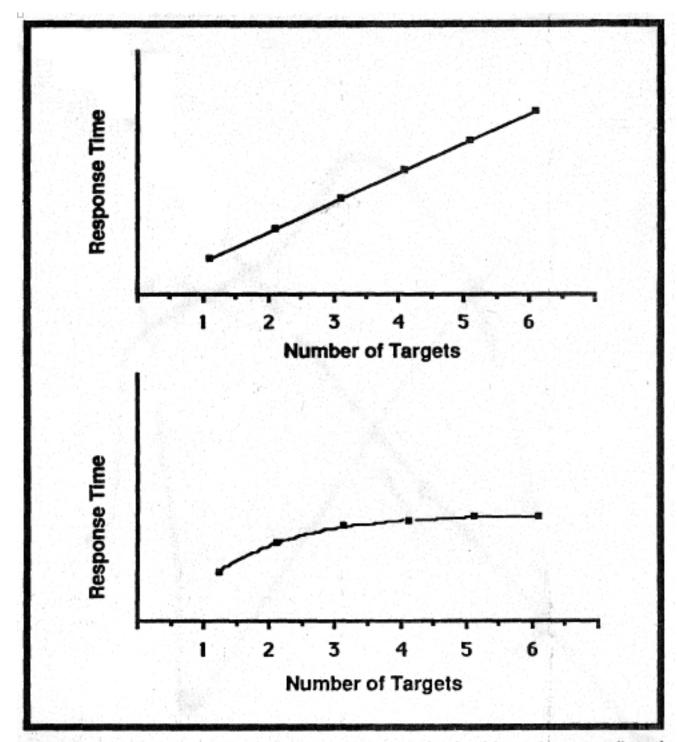
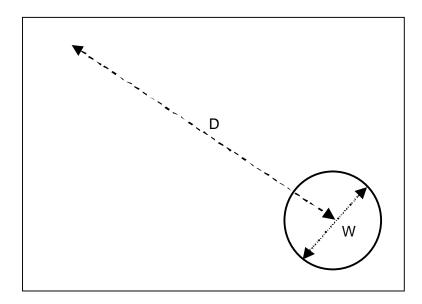


Figure 4.5. Idealized response times of unpracticed subjects (top panel) and highly practiced subjects (bottom panel) in a visual scan task as a function of the number of targets.

## 2. Positioning time P



Fitt's law:  $P = C_1 + C_2 \log_2 (2D / W)$ 

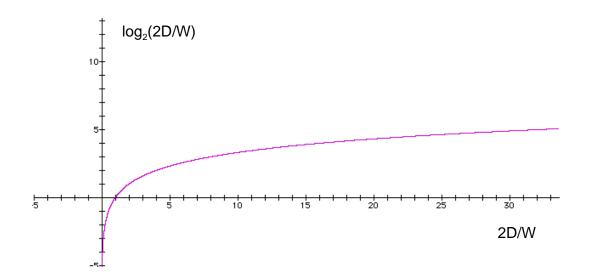
Some authors: ...+  $C_3 log_2(C_4/W)$ 

P = Positioning time

D =Distance between Cursor and Object

W= Size of the Object

C<sub>i</sub> = Constants depending on pointing device



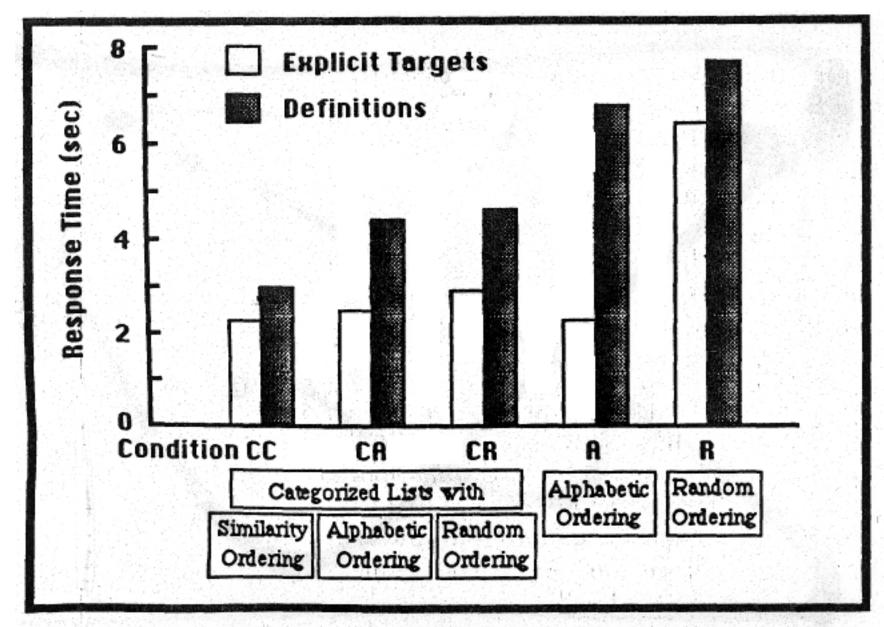


Figure 6.3. Response time as a function of type of organization for explicit targets and for definitions.

Control	Edit Style Format
	Undo Insert Append Move Delete
	Find Co.

Control	CONTRACTOR OF THE PARTY OF THE	le Format
One of you want to livingspace consider th you. Get a Then outlin	Append Move Delete	soints in remodeling your home is knowing when sider the utilitarian aspects. Do you need morent layout of the house satisfactory? Then What aspects of interior design are pleasing to ideal if you could do anything that you wanted um that you would settle for.

Control	Edit St	yle Format
Undo- ca Insert- a Append- Move- m Delete- a Find- loc	Insert Append Move Delete	ast command an goes to previous state location of cursor t end of file ted text to the location of cursor ected text

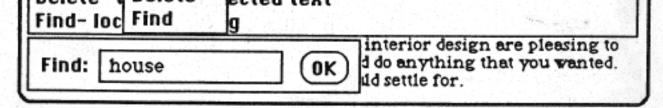


Figure 6.1. Figure-ground segmentation of the screen display. (Top panel: Good figure-ground distinction. Middle Panel: Moderate distinction with figure over figure. Bottom Panel: Poor distinction with figure over distracting figure.)

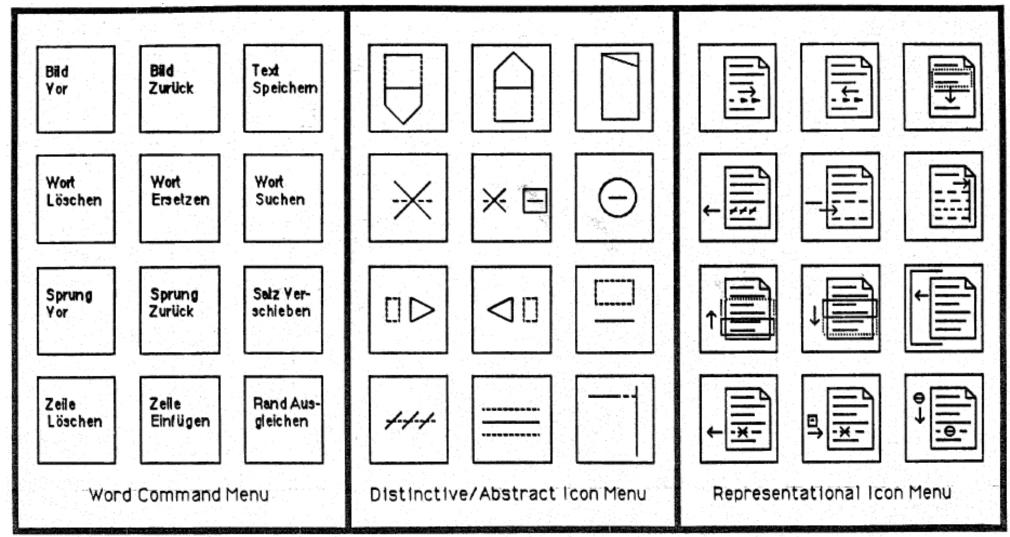


Figure 6.9. Word command menu, distinctive/abstract icon menu, and representional icon menu used by Arend, Muthig, and Wandmacher (1987).

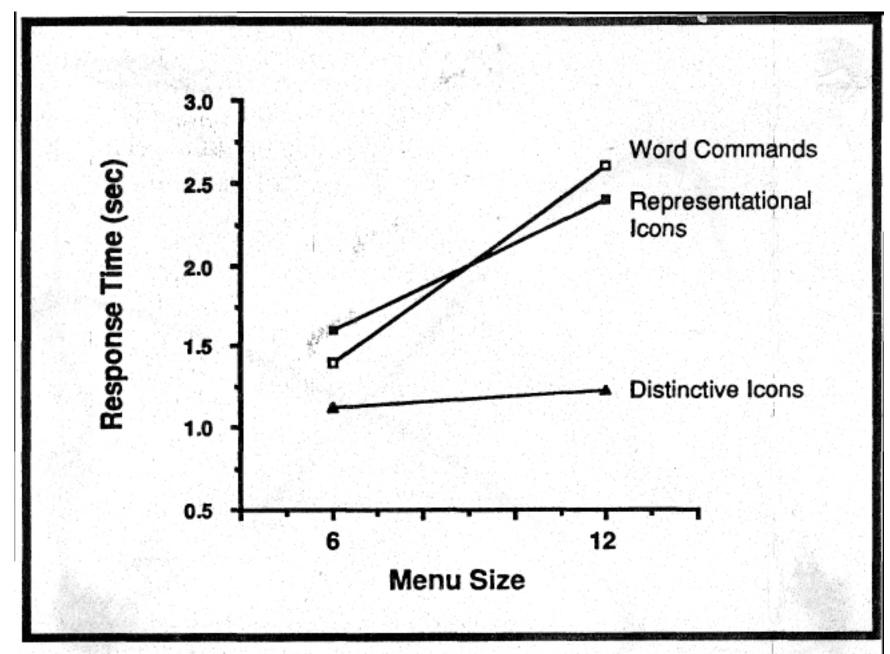


Figure 6.10. Mean response times to word commands, distinctive icons, and representational icons as a function of menu size.

NEW STIIDEN	T ENROLLMENT
COLLEGE OF MERGERS, ACQUISIT	
Student Name:	
Address:	
City:	St: Zip:
Subjects: Major Cod	e: Minor Code:
Semester Enrolling:	Maximum Course Load:
Fee Paid://_	Payment Amount:
Last Bill Sent://_	Outstanding Balance:
Fee Paid: _/_/ Last Bill Sent: _/_/ Application Received: _/	/ Evaluation://
Advisor Name:	Phone: School: Code:Minor Code:
Undergraduate Degree:	School:
Year Graduated: Major	Code: Minor Code:
GPA: Transcript on F	File? (Y/N) _
F1-Help F3-Add Student Esc	-Cancel PgDn-Next Screen

Figure 3-4. Screen with poorly used whitespace.

N)	EW STUDENT ENROLI	LMENT
COLLEGE OF MERGERS,		D YUPPIE LIFESTYLES
Student Name: Address:		
City:		St: Zip:

	City:		st: zip.	
Sem	Subjects: Nester Enroll	Major Code: Maxim	_ Minor Code:	
Fee . Last	Paid: _/_/ Bill Sent:	// Outst	Payment Amount: anding Balance:	·•
Appl Advi	ication Rece sor Name:	ived://_	Evaluation:/ Phone:	
Unde Year GPA:	rgraduate De Graduated: Transc	gree: Sch Major Code ript on File?	Minor Code	• _
F1-Help	F3-Add Stu	dent Esc-Canc	el PgDn-Next Sci	reen

Figure 3-5. Screen with better use of whitespace.

Name:	EE INFORMATION
Address: City: St: Zip: Phone: ( )	
Employer: Work Phone: ()	
Degree: School:	
Year Awarded:	
F1-Help F3-Accept	Changes Esc-Cancel

Figure 3-7. Unbalanced screen.

Name:	CHANGE EMPLOY	EE INFORM	ATION		
Address:		St:	Zip:		
Phone: (	)				
Employer: Work Phone:	()				
Degree: School:	Year Aw	arded:			
F1-Help	F3-Accept	Changes	I	Ssc-Cancel	i i

## Human Vision

Human visual field: about 180 degrees of arc. Fovea(area of highest resolution): about 2 degrees of arc.

75% of the human visual operations are related to the fovea.

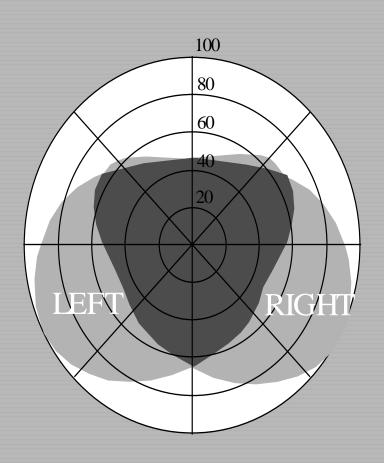
Light reception takes place in the *retina*, which contains 2 types of photoreceptors:

	Cones	Rods
Mediated visual impression	colors	degrees of brightness (b/w)
Distribution over retina	fovea only	not in the fovea
Sensitivity for brightness	low	high

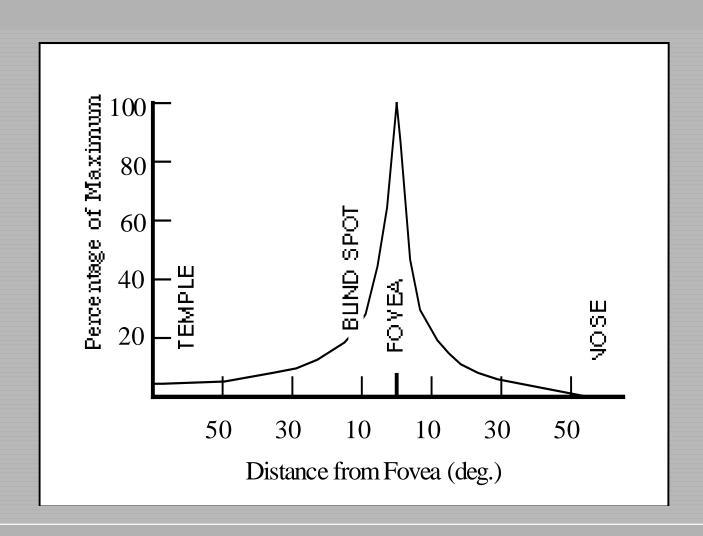
Three types of cones: •

- red-sensitive: 64%, high concentration in fovea area
- green-sensitive: 32%, high concentration in fovea area
- blue-sensitive: 2%, evenly distributed over retina; none in the center of the fovea.

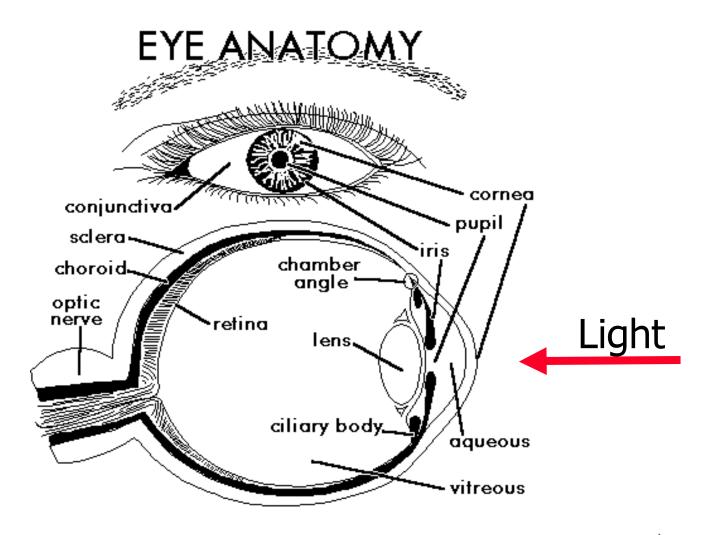
# Human Visual Field



# Acuity Distribution



## What we know about the Eye

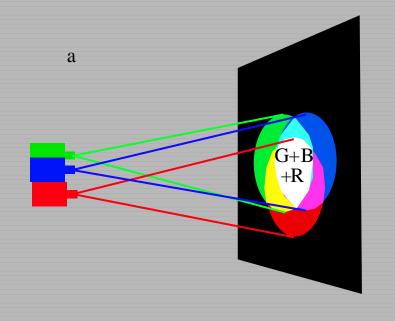


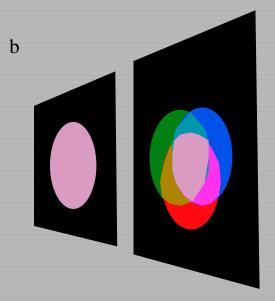


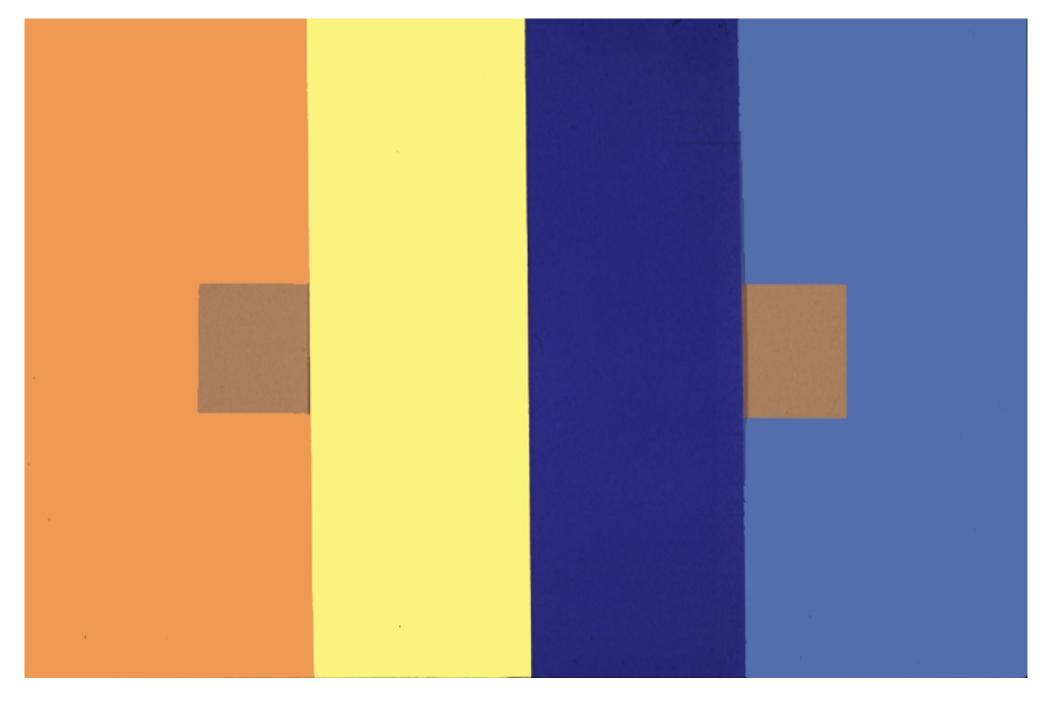


# Trichromacy

Three cones types in retina







# Different color associations

	Hong Kong Chinese (N=784)		Americans	
Concept	Color	%	Color	%
Safe	Green	62.2	Green	61.4
Cold	White	71.5	Blue	96.1
Caution	Yellow	44.1	Yellow	81.1
Go	Green	44.7	Green	99.2
On	Green	22.3	Red	50.4
Hot	Red	31.1	Red	94.5
Danger	Red	64.7	Red	89.8
Off	Black	53.5	Blue	31.5
Stop	Red	48.5	Red	100

Courtney (1986), Bergum and Bergum (1981) Choice of 8 different colors

## Implications from the physiology of the eye

- Do not use blue for small objects (since human sensitivity for blue is very low, particularly in the fovea)
- Blue is a good background color (since human sensitivity for blue is very low and since receptors for blue are roughly evenly distributed over the retina)
- . Neighboring objects should not merely differ by their amount of blue. a a a (red, red with 50% blue, red with 100% blue)
- If red and green are used for small objects, these should be in the center (since the sensitivity for these colors is far higher in the center).
- If red and green are used as signals (warnings) in the periphery, they should have additional emphasis (like blinking or change in size). • •
- . Black, white, yellow and blue can be used in the

periphery since the sensitivity of the retina is roughly the same.





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How do I 'turn on' Cookies in my browser?

Where can I get the latest browsers?

Who do I contact if I have trouble logging in?

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This error message means that your UCInetID and/or password are not valid. If you have forgotten your UCInetID or UCInetID password, please contact:

Network & Academic Computing Services (949)824-6116 - nacs@uci.edu





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Please enter the Electronic Educational Environment using your UCInetID and password within the Secure Sign In form.

**Please Note:** Your password information is secured using this page. After you click 'Sign In' you may receive a **Security Information** box indicating you'll be going to a non-secure page. Simply click 'Continue' or 'OK' as appropriate.



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Table 3-2. Ratings for Color Combinations

Background	Good Foreground Choices	Poor Foreground Choices
black	bright cyan, bright white, cyan, green, white, yellow	blue, brown, magenta
blue	bright white, white, yellow	black, bright red, brown, magenta, red
brown	black, white, yellow	bright blue, bright magenta, magenta, red
cyan	black, blue, bright white, brown, yellow	bright green, bright red, bright magenta, green, red, white
green	black, bright white, white, yellow	bright red, cyan, magenta
magenta	bright magenta, bright white, white, yellow	blue, bright blue, green, red
red	black, bright cyan, bright magenta, bright red, bright white, green, white, yellow	blue, bright blue, brown, magenta
white	black, blue, bright blue, bright white, brown, magenta, red, yellow	cyan, bright cyan, bright magenta, bright red, green

Table 3-1. Uses for 16 Colors Available on PC Monitors

Color	Use
Black	Best for background; acceptable for text in reverse video (black text on a white background) when used in a limited area
Blue	A soothing background color; next to black, the best color to use for backgrounds; poor choice for foreground (text) color, however.
Bright Blue	Usually too bright to read; use cyan instead as the text (foreground) color for contrast.
Bright Cyan	Use only when contrasting with normal cyan.
Bright Green	Usually too bright to read; more difficult to read than other bright colors.
Bright Magenta	Difficult to read; avoid it.
Bright Red	Monitors do not usually display this color accurately, making it extremely difficult to read. For warnings, use regular red.
Bright White	Good choice for text, especially for contrast.
Brown	Almost always looks muddy, and is difficult to read. On some monitors, brown actually appears as red, and thus brown text may be mistaken for a serious error message.
Cyan	This blue-green shade provides good contrast with blue backgrounds, and thus makes an excellent border color or background for data entry fields. It can also be used for text, such as the file name in a word processor or date and time in a heading.
Gray	Difficult to display accurately (usually appears as black). Best to avoid it.
Green	Mostly closely associated with go, so use it for continue messages (Press any key to continue). Also good as a border color. Use a green

Green wostly closely associated with go, so use it for continue messages (Press any key to continue). Also good as a border color. Use a green background with white text or green text on a black background. Magenta Avoid when possible; text is difficult to read in this color. It may be acceptable if used in a warning message or to indicate unusual situations (negative numbers in a report); magenta text appears best against a white or gray background. Red Use for warnings or severe error messages, or for messages that require the user to stop (such as the WAIT message when a spreadsheet is recalculating). White Useful for text, especially when bright white indicates boldness. Yellow An excellent choice for text, especially when you need contrast. Also good for titles, headings, and borders.

### **Best Color Combinations**

### (N=16)

	Thin Lines and Text	Thick Lines and Panels
Backgroun	d	
White	Blue(94%). Black(63%), Red(25%)	Black(69%), Blue(63%), Red(31%)
Black	White(75%), Yellow(63%)	Yellow(69%), White(50%), Green(25%)
Red	Yellow(75%), White(56%), Black(44%)	Black(50%), Yellow(44%), White(44%), Cyan(31%)
Green	Black(100%), Blue(56%), Red(25%)	Black(69%), Red(63%), Blue(31%)
Blue	White(81%), Yellow(50%), Cyan(25%)	Yellow(38%), Magenta(38%), Black(31%), Cyan(31%), White(25%)
Cyan	Blue(69%), Black(56%), Red(37%)	Red(56%), Blue(50%), Black(44%), Magenta(25%)
Magenta	Black(63%), White(56%), Blue(44%)	Blue(50%), Black(44%), Yellow(25%)
Yellow	Red(63%), Blue(63%), Black(56%)	Red(75%), Blue(63%), Black(50%)
4	The state of the s	

### **Worst Color Combinations**

(N=16)

Thin Lines and Text

Thick Lines and Panels

Background

White	Yellow(100%), Cyan(94%)	Yellow(94%), Cyan(75%)
Black	Blue(87%), Red(37%), Magenta(25%)	Blue(81%), Magenta(31%)
Red	Magenta(81%), Blue(44%), Green(25%), Cyan(25%)	Magenta(69%), Blue(50%), Green(37%), Cyan(25%)
Green	Cyan(81%), Magenta(50%), Yellow(37%)	Cyan(81%), Magenta(44%), Yellow(44%)
Blue	Green(62%), Red(37%), Black(37%)	Green(44%), Red(31%), Black(31%)
Cyan	Green(81%), Yellow(75%), White(31%)	Yellow(69%), Green(62%), White(56%)
Magenta	Green(75%), Red(56%), Cyan(44%)	Cyan(81%), Green(69%), Red(44%)
Yellow	White(81%), Cyan(81%)	White(81%), Cyan(56%), Green(25%)

Background

Figure 8.3 Best and Worst Color Combinations from Murch [1984b]

#### Effective Color Combinations for Text Applications in Interactive Displays

#### Dark Backgrounds

Number of Colors	Good	<b>Bad</b>
2	white + green gold + cyan/green green + magenta/lavender cyan + red	red + blue/green/purple/yellow/magenta white + cyan/yellow white+ cyan/yellow blue + green/purple green + cyan cyan + lavender
1.45 (1.45)	wnne + gold + green/blue/magenta white + red + cyan red + cyan + gold cyan + yellow + lavender gold + magenta + blue/green gold + kwender + green	red + yellow + green red + blue + green white + cyan + yellow red + magenta + blu- green + cyan + blue

#### Effective Colors for Computer Aided Design Applications

#### 3D effects

Number or colors	furthest	to	closest
2	<b>b</b> fuie	-	red
3	blue gre	en / yellow	- red
4	blue - gree	en - yello	w - red
5	blue - green	- yellow - or	ange - red
6	purple -blue-g	T .	1

#### Process Control Applications

To Show:

concentration levels LOW concentration levels HIGH

life support status OK life support status CAUTION life support status EMERGENCY

direction IN direction OUT

#### Measurement Applications

Inspection/Quality Graphs

For:

gnids data points variance or error bars out of spec data labels ·X

Use:

desaturated colors scriurated colors

blue/green/white yellow/gold red (flashing option)

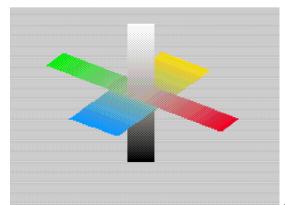
ređ blue

Use:

gray yellow blue (medium) red lavender limegreen cyan

# More guidelines for the usage of colors

- . Do not use more than 4-7 colors per screen.
- Color impression varies, depending on the background.

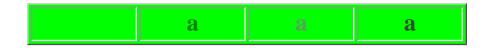


A possible color model

 To distinguish small objects, they should not only differ in their colors but also in their *lightness* (= amount of achromatic color, ranging from white over grey to

- black) aa aa
- . For very fine details, use black and white.
- To draw attention to an object, make it differ from its environment in terms of its brightness and saturation (brightness is determined by the intensity of the light source; a saturated color is one that is composed of light with a narrow spec trum)

E xample:



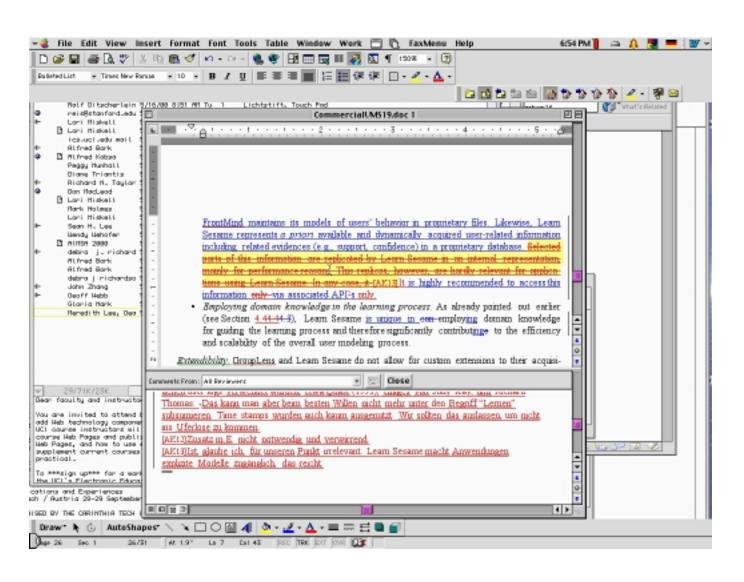
Green letter against green background that is distinguished in (a) nothing, (b) lightness (not brightness!), (c) saturation, (d) lightness and saturation.

Reading becomes harder if colors differ both in saturation and in their spectra.

+ Use color conservatively

Design for monochrome first • Use automatic color palettes

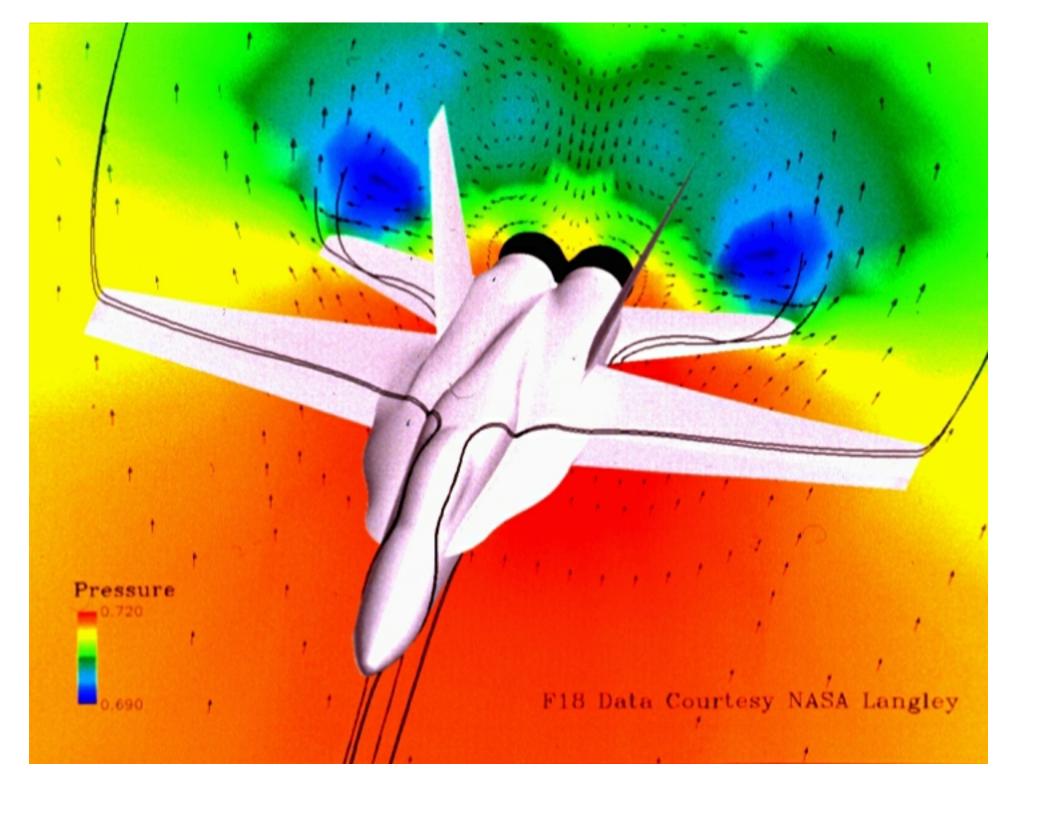
# Color in a typical contemporary screen



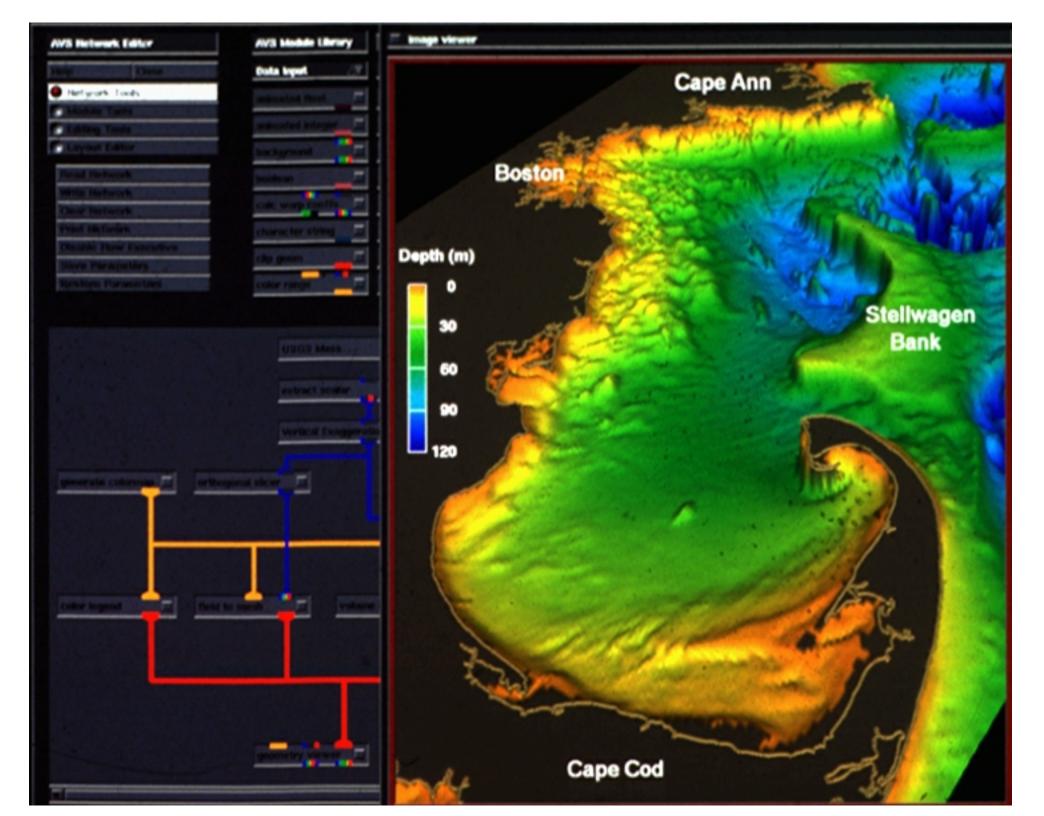
The screen looks relatively colorful, but this is due to text being edited (red font indicates changed text, and yellow background signals marked text). The general appearance of the application shown here is very much monochrome, as is the case for most other commercial applications today.

### Recommendable usage of colors

- Emphasis (particularly when used as background)
- Grouping of neighboring objects
   (particularly when used as background)
- Coding of discrete data
   (not more than 7+/-2 colors if codes have to be remembered)
- . Window systems: marking the type of window or application
- Graphics: Visual separation of overlapping graphical elements or labels
- Depth in 3-D graphics
   (reddish colors appear closer, bluish colors more distant)
- Naturalness in photorealistic images
- Coding of continuous data in information landscapes (e.g., false color representation)
- . Warnings, status reports
- To increase the attractiveness of an interface, following guidelines for color selection (increased attractiveness does not necessarily imply an increase in usability)







# Hypermedia

- 1. What is hypermedia? •
- 2. Hypermedia design goes far beyond HCI design • •
- 3. Unrestricted hypermedia makes orientation difficult •
- 4. HCl guidelines for web design (Farkas & Farkas) •
- 5. Scent •

# Hypermedia (specifically the WWW)

## Two major architectural components:

#### **Nodes**

contain information, which is presented through several media

#### Links

lead from visible elements in nodes to other nodes (or sometimes to other elements within the same node)

#### HCI view:

#### **Navigation between pages**

contributions from HCI, domain experts, technical communication **Information presentation** 

contributions from technical communication, domain experts, writing sciences, marketing, HCI, cinematic arts

#### **Multimedia layout**

contributions from visual arts, media arts, marketing, HCI



jadore LE FEMININ ABSOLU.

Make-up

Fragrances

Skincare

YOUT COLORS

Where make-up meets wardrobe

Master your make-up

Secrets from the experts for your:

Complexion Hair Eyes Lips Manicure Cheeks



Make-up at a glance

An overview of Dior's family of:

Lipsticks Foundations Mascaras

Exotic chic!

Add some spice to your life with a touch of the exotic!

From the editors of ELLE

Do's and Dont's
The eyes have it!

May 2000

From the editors of ELLE

Magazine

Dior's Eye on Beauty Trends

Make-up Guide:

advice from an expert Mother's day Dior Gallery

The best of Dior

Gruau forever!

Red: Story of a Color

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INANCE



Chairman's message

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Financial release

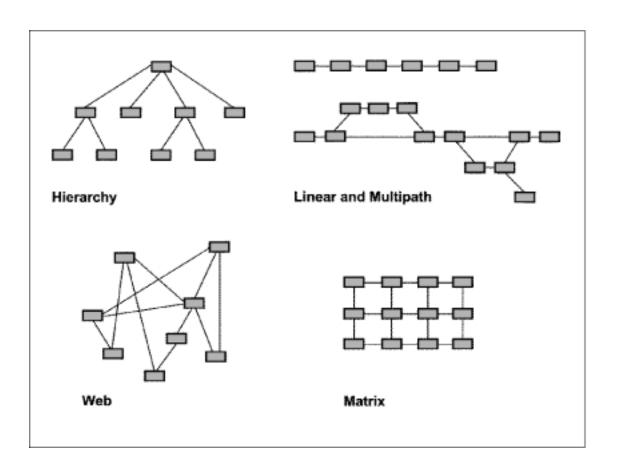
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# Possibe web structures



- Users generally prefer hierarchical or linear structures
- Beginning users and particularly elderly people have considerable orientation problems with web-like structures ("lost in hyperspace")

# Web Design Guidelines by Farkas & Farkas

## 1. Designing an Effective Link

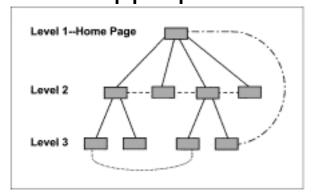
- 1.1 Be sure that all links indicate that they are links underlining, buttons, items in colums, textual hints, mouse rollover, changing cursor icon, and semantics ◆
- 1.2 Work to ensure that users will view and notice links

  Put important links above scroll lines; entice users to scroll past scroll lines
- 1.3 Be sure that all links clearly indicate their destinations Text links, explanatory text, mouse rollover

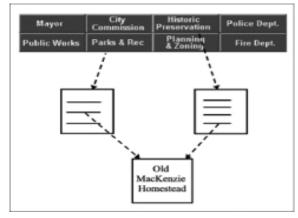
# 2. Managing large number of links

2.1 Plan effective ratios of breadth and depth in Web site hierarchies Breadth over depth, grouping •

2.2 Supplement the primary links of a Web site with secondary links, when appropriate



2.3 Allow branches of a hierarchy to converge whenappropriate



2.4 Design the interface to readily reveal the underlying information structure

# 3. Providing orientation information

3.1 Provide clear, brief, and highly conspicuous orientation

information on the home

**Page.** What is this site about? ◆ ("Splash" pages are o.k. if you can click them away).

3.2 Provide orientation information on lower-level pages to support continued

exploration of your Web site.

static: ◆ collapsable: ◆ multi-layered: ◆ expandible wheels: ◆

# 4. Augmenting link to link navigation

4.1 Employ site maps to show the global structure of a site and to provide

direct access to nodes • • •

- 4.2 Provide a search facility or an index for direct access to content
- 4.3 Provide a link to the home page throughout the site

# Scent

Links should "smell" like what the user wants.

- confidence before clicking the link
- feeling closer to the answer afterwards

### Pragmatic measure of information scent (Spool et al., 1998)

- 1. Ask users before they click
  - a) What they thought they would get
  - b) How confident they were (on a -2 to +2 scale)
- 2. Ask users after they click
  - c) whether they were closer to the search goal (on a -2 to +2 scale)
  - d) add the results from (b) and (c)
  - e) add the results from (d) cumulatively

The score in (d) is highly correlated with ultimate success. It should

increase monotonously.

Users are however notorously bad in predicting how far the desired information is still away.

# Virtual Realities

#### Main characteristics:

- Three-dimensional objects and environments
- Multi-sensory input (visual, auditive, haptic, autosensory)
- User should feel immersed

#### I/O devices:

- "Desktop VR": (touchsensitive) Screen, Mouse (3D) •
- "Immersion VR": helmet , LCD glasses, or cave data glove, location detectors

# Main usage

- Exploration \*\* and demonstration \* of 3D objects or environments
- Training
- Virtual interface
- Physical co-presence with others (entertainment, meetings)

### Immersion improved through:

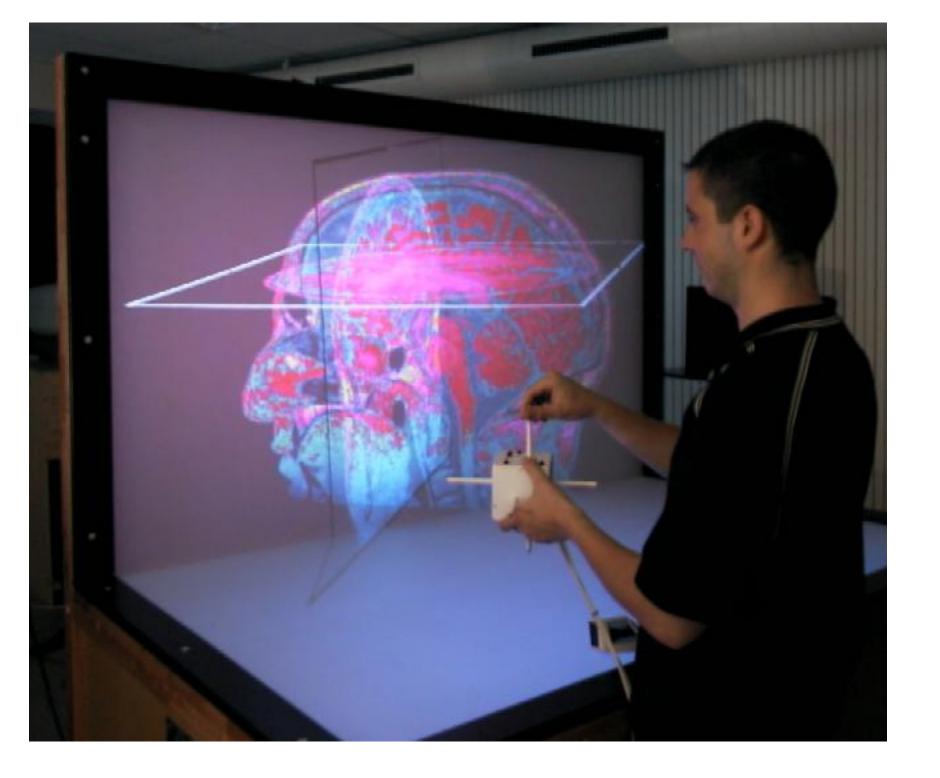
- matching input from at least two sensors
- high refresh rate
- small delays after user actions (< 100 msec)</li>
- at least monoscopic view with motion parallax (added stereoscopy is better)
- three-dimensional sound

#### **Problems:**

 many users of immersion VR get headaches, become drowsy, nauseous...

(due to vection, lag of visual update??)

• users loose orientation (\* landmarks, simple layout, color codes, footprints...)





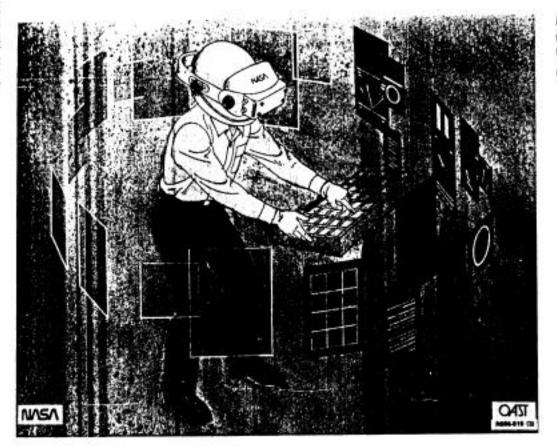
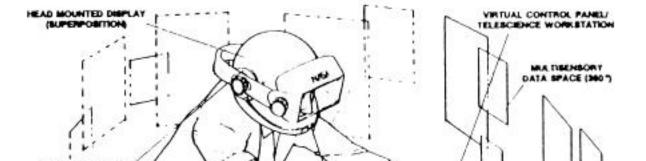


Figure 7: Telepresence in Dataspac with the Ames Virtual Environment Workstation. Picture courtesy of NASA.

#### VIRTUAL INTERFACE ENVIRONMENT SPACE STATION SYSTEMS AND DATA MANAGEMENT



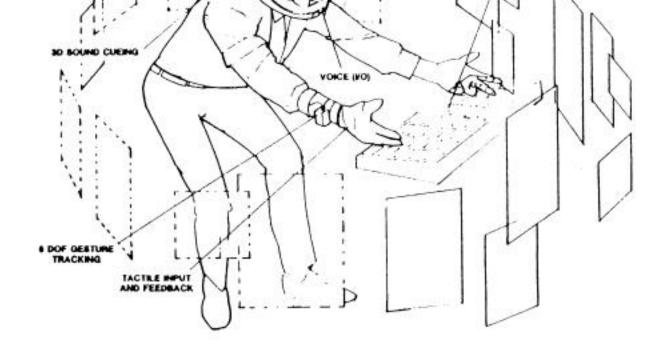


Figure 9.14 The NASA design for telerobotics

## Computer-Supported Cooperative Work

- Types of CSCW, and supporting technology
- Some key problems in CSCW
- Usefulness of different modalities for synchroneous CSCW
- New paradigms

# Computer-Supported Cooperative Work (CSCW): Types and Supporting Technology

	Same time (synchronous)	Different time (asynchronous)
Same location	Computer-supported meeting rooms •	<ul><li>E-mail</li><li>Newgroups</li><li>Shared repositories</li><li>Group awareness tools</li><li>Workflow systems</li></ul>
locations  • text-based chat  • Group awarenes		<ul><li>Newsgroups</li><li>Shared repositories</li><li>Group awareness tools</li><li>Distributed workflow</li></ul>

# **Key problems in CSCW**

- 1. In multi-party remote meetings:
  - Turntaking (audio delay, video angle, lack of peripheral/sublimal awareness...):
    - \* requires strict floor control
  - Lack of immersion

2. In multi-party physical meetings with remote members:

Same as above, for remote members

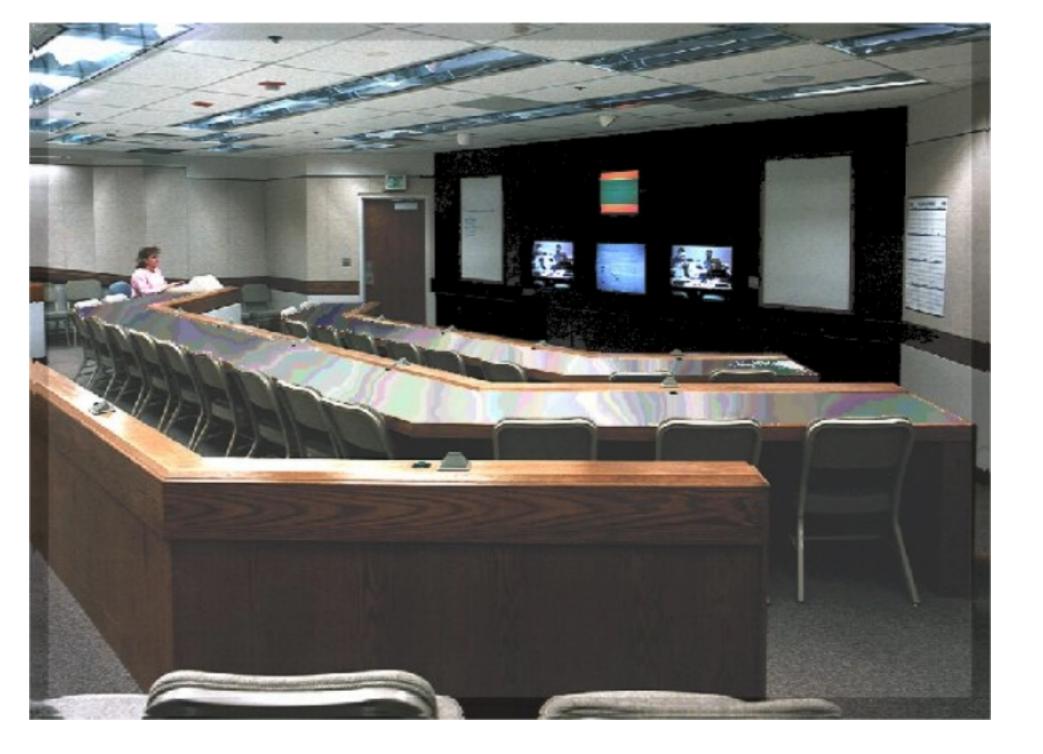
Social dynamics changes •

3. In 1 on 1 conferencing (but also multi-party)

Eye contact ◆

# Usefulness of different modalities for synchronous CSCW

	Audio only	Audio + shared objects	Audio + Video
1 on 1 conferencing	++	+++	++
multiparty physical meeting with remote members	0	+	+
multiparty remote meeting	+	++	+
peripheral awareness	++	n.a.	++









# **Handheld Devices**

Wide variety of shapes

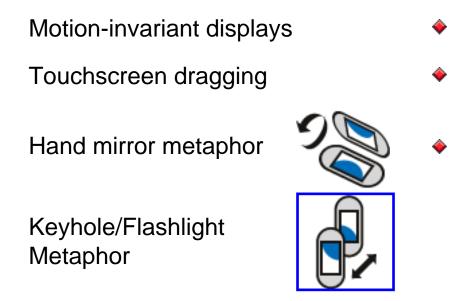


- Often used in an "eye-less mode" (due to distraction or adverse light conditions)
  - + High-tactility keypads necessary
     (elevated keys, sufficient distance, from material that feels different than chassis)
     [audio feedback too much dependent on ambient noise level!]
- Menus should be relatively flat

Vertical screen size thereby does not seem to play a major role, unless it is very tiny (i.e. one line only)

- Highly targeted information provision necessary
  - + A case for personalization

## New interaction paradigms possible



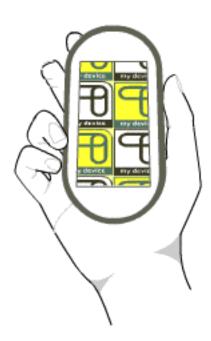


Merely speaking to other people by phone places a sufficiently dangerous cognitive load on drivers (much higher than when talking to a passenger)

P.S.: All these guidelines are still in flux and scientifically not yet fully established









# HCI for people with disabilites

- 1. Manually impaired users •
- 2. Visually impaired users •
- 3. Hearing-impaired users
- 4. Cognitively impaired users

Legal requirements to make software and websites accessible:

- Americans with Disabilities Act (ADA)
- Presidential Directive for Federal Government sites
- Section 508 of the Rehabilitation Act of 1973 for colleges
- Institutional directives (e.g., UCI's Electronic Communications Policy)

# Manually impaired users

Includes people with disabilities, but also many elderly users and "situationally handicapped" users. They have, e.g., problems

- 1. Positioning the mouse, clicking and dragging.
- \* Mouse operations should also be performable using the keyboard only
- (e.g., use cursor keys for navigation, function key for selecting menu items)
- 2. Simultaneously pressing two or more keys (e.g., CTRL and SHIFT).
- \* Allow users to press these keys sequentially.
- 3. Entering larger amounts of data
- \* Provide default values

Provide next possible values when user presses a key Successively provide next possible value; stop when user hits a key

Expand input to first possible value
Allow users to define aliases and shortcuts

For severe forms of manual impairment, special input devices are needed (head mouse, foot mouse, suction tubes, speech recognition.)

# Visually impaired users

Includes many elderly users.

## 1. Problems with color perception •

\* Use color redundantly Color-code larger areas only Colors should differ in at least two primary colors For elderly people, allow for more brightness after extended computer work

# 2. Problems perceiving small objects

\* Allow for screen magnification

## 3. Blindness

\* Special I/O devices (Braille •, speech output, physical models) Special software (e.g, "screen readers", "web-to-speech translators")

Special design guidelines (e.g., http://www.w3.org/WAI/#Guidelines •)

Web analyzer Bobby <a href="http://www.cast.org/bobby/">http://www.cast.org/bobby/</a>



# Designing and Evaluating Uls

1. Set up a design *team* 

(Programmers, HCI designers, graphical designers / artists, technical authors, user representatives, management representatives)

- 2. Gather requirements, analyze tasks and users
- 3. Start UI design early (before code is written)
  - helps elicit requirements from customers
  - serves as a requirements specification for customers and programmers
- 4. Use software tools for UI design and prototyping •
- 5. Follow guidelines (e.g., ISO 9241, OS-specific guidelines ♦ ♦, house styles)
- Make evaluation

   a central component of system design
  - Start early (before code has been written)
  - Use evaluation in all phases (formative and summative)
  - Involve real users
  - Use "cheap" techniques first (e.g., walkthroughs)

## 7. Develop guidelines







Performance from Experience

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Feedback

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0.00

-7.05

Change

Go

Personalize: Page Settings . Content . Layout . Color





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#### Northeast Readies For Snowstorm

Authorities in the Northeast readied salt trucks and imposed emergency regulations Sunday in anticipation of a powerful winter storm that could paralyze the region with more than a foot of snow. Winter storm watches were in effect from Virginia beginning Sunday and . . . more

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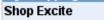
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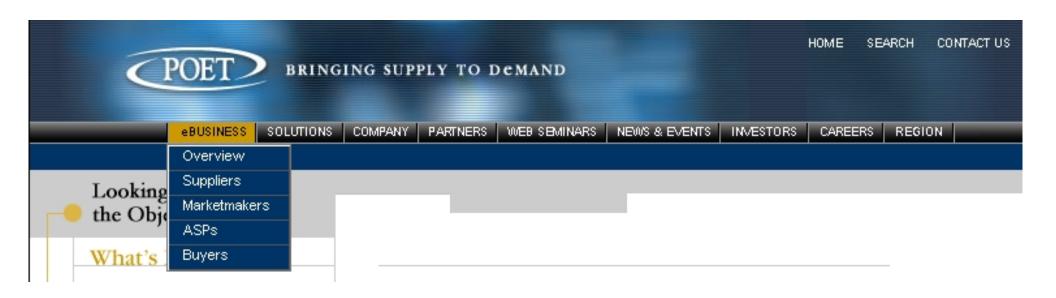
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### Welcome to humanIT

## Successful Presentation during WDR Computer Night at the Heinz Nixdorf Museums Forum



"Visions 2000 - Windows into the next Millenium" was the theme of the 1999 WDR Computer Night and humanIT was a natural partner, showcasing its revolutionary visualization product InfoZoom®.

InfoZoom was at the center of the humanIT booth where Andreas Brueggenthies demonstrated the excellence of InfoZoom in a live television interview with CCNight moderator Wolfgang Back (see picture).

3000 attendees at the sold out Heinz Nixdorf Forum (Paderborn), WDR television viewers, Deutschlandfunk radio listeners, and internet-fans (full live-cast) were part of the event. See <a href="http://www.ccnacht.de/">http://www.ccnacht.de/</a> (in German) for details.



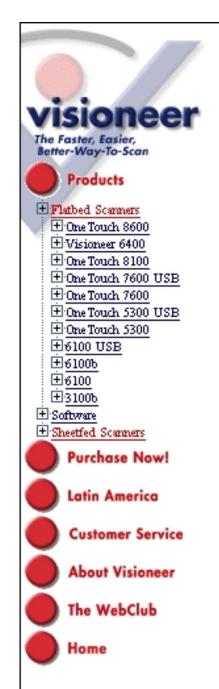


humanIT was present at three booths of its partners:

- GMD Hall 16 / Booth D59
- POET Hall 3 / Booth D03
- <u>Eutelis</u>
   Hall 25 / Booth D84/2

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Our Products





#### North American Sales

Flatbed Scanners Name/Description OneTouch Scanners	Price		Rebate	Aft	
OneTouch 8600 600x1200 dpi, 36-bit, 7 buttons, JET Compression, Win 98/USB, Win 95/98/NT 4.0/Parallel Part No. 86001D-WC	\$199.99	N/A		\$199.99	
OneTouch 8100 600x1200 dpi, 42-bit Color, 5 buttons, Win 98, USB and Win 95/98/NT, Parallel	\$179.99	<u>\$30.</u>		\$149.99	
OneTouch 7600USB 600x1200 dpi, 36-bit, 5 buttons, Win 98, USB Part No. 76001D-WU	\$99.99	N/A		\$99.99	
OneTouch 7600 600x1200 dpi, 36-bit, 5 buttons, Win 95/98/NT, Parallel Part No. 76001D-WP	\$99.99	N/A		\$99.99	
OneTouch 5300USB 300x600 dpi, 36-bit, 5 buttons,	\$79.99	N/A		\$79.99	



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Men's ( Gifts Gap Cl Wear to	assics	Jeans Khakis Pants Shorts	Polo Ts Shir Swe		Outerwear Activewear Accessorie	•Und s •Lou	ody: erwear nge/Sleep Scents	you have: 0 Item(s) Checkout

#### Polos

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#### Polos

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Topo USA: Fly-Fishing Edition

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**Network Editions** 

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GpsTripmate®

Earthmate Road Warrior Edition

GPS PostPro®

Solus Pro

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<u>GPS Adapter Cable for</u> <u>Palm™ III and VII</u> Handhelds

GPS Adapter Cable for Palm™ V Handhelds

GPS Adapter Cable for Palm m100 Handhelds

GPS Adapter Cable for Handspring Visor™ Handhelds

<u>Jotto Desk: in-car</u> mobile office desk

<u>Power UniMount™ from</u> Revolve Design

<u>Laptop Power Adapter</u> <u>Cable for Earthmate</u> GPS Receiver

<u>Earthmate USB Power</u> Adapter Cable

#### Paper Maps & Books

Atlas & Gazetteer\*\*
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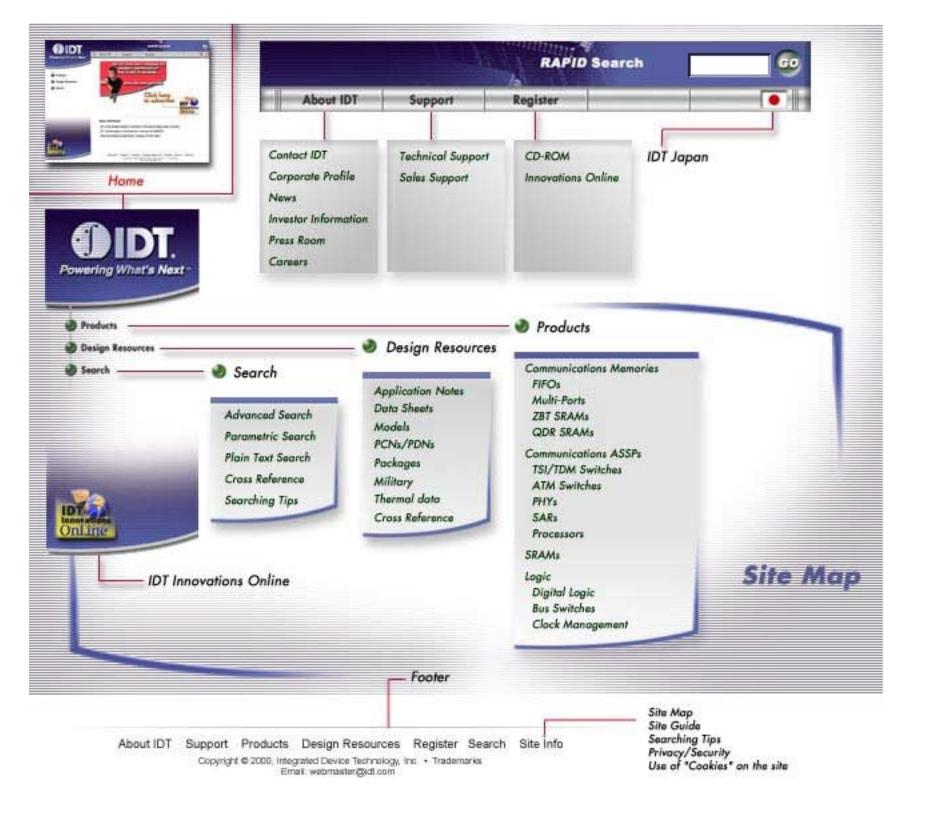
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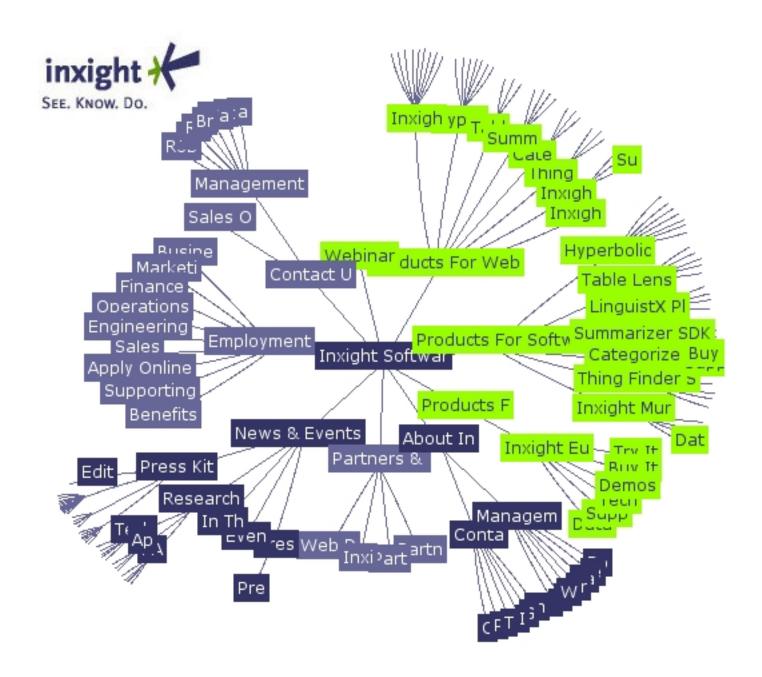
<u>Atlas</u> <u>Accessories</u>

Product Reviews

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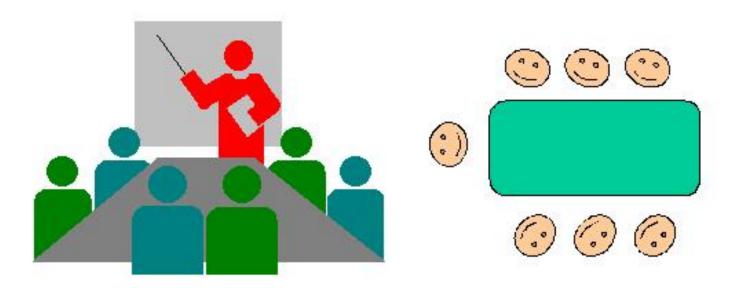






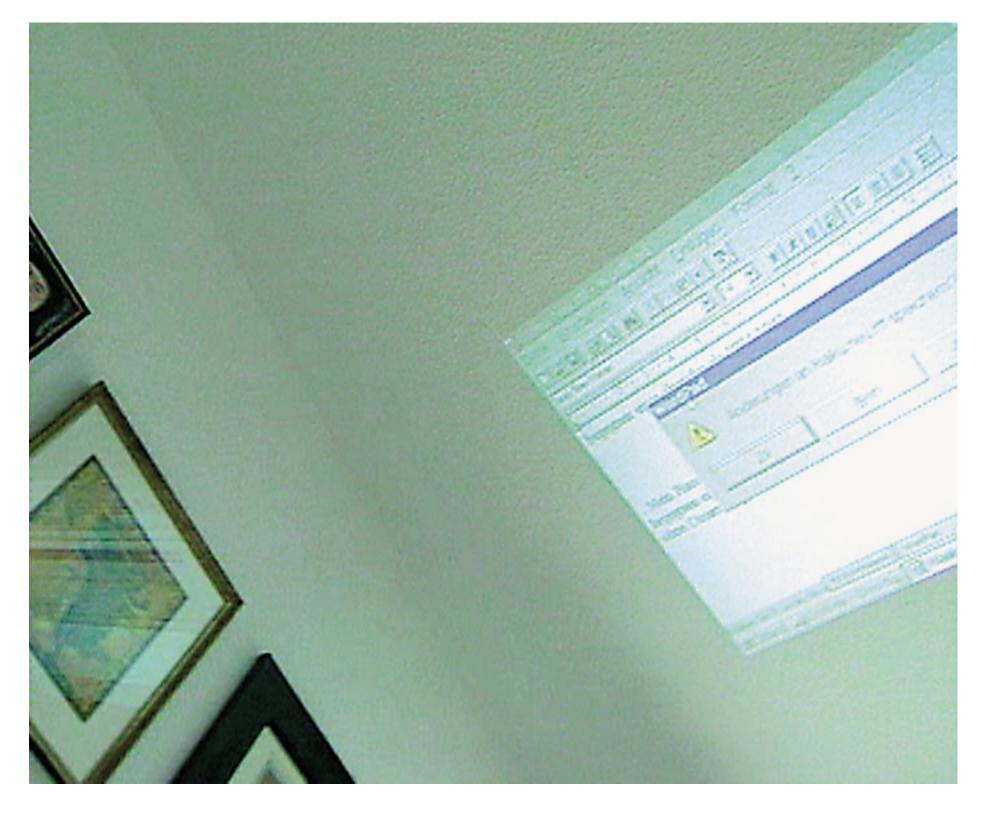


# Videoconferences can change social dynamics



- Meeting behaviors are highly practiced.
- What happens when camera, microphone, and monitor are added?





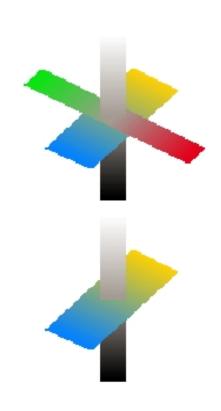
# Color deficiencies, adaptation problems

## 1. Color deficiencies

8% of white U.S. males are red/green blind

(less in other races; white females: 0.5%) these colors appear medium-gray

Design for monochrome first, and add color as a *redundant* device.
 If this is not (fully) possible, objects should not only be distinguished by their amount of red or green.

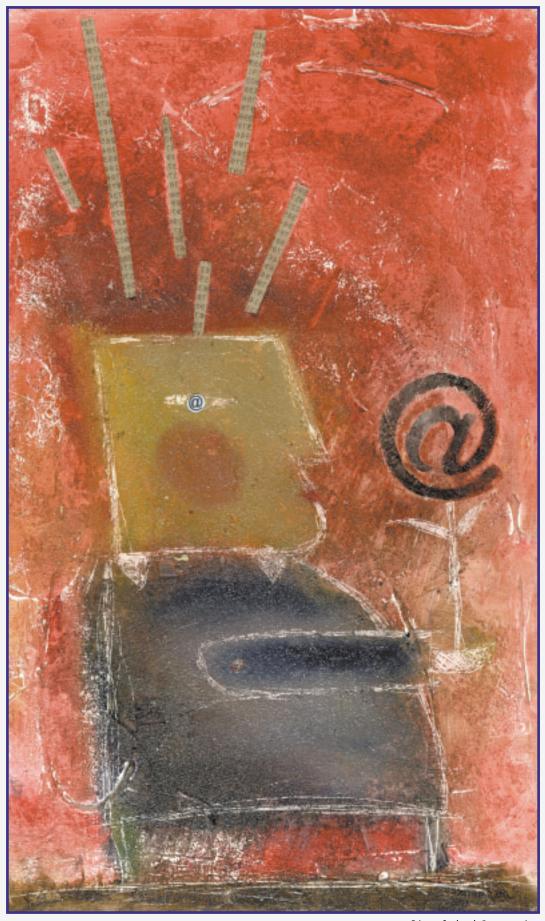


# 2. Adaptation problems

Colors have different wavelengths, ranging from red (610nm) to orange, yellow,

green, blue and violett (380nm). Pupils must refocus when colors change.

+ When users' eyes must constantly switch between objects of different color, avoid combinations of colors that differ strongly in their wavelengths (this hold particularly true for elderly users).



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# Web Content Accessibility Guidelines 1.0

#### EDITORS:

Wendy Chisholm, Trace R & D Center, University of Wisconsin—Madison Gregg Vanderheiden, Trace R & D Center, University of Wisconsin—Madison Ian Jacobs, W3C

#### Abstract

These guidelines explain how to make Web content accessible to people with disabilities. The guidelines are intended for all Web content developers (page authors and site designers) and for developers of authoring tools. The primary goal of these guidelines is to promote accessibility. However, following them will also make Web content more available to all users, whatever user agent they are using (e.g., desktop browser, voice browser, mobile phone, automobile-based personal computer, etc.) or constraints they may be operating under (e.g., noisy surroundings, under- or over-illuminated rooms, in a hands-free environment, etc.). Following these guidelines will also help people find information on the Web more quickly. These guidelines do not discourage content developers from using images, video, etc., but rather explain how to make multimedia content more accessible to a wide audience.

This is a reference document for accessibility principles and design ideas. Some of the strategies discussed in this document address certain Web internationalization and mobile access concerns. However, this document focuses on accessibility and does not fully address the related concerns of other W3C Activities. Please consult the W3C Mobile Access Activity home page and the W3C Internationalization

Activity home page for more information.

This document is meant to be stable and therefore does not provide specific information about browser support for different technologies as that information changes rapidly. Instead, the Web Accessibility Initiative (WAI) Web site provides such information (refer to [WAI-UA-SUPPORT]).

This document includes an appendix that organizes all of the checkpoints by topic and priority. The checkpoints in the appendix link to their definitions in the current document. The topics identified in the appendix include images, multimedia, tables, frames, forms, and scripts. The appendix is available as either a tabular summary of checkpoints or as a simple list of checkpoints.

A separate document, entitled "Techniques for Web Content Accessibility Guidelines 1.0" ([TECHNIQUES]), explains how to implement the checkpoints defined in the current document. The Techniques Document discusses each checkpoint in more detail and provides examples using the Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), Synchronized Multimedia Integration Language (SMIL), and the Mathematical Markup Language (MathML). The Techniques Document also includes techniques for document validation and testing, and an index of HTML elements and

attributes (and which techniques use them). The Techniques Document has been designed to track changes in technology and is expected to be updated more frequently than the current document. Note. Not all browsers or multimedia tools may support the features described in the guidelines. In particular, new features of HTML

4.0 or CSS 1 or CSS 2 may not be supported.

"Web Content Accessibility Guidelines 1.0" is part of a series of accessibility guidelines published by the Web Accessibility Initiative. The series also includes User Agent Accessibility Guidelines ([WAI-USERAGENT]) and Authoring Tool Accessibility Guidelines ([WAI-AUTOOLS]).

#### 1. Introduction

For those unfamiliar with accessibility issues pertaining to Web page design, consider that many users may be operating in contexts very different from your own:

- ★ They may not be able to see, hear, move, or may not be able to process some types of information easily or at all.
- They may have difficulty reading or comprehending text.
- ★ They may not have or be able to use a keyboard or mouse.
- ★ They may have a text-only screen, a small screen, or a slow Internet connection.
- ➤ They may not speak or understand fluently the language in which the document is written.
- ➤ They may be in a situation where their eyes, ears, or hands are busy or interfered with (e.g., driving to work, working in a loud environment, etc.).
- ★ They may have an early version of a browser, a different browser entirely, a voice browser, or a different operating system.

Content developers must consider these different situations during page design. While there are several situations to consider, each accessible design choice generally benefits several disability groups at once and the Web community as a whole. For example, by using style sheets to control font styles and eliminating the FONT element, HTML authors will have more control over their pages, make those pages more accessible to people with low vision, and by sharing the style sheets, will often shorten page download times for all users.

The guidelines discuss accessibility issues and provide accessible design solutions. They

address typical scenarios (similar to the font style example) that may pose problems for users with certain disabilities. For example, the first guideline explains how content developers can make images accessible. Some users may not be able to see images, others may use text-based browsers that do not support images, while others may have turned off support for images (e.g., due to a slow Internet connection). The guidelines do not suggest avoiding images as a way to improve accessibility. Instead, they explain that providing a text equivalent of the image will make it accessible.

How does a text equivalent make the image accessible? Both words in "text equivalent" are important:

- ➤ Text content can be presented to the user as synthesized speech, braille, and visually-displayed text. Each of these three mechanisms uses a different sense—ears for synthesized speech, tactile for braille, and eyes for visually-displayed text—making the information accessible to groups representing a variety of sensory and other disabilities.
- ➤ In order to be useful, the text must convey the same function or purpose as the image. For example, consider a text equivalent for a photographic image of the Earth as seen from outer space. If the purpose of the image is mostly that of decoration, then the text "Photograph of the Earth as seen from outer space" might fulfill the necessary function. If the purpose of the photograph is to illustrate specific information about world geography, then the text equivalent should convey that information. If the photograph has been

designed to tell the user to select the image (e.g., by clicking on it) for information about the earth, equivalent text would be "Information about the Earth." Thus, if the text conveys the same function or purpose for the user with a disability as the image does for other users, then it can be considered a text equivalent.

Note that, in addition to benefitting users with disabilities, text equivalents can help all users find pages more quickly, since search robots can use the text when indexing the pages.

While Web content developers must provide text equivalents for images and other multimedia content, it is the responsibility of user

agents (e.g., browsers and assistive technologies such as screen readers, braille displays, etc.) to present the information to the user.

Non-text equivalents of text (e.g., icons, pre-recorded speech, or a video of a person translating the text into sign language) can make documents accessible to people who may have difficulty accessing written text, including many individuals with cognitive disabilities, learning disabilities, and deafness. Non-text equivalents of text can also be helpful to nonreaders. An auditory description is an example of a non-text equivalent of visual information. An auditory description of a multimedia presentation's visual track benefits people who cannot see the visual information.

ly. Pages that transform gracefully remain accessible despite any of the constraints described in the introduction, including physical, sensory, and cognitive disabilities, work constraints, and technological barriers. Here are some keys to designing pages that transform gracefully:

- ★ Separate structure from presentation (refer to the difference between content, structure, and presentation).
- ★ Provide text (including text equivalents). Text can be rendered in ways that are available to almost all browsing devices and accessible to almost all users.
- ★ Create documents that work even if the

#### Status of this document

This document has been reviewed by W3C Members and other interested parties and has been endorsed by the Director as a W3C Recommendation. It is a stable document and may be used as reference material or cited as a normative reference from another documents. W3C's role in making the Recommendation is to draw attention to the specification and to promote its widespread deployment. This enhances the functionality and universality of the Web.

The English version of this specification is the only normative version. However, for translations in other languages see http://www.w3.org/WAI/GL/WAI-WEBCONTENT-TRANSLATIONS.

The list of known errors in this document is available at http://www.w3.org/WAI/GL/WAI-WEBCONTENT-ERRATA. Please report errors in this document to wai-wcag-editor@w3.org.

A list of current W3C Recommendations and other technical documents can be found at http://www.w3.org/TR.

This document has been produced as part of the W3C Web Accessibility Initiative. The goal of the Web Content Guidelines Working Group is discussed in the Working Group charter.

The specifications may be found at: http://www.w3.org/TR/WCAG10/

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#### 2. Themes of Accessible Design

The guidelines address two general themes: ensuring graceful transformation, and making content understandable and navigable.

#### 2.1 Ensuring Graceful Transformation

By following these guidelines, content developers can create pages that transform graceful-

user cannot see and/or hear. Provide information that serves the same purpose or function as audio or video in ways suited to alternate sensory channels as well. This does not mean creating a prerecorded audio version of an entire site to make it accessible to users who are blind. Users who are blind can

- use screen reader technology to render all text information in a page.
- ➤ Create documents that do not rely on one type of hardware. Pages should be usable by people without mice, with small screens, low resolution screens, black and white screens, no screens, with only voice or text output, etc.

The theme of graceful transformation is addressed primarily by guidelines 1 to 11.

### 2.2 Making Content Understandable and Navigable

Content developers should make content understandable and navigable. This includes not only making the language clear and simple, but also providing understandable mechanisms for navigating within and between pages. Providing navigation tools and orientation information in pages will maximize accessibility and usability. Not all users can make use of visual clues such as image maps, proportional scroll bars, side-by-side frames, or graphics that guide sighted users of graphical desktop browsers. Users also lose contextual information when they can only view a portion of a page, either because they are accessing the page one word at a time (speech synthesis or braille display), or one section at a time (small display, or a magnified display). Without orientation information, users may not be able to understand very large tables, lists, menus, etc.

The theme of making content understandable and navigable is addressed primarily in guidelines 12 to 14.

### 3. How the Guidelines are Organized

This document includes fourteen guidelines, or general principles of accessible design. Each guideline includes:

- ★ The guideline number.
- ★ The statement of the guideline.
- ➤ Guideline navigation links. Three links allow navigation to the next guideline (right arrow icon), the previous guideline (left arrow icon), or the current guideline's position in the table of contents (up arrow icon).
- \* The rationale behind the guideline

- and some groups of users who benefit from it.
- ★ A list of checkpoint definitions.

The checkpoint definitions in each guideline explain how the guideline applies in typical content development scenarios. Each checkpoint definition includes:

- **★** The checkpoint number.
- \* The statement of the checkpoint.
- ➤ The priority of the checkpoint. Priority 1 checkpoints are highlighted through the use of style sheets.
- ★ Optional informative notes, clarifying examples, and cross references to related guidelines or checkpoints.
- ★ A link to a section of the Techniques Document ([TECHNIQUES]) where implementations and examples of the checkpoint are discussed.

Each checkpoint is intended to be specific enough so that someone reviewing a page or site may verify that the checkpoint has been satisfied.

#### 3.1 Document conventions

The following editorial conventions are used throughout this document:

- ★ Element names are in uppercase letters.
- ★ Attribute names are quoted in lowercase letters.
- ★ Links to definitions are highlighted through the use of style sheets.

#### 4. Priorities

Each checkpoint has a priority level assigned by the Working Group based on the checkpoint's impact on accessibility.

[Priority 1]

A Web content developer **must** satisfy this checkpoint. Otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents.

[Priority 2]

A Web content developer **should** satisfy this checkpoint. Otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing Web documents.

[Priority 3]

A Web content developer **may** address this checkpoint. Otherwise, one or more groups will find it somewhat difficult to access information in the document. Satisfying this checkpoint will improve access to Web documents.

Some checkpoints specify a priority level that may change under certain (indicated) conditions.

#### 5. Conformance

This section defines three levels of conformance to this document:

- ★ Conformance Level "A": all Priority 1 checkpoints are satisfied;
- ★ Conformance Level "Double-A": all Priority 1 and 2 checkpoints are satisfied;
- ★ Conformance Level "Triple-A": all Priority 1, 2, and 3 checkpoints are satisfied;

**Note.** Conformance levels are spelled out in text so they may be understood when rendered to speech.

Claims of conformance to this document must use one of the following two forms.

Form 1: Specify:

- ★ The guidelines title: "Web Content Accessibility Guidelines 1.0"
- ➤ The guidelines URI: http://www.w3.org/TR/1999/WAI-WEBCONTENT-19990505
- ★ The conformance level satisfied: "A," "Double-A," or "Triple-A."
- ➤ The scope covered by the claim (e.g., page, site, or defined portion of a site). Example of Form 1:

This page conforms to W3C's "Web Con-

tent Accessibility Guidelines 1.0," available at http://www.w3.org/TR/1999/WAI-WEB-CONTENT-19990505, level Double-A. Form 2: Include, on each page claiming conformance, one of three icons provided by W3C and link the icon to the appropriate

W3C and link the icon to the appropriate W3C explanation of the claim. Information about the icons and how to insert them in pages is available at [WCAG-ICONS].

### 6. Web Content Accessibility Guidelines

Guideline 1. Provide equivalent alternatives to auditory and visual content.

Provide content that, when presented to the user, conveys essentially the same function or purpose as auditory or visual content.

Although some people cannot use images, movies, sounds, applets, etc. directly, they may still use pages that include equivalent information to the visual or auditory content. The equivalent information must serve the same purpose as the visual or auditory content. Thus, a text equivalent for an image of an upward arrow that links to a table of contents could be "Go to table of contents." In some cases, an equivalent should also describe the appearance of visual content (e.g., for complex charts, billboards, or diagrams) or the sound of auditory content (e.g., for audio samples used in education).

This guideline emphasizes the importance of providing text equivalents of non-text content (images, pre-recorded audio, video). The power of text equivalents lies in their capacity to be rendered in ways that are accessible to people from various disability groups using a variety of technologies. Text can be readily output to speech synthesizers and braille displays, and can be presented visually (in a variety of sizes) on computer displays and paper. Synthesized speech is critical for individuals who are blind and for many people with the reading difficulties that often accompany cognitive disabilities, learning disabilities, and deafness. Braille is essential for individuals who are both deaf and blind, as well as many individuals whose only sensory disability is blindness. Text displayed visually benefits users who are deaf as well as the majority of Web users.

Providing non-text equivalents (e.g., pictures, videos, and pre-recorded audio) of text is also beneficial to some users, especially non-readers or people who have difficulty reading. In movies or visual presentations, visual action such as body language or other visual cues may not be accompanied by enough audio information to convey the same information. Unless verbal descriptions of this visual information are provided, people who cannot see (or look at) the visual content will not be able to perceive it.

Checkpoints:

1.1 Provide a text equivalent for every non-

text element (e.g., via "alt," "longdesc," or in element content). This includes: images, graphical representations of text (including symbols), image map regions, animations (e.g., animated GIFs), applets and programmatic objects, ascii art, frames, scripts, images used as list bullets, spacers, graphical buttons, sounds (played with or without user interaction), stand-alone audio files, audio tracks of video, and video. [Priority 1]

For example, in HTML:

- ★ Use "alt" for the IMG, INPUT, and APPLET elements, or provide a text equivalent in the content of the OBJECT and APPLET elements.
- ➤ For complex content (e.g., a chart) where the "alt" text does not provide a complete text equivalent, provide an additional description using, for example, "longdesc" with IMG or FRAME, a link inside an OBJECT element, or a description link.
- ➤ For image maps, either use the "alt" attribute with AREA, or use the MAP element with A elements (and other text) as content.

Refer also to checkpoint 9.1 and checkpoint 13.10.

Techniques for checkpoint 1.1

1.2 Provide redundant text links for each active region of a server-side image map. [Priority 1]

Refer also to checkpoint 1.5 and checkpoint 9.1.

Techniques for checkpoint 1.2

1.3 Until user agents can automatically read aloud the text equivalent of a visual track, provide an auditory description of the important information of the visual track of a multimedia presentation. [Priority 1]

Synchronize the auditory description with the audio track as per checkpoint 1.4. Refer to checkpoint 1.1 for information about textual equivalents for visual information.

Techniques for checkpoint 1.3

1.4 For any time-based multimedia presentation (e.g., a movie or animation), synchronize equivalent alternatives (e.g., captions or auditory descriptions of the visual track) with the presentation. [Priority 1]

Techniques for checkpoint 1.4

1.5 Until user agents render text equivalents for client-side image map links, provide redundant text links for each active region of a client-side image map. [Priority 3]

Refer also to checkpoint 1.2 and checkpoint 9.1.

Techniques for checkpoint 1.5

#### Guideline 2. Don't rely on color alone.

Ensure that text and graphics are understandable when viewed without color.

If color alone is used to convey information, people who cannot differentiate between certain colors and users with devices that have non-color or non-visual displays will not receive the information. When foreground and background colors are too close to the same hue, they may not provide sufficient contrast when viewed using monochrome displays or by people with different types of color deficits.

Checkpoints:

2.1 Ensure that all information conveyed with color is also available without color, for example from context or markup. [Priority 1]

Techniques for checkpoint 2.1

2.2 Ensure that foreground and background color combinations provide sufficient contrast when viewed by someone having color deficits or when viewed on a black and white screen. [Priority 2 for images, Priority 3 for text].

Techniques for checkpoint 2.2

### Guideline 3. Use markup and style sheets and do so properly.

Mark up documents with the proper structural elements. Control presentation with style sheets rather than with presentation elements and attributes.

Using markup improperly—not according to specification—hinders accessibility. Misusing markup for a presentation effect (e.g., using a table for layout or a header to change the font size) makes it difficult for users with specialized software to understand the organization of the page or to navigate through it. Furthermore, using presentation markup rather than structural markup to convey structure (e.g., constructing what looks like a table of data

with an HTML PRE element) makes it difficult to render a page intelligibly to other devices (refer to the description of difference between content, structure, and presentation).

Content developers may be tempted to use (or misuse) constructs that achieve a desired formatting effect on older browsers. They must be aware that these practices cause accessibility problems and must consider whether the formatting effect is so critical as to warrant making the document inaccessible to some users.

At the other extreme, content developers must not sacrifice appropriate markup because a certain browser or assistive technology does not process it correctly. For example, it is appropriate to use the TABLE element in HTML to mark up tabular information even though some older screen readers may not handle side-by-side text correctly (refer to checkpoint 10.3). Using TABLE correctly and creating tables that transform gracefully (refer to guideline 5) makes it possible for software to render tables other than as two-dimensional grids.

Checkpoints:

3.1 When an appropriate markup language exists, use markup rather than images to convey information. [Priority 2]

> For example, use MathML to mark up mathematical equations, and style sheets to format text and control layout. Also, avoid using images to represent text—use text and style sheets instead. Refer also to guideline 6 and guideline 11.

Techniques for checkpoint 3.1

3.2 Create documents that validate to published formal grammars. [Priority 2]

> For example, include a document type declaration at the beginning of a document that refers to a published DTD (e.g., the strict HTML 4.0 DTD).

Techniques for checkpoint 3.2

3.3 Use style sheets to control layout and presentation. [Priority 2]

> For example, use the CSS 'font' property instead of the HTML FONT element to control font styles.

Techniques for checkpoint 3.3

3.4 Use relative rather than absolute units

in markup language attribute values and style sheet property values. [Priority 2]

> For example, in CSS, use 'em' or percentage lengths rather than 'pt' or 'cm', which are absolute units. If absolute units are used, validate that the rendered content is usable (refer to the section on validation).

Techniques for checkpoint 3.4

3.5 Use header elements to convey document structure and use them according to specification. [Priority 2]

> For example, in HTML, use H2 to indicate a subsection of H1. Do not use headers for font effects.

Techniques for checkpoint 3.5

3.6 Mark up lists and list items properly.

For example, in HTML, nest OL, UL, and DL lists properly.

Techniques for checkpoint 3.6

3.7 Mark up quotations. Do not use quotation markup for formatting effects such as indentation. [Priority 2]

> For example, in HTML, use the Q and BLOCKQUOTE elements to markup short and longer quotations, respectively.

Techniques for checkpoint 3.7

#### Guideline 4. Clarify natural language usage.

Use markup that facilitates pronunciation or interpretation of abbreviated or foreign text. When content developers mark up natural language changes in a document, speech synthesizers and braille devices can automatically switch to the new language, making the document more accessible to multilingual users. Content developers should identify the predominant natural language of a document's content (through markup or HTTP headers). Content developers should also provide expansions of abbreviations and acronyms.

In addition to helping assistive technologies, natural language markup allows search engines to find key words and identify documents in a desired language. Natural language markup also improves readability of the Web for all people, including those with learning disabilities, cognitive disabilities, or people who are deaf.

When abbreviations and natural language changes are not identified, they may be indecipherable when machine-spoken or brailled.

Checkpoints:

4.1 Clearly identify changes in the natural language of a document's text and any text equivalents (e.g., captions). [Priority 1]

For example, in HTML use the "lang" attribute. In XML, use "xml:lang." Techniques for checkpoint 4.1

**4.2** Specify the expansion of each abbreviation or acronym in a document where it first occurs. [Priority 3]

For example, in HTML, use the "title" attribute of the ABBR and ACRONYM elements. Providing the expansion in the main body of the document also helps document usability.

Techniques for checkpoint 4.2

**4.3** Identify the primary natural language of a document. [Priority 3]

For example, in HTML set the "lang" attribute on the HTML element. In XML, use "xml:lang." Server operators should configure servers to take advantage of HTTP content negotiation mechanisms ([RFC2068], section 14.13) so that clients can automatically retrieve documents of the preferred language.

### Guideline 5. Create tables that transform gracefully.

Ensure that tables have necessary markup to be transformed by accessible browsers and other user agents.

Tables should be used to mark up truly tabular information ("data tables"). Content developers should avoid using them to lay out pages ("layout tables"). Tables for any use also present special problems to users of screen readers (refer to checkpoint 10.3).

Some user agents allow users to navigate among table cells and access header and other table cell information. Unless marked-up properly, these tables will not provide user agents with the appropriate information. (Refer also to guideline 3.)

The following checkpoints will directly

benefit people who access a table through auditory means (e.g., a screen reader or an automobile-based personal computer) or who view only a portion of the page at a time (e.g., users with blindness or low vision using speech output or a braille display, or other users of devices with small displays, etc.).

Checkpoints:

**5.1** For data tables, identify row and column headers. [Priority 1]

For example, in HTML, use TD to identify data cells and TH to identify headers.

Techniques for checkpoint 5.1

**5.2** For data tables that have two or more logical levels of row or column headers, use markup to associate data cells and header cells. [Priority 1]

For example, in HTML, use THEAD, TFOOT, and TBODY to group rows, COL and COLGROUP to group columns, and the "axis," "scope," and "headers" attributes, to describe more complex relationships among data. Techniques for checkpoint 5.2

5.3 Do not use tables for layout unless the table makes sense when linearized. Otherwise, if the table does not make sense, provide an alternative equivalent (which may be a linearized version). [Priority 2]

Note. Once user agents support style sheet positioning, tables should not be used for layout. Refer also to checkpoint 3.3.

Techniques for checkpoint 5.3

**5.4** If a table is used for layout, do not use any structural markup for the purpose of visual formatting. [Priority 2]

For example, in HTML do not use the TH element to cause the content of a (non-table header) cell to be displayed centered and in bold.

Techniques for checkpoint 5.4

- 5.5 Provide summaries for tables. [Priority 3] For example, in HTML, use the "summary" attribute of the TABLE element. Techniques for checkpoint 5.5
- **5.6** Provide abbreviations for header labels. [Priority 3]

For example, in HTML, use the "abbr" attribute on the TH element.

Techniques for checkpoint 5.6 Refer also to checkpoint 10.3.

### Guideline 6. Ensure that pages featuring new technologies transform gracefully.

Ensure that pages are accessible even when newer technologies are not supported or are turned off. Although content developers are encouraged to use new technologies that solve problems raised by existing technologies, they should know how to make their pages still work with older browsers and people who choose to turn off features.

Checkpoints:

6.1 Organize documents so they may be read without style sheets. For example, when an HTML document is rendered without associated style sheets, it must still be possible to read the document. [Priority 1]

When content is organized logically, it will be rendered in a meaningful order when style sheets are turned off or not supported.

Techniques for checkpoint 6.1

**6.2** Ensure that equivalents for dynamic content are updated when the dynamic content changes. [Priority 1]

Techniques for checkpoint 6.2

**6.3** Ensure that pages are usable when scripts, applets, or other programmatic objects are turned off or not supported. If this is not possible, provide equivalent information on an alternative accessible page. [Priority 1]

For example, ensure that links that trigger scripts work when scripts are turned off or not supported (e.g., do not use "javascript:" as the link target). If it is not possible to make the page usable without scripts, provide a text equivalent with the NOSCRIPT element, or use a server-side script instead of a client-side script, or provide an alternative accessible page as per checkpoint 11.4. Refer also to guideline 1. Techniques for checkpoint 6.3

**6.4** For scripts and applets, ensure that event handlers are input device-independent. [Priority 2]

Refer to the definition of device independence.

Techniques for checkpoint 6.4

**6.5** Ensure that dynamic content is accessible or provide an alternative presentation or page. [Priority 2]

For example, in HTML, use NOFRAMES at the end of each frameset. For some applications, serverside scripts may be more accessible than client-side scripts.

Techniques for checkpoint 6.5 Refer also to checkpoint 11.4.

#### Guideline 7. Ensure user control of timesensitive content changes.

Ensure that moving, blinking, scrolling, or autoupdating objects or pages may be paused or stopped.

Some people with cognitive or visual disabilities are unable to read moving text quickly enough or at all. Movement can also cause such a distraction that the rest of the page becomes unreadable for people with cognitive disabilities. Screen readers are unable to read moving text. People with physical disabilities might not be able to move quickly or accurately enough to interact with moving objects.

Note. All of the following checkpoints involve some content developer responsibility until user agents provide adequate feature control mechanisms.

Checkpoints:

7.1 Until user agents allow users to control flickering, avoid causing the screen to flicker. [Priority 1]

Note. People with photosensitive epilepsy can have seizures triggered by flickering or flashing in the 4 to 59 flashes per second (Hertz) range with a peak sensitivity at 20 flashes per second as well as quick changes from dark to light (like strobe lights).

Techniques for checkpoint 7.1

7.2 Until user agents allow users to control blinking, avoid causing content to blink (i.e., change presentation at a regular rate, such as turning on and off). [Priority 2]

Techniques for checkpoint 7.2

7.3 Until user agents allow users to freeze moving content, avoid movement in pages. [Priority 2]

When a page includes moving con-

tent, provide a mechanism within a script or applet to allow users to freeze motion or updates. Using style sheets with scripting to create movement allows users to turn off or override the effect more easily. Refer also to guideline 8.

Techniques for checkpoint 7.3

7.4 Until user agents provide the ability to stop the refresh, do not create periodically auto-refreshing pages. [Priority 2]

For example, in HTML, don't cause pages to auto-refresh with "HTTP-EQUIV=refresh" until user agents allow users to turn off the feature. Techniques for checkpoint 7.4

7.5 Until user agents provide the ability to stop auto-redirect, do not use markup to redirect pages automatically. Instead, configure the server to perform redirects. [Priority 2]

Techniques for checkpoint 7.5

Note. The BLINK and MARQUEE elements are not defined in any W3C HTML specification and should not be used. Refer also to guideline 11.

### Guideline 8. Ensure direct accessibility of embedded user interfaces.

Ensure that the user interface follows principles of accessible design: device-independent access to functionality, keyboard operability, self-voicing, etc.

When an embedded object has its "own interface," the interface—like the interface to the browser itself—must be accessible. If the interface of the embedded object cannot be made accessible, an alternative accessible solution must be provided.

Note. For information about accessible interfaces, please consult the User Agent Accessibility Guidelines ([WAI-USERA-GENT]) and the Authoring Tool Accessibility Guidelines ([WAI-AUTOOL]).

Checkpoint:

**8.1** Make programmatic elements such as scripts and applets directly accessible or compatible with assistive technologies [Priority 1 if functionality is important and not presented elsewhere, otherwise Priority 2.]

Refer also to guideline 6. Techniques for checkpoint 8.1

#### Guideline 9. Design for deviceindependence.

Use features that enable activation of page elements via a variety of input devices.

Device-independent access means that the user may interact with the user agent or document with a preferred input (or output) device—mouse, keyboard, voice, head wand, or other. If, for example, a form control can only be activated with a mouse or other pointing device, someone who is using the page without sight, with voice input, or with a keyboard or who is using some other non-pointing input device will not be able to use the form

Note. Providing text equivalents for image maps or images used as links makes it possible for users to interact with them without a pointing device. Refer also to guideline 1.

Generally, pages that allow keyboard interaction are also accessible through speech input or a command line interface.

Checkpoints:

**9.1** Provide client-side image maps instead of server-side image maps except where the regions cannot be defined with an available geometric shape. [Priority 1]

Refer also to checkpoint 1.1, checkpoint 1.2, and checkpoint 1.5. Techniques for checkpoint 9.1

**9.2** Ensure that any element that has its own interface can be operated in a device-independent manner. [Priority 2]

Refer to the definition of device independence.

Refer also to guideline 8.

Techniques for checkpoint 9.2

**9.3** For scripts, specify logical event handlers rather than device-dependent event handlers. [Priority 2]

Techniques for checkpoint 9.3

**9.4** Create a logical tab order through links, form controls, and objects. [Priority 3]

For example, in HTML, specify tab order via the "tabindex" attribute or ensure a logical page design.

Techniques for checkpoint 9.4

**9.5** Provide keyboard shortcuts to important links (including those in client-side image maps), form controls, and groups of form controls. [Priority 3]

For example, in HTML, specify shortcuts via the "accesskey" attribute. Techniques for checkpoint 9.5

#### Guideline 10. Use interim solutions.

Use interim accessibility solutions so that assistive technologies and older browsers will operate correctly.

For example, older browsers do not allow users to navigate to empty edit boxes. Older screen readers read lists of consecutive links as one link. These active elements are therefore difficult or impossible to access. Also, changing the current window or popping up new windows can be very disorienting to users who cannot see that this has happened.

Note. The following checkpoints apply until user agents (including assistive technologies) address these issues. These checkpoints are classified as "interim," meaning that the Web Content Guidelines Working Group considers them to be valid and necessary to Web accessibility as of the publication of this document. However, the Working Group does not expect these checkpoints to be necessary in the future, once Web technologies have incorporated anticipated features or capabilities.

Checkpoints:

10.1 Until user agents allow users to turn off spawned windows, do not cause pop-ups or other windows to appear and do not change the current window without informing the user. [Priority 2]

For example, in HTML, avoid using a frame whose target is a new window. Techniques for checkpoint 10.1

10.2 Until user agents support explicit associations between labels and form controls, for all form controls with implicitly associated labels, ensure that the label is properly positioned. [Priority 2]

The label must immediately precede its control on the same line (allowing more than one control/label per line) or be in the line preceding the control (with only one label and one control per line). Refer also to checkpoint 12.4. Techniques for checkpoint 10.2

10.3 Until user agents (including assistive technologies) render side-by-side text correctly, provide a linear text alternative (on the cur-

rent page or some other) for all tables that lay out text in parallel, word-wrapped columns. [Priority 3]

Note. Please consult the definition of linearized table. This checkpoint benefits people with user agents (such as some screen readers) that are unable to handle blocks of text presented side-by-side; the checkpoint should not discourage content developers from using tables to represent tabular information. Techniques for checkpoint 10.3

10.4 Until user agents handle empty controls correctly, include default, place-holding characters in edit boxes and text areas. [Priority 3]

For example, in HTML, do this for TEXTAREA and INPUT.

Techniques for checkpoint 10.4

10.5 Until user agents (including assistive technologies) render adjacent links distinctly, include non-link, printable characters (surrounded by spaces) between adjacent links. [Priority 3]

Techniques for checkpoint 10.5

### Guideline 11. Use W3C technologies and quidelines.

Use W3C technologies (according to specification) and follow accessibility guidelines. Where it is not possible to use a W3C technology, or doing so results in material that does not transform gracefully, provide an alternative version of the content that is accessible.

The current guidelines recommend W3C technologies (e.g., HTML, CSS, etc.) for several reasons:

- ★ W3C technologies include "built-in" accessibility features.
- ★ W3C specifications undergo early review to ensure that accessibility issues are considered during the design phase.
- ★ W3C specifications are developed in an open, industry consensus process.

Many non-W3C formats (e.g., PDF, Shockwave, etc.) require viewing with either plug-ins or stand-alone applications. Often, these formats cannot be viewed or navigated with standard user agents (including assistive technologies). Avoiding non-W3C and non-standard features (proprietary elements,

attributes, properties, and extensions) will tend to make pages more accessible to more people using a wider variety of hardware and software. When inaccessible technologies (proprietary or not) must be used, equivalent accessible pages must be provided.

Even when W3C technologies are used, they must be used in accordance with accessibility guidelines. When using new technologies, ensure that they transform gracefully (Refer also to guideline 6.).

Note. Converting documents (from PDF, PostScript, RTF, etc.) to W3C markup languages (HTML, XML) does not always create an accessible document. Therefore, validate each page for accessibility and usability after the conversion process (refer to the section on validation). If a page does not readily convert, either revise the page until its original representation converts appropriately or provide an HTML or plain text version.

Checkpoints:

11.1 Use W3C technologies when they are available and appropriate for a task and use the latest versions when supported. [Priority 2]

Refer to the list of references for information about where to find the latest W3C specifications and [WAI-UA-SUPPORT] for information about user agent support for W3C technologies.

Techniques for checkpoint 11.1

11.2 Avoid deprecated features of W3C technologies. [Priority 2]

For example, in HTML, don't use the deprecated FONT element; use style sheets instead (e.g., the 'font' property in CSS).

Techniques for checkpoint 11.2

11.3 Provide information so that users may receive documents according to their preferences (e.g., language, content type, etc.) [Priority 3]

Note. Use content negotiation where possible.

Techniques for checkpoint 11.3

11.4 If, after best efforts, you cannot create an accessible page, provide a link to an alternative page that uses W3C technologies, is accessible, has equivalent information (or functionality), and is updated as often as the

inaccessible (original) page. [Priority 1] Techniques for checkpoint 11.4

Note. Content developers should only resort to alternative pages when other solutions fail because alternative pages are generally updated less often than "primary" pages. An out-of-date page may be as frustrating as one that is inaccessible since, in both cases, the information presented on the original page is unavailable. Automatically generating alternative pages may lead to more frequent updates, but content developers must still be careful to ensure that generated pages always make sense, and that users are able to navigate a site by following links on primary pages, alternative pages, or both. Before resorting to an alternative page, reconsider the design of the original page; making it accessible is likely to improve it for all users.

### Guideline 12. Provide context and orientation information.

Provide context and orientation information to help users understand complex pages or elements. Grouping elements and providing contextual information about the relationships between elements can be useful for all users. Complex relationships between parts of a page may be difficult for people with cognitive disabilities and people with visual disabilities to interpret.

Checkpoints:

**12.1** Title each frame to facilitate frame identification and navigation. [Priority 1]

For example, in HTML use the "title" attribute on FRAME elements.

Techniques for checkpoint 12.1

12.2 Describe the purpose of frames and how frames relate to each other if it is not obvious by frame titles alone. [Priority 2]

For example, in HTML, use "longdesc," or a description link.

Techniques for checkpoint 12.2

12.3 Divide large blocks of information into more manageable groups where natural and appropriate. [Priority 2]

For example, in HTML, use OPT-GROUP to group OPTION elements inside a SELECT; group form controls with FIELDSET and LEGEND; use nested lists where appropriate; use headings to structure documents, etc.

Refer also to guideline 3.

Techniques for checkpoint 12.3

12.4 Associate labels explicitly with their controls. [Priority 2]

For example, in HTML use LABEL and its "for" attribute.

Techniques for checkpoint 12.4

### Guideline 13. Provide clear navigation mechanisms.

Provide clear and consistent navigation mechanisms—orientation information, navigation bars, a site map, etc.—to increase the likelihood that a person will find what they are looking for at a site.

Clear and consistent navigation mechanisms are important to people with cognitive disabilities or blindness, and benefit all users.

Checkpoints:

**13.1** Clearly identify the target of each link. [Priority 2]

Link text should be meaningful enough to make sense when read out of context—either on its own or as part of a sequence of links. Link text should also be terse.

For example, in HTML, write "Information about version 4.3" instead of "click here." In addition to clear link text, content developers may further clarify the target of a link with an informative link title (e.g., in HTML, the "title" attribute).

Techniques for checkpoint 13.1

13.2 Provide metadata to add semantic information to pages and sites. [Priority 2]

For example, use RDF ([RDF]) to indicate the document's author, the type of content, etc.

Note. Some HTML user agents can build navigation tools from document relations described by the HTML LINK element and "rel" or "rev" attributes (e.g., rel="next", rel="previous", rel="index", etc.). Refer also to checkpoint 13.5.

Techniques for checkpoint 13.2

13.3 Provide information about the general layout of a site (e.g., a site map or table of contents). [Priority 2]

In describing site layout, highlight and

explain available accessibility features. Techniques for checkpoint 13.3

**13.4** Use navigation mechanisms in a consistent manner. [Priority 2]

Techniques for checkpoint 13.4

13.5 Provide navigation bars to highlight and give access to the navigation mechanism. [Priority 3]

Techniques for checkpoint 13.5

13.6 Group related links, identify the group (for user agents), and, until user agents do so, provide a way to bypass the group. [Priority 3]

Techniques for checkpoint 13.6

13.7 If search functions are provided, enable different types of searches for different skill levels and preferences. [Priority 3]

Techniques for checkpoint 13.7

13.8 Place distinguishing information at the beginning of headings, paragraphs, lists, etc. [Priority 3]

Note. This is commonly referred to as "front-loading" and is especially helpful for people accessing information with serial devices such as speech synthesizers.

Techniques for checkpoint 13.8

13.9 Provide information about document collections (i.e., documents comprising multiple pages.). [Priority 3]

For example, in HTML specify document collections with the LINK element and the "rel" and "rev" attributes. Another way to create a collection is by building an archive (e.g., with zip, tar and gzip, stuffit, etc.) of the multiple pages.

Note. The performance improvement gained by offline processing can make browsing much less expensive for people with disabilities who may be browsing slowly.

Techniques for checkpoint 13.9

**13.10** Provide a means to skip over multiline ASCII art. [Priority 3]

Refer to checkpoint 1.1 and the example of ascii art in the glossary. Techniques for checkpoint 13.10

Guideline 14. Ensure that documents are clear and simple.

Ensure that documents are clear and simple so they may be more easily understood.

Consistent page layout, recognizable graphics, and easy to understand language benefit all users. In particular, they help people with cognitive disabilities or who have difficulty reading. (However, ensure that images have text equivalents for people who are blind, have low vision, or for any user who cannot or has chosen not to view graphics. Refer also to guideline 1.)

Using clear and simple language promotes effective communication. Access to written information can be difficult for people who have cognitive or learning disabilities. Using clear and simple language also benefits people whose first language differs from your own, including those people who communicate primarily in sign language.

Checkpoints:

**14.1** Use the clearest and simplest language appropriate for a site's content. [Priority 1]

Techniques for checkpoint 14.1

14.2 Supplement text with graphic or auditory presentations where they will facilitate comprehension of the page. [Priority 3]

Refer also to guideline 1.

Techniques for checkpoint 14.2

14.3 Create a style of presentation that is consistent across pages. [Priority 3]

Techniques for checkpoint 14.3

#### Appendix A. — Validation

Validate accessibility with automatic tools and human review. Automated methods are generally rapid and convenient but cannot identify all accessibility issues. Human review can help ensure clarity of language and ease of navigation. Begin using validation methods at the earliest stages of development. Accessibility issues identified early are easier to correct and avoid.

Following are some important validation methods, discussed in more detail in the section on validation in the Techniques Document.

1. Use an automated accessibility tool and browser validation tool. Please note that software tools do not address all accessibility issues, such as the meaningfulness of link text, the applicability of a text equivalent, etc.

- 2. Validate syntax (e.g., HTML, XML, etc.).
- 3. Validate style sheets (e.g., CSS).
- 4. Use a text-only browser or emulator.
- 5. Use multiple graphic browsers, with:
  - ★ sounds and graphics loaded,
  - \* graphics not loaded,
  - \* sounds not loaded,
  - \* no mouse,
  - \* frames, scripts, style sheets, and applets not loaded
- 6. Use several browsers, old and new.
- 7. Use a self-voicing browser, a screen reader, magnification software, a small display, etc.
- 8. Use spell and grammar checkers. A person reading a page with a speech synthesizer may not be able to decipher the synthesizer's best guess for a word with a spelling error. Eliminating grammar problems increases comprehension.
- 9. Review the document for clarity and simplicity. Readability statistics, such as those generated by some word processors may be useful indicators of clarity and simplicity. Better still, ask an experienced (human) editor to review written content for clarity. Editors can also improve the usability of documents by identifying potentially sensitive cultural issues that might arise due to language or icon usage.
- 10. Invite people with disabilities to review documents. Expert and novice users with disabilities will provide valuable feedback about accessibility or usability problems and their severity.

#### Appendix B. — Glossary

Accessible

Content is accessible when it may be used by someone with a disability.

Applet

A program inserted into a Web page.

#### Assistive technology

Software or hardware that has been specifically designed to assist people with disabilities in carrying out daily activities. Assistive technology includes wheelchairs, reading machines, devices for grasping, etc. In the area of Web Accessibility, common software-based assistive technolo-

gies include screen readers, screen magnifiers, speech synthesizers, and voice input software that operate in conjunction with graphical desktop browsers (among other user agents). Hardware assistive technologies include alternative keyboards and pointing devices.

#### ASCII art

ASCII art refers to text characters and symbols that are combined to create an image. For example ";-)" is the smiley emoticon. The following is an ascii figure showing the relationship between flash frequency and photoconvulsive response in patients with eyes open and closed [skip over ascii figure or consult a description of chart]:

A **braille display,** commonly referred to as a "dynamic braille display," raises or lowers dot patterns on command from an electronic device, usually a computer. The result is a line of braille that can change from moment to moment. Current dynamic braille displays range in size from one cell (six or eight dots) to an eighty-cell line, most having between twelve and twenty cells per line.

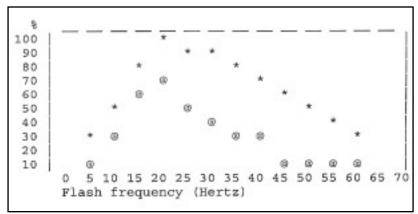
#### Content developer

Someone who authors Web pages or designs Web sites.

#### Deprecated

A deprecated element or attribute is one that

has been outdated by newer constructs. Deprecated elements may become obsolete in future versions of HTML. The index of HTML elements and attributes in the Techniques Document indicates which elements



Authoring tool

HTML editors, document conversion tools, tools that generate Web content from databases are all authoring tools. Refer to the "Authoring Tool Accessibility Guidelines" ([WAI-AUTOOLS]) for information about developing accessible tools.

#### Backward compatible

Design that continues to work with earlier versions of a language, program, etc.

#### Braille

Braille uses six raised dots in different patterns to represent letters and numbers to be read by people who are blind with their fingertips. The word "Accessible" in braille follows: and attributes are deprecated in HTML 4.0.

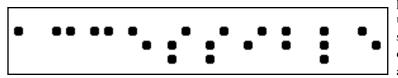
Authors should avoid using deprecated elements and attributes. User agents should continue to support for reasons of backward compatibility.

#### Device independent

Users must be able to interact with a user agent (and the document it renders) using the supported input and output devices of their choice and according to their needs. Input devices may include pointing devices, keyboards, braille devices, head wands, microphones, and others. Output devices may include monitors, speech synthesizers, and braille devices.

Please note that "device-independent sup-

port" does not mean that user agents must support every input or output device. User agents should offer



redundant input and output mechanisms for those devices that are supported. For example, if a user agent supports keyboard and mouse input, users should be able to interact with all features using either the keyboard or the mouse.

Document Content, Structure, and Presentation The content of a document refers to what it says to the user through natural language, images, sounds, movies, animations, etc. The structure of a document is how it is organized logically (e.g., by chapter, with an introduction and table of contents, etc.). An element (e.g., P, STRONG, BLOCKQUOTE in HTML) that specifies document structure is called a structural element. The presentation of a document is how the document is rendered (e.g., as print, as a two-dimensional graphical presentation, as an text-only presentation, as synthesized speech, as braille, etc.) An element that specifies document presentation (e.g., B, FONT, CENTER) is called a presentation element.

Consider a document header, for example. The content of the header is what the header says (e.g., "Sailboats"). In HTML, the header is a structural element marked up with, for example, an H2 element. Finally, the presentation of the header might be a bold block text in the margin, a centered line of text, a title spoken with a certain voice style (like an aural font), etc.

#### Dynamic HTML (DHTML)

DHTML is the marketing term applied to a mixture of standards including HTML, style sheets, the Document Object Model [DOM1] and scripting. However, there is no W3C specification that formally defines DHTML. Most guidelines may be applicable to applications using DHTML, however the following guidelines focus on issues related to scripting and style sheets: guideline 1, guideline 3, guideline 6, guideline 7, and guideline 9.

#### Element

This document uses the term "element" both in the strict SGML sense (an element is a syntactic construct) and more generally to mean a type of content (such as video or sound) or a logical construct (such as a header or list). The second sense emphasizes that a guideline inspired by HTML could easily apply to another markup language.

Note that some (SGML) elements have content that is rendered (e.g., the P, LI, or TABLE elements in HTML), some are replaced by external content (e.g., IMG), and some affect processing (e.g., STYLE and SCRIPT cause information to be processed by a style sheet or script engine). An element that causes text characters to be part of the document is called a text element.

#### Equivalent

Content is "equivalent" to other content when both fulfill essentially the same function or purpose upon presentation to the user. In the context of this document, the equivalent must fulfill essentially the same function for the person with a disability (at least insofar as is feasible, given the nature of the disability and the state of technology), as the primary content does for the person without any disability. For example, the text "The Full Moon" might convey the same information as an image of a full moon when presented to users. Note that equivalent information focuses on fulfilling the same function. If the image is part of a link and understanding the image is crucial to guessing the link target, an equivalent must also give users an idea of the link target. Providing equivalent information for inaccessible content is one of the primary ways authors can make their documents accessible to people with disabilities.

As part of fulfilling the same function of content an equivalent may involve a description of that content (i.e., what the content looks like or sounds like). For example, in order for users to understand the information conveyed by a complex chart, authors should describe the visual information in the chart.

Since text content can be presented to the user as synthesized speech, braille, and visually-displayed text, these guidelines require **text equivalents** for graphic and audio information. Text equivalents must be written so that they convey all essential content. **Non-text equivalents** (e.g., an auditory description of a visual presentation, a video of a person telling

a story using sign language as an equivalent for a written story, etc.) also improve accessibility for people who cannot access visual information or written text, including many individuals with blindness, cognitive disabilities, learning disabilities, and deafness.

Equivalent information may be provided in a number of ways, including through attributes (e.g., a text value for the "alt" attribute in HTML and SMIL), as part of element content (e.g., the OBJECT in HTML), as part of the document's prose, or via a linked document (e.g., designated by the "longdesc" attribute in HTML or a description link). Depending on the complexity of the equivalent, it may be necessary to combine techniques (e.g., use "alt" for an abbreviated equivalent, useful to familiar readers, in addition to "longdesc" for a link to more complete information, useful to first-time readers). The details of how and when to provide equivalent information are part of the Techniques Document ([TECHNIQUES]).

A text transcript is a text equivalent of audio information that includes spoken words and non-spoken sounds such as sound effects. A **caption** is a text transcript for the audio track of a video presentation that is synchronized with the video and audio tracks. Captions are generally rendered visually by being superimposed over the video, which benefits people who are deaf and hard-of-hearing, and anyone who cannot hear the audio (e.g., when in a crowded room). A collated text transcript combines (collates) captions with text descriptions of video information (descriptions of the actions, body language, graphics, and scene changes of the video track). These text equivalents make presentations accessible to people who are deaf-blind and to people who cannot play movies, animations, etc. It also makes the information available to search engines.

One example of a non-text equivalent is an **auditory description** of the key visual elements of a presentation. The description is either a prerecorded human voice or a synthesized voice (recorded or generated on the fly). The auditory description is sysnchronized with the audio track of the presentation, usually during natural pauses in the audio track. Auditory descriptions include information

about actions, body language, graphics, and scene changes.

Image

A graphical presentation.

Image map

An image that has been divided into regions with associated actions. Clicking on an active region causes an action to occur.

When a user clicks on an active region of a client-side image map, the user agent calculates in which region the click occurred and follows the link associated with that region. Clicking on an active region of a server-side image map causes the coordinates of the click to be sent to a server, which then performs some action.

Content developers can make client-side image maps accessible by providing device-independent access to the same links associated with the image map's regions. Client-side image maps allow the user agent to provide immediate feedback as to whether or not the user's pointer is over an active region.

**Important** 

Information in a document is important if understanding that information is crucial to understanding the document.

Linearized table

A table rendering process where the contents of the cells become a series of paragraphs (e.g., down the page) one after another. The paragraphs will occur in the same order as the cells are defined in the document source. Cells should make sense when read in order and should include structural elements (that create paragraphs, headers, lists, etc.) so the page makes sense after linearization.

Link text

The rendered text content of a link.

Natural Language

Spoken, written, or signed human languages such as French, Japanese, American Sign Language, and braille. The natural language of content may be indicated with the "lang" attribute in HTML ([HTML40], section 8.1)

and the "xml:lang" attribute in XML ([XML], section 2.12).

#### Navigation Mechanism

A navigation mechanism is any means by which a user can navigate a page or site. Some typical mechanisms include:

#### \* navigation bars

A navigation bar is a collection of links to the most important parts of a document or site.

#### **★** site maps

A site map provides a global view of the organization of a page or site.

#### \* table of contents

A table of contents generally lists (and links to) the most important sections of a document.

#### Personal Digital Assistant (PDA)

A PDA is a small, portable computing device. Most PDAs are used to track personal data such as calendars, contacts, and electronic mail. A PDA is generally a handheld device with a small screen that allows input from various sources.

#### Screen magnifier

A software program that magnifies a portion of the screen, so that it can be more easily viewed. Screen magnifiers are used primarily by individuals with low vision.

#### Screen reader

A software program that reads the contents of the screen aloud to a user. Screen readers are used primarily by individuals who are blind. Screen readers can usually only read text that is printed, not painted, to the screen.

#### Style sheets

A style sheet is a set of statements that specify presentation of a document. Style sheets may have three different origins: they may be written by content providers, created by users, or built into user agents. In CSS ([CSS2]), the interaction of content provider, user, and user agent style sheets is called the cascade.

**Presentation markup** is markup that achieves a stylistic (rather than structuring) effect such as the B or I elements in HTML. Note that the STRONG and EM elements are not considered presentation markup since

they convey information that is independent of a particular font style.

#### Tabular information

When tables are used to represent logical relationships among data—text, numbers, images, etc., that information is called "tabular information" and the tables are called "data tables." The relationships expressed by a table may be rendered visually (usually on a two-dimensional grid), aurally (often preceding cells with header information), or in other formats.

#### Until user agents...

In most of the checkpoints, content developers are asked to ensure the accessibility of their pages and sites. However, there are accessibility needs that would be more appropriately met by user agents (including assistive technologies). As of the publication of this document, not all user agents or assistive technologies provide the accessibility control users require (e.g., some user agents may not allow users to turn off blinking content, or some screen readers may not handle tables well). Checkpoints that contain the phrase "until user agents..." require content developers to provide additional support for accessibility until most user agents readily available to their audience include the necessary accessibility features.

Note. The W3C WAI Web site (refer to [WAI-UA-SUPPORT]) provides information about user agent support for accessibility features. Content developers are encouraged to consult this page regularly for updated information.

#### User agent

Software to access Web content, including desktop graphical browsers, text browsers, voice browsers, mobile phones, multimedia players, plug-ins, and some software assistive technologies used in conjunction with browsers such as screen readers, screen magnifiers, and voice recognition software.

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The original draft of this document is based on "The Unified Web Site Accessibility Guidelines" ([UWSAG]) compiled by the Trace R & D Center at the University of Wisconsin. That document includes a list of additional contributors.

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## Requirements Analysis

### Analyze

### Activities of the workplace:

What goals do individuals or groups pursue?

What tasks do they perform?

What actions do they carry out.

### Artefacts of the workplace:

What information is retrieved or created in these work activities? What tools are being used?

### Social context of the workplace:

How are individuals and groups organized into larger structures?

What roles are defined (implicitly or explicitly)?

How do people depend on each other in achieving their goals?

Involve all stakeholders (users, customers, management, owners...)

Early prototyping helps in the requirements analysis phase.

# Tool systems for user interface design and development

- 0. Paper and pencil; whiteboard/blackboard and post-its
- 1. Drafting tools:
  - Presentation software (MS Powerpoint,...)
  - Hypermedia authoring tools (MacroMedia Director, Asymetrix Toolbook,...)
- 2. "GUI builders" (Visual Basic/C++, Borland Delphi, Symantec Cafe,...)
- 3. WYSIWYG web authoring tools
- 3. GUI toolkits (MS Windows Developers' Toolkit, MacApp, OSF Motif, ...)
- 4. Scripting Languages (Tcl/Tk)
- 5. Critiquing Tools