UNIT -II

DESIGN PROCESS

TOPICS COVERED:

- Understanding how people interact with computers
- Human characteristics in Design
- Human Considerations
- Human Interaction speeds

Human interaction with computers

- Understanding How People Interact with Computers
- Characteristics of computer systems, past and present, that have caused, and are causing, people problems.
- We will then look at the effect these problems have
- Why people have trouble with computers
- Responses to poor design
- People and their tasks

Why People Have Trouble with Computers

- Extensive technical knowledge but little behavioral training
- With its extensive graphical capabilities.
- Poorly designed interfaces.
- What makes a system difficult to use in the eyes of its user?

Use of jargon: Systems often speak in a strange language. Words that are completely alien to the office or home environment or used in different contexts, such as filespec, abend, segment, and boot, proliferate.

Non-obvious design: Complex or novel design elements are not obvious or intuitive, but they must nevertheless be mastered. Operations may have prerequisite conditions that must be satisfied before they can be accomplished, or outcomes may not always be immediate, obvious, or visible. The overall framework of the system may be invisible, with the effect that results cannot always be related to the actions that accomplish them.

Fine distinctions: Different actions may accomplish the same thing, depending upon when they are performed, or different things may result from the same action. Often these distinctions are minute and difficult to keep track of. Critical distinctions are not made at the appropriate time, or distinctions having no real consequence are made instead, as illustrated by the user who insisted that problems were caused by pressing the Enter key "in the wrong way."

Disparity in problem-solving strategies an "error-preventing" strategy: People learn best by doing. They have trouble following directions and do not always read instructions before taking an action. Human problem solving can best be characterized as "error-correcting" or "trial and error," whereby a tentative solution is formulated based on the available evidence and then tried. This tentative solution often has a low chance of success, but the action's results are used to modify one's next attempt and so increase the chance of success. Most early computer systems however, have enforced an "error-preventing" strategy, which assumes that a person will not tak an action until a high degree of confidence exists in its success. The result is that when people head down wrong one-way paths, they often get entangled in situations difficult, or impossible, to get out of. The last resort action? Turn off the computer and start again.

Design inconsistency: The same action may have different names: for example, "save" and "keep," "write" and "list." The same command may cause different things to happen. The same result may be described differently: for example, "not legal" and "not valid." Or the same information may be ordered differently on different screens. The result is that system learning becomes an exercise in rote memorization. Meaningful or conceptual learning becomes very difficult.

Responses to poor Design

Unfortunately, people remember the one thing that went wrong, not the many that go right, so problems are ascribed an abnormal level of importance. Errors are a symptom of problems. The magnitude of errors in a computer-based system has been found to be as high as 46 percent for commands, tasks, or transactions. Errors, and other problems that befuddle one, lead to a variety of psychological and physical user responses.

Psychological

Typical psychological responses to poor design are:

Confusion:

- Detail overwhelms the perceived structure.
- Meaningful patterns are difficult to ascertain, and the conceptual model or underlying framework cannot be understood or established.

Annoyance:

- Roadblocks that prevent a task being completed, or a need from being satisfied, promptly and efficiently lead to annoyance.
- Inconsistencies in design, slow computer reaction times, difficulties in quickly finding information, outdated information, and visual screen distractions are a few of the many things that may annoy users.

Frustration:

- An overabundance of annoyances, an inability to easily convey one's intentions to the computer, or an inability to finish a task or satisfy a need can cause frustration.
- Frustration is heightened if an unexpected computer response cannot be undone or if what really took place cannot be determined: Inflexible and un-forgiving systems are a major source of frustration.

Panic or stress:

- Unexpectedly long delays during times of severe or unusual pres-sure may introduce panic or stress.
- Some typical causes are unavailable systems or long response times when the user is operating under a deadline or dealing with an irate customer.

Boredom:

Boredom results from improper computer pacing (slow response times or long download times) or overly simplistic jobs.

Physical

Psychological responses frequently lead to, or are accompanied by, the following physical reactions.

Abandonment of the system:

- The system is rejected and other information sources are relied upon. These sources must, of course, be available and the user must have the discretion to perform the rejection.
- In business systems this is a common reaction of managerial and professional personnel. With the Web, almost all users can exercise this option.

Partial use of the system:

- Only a portion of the system's capabilities are used, usually those operations that are easiest to perform or that provide the most benefits. Historically, this has been the most common user reaction to most computer systems.
- Many aspects of many systems often go unused. Indirect use of the system: An intermediary is placed between the would-be user and the computer. Again, since this requires high status and discretion, it is another typical response of managers or others with authority.

Modification of the task: The task is changed to match the capabilities of the system. This is a prevalent reaction when the tools are rigid and the problem is unstructured, as in scientific problem solving.

Compensatory activity: Additional actions are performed to compensate for system inadequacies. A common example is the manual reformatting of information to match the structure required by the computer. This is a reaction common to workers whose discretion is limited, such as clerical personnel.

Misuse of the system: The rules are bent to shortcut operational difficulties. This requires significant knowledge of the system and may affect system integrity.

Direct programming:

The system is reprogrammed by its user to meet specific needs. This is a typical response of the sophisticated worker. These physical responses also greatly diminish user efficiency and effectiveness. They force the user to rely upon other information sources, to fail to use a system's complete capabilities, or to perform time-consuming "work-around" actions.

Important Human Characteristics in Design

We are complex organisms with a variety of attributes that have an important influence on interface and screen design. Of particular importance in design are perception, memory, visual acuity, foveal and peripheral vision, sensory storage, information processing, learning, skill, and individual differences.

- Perception,
- Memory,
- Visual acuity,
- foveal and peripheral vision,
- sensory storage,
- information processing,
- learning, skill, and
- Individual differences.

Perception

Perception is our awareness and understanding of the elements and objects of our environment through the physical sensation of our various senses, including sight, sound, smell, and so forth. Perception is influenced, in part, by experience. We classify stimuli based on models stored in our memories and in this way achieve understanding. In essence, we tend to match objects or sensations perceived to things we already know. Comparing the accumulated knowledge of the child with that of an adult in interpreting the world is a vivid example of the role of experience in perception. Other perceptual characteristics include the following:

- Proximity: Our eyes and mind see objects as belonging together if they are near each other in space.

- Similarity: Our eyes and mind see objects as belonging together if they share a common visual property, such as colour, size, shape, brightness, or orientation.
- Matching patterns: We respond similarly to the same shape in different sizes. The letters of the alphabet, for example, possess the same meaning, regardless of physical size.
- Succinctness: We see an object as having some perfect or simple shape because perfection or simplicity is easier to remember
- Closure: Our perception is synthetic; it establishes meaningful wholes. If something does not quite close itself, such as a circle, square, triangle, or word, we see it as closed anyway.
- Unity: Objects that form closed shapes are perceived as a group.
- Continuity: Shortened lines may be automatically extended.
- Balance: We desire stabilization or equilibrium in our viewing environment. Vertical, horizontal, and right angles are the most visually satisfying and easiest to look at.
- Expectancies: Perception is also influenced by expectancies; sometimes we perceive not what is there but what we expect to be there. Missing a spelling mistake in proofreading something we write is often an example of a perceptual expectancy error; we see not how a word spelled, but how we *expect* to see it spelled.
- Context: Context, environment, and surroundings also influence individual perception. For example, two drawn lines of the same length may look the same length or different lengths, depending on the angle of adjacent lines or what other people have said about the size of the lines.
- **Signals versus noise.** Our sensing mechanisms are bombarded by many stimuli, some of which are important and some of which are not. Important stimuli are called signals; those that are not important or unwanted are called noise. Signals are more quickly comprehended if they are easily distinguishable from noise in our sensory environment. Noise interferes with the perception of signals to the extent that they are similar to one another. Noise can even mask a critical signal. For example, imagine a hidden word puzzle where meaningful words are buried in a large block matrix of alphabetic characters. The signals, alphabetic characters constituting meaningful words, are masked by the matrix of meaningless letters.

Memory:

Memory is not the most stable of human attributes, as anyone who has forgotten why they walked into a room, or forgotten a very important birthday, can attest. Today, memory is viewed as consisting of two components, long-term and short-term (or working) memory. This has not always been the case.

In the 1950s, most researchers believed there was only one memory system; the short-term component was not recognized or accepted. It was in this era that the classic memory study was published (Miller, 1956) indicating that memory limit is 7 ± 2 “chunks” of information.

Shortly after this the concept of a short-term memory was identified and, in the 1970s, the view of short-term memory was broadened and called "working memory."

Short-term, or working, memory receives information from either the senses or long-term memory, but usually cannot receive both at once, the senses being processed separately. Within short-term memory a limited amount of information processing takes place. Information stored within it is variously thought to last from 10 to 30 seconds, with the lower number being the most reasonable speculation. Based upon research over the years, estimates of working memory storage capacity has gradually been lowered from Miller's 7 ± 2 items to a size of 3–4 items today.

Long-term memory contains the knowledge we possess. Information received in short-term memory is transferred to it and encoded within it, a process we call learning. It is a complex process requiring some effort on our part. The learning process is improved if the information being transferred from short-term memory has structure and is meaningful and familiar. Learning is also improved through repetition. Unlike short-term memory, with its distinct limitations, long-term memory capacity is thought to be unlimited.

An important memory consideration, with significant implications for interface design, is the difference in ability to recognize or recall words. The human active vocabulary (words that can be recalled) typically ranges between 2,000 and 3,000 words. Passive vocabulary (words that can be recognized) typically numbers about 100,000. Our power of recognition, therefore, is much greater than our power of recall, and this phenomenon should be utilized in design. To do this, one should present, whenever possible, lists of alternatives to remind people of the choices they have.

Other general ways to reduce user memory loads, reduce the need for mental integration, and expand working memory, thus enhancing system usability include:

- Presenting information in an organized, structured, familiar, and meaningful way.
- Placing all required information for task performance in close physical proximity.
- Giving the user control over the pace of information presentation.

Sensory Storage:

Sensory storage is the buffer where the automatic processing of information collected from our senses takes place. It is an unconscious process, large, attentive to the environment, quick to detect changes, and constantly being replaced by newly gathered stimuli. In a sense, it acts like radar, constantly scanning the environment for things that are important to pass on to higher memory.

Though seemingly overwhelmed at times by noise, it can occasionally detect, proverbially, a tree through a forest. One good example is what is sometimes called the "cocktail party affect." Have you ever been at a party when, across the room, through the din of voices, someone mentions your name, and you hear it? In spite of the noise, your radar was functioning. Repeated and excessive stimulation can fatigue the sensory storage mechanism, making it less attentive and unable to distinguish what is important (called *habituation*).

Avoid unnecessarily stressing it. Design the interface so that all aspects and elements serve a definite purpose. Eliminating interface noise will ensure that important things will be less likely to be missed.

Visual Acuity:

The capacity of the eye to resolve details is called *visual acuity*. It is the phenomenon that results in an object becoming more distinct as we turn our eyes toward it and rapidly losing distinctness as we turn our eyes away—that is, as the visual angle from the point of fixation increases. It has been shown that relative visual acuity is approximately halved at a distance of 2.5 degrees from the point of eye fixation (Bouma, 1970).

Therefore, a five-degree diameter circle cantered around an eye fixation character on a display has been recommended as the area near that character (Tullis, 1983) or the maximum length for a displayed word (Danchak, 1976).

If one assumes that the average viewing distance of a display screen is 19 inches (475 mm), the size of the area on the screen of optimum visual acuity is 1.67 inches (41.8 mm) in diameter. Assuming "average" character sizes and character and line spacings, the number of characters on a screen falling within this visual acuity circle is 88, with 15 characters being contained on the widest line, and seven rows being consumed, as illustrated in Figure 1.1.

The eye's sensitivity increases for those characters closest to the fixation point (the "0") and decreases for those characters at the extreme edges of the circle (a 50/50 chance exists for getting these characters correctly identified). This may be presumed to be a visual "chunk" of a screen and will have implications for screen grouping guidelines to be presented later. (Remember, it is the physical size of the circle, five degrees, that is critical, not the number of characters. A larger or smaller character size will decrease or increase the number of viewable characters.)

The eye is also never perfectly steady as it sees; it trembles slightly. This tremor improves the detection of edges of objects being looked at, thus improving acuity. This tremor, however, can sometimes create problems. Patterns of closely spaced lines or dots are seen to shimmer. This movement can be distracting and disturbing. Patterns for fill-in areas of screens (bars, circles, and so on.) must be carefully chosen to avoid this visual distraction.

Foveal and Peripheral Vision:

Foveal vision is used to focus directly on something; *peripheral vision* senses anything in the area surrounding the location we are looking at, but what is there cannot be clearly resolved because of the limitations in visual acuity just described. Foveal and peripheral vision maintain, at the same time, a cooperative and a competitive relationship. Peripheral vision can aid a visual search, but can also be distracting.

In its cooperative nature, peripheral vision is thought to provide clues to where the eye should go next in the visual search of a screen. Patterns, shapes, and alignments peripherally visible can guide the eye in a systematic way through a screen.

In its competitive nature, peripheral vision can compete with foveal vision for attention. What is sensed in the periphery is passed on to our information-processing system along with what is actively being viewed foveal. It is, in a sense, visual noise. Mori and Hayashi (1993) experimentally evaluated the effect of windows in both a foveal and peripheral relationship and found that performance on a foveal window deteriorates when there are peripheral windows, and the performance degradation is even greater if the information in the peripheral is dynamic or moving. Care should be exercised in design to utilize peripheral vision in its positive nature, avoiding its negative aspects.

Information Processing:

The information that our senses collect that is deemed important enough to do something about then has to be processed in some meaningful way. Recent thinking (Lind, Johnson, and Sandblad, 1992) is that there are two levels of information processing going on within us. One level, the highest level, is identified with consciousness and working memory. It is limited, slow, and sequential, and is used for reading and understanding.

You are utilizing this higher level now reading this book. In addition to this higher level, there exists a lower level of information processing, and the limit of its capacity is unknown. This lower-level processes familiar information rapidly, in parallel with the higher level, and without conscious effort. We look rather than see, perceive rather than read. Repetition and learning results in a shift of control from the higher level to the lower level.

Both levels function simultaneously, the higher-level performing reasoning and problem solving, the lower level perceiving the physical form of information sensed.

You've probably experienced this difference in working with screens. When a screen is displayed, you usually will want to verify that it is the one you want. If you're new to a system, or if a screen is new to you, you rely on its concrete elements to make that determination, its title, the controls and information it contains, and so forth. You consciously look at the screen and its components using this higher-level processing.

Mental Models:

- As a result of our experiences and culture, we develop mental models of things and people we interact with.
- A mental model is simply an internal representation of a person's current understanding of something. Usually, a person cannot describe this mental mode and

most often is unaware it even exists. Mental models are gradually developed in order to understand something, explain things, make decisions, do something, or interact with another person.

- Mental models also enable a person to predict the actions necessary to do things if the action has been forgotten or has not yet been encountered.

Movement Control:

Once data has been perceived and an appropriate action decided upon, a response must be made; in many cases the response is a movement. In computer systems, movements include such activities as pressing keyboard keys, moving the screen pointer by pushing a mouse or rotating a trackball, or clicking a mouse button

The implications in screen design are: – Provide large objects for important functions. – Take advantage of the "pinning" actions of the sides, top, bottom, and corners of the screen.

Learning:

Learning, as has been said, is the process of encoding in long-term memory information that is contained in short-term memory. It is a complex process requiring some effort on our part. Our ability to learn is important-it clearly differentiates people from machines. Given enough time people can improve the performance in almost any task. Too often, however, designers use our learning ability as an excuse to justify complex design. A design developed to minimize human learning time can greatly accelerate human performance. People prefer to stick with what they know, and they prefer to jump in and get started. Unproductive time spent learning is something frequently avoided.

- Allows skills acquired in one situation to be used in another somewhat like it.
- Design consistency accomplishes this.
- Provides complete and prompt feedback.
- Is phased, that is, it requires a person to know only the information needed at that stage of the learning process.

Skill:

- The goal of human performance is to perform skillfully. To do so requires linking in-puts and responses into a sequence of action. The essence of skill is performance of actions or movements in the correct time sequence with adequate precision. It is characterized by consistency and economy of effort. Economy of effort is achieved by establishing a work pace that represents optimum efficiency.
- It is accomplished by in-creasing mastery of the system through such things as progressive learning of short-cuts, increased speed, and easier access to information or data. Skills are hierarchical in nature, and many basic skills may be integrated to

form increasingly complex ones. Lower-order skills tend to become routine and may drop out of consciousness.
- System and screen design must permit development of increasingly skillful performance.

Individual Differences:

In reality, there is no average user. A complicating but very advantageous human characteristic is that we all differ-in looks, feelings, motor abilities, intellectual abilities, learning abilities and speed, and so on. In a keyboard data entry task.

For example, the best typists will probably be twice as fast as the poorest and make 10 times fewer errors.

Human considerations

The User's Knowledge and Experience:

The knowledge possessed by a person, and the experiences undergone, shape the design of the interface in many ways. The following kinds of knowledge and experiences should be identified.

- Computer Literacy - Highly technical or experienced, moderate computer experience, or none
- System Experience - High, moderate, or low knowledge of a particular system and its methods of interaction
- Application Experience - High, moderate, or low knowledge of similar systems
- Task Experience - Other Level of knowledge of job and job tasks
- Systems Use - Frequent or infrequent use of other systems in doing job
- Education - High school, college, or advanced degree
- Reading Level - Less than 5th grade, 5th-12th, more than 12th grade
- Typing Skill - Expert (135 WPM), skilled (90 WPM), good (55 WPM), average (40 WPM), or "hunt and peck" (10 WPM).
- Native Language or Culture- English, another, or several

JOB/TASK/NEED

- Type of System Use -Mandatory or discretionary use of the system.
- Frequency of Use -Continual, frequent, occasional, or once-in-a- lifetime use of system
- Task or Need importance - High, moderate, or low importance of the task being performed
- Task Structure - Repetitiveness or predictability of tasks being automated, high, moderate, or low

- Social Interactions - Verbal communication with another person required or not required
- Primary Training - Extensive or formal training, self-training through manuals, or no training
- Turnover Rate - High, moderate, or low turnover rate for jobholders
- Job Category- Executive, manager, professional, secretary, clerk
- Lifestyle - For Web e-commerce systems, includes hobbies, recreational pursuits, and economic status

PSYCHOLOCICAL CHARACTERISTICS:

- Attitude - Positive, neutral, or negative feeling toward job or system
- Motivation - Low, moderate, or high due to interest or fear
- Patience - Patience or impatience expected in accomplishing goal
- Expectations - Kinds and reasonableness
- Stress Level - High, some, or no stress generally resulting from task performance
- Cognitive Style - Verbal or spatial, analytic or intuitive, concrete or abstract

PHYSICAL CHARACTERISTICS:

- Age Young middle aged or elderly
- Gender Male or Female
- Handness Left, right or ambidextrous
- Disabilities Blind, defective vision, deafness, motor handicap

Human interaction speeds.

The speed at which people can perform using various communication methods has been studied by a number of researchers.

Reading:

- The average adult, reading English Prose in the United States, has a reading speed in the order of 250-300 words per minute.
- Proof reading text on paper has been found to occur at about 200 words per minute, on a computer monitor, about 180 words per minute.
- One technique that has dramatically increased reading speeds is called Rapid Serial Visual Presentation, or RSVP.
- In this technique single words are presented one at a time in the center of a screen. New words continually replace old words at a rate set by the reader.
- For a sample of people whose paper document reading speed was 342 words per minute? (With a speed range of 143 to 540 words per minute.)

- Single words were presented on a screen in sets at a speed sequentially varying ranging from 600 to 1,600 words per minute. After each set a comprehension test was administered Prose text - 250-300 words per minute.
- Proof reading text on paper - 200 words per minute. Proofreading text on a monitor - 180 words per minute.

Listening

Words can be comfortably heard and understood at a rate of 150 to 160 words per minute. This is generally the recommended rate for audio books and video narration (Williams, 1998). Omoigui, et al, (1999) did find, however, that when normal speech is speeded up using compression, a speed of 210 words per minute results in no loss of comprehension.

- Speaking to a computer:
- 150-160 words per minute.
- After recognition corrections: 105 words per minute.

Speaking.

Dictating to a computer occurs at a rate of about 105 words per minute (Karat, et al., 1999; Lewis, 1999). Speech recognizer misrecognitions often occur, however, and when word correction times are factored in, the speed drops significantly, to an average of 25 words per minute. Karat, et al. (1999) also found that the speaking rate of new users was 14 words per minute during transcription and 8 words per minute during composition.

Keying

- Fast typewriter typists can key at rates of 150 words per minute and higher. Average typing speed is considered to be about 60–70 words per minute. Computer keying has been found to be much slower, however. Speed for simple transcription found by Karat, et al. (1999) was only 33 words per minute and for composition only 19 words per minute. In this study, the fastest typists typed at only 40 words per minute, the slowest at 23 words per minute. Brown (1988) reports that two-finger typists can key memorized text at 37 words per minute and copied text at 27 words per minute. Something about the computer, its software, and the keyboard does seem to significantly degrade the keying process. (And two-finger typists are not really that bad off after all.)
- Typewriter
- Fast typist: 150 words per minute and higher Average typist: 60-70 words per minute Computer
- Transcription 33 words per minute
- Composition: 19 words per minute

- Two finger typists Memorized text: 37 words per minute
- Copying text: 27 words per minute
- Hand printing Memorized text: 31 words per minute.
- Copying text: 22 words per minute.

Hand printing. People hand prints memorized text at about 31 words per minute. Text is copied at about 22 words per minute (Brown, 1988).