MERU UNIVERSITY OF SCIENCE & TECHNOLOGY

Foundation of Innovations

LECTURE NOTES
ON
HUMAN COMPUTER INTERACTION

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HISTORY OF THE HUMAN-COMPUTER INTERFACE

- The need for people to communicate with each other has existed since we first walked upon this planet.
- The lowest and most common level of communication modes we share are movements and gestures.
- Movements and gestures are language independent, that is, they permit people who do not speak the same language to deal with one another.
- The next higher level, in terms of universality and complexity, is spoken language.
- Most people can speak one language, some two or more. A spoken language is a very efficient mode of communication if both parties to the communication understand it.
- At the third and highest level of complexity is written language. While most people speak, not all can write.
- But for those who can, writing is still nowhere near as efficient a means of communication as speaking.
- In modem times, we have the typewriter, another step upward in communication complexity.
- Significantly fewer people type than write. (While a practiced typist can find typing faster and more efficient than handwriting, the unskilled may not find this the case.)
- Spoken language, however, is still more efficient than typing, regardless' of typing skill level.
- Through its first few decades, a computer's ability to deal with human communication was inversely related to what was easy for people to do.

- The computer demanded rigid, typed input through a keyboard; people responded slowly using this device and with varying degrees of skill.
- The human-computer dialog reflected the computer's preferences, consisting of one style or a combination of styles using keyboards, commonly referred to as Command Language,

Question and Answer, Menu selection, Function Key Selection, and Form Fill-In.

- Throughout the computer's history, designers have been developing, with varying degrees of success, other human-computer interaction methods that utilize more general, widespread, and easier-to-learn capabilities: voice and handwriting.

Systems that recognize human speech and handwriting now exist, although they still lack the universality and richness of typed input.

INTRODUCTION TO HCI

Human–computer interaction (HCI), alternatively man–machine interaction (MMI) or computer–human interaction (CHI) is the study of interaction between people (users) and computers.

• With today's technology and tools, and our motivation to create really effective and usable interfaces and screens, why do we continue to produce systems that are inefficient and confusing or, at worst, just plain unusable? Is it because:

1. We don't care?
2. We don't possess common sense?
3. We don't have the time?
4. We still don't know what really makes good design?

DEFINITION

• "Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them."

GOALS OF HCI

The goals of HCI are to produce usable and safe systems, as well as functional systems. In order to produce computer systems with good usability, developers must attempt to: understand the factors that determine how people use technology, develop tools and techniques to enable building suitable systems, achieve efficient, effective, and safe interaction put people first.

• A basic goal of HCI is
  – to improve the interactions between users and computers
  – by making computers more usable and receptive to the user's needs.
• A long term goal of HCI is
  – to design systems that minimize the barrier between the human's cognitive model of what they want

– to accomplish and the computer's understanding of the user's task

- **Usability**

  Usability is one of the key concepts in HCI. It is concerned with making systems easy to learn and use. A usable system is:

  -easy to learn
  -easy to remember how to use
  -effective to use
  -efficient to use
  -safe to use
  -enjoyable to use

Factors in HCI

There are a large number of factors which should be considered in the analysis and design of a system using HCI principles. Many of these factors interact with each other, making the analysis even more complex. The main factors are listed in the table below:

a) Organization Factors

-Training, job design, politics, roles, work organization
-Environmental Factors
-Noise, heating, lighting, ventilation
-Health and Safety Factors

The User

-Cognitive processes and capabilities
-Motivation, enjoyment, satisfaction, personality, experience
-Comfort Factors
-Seating, equipment, layout.

User Interface

-Input devices, output devices, dialogue structures, use of color, icons, commands, navigation, graphics, natural language, user support, multimedia,

b) **Task Factors:** Easy, complex, novel, task allocation, monitoring, skills
   Constraints: Cost, timescales, budgets, staff, equipment, buildings
   System Functionality: Hardware, software, application

c) **Productivity Factors :** Increase output, increase quality, decrease costs, decrease errors, increase innovation

WHY IS HCI IMPORTANT

- User-centered design is getting a crucial role!
- It is getting more important today to increase competitiveness via HCI studies (Norman, 1990)
- High-cost e-transformation investments
- Users lose time with badly designed products and services
- Users even give up using bad interface
- Ineffective allocation of resources

DEFINING THE USER INTERFACE

User interface, design is a subset of a field of study called *human-computer interaction* (HCI).

Human-computer interaction is the study, planning, and design of how people and computers work together so that a person's needs are satisfied in the most effective way.

HCI designers must consider a variety of factors:

a. what people want and expect, physical limitations and abilities people possess, --how information processing systems work,

b. what people find enjoyable and attractive.

c. Technical characteristics and limitations of the computer hardware and software must also be considered.

- The *user interface* is to
  – the part of a computer and its software that people can see, hear, touch, talk to, or otherwise understand or direct.

- The user interface has essentially two components: input and output.

- *Input* is how a person communicates his / her needs to the computer.
  – Some common input components are the keyboard, mouse, trackball, one's finger, and one's voice.

- *Output* is how the computer conveys the results of its computations and requirements to the user.
  – Today, the most common computer output mechanism is the display screen, followed by mechanisms that take advantage of a person's auditory capabilities: voice and sound.

- The use of the human senses of smell and touch output in interface design still remain largely unexplored.

- Proper interface design will provide a mix of well-designed input and output mechanisms that satisfy the user's needs, capabilities, and limitations in the most effective way possible.

- The best interface is one that it not noticed, one that permits the user to focus on the information and task at hand, not the mechanisms used to present the information and perform the task.

THE IMPORTANCE OF GOOD DESIGN

With today's technology and tools, and our motivation to create really effective and usable interfaces and screens, why do we continue to produce systems that are inefficient and confusing or, at worst, just plain unusable? Is it because:

- We don't care?
- We don't possess common sense?
- We don't have the time?
- We still don't know what really makes good design?

d) But we never seem to have time to find out what makes good design, nor to properly apply it. After all, many of us have other things to do in addition to designing interfaces and screens.

e) So we take our best shot given the workload and time constraints imposed upon us. The result, too often, is woefully inadequate.

f) Interface and screen design were really a matter of common sense, we developers would have been producing *almost identical* screens for representing the real world.

g) Example bad designs
   a. Closed door with complete wood
   b. suggestion : glass door

THE IMPORTANCE OF THE USER INTERFACE

1. A well-designed interface and screen is terribly important to our users. It is their window to view the capabilities of the system.

2. It is also the vehicle through which many critical tasks are presented. These tasks

often have a direct impact on an organization's relations with its customers, and its profitability.

3. A screen's layout and appearance affect a person in a variety of ways. If they are confusing and inefficient, people will have greater difficulty in doing their jobs and will make more mistakes.

4. Poor design may even chase some people away from a system permanently. It can also lead to aggravation, frustration, and increased stress.

The Benefits of Good Design

1. Poor clarity forced screen users to spend one extra second per screen.
    a. Almost one additional year would be required to process all screens.
    b. Twenty extra seconds in screen usage time adds an additional 14 person year

2. The benefits of a well-designed screen have also been under experimental scrutiny for many years.
    a. One researcher, for example, attempted to improve screen clarity and readability by making screens less crowded.
    b. Separate items, which had been combined on the same display line to conserve space, were placed on separate lines instead.
    c. The result screen users were about 20 percent more productive with the less crowded version.

3. Proper formatting of information on screens does have a significant positive effect on performance.
    a. In recent years, the productivity benefits of well-designed Web pages have also been scrutinized.

4. Training costs are lowered because training time is reduced.

5. Support line costs are lowered because fewer assist calls are necessary.

6. Employee satisfaction is increased because aggravation and frustration are reduced.

7. Ultimately, that an organization's customers benefit because of the improved service they receive.

8. Identifying and resolving problems during the design and development process also has significant economic benefits

9. How many screens are used each day in our technological world?

10. How many screens are used each day in your organization? Thousands? Millions?

11. Imagine the possible savings. Proper screen design might also, of course, lower the costs of replacing "broken" PCs

INTRODUCTION OF THE GRAPHICAL USER INTERFACE

- The Xerox systems, Altus and STAR, introduced the mouse and pointing and selecting as the primary human-computer communication method.

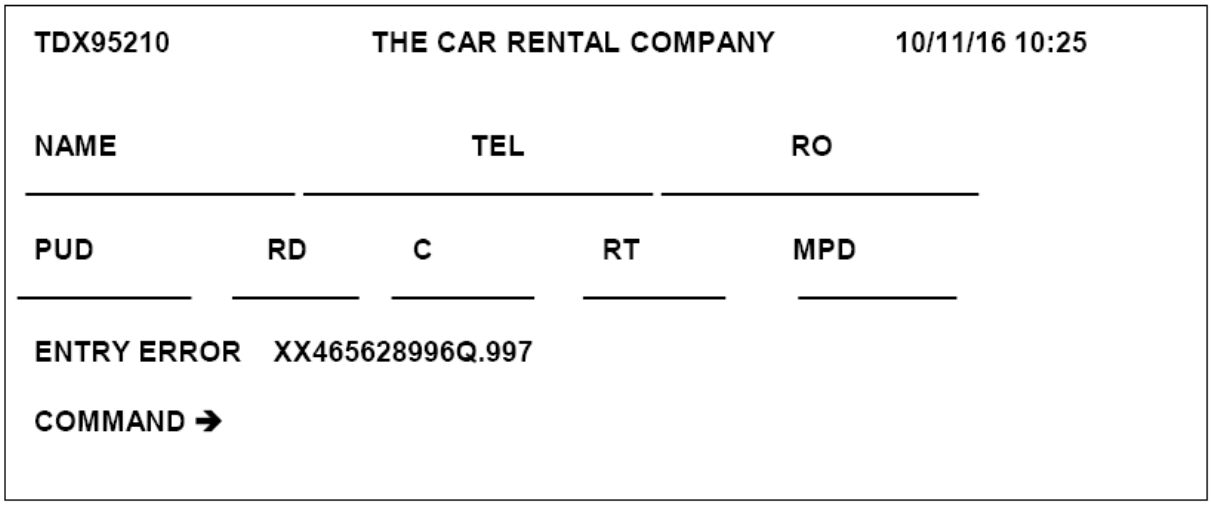
- The user simply pointed at the screen, using the mouse as an intermediary

- These systems also introduced the graphical user interface as we know it a new concept was born, revolutionizing the human-computer interface.

A BRIEF HISTORY OF SCREEN DESIGN

h) While developers have been designing screens since a cathode ray tube display was first attached to a computer, more widespread interest in the application of good design principles to screens did not begin to emerge until the early 1970s, when IBM introduced its 3270 cathode ray tube text-based terminal.

It usually consisted of many fields (more than are illustrated here) with very cryptic and often unintelligible captions.



- It was visually cluttered, and often possessed a command field that challenged the user to remember what had to be keyed into it.

- Ambiguous messages often required referral to a manual to interpret.

- Effectively using this kind of screen required a great deal of practice and patience.

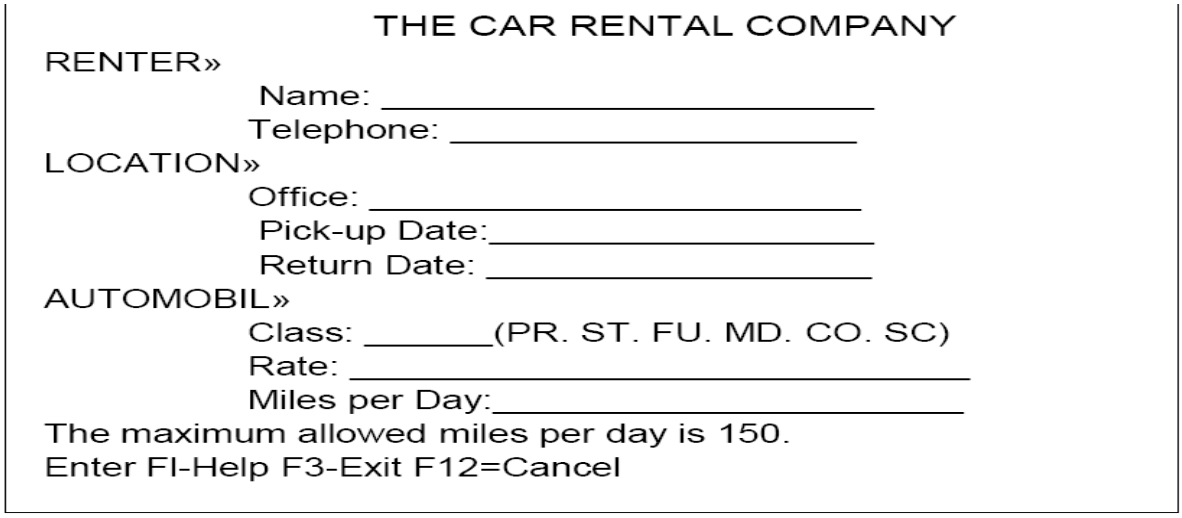
- Most early screens were monochromatic, typically presenting green text on black backgrounds.

- At the turn of the decade guidelines for text-based screen design were finally made widely available and many screens began to take on a much less cluttered look through concepts such as grouping and alignment of elements, as illustrated in Figure 1.2.

- User memory was supported by providing clear and meaningful field captions and by listing commands on the screen, and enabling them to be applied, through function keys. Messages also became clearer.

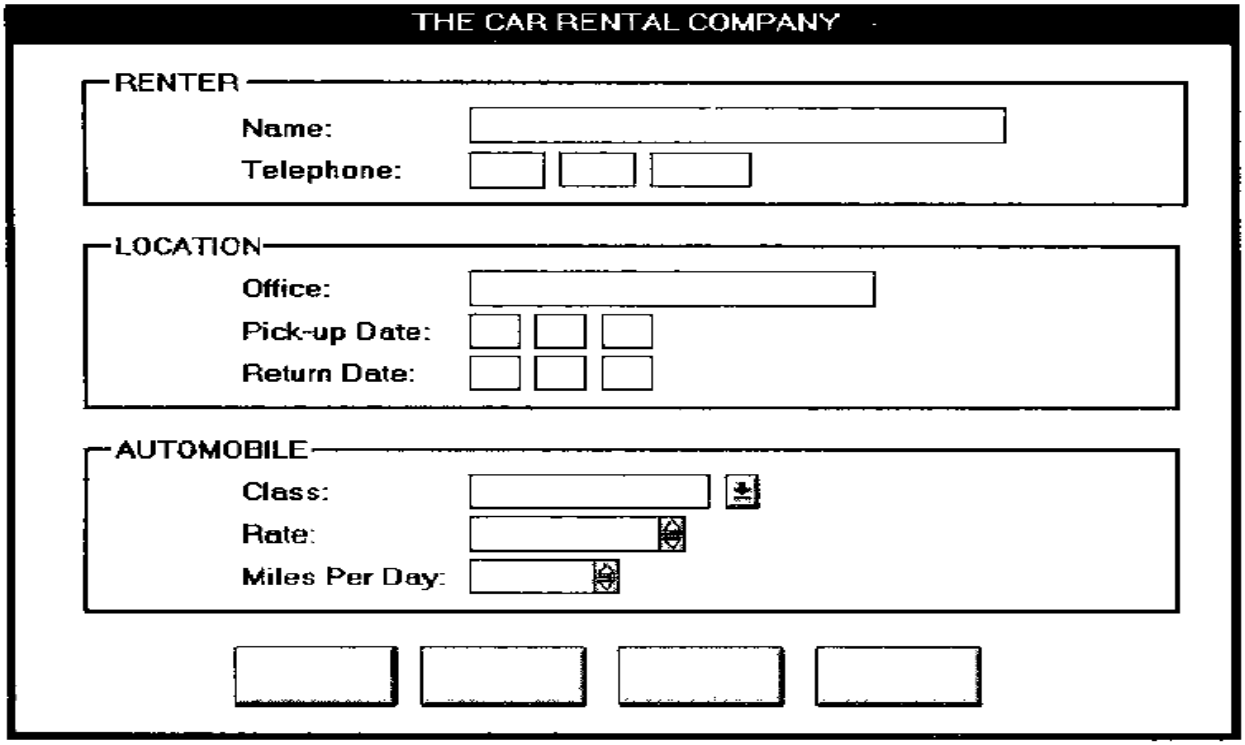
- These screens were not entirely clutter-free, however. Instructions and reminders to the user had to be inscribed on the screen in the form of prompts or completion aids such as the codes PR and Sc.

- Not all 1980s screens looked like this, however. In the 1980s, 1970s-type screens were still being designed, and many still reside in systems today.



i) The advent of graphics yielded another milestone in the evolution of screen design, as illustrated in Figure above

While some basic "design principles did not change, groupings and alignment, for example,
Borders were made available to visually enhance groupings and buttons and menus for implementing commands replaced function keys.



- Multiple properties of elements were also provided, including many different font sizes and styles, line thicknesses, and colors.

- The entry field was supplemented by a multitude of other kinds of controls, including list boxes, drop-down combination boxes, spin boxes, and so forth.

- These new controls were much more effective in supporting a person's memory, now simply allowing for selection from a list instead of requiring a remembered key entry.

- Completion aids disappeared from screens, replaced by one of the new listing controls. Screens could also be simplified, the much more powerful computers being able to quickly present a new screen.

- In the 1990s, our knowledge concerning what makes effective screen design continued to expand. Coupled with ever-improving technology, the result was even greater improvements in the user-computer screen interface as the new century dawned.

THE POPULARITY OF GRAPHICS

- A graphical screen bore scant resemblance to its earlier text-based colleagues.
- Older text-based screen possessed a one dimensional
- Graphic screens assumed a three-dimensional look.
- Controls appeared to rise above the screen and move when activated.
- Information could appear, and disappear, as needed.
- Text could be replaced by graphical images called icons.
- These icons could represent objects or actions
- selection fields such as radio buttons, check boxes, list boxes, and palettes coexisted with the reliable old text entry field
- More sophisticated text entry fields with attached or dropdown menus of.
- Objects and actions were selected through use of pointing mechanisms.
- Increased computer power.
- User's actions to be reacted to quickly, dynamically, and meaningfully.
- WIMP interface: windows, icons, menus, and pointers.
- Graphic presentation is much more effective than other presentation methods.
- Properly used, it reduces the requirement for perceptual and mental information recoding and reorganization, and also reduces the memory loads.
- It permits faster information transfer between computers and people by permitting more visual comparisons of amounts, trends, or relationships; more compact representation of information;
- Graphics also can add appeal or charm to the interface and permit greater customization to create a unique corporate or organization style.

GRAPHICAL SYSTEMS ADVANTAGES AND DISADVANTAGES

- Reduce the memory requirements.
- More effective use of one's information.
- Dramatically reduce system learning requirements.
- Experience indicates that for many people they have done all these things.

ADVANTAGES

- Symbols recognized faster than text
- Faster learning
- Faster use and problem solving
- Easier remembering
- More natural

- Exploits visual/spatial cues
- Fosters more concrete thinking
- Provides context
- Fewer errors
- Increased feeling of control
- Immediate feedback
- Predictable system responses
- Easily reversible actions
- Less anxiety concerning use
- More attractive
- May consume less space
- Replaces national languages
- Easily augmented with text displays
- Smooth transition from command language system

DISADVANTAGES

- Greater design complexity.
- Learning still necessary
- Replaces national languages
- Easily augmented with text displays
- Smooth transition from command language system
- Lack of experimentally-derived design guidelines
- use a pointing device may also have to be learned
- Working domain is the present
- Human comprehension limitations
- Window manipulation requirements
- Production limitations
- Few tested icons exist
- Inefficient for touch typists
- Inefficient for expert users
- Not always the preferred style of interaction
- Not always fastest style of interaction
- Increased chances of clutter and confusion
- May consume more screen space
- Hardware limitations

THE CONCEPT OF DIRECT MANIPULATION

The system is portrayed as an extension of the real world: It is assumed that a person is already familiar with the objects and actions in his or her environment of interest.

The system simply replicates them and portrays them on a different medium, the screen. A person has the power to access and modify these objects, among which are windows.

A person is allowed to work in a familiar environment and in a familiar way, focusing on the data, not the application and tools.

The physical organization of the system, which most often is unfamiliar, is hidden from view and is not a distraction.

Continuous visibility of objects and actions: Like one's desktop, objects are continuously visible. Reminders of actions to be performed are also obvious, labeled buttons replacing complex syntax and command names.

Cursor action and motion occurs in physically obvious and natural ways. One problem in direct manipulation, however, is that there is no direct analogy on the desk for all necessary windowing operations.

A piece of paper on one's desk maintains a constant size, never shrinking or growing. Windows can do both. Solving this problem required embedding a control panel, a familiar concept to most people, in a window's border.

This control panel is manipulated, not the window itself. Actions are rapid and incremental with visible display of results, the results of actions are immediately displayed visually on the screen in their new and current form.

Auditory feedback may also be provided. The impact of a previous action is quickly seen, and the evolution of tasks is continuous and effortless. Incremental actions are easily reversible.

EARLIER DIRECT MANIPULATION SYSTEMS

- The concept of direct manipulation actually preceded the first graphical system. The earliest full-screen text editors possessed similar characteristics.

- Screens of text resembling a piece of paper on one's desk could be created (extension of real world) and then reviewed in their entirety (continuous visibility).

- Editing or restructuring could be easily accomplished (through rapid incremental actions) and the results immediately seen.

- Actions could be reversed when necessary. It took the advent of graphical systems to crystallize the direct manipulation concept, however.

INDIRECT MANIPULATION

In practice, direct manipulation of all screen objects and actions may not be feasible because of the following:The operation may be difficult to conceptualize in the graphical system.

- The graphics capability of the system may be limited.
- The amount of space available for placing manipulation controls in the window border may be limited.
- It may be difficult for people to learn and remember all the necessary operations and actions.
- When this occurs, indirect manipulation is provided. Indirect manipulation substitutes words and text, such as pull-down or pop-up menus, for symbols, and substitutes typing for pointing.
- Most window systems are a combination of both direct and indirect manipulation. A menu may be accessed by pointing at a menu icon and then selecting it (direct manipulation).
- The menu itself, however, is a textual list of operations (indirect manipulation). When an operation is selected from the list, by pointing or typing, the system executes it as a command.
- Which style of interaction-direct manipulation, indirect manipulation, or a combination of both-is best, under what conditions and for whom, remains a question whose answer still eludes us?

CHARACTERISTICS OF THE GRAPHICAL USER INTERFACE

A graphical system possesses a set of defining concepts. Included are sophisticated visual Presentation, pick-and click interaction, a restricted set of interface options, visualization, object orientation, extensive use of a person's recognition memory, and concurrent performance of functions

Sophisticated Visual Presentation:

Visual presentation is the visual aspect of the interface. It is what people see on the screen.

- The sophistication of a graphical system permits displaying lines, including drawings and icons.

- It also permits the displaying of a variety of character fonts, including different sizes and styles.

- The display of 16 million or more colors is possible on some screens. Graphics also permit animation and the presentation of photograph and motion video.

The meaningful interface elements visually presented to the user in a graphical System include windows (primary, secondary, or dialog boxes), menus (menu bar, pull down, pop-up, cascading), icons to represent objects such as programs or files, assorted screen-based controls (text boxes, list boxes, combination boxes, settings, scroll bar and buttons), and a mouse pointer and cursor.

-- The objective is to reflect visually on screen the real world of the user as realistically, meaningfully, simply, and clearly possible.

A graphical system possesses a set of defining concepts. Included are sophisticated visual presentation, pick-and click interaction, a restricted set of interface options, visualization, object orientation, extensive use of a person's recognition memory, and concurrent performance of functions.

Restricted Set of Interface Options: The array of alternatives available to the user is what is presented on the screen or may be retrieved through what is presented on the screen, nothing less, and nothing more. This concept fostered the acronym WYSIWYG.

Pick-and-Click Interaction: Elements of a graphical screen upon which some action is to be performed must first identified.

- The motor activity required of a person to identify this element for a proposed action is

commonly referred to as pick, the signal to perform an action as cue.

- The primary mechanism for performing this pick-and-click is most often the mouse and its buttons.

- The user moves the mouse pointer to the relevant element (pick) and the action is signaled (click).

- Pointing allows rapid selection and feedback. The hand and mind seem to work smoothly and efficiently together.

- The secondary mechanism for performing these selection actions is the keyboard most systems permit pick-and-click to be performed using the keyboard as well.

Visualization: Visualization is a cognitive process that allows people to understand .Information that is difficult to perceive, because it is either too voluminous or too abstract

Presenting specialized graphic portrayals facilitates visualization.

The best visualization method for an activity depends on what People are trying to learn from the data.

The goal is not necessarily to reproduce a really graphical image, but to produce one that conveys the most relevant information.

Effective visualizations can facilitate mental insights, increase productivity, and for faster and more accurate use of data.

Object Orientation: A graphical system consists of objects and actions. Objects are what people see on screen. They are manipulated as a single unit.

- Objects can be composed of sub objects. For example, an object may be a document. The document's sub objects may be a paragraph, sentence, word, and letter.

- A collection is the simplest relationship-the objects sharing a common aspect.

- A collection might be the result of a query or a multiple selection of objects. Operations can be applied to a collection of objects.

- A constraint is a stronger object relationship. Changing an object in a set affects some other object in the set.

- A document being organized into pages is an example of a constraint. A composite exists when the relationship between objects becomes so significant that the aggregation itself can be identified as an object.

- Examples include a range of cells organized into a spreadsheet, or a collection of words organized into a paragraph.

- A *container* is an object in which other objects exist. Examples include text in a document or documents in a folder.

A container often influences the behavior of its content. It may add or suppress certain properties or operations of objects placed within it, control access to its content, or control access to kinds of objects it will accept. These relationships help define an object's type. Similar traits and behaviors exist in objects of the same object type.

Another important object characteristic is persistence. Persistence is the maintenance of a state once it is established. An object's state (for example, window size, cursor location, scroll position, and so on) should always be automatically preserved when the user changes it.

Use of Recognition Memory: Continuous visibility of objects and actions encourages use of a person's more powerful recognition memory. The "out of sight, out of mind" problem is eliminated

CONCURRENT PERFORMANCE OF FUNCTIONS

Graphic systems may do two or more things at one time. Multiple programs may run simultaneously. When a system is not busy on a primary task, it may process background tasks (cooperative multitasking).When applications are running as truly separate tasks, the system may divide the processing power into time slices and allocate portions to each application.

Data may also be transferred between programs. It may be temporarily stored on a "clipboard" for later transfer or be automatically swapped between programs.

THE GRAPHICAL USER INTERFACE (GUI)

- A user interface is a collection of techniques and mechanisms to interact with something.
- In a graphical interface the primary interaction mechanism is a pointing device of some kind.
- This device is the electronic equivalent to the human hand. What the user interacts with is a collection of elements referred to as objects.
- They can be seen, heard, touched, or otherwise perceived.
- Objects are always visible to the user and are used to perform tasks.
- They are interacted with as entities independent of all other objects.
- People perform operations, called actions, on objects. The operations include accessing and modifying objects by pointing, selecting, and manipulating. All objects have standard resulting behaviors.

THE WEB USER INTERFACE

The expansion of the World Wide Web since the early 1990s has been truly amazing. Once simply a communication medium for scientists and researchers, its many and pervasive tentacles have spread deeply into businesses, organizations, and homes around the world. Unlike earlier text-based and GUI systems that were developed and nurtured in an organization's Data Processing and Information Systems groups, the Web's roots were sown in a market-driven society thirsting for convenience and information.

Web interface design is essentially the design of navigation and the presentation of information. It is about content, not data.

Proper interface design is largely a matter of properly balancing the structure and relationships of menus, content, and other linked documents or graphics. The design goal is to build a hierarchy of menus and pages that feels natural, is well structured, is easy to use, and is truthful.

The Web is a navigation environment where people move between pages of information, not an application environment. It is also a graphically rich environment.

Web interface design is difficult for a number of reasons. First, its underlying design language, HTML, was never intended for creating screens to be used by the general population.

Its scope of users was expected to be technical. HTML was limited in objects and interaction styles and did not provide a means for presenting information in the most effective way for people.

Next, browser navigation retreated to the pre-GUI era. This era was characterized by a "command" field whose contents had to be learned, and a navigational organization and structure that lay hidden beneath a mostly dark and blank screen.

GUIs eliminated the absolute necessity for a command field, providing menus related to the task and the current contextual situation.

Browser navigation is mostly confined to a "Back" and "Forward" concept, but "back-to where" and "forward-to where" is often unremembered or unknown.

Web interface design is also more difficult because the main issues concern information Architecture and task flow, neither of which is easy to standardize.

It is more difficult because of the availability of the various types of multimedia, and the desire of many designers to use something simply because it is available.

It is more difficult because users are ill defined, and the user's tools so variable in nature.

The ultimate goal of a Web that feels natural, is well structured, and is easy to use will reach fruition.

THE POPULARITY OF THE WEB

While the introduction of the graphical user interface revolutionized the user interface, the Web has revolutionized computing.

It allows millions of people scattered across the globe to communicate, access information, publish, and be heard.

- It allows people to control much of the display and the rendering of Web pages.

- Aspects such as typography and colors can be changed, graphics turned off, and decisions made whether or not to transmit certain data over non secure channels or whether to accept or refuse cookies.

- Commercialization of the Internet saw even greater expansion of the growth rate. In 1993, Internet traffic was expanding at a 341,634 percent annual growth rate. In 1996, there were nearly 10 million hosts online and 40 million connected people (PBS Timeline).

- User control has had some decided disadvantages for some Web site owners as well.
- Users have become much more discerning about good design.
- Slow download times, confusing navigation, confusing page organization, disturbing animation, or other undesirable site features often results in user abandonment of the site for others with a more agreeable interface.

People are quick to vote with their mouse, and these warnings should not go unheeded.