UNIT-3

Design process – Human interaction with computers, importance of human characteristics, human consideration, Human interaction speeds, understanding business junctions.

INTRODUCTION:

The journey into the world of interface design and the screen design process mustbegin with an understanding of the system user, the ***most important***part of any computersystem. It is the user whose needs a system is built to serve. Understanding peopleand what they do is a difficult and often undervalued process but very criticalbecause of the gap in knowledge, skills, and attitudes existing between system usersand developers that build them. To create a truly usable system, the designer must alwaysdo the following:

- Understand how people interact with computers.
- Understand the human characteristics important in design.
- Identify the user's level of knowledge and experience.
- Identify the characteristics of the user's needs, tasks, and jobs.
- Identify the user's psychological characteristics.
- Identify the user's physical characteristics.
- Employ recommended methods for gaining understanding of users.

HUMAN INTERACTION WITH COMPUTERS:

Understanding How People Interact with Computers :

Characteristics of computer systems, past and present, thathave caused, and are causing, people problems. We willthen 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

- What makes a system difficult to use in the eyes of its user? Listed below are several contributing factors that apply to traditional business systems.
    - Use of jargon(terminalogy).

- Non-obvious design.
- Fine distinctions
- Disparity(difference) in problem-solving strategies.
- Design inconsistency.

Use of jargon: Systems often speak in a strange language. Words that are completelyalien to the office or home environment or used in different contexts, such as *filespec*,*abend*, *segment*, and *boot*, proliferate. Learning to use a system often requireslearning a new language.

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

Fine distinctions: Different actions may accomplish the same thing, dependingupon 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 distinctionsare not made at the appropriate time, or distinctions having no realconsequence are made instead, as illustrated by the user who insisted that problemswere caused by pressing the Enter key "in the wrong way."

Disparity in problem-solving strategies: People learn best by doing. They havetrouble following directions and do not always read instructions before taking anaction. Human problem solving can best be characterized as "error-correcting" or"trial and error," whereby a tentative solution is formulated based on the availableevidence 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 increasethe chance of success. Most early computer systems, however, have enforced an "error-preventing" strategy, which assumes that a person will not take an actionuntil a high degree of confidence exists in its success. The result is that when peoplehead 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 andstart again.

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

Responses to Poor Design: 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.
- Annoyance.
- Frustration (disappointment).
- Panic (fear) or stress.
- Boredom (dullness).

Confusion: Detail overwhelms the perceived structure. Meaningful patterns are difficult to ascertain, and the conceptual model or underlying framework cannot beunderstood or established.

Annoyance: Roadblocks that prevent a task being completed, or a need from being satisfied, promptly andefficiently lead to annoyance.

Inconsistencies in design, slow computer reaction times, difficulties in quickly finding information, outdatedinformation, 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 aninability 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 placecannot be determined: Inflexible and unforgiving systems are a major source of frustration.

Panic or stress: Unexpectedly long delays during times of severe or unusual pressure may introduce panic or stress.

Some typical causes are unavailable systems or long response times when the user is operating under adeadline or dealing with an irate customer.

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

• These psychological responses diminish user effectiveness because they are severe blocks to concentration.

. Thoughts irrelevant to the task at hand are forced to the user’s attention, and necessary concentration is impossible.

The result, in addition to higher error rates, is poor performance, anxiety, and dissatisfaction

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

- Abandonment of the system.
- Partial use of the system.
- Indirect use of the system.
- Modification of the task.
- Compensatory activity.
- Misuse of the system.
- Direct programming.

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 areeasiest 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 systemsoften 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 knowledgeof 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 ofthe 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 toperform time-consuming "work-around" actions

IMPORTANT HUMAN CHARACTERISTICS IN DESIGN:

We are complex organisms with a variety of attributes that have an important influenceon 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

1. Perception
2. Memory
3. Sensory Storage
4. Visual Acuity
5. Foveal and Peripheral Vision
6. Information Processing
7. Mental Models
8. Movement Control
9. Learning
10. Skill
11. 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.

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 color, 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 is 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.

2. Memory: Memory is viewed as consisting of two components, long-term and short-term (or 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. Knowledge, experience, and familiarity govern the size and complexity of the information that can be remembered.
- 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.

3.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.
- 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.

4.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
- 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

5.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.
- 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 foveally.

6.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.
- 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.
- 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.
- Both levels function simultaneously, the higher level performing reasoning and problem solving, the lower level perceiving the physical form of information sensed.

7.Mental Models

- 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.
- A person already familiar with one computer system will bring to another system a mental model containing specific visual and usage expectations. If the new system complies with already-established models, it will be much easier to learn and use.
- The key to forming a transferable mental model of a system is design consistency and design standards.

8.Movement Control

- Particularly important in screen design is Fitts' Law (1954). This law states that:
- The time to acquire a target is a function of the distance to and size of the target.
- This simply means that the bigger the target is, or the closer the target is, the faster it will be reached. 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.

9.Learning

- Learning, as has been said, is the process of encoding in long-term memory information
- 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 that is contained in short-term memory.
- Learning can be enhanced if it:
    - 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.

10. Skill

- The goal of human performance is to perform skillfully. To do so requires linking inputs 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.
- 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.

11. 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.
- Individual differences complicate design because the design must permit people with widely varying characteristics to satisfactorily and comfortably learn the task or job, or use the Web site.
- Multiple versions of a system can easily be created. Design must provide for the needs of all potential users.

HUMAN CONSIDERATIONS IN DESIGN:

The human characteristics described above are general qualities we all possess. Thereare also a host of other human aspects in which people may vary greatly. These are alsoimportant and must be identified in the design process. The kinds of user/task characteristicsthat must be established are summarized in below.

The User's Knowledge and Experience

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

Computer Literacy

Are the users highly technical such as programmers or experienced data entry clerks?Do they have moderate computer experience or none at all? Will they be familiar withcomputer concepts and terms, the keyboard and its keys, and a mouse or other inputmechanisms? If familiar, how familiar?

The user's Knowledge/Experience	
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	Level of knowledge of job and job tasks.
Other 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.

System Experience

Are users already familiar with the interaction requirements of the new system, somewhatfamiliar, or not familiar at all? Have users worked with similar systems? If so,what kind? What are the similarities? The differences? The same questions can beasked for Web systems.

At one time or another, various schemes have been proposed to classify the differentand sometimes changing characteristics of people as they become more experiencedusing a system. Words to describe the new, relatively new, or infrequent user.

JOB/TASK AND 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.

Psychological 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.
Handedness	Left, right, or ambidextrous.
Disabilities	Blind, defective vision, deafness, motor handicap.

The User's Knowledge and Experience:

- The following kinds of knowledge and experiences should be identified.

Computer Literacy

- Are the users highly technical such as programmers or experienced data entry clerks or vice versa?

System Experience

Novice Vs Experts

- Words to describe the new, relatively new, or infrequent user have included naive, casual, inexperienced, or novice. At the other end of the experience continuum lie terms such as experienced, full-time, frequent, power, or expert. In between these extremes is a wide range of intermediate or intermittent users.
- In business systems, novice users have been found to:
    - Depend on system features that assist recognition memory: menus, prompting information, and instructional and help screens.
    - Need restricted vocabularies, simple tasks, small numbers of possibilities, and very informative feedback.
    - View practice as an aid to moving up to expert status.
- Experts, on the other hand:
    - Rely upon free recall &Expect rapid performance.
    - Need less informative feedback.
    - Seek efficiency by bypassing novice memory aids, reducing keystrokes, chunking and summarizing
- Novice users often have difficulties:
    - Dragging and double-clicking using the mouse. Distinguishing between double-clicks and two separate clicks is particularly confusing
    - In window management. That overlapping windows represent a three-dimensional space is not always realized. Hidden windows are assumed to be gone and no longer exist.
    - In file management. The organization of files and folders nested more than two levels deep is difficult to understand. Structure is not as apparent as with physical files and folders.
- Experts possess the following traits:
    - They possess an integrated conceptual model of a system.
    - They possess knowledge that is ordered more abstractly and more procedurally.
    - They organize information more meaningfully, orienting it toward their task.

- They structure information into more categories.
- They are better at making inferences and relating new knowledge to their objectives and goals.
- They pay less attention to low-level details.
- They pay less attention to surface features of a system.

- Novices exhibit these characteristics:
  - They possess a fragmented conceptual model of a system.
  - They organize information less meaningfully, orienting it toward surface features of the system.
  - They structure information into fewer categories.
  - They have difficulty in generating inferences and relating new knowledge to their objectives and goals.
  - They pay more attention to low-level details
  - They pay more attention to surface features of the system.

Application Experience

- Have users worked with a similar application (for example, word processing, airline reservation, and so on)? Are they familiar with the basic application terms? Or does little or no application experience exist?

Task Experience: Are users experienced with the task being automated? Or do users possess little or no knowledge of the tasks the system will be performing?

Other System Use: Will the user be using other systems while using the new system?

Education : What is the general educational level of users? Do they generally have high school degrees, college degrees, or advanced degrees?

Reading Level : For textual portions of the interface, the vocabulary and grammatical structure must be at a level that is easily understood by the users.

Typing Skill : Is the user a competent typist or of the hunt-and-peck variety? Is he or she familiar with the standard keyboard layout or other newer layouts?

Native Language and Culture : Do the users speak English, another language, or several other languages? Will the screens be in English or in another language? Other languages often impose different screen layout requirements.

- Are there cultural or ethnic differences between users?

The User's Tasks and Needs: The user's tasks and needs are also important in design. The following should be determined:

Mandatory Vs Discretionary Use

- Users of the earliest computer systems were mandatory or nondiscretionary. That is, they required the computer to perform a task that, for all practical purposes, could be performed no other way.
- This newer kind of user is the office executive, manager, or other professional, whose computer use is completely discretionary.

Characteristics of mandatory use can be summarized as follows:

- The computer is used as part of employment.
- Time and effort in learning to use the computer are willingly invested.
- High motivation is often used to overcome low usability characteristics.
- The user may possess a technical background.
- The job may consist of a single task or function.

Common general characteristics of the discretionary user are as follows:

- Use of the computer or system is not absolutely necessary.
- Technical details are of no interest &Extra effort to use the system may not be invested.
- High motivation to use the system may not be exhibited.
- May be easily disenchanted.
- Voluntary use may have to be encouraged.
- Is from a heterogeneous culture.

Frequency of Use: Is system use a continual, frequent, occasional, or once-in-a-lifetime experience? Frequency of use affects both learning and memory.

- Occasional or infrequent users prefer ease of learning and remembering,

Task or Need Importance

- How important is the task or need for the user?
- People are usually willing to spend more time learning something if it makes the task being performed or need being fulfilled more efficient.

Task Structure: How structured is the task being performed? Is it repetitive and predictable or not so?

Social Interactions

- Will the user, in the normal course of task performance, be engaged in a conversation with another person, such as a customer, while using the system? If so, design should not interfere with the social interaction.
- Neither the user nor the person to whom the user is talking must be distracted in any way by computer interaction requirements. The design must accommodate the social interaction.

Job Category

- In a business system, is the user an executive, manager, professional, secretary, or clerk? While job titles have no direct bearing on design per se, they do enable one to predict some job characteristics when little else is known about the user.
- For example, executives and managers are most often discretionary users, while clerks are most often mandatory ones.

The User's Psychological Characteristics

- A person's psychological characteristics also affect one's performance of tasks requiring motor, cognitive, or perceptual skills.

Attitude and Motivation

- Is the user's attitude toward the system positive, neutral, or negative? Is motivation high, moderate, or low?
- While all these feelings are not caused by, and cannot be controlled by, the designer, a positive attitude and motivation allows the user to concentrate on the productivity qualities of the system.

Patience:

- Is the user patient or impatient?
- They are exhibiting less tolerance for Web use learning requirements, slow response times, and inefficiencies in navigation and locating desired content.

Stress Level

- Will the user be subject to high levels of stress while using the system? Interacting with an angry boss, client, or customer, can greatly increase a person's stress level.
- System navigation or screen content may have to be redesigned for extreme simplicity in situations that can become stressful.

Expectations

- What are user's expectations about the system or Web site? Are they realistic?
- Is it important that the user's expectations be realized?

Cognitive Style

- People differ in how they think about and solve problems.
- Some people are better at verbal thinking, working more effectively with words and equations.
- Others are better at spatial reasoning—manipulating symbols, pictures, and images.
- Some people are analytic thinkers, systematically analyzing the facets of a problem.
- Others are intuitive, relying on rules of thumb, hunches, and educated guesses.
- Some people are more concrete in their thinking, others more abstract.

The User's Physical Characteristics

- The physical characteristics of people can also greatly affect their performance with a system.

Age : Are the users children, young adults, middle-aged, senior citizens, or very elderly? Age can have an affect on both computer and system usage.

Young Adults VS Older Adults

Young adults (aged 18–36), in comparison to older adults (aged 64–81)

- Use computers and ATMs more often.
- Read faster.
- Possess greater reading comprehension and working memory capacity.
- Possess faster choice reaction times & higher perceptual speed scores.
- Complete a search task at a higher success rate.
- Use significantly less moves (clicks) to complete a search task.
- Are more likely to read a screen a line at a time.

Older adults, as compared to young adults:

- Are more educated.
- Possess higher vocabulary scores.
- Have more difficulty recalling previous moves and location of previously viewed information.
- Have more problems with tasks that require three or more moves (clicks).
- Are more likely to scroll a page at a time
- Respond better to full pages rather than long continuous scrolled pages.

Methods for Gaining an Understanding of Users

- Visit user locations, particularly if they are unfamiliar to you, to gain an understanding of the user's work environment.
- Talk with users about their problems, difficulties, wishes, and what works well now. Establish direct contact; avoid relying on intermediaries.
- Observe users working or performing a task to see what they do, their difficulties, and their problems.
- Videotape users working or performing a task to illustrate and study problems and difficulties.
- Learn about the work organization where the system may be installed.
- Have users think aloud as they do something to uncover details that may not otherwise be solicited.
- Try the job yourself. It may expose difficulties that are not known, or expressed, by users.
- Prepare surveys and questionnaires to obtain a larger sample of user opinions.
- Establish testable behavioral target goals to give management a measure for what progress has been made and what is still required.

Hearing: As people age, they require louder sounds to hear, a noticeable attribute in almost any everyday activity.

Age in Years	Sound Level in dB
25	57
45	65
65	74
85	85

Vision: Older adults read prose text in smaller type fonts more slowly than younger adults

- (Charness and Dijkstra, 1999). For older adults they recommend:
    - 14-point type in 4-inch wide columns.
    - 12-point type in 3-inch wide columns.
- Ellis and Kurniawan (2000) recommend the following fonts for older users:
    - San serif (Arial, Helvetica, and Verdana).
    - Black type on a white background.
- Ellis and Kurniawan (2000) and Czaja (1997) suggest Web links should be:

- Distinct and easy to see.
- Large (at least 180 × 22 pixels for a button).
- Surrounded by a large amount of white space.

Cognitive Processing

- Brain processing also appears to slow with age. Working memory, attention capacity, and visual search appear to be degraded.
- Tasks where knowledge is important show the smallest age effect and tasks dependent upon speed show the largest effect

Gender : A user's sex may have an impact on both motor and cognitive performance because

- Women are not as strong as men,
- Women also have smaller hands than men, and
- Significantly more men are color-blind than women

Handedness: A user's handedness, left or right, can affect ease of use of an input mechanism, depending on whether it has been optimized for one or the other hand.

Disabilities : Blindness, defective vision, color-blindness, poor hearing, deafness, and motor handicaps can affect performance on a system not designed with these disabilities in mind.

- People with special needs must be considered in design especially for systems like web design.

HUMAN INTERACTION SPEEDS:

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

Reading. The average adult, reading English prose in the United States, has a readingspeed in the order of 250–300 words per minute. Proofreading text on paperhas been found to occur at about 200 words per minute, on a computer monitor,about 180 words per minute (Ziefle, 1998).

Table 1.3 Average Human Interaction Speeds

Reading	
Prose text:	250–300 words per minute.
Proofreading text on paper:	200 words per minute.
Proofreading text on a monitor:	180 words per minute.
Listening:	150–160 words per minute.
Speaking to a computer:	105 words per minute.
After recognition corrections:	25 words per minute.
Keying	
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.

For measured comprehension scores of 75 percent or higher, the average readingspeed was 1,212 words per minute. This is about 3.5 times faster than reading inthe traditional way. Bailey concludes that computer technology can help improvereading speeds, but nontraditional techniques must be used.

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

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 foundthat the speaking rate of new users was 14 words per minute during transcriptionand 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. Computerkeying has been found to be much slower, however. Speed for simple transcriptionfound by Karat, et al. (1999) was only 33 words per

minute and forcomposition only 19 words per minute. In this study, the fastest typists typed atonly 40 words per minute, the slowest at 23 words per minute. Brown (1988) re- ports that two-finger typists can key memorized text at 37 words per minute andcopied text at 27 words per minute. Something about the computer, its software,and the keyboard does seem to significantly degrade the keying process. (Andtwo-finger typists are not really that bad off after all.)

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

Understand the Business Function:The general steps to be performed are:

- Perform a business definition and requirements analysis.
- Determine basic business functions &Describe current activities through task analysis.
- Develop a conceptual model of the system &Establish design standards or style guides.
- Establish system usability design goals &Define training and documentation needs.

Business Definition and Requirements Analysis

- The objective of this phase is to establish the need for a system. A requirement is an objective that must be met.
- A product description is developed and refined, based on input from users or marketing. There are many techniques for capturing information for determining requirements.

DIRECT METHODS:

Advantages

- The significant advantage of the direct methods is the opportunity they provide to hear the user's comments in person and firsthand.
- Person-to-person encounters permit multiple channels of communication (body language, voice inflections, and so on) and provide the opportunity to immediately follow up on vague or incomplete data.

Here are some recommended direct methods for getting input from users.

Individual Face-to-Face Interview

- A one-on-one visit with the user to obtain information. It may be structured or somewhat open-ended.
- A formal questionnaire should not be used, however. Useful topics to ask the user to describe in an interview include:

- The activities performed in completing a task or achieving a goal or objective.
- The methods used to perform an activity.
- What interactions exist with other people or systems?
- It is also very useful to also uncover any:
    - Potential measures of system usability
    - Unmentioned exceptions to standard policies or procedures.
    - Relevant knowledge the user must possess to perform the activity.
- **Advantages**
    - Advantages of a personal interview are that you can give the user your full attention, can easily include follow-up questions to gain additional information, will have more time to discuss topics in detail, and will derive a deeper understanding of your users, their experiences, attitudes, beliefs, and desires.
- **Disadvantages**
    - Disadvantages of interviews are that they can be costly and time-consuming to conduct, and someone skilled in interviewing techniques should perform them.

Telephone Interview or Survey

- A structured interview conducted via telephone.
- **Advantages**
    - Arranging the interview in advance allows the user to prepare for it.
    - Telephone interviews are less expensive and less invasive than personal interviews.
    - They can be used much more frequently and are extremely effective for very specific information.
- **Disadvantage**
    - It is impossible to gather contextual information, such as a description of the working environment, replies may be easily influenced by the interviewer's comments, and body language cues are missing.
    - Also, it may be difficult to contact the right person for the telephone interview.

Traditional Focus Group

- A small group of users and a moderator brought together to verbally discuss the requirements.
- The purpose of a focus group is to probe user's experiences, attitudes, beliefs, and desires, and to obtain their reactions to ideas or prototypes
- Setting up focus group involves the following:

- Establish the objectives of the session.
- Select participants representing typical users, or potential users.
- Write a script for the moderator to follow.
- Find a skilled moderator to facilitate discussion, to ensure that the discussion remains focused on relevant topics, and to ensure that everyone participates.
- Allow the moderator flexibility in using the script.
- Take good notes, using the session recording for backup and clarification

Facilitated Team Workshop

- A facilitated, structured workshop held with users to obtain requirements information. Similar to the traditional Focus Group
- Like focus groups, they do require a great deal of time to organize and run.

Observational Field Study

- Users are observed and monitored for an extended time to learn what they do.
- Observation provides good insight into tasks being performed, the working environment and conditions, the social environment, and working practices
- Observation, however, can be time-consuming and expensive.
- Video recording of the observation sessions will permit detailed task analysis.

Requirements Prototyping

- A demo, or very early prototype, is presented to users for comments concerning functionality.

User-Interface Prototyping: A demo, or early prototype, is presented to users to uncover user-interface issues and problems

Usability Laboratory Testing

- Users at work are observed, evaluated, and measured in a specially constructed laboratory to establish the usability of the product at that point in time.
- Usability tests uncover what people actually do, not what they think they do a common problem with verbal descriptions
- The same scenarios can be presented to multiple users, providing comparative data from several users.

Card Sorting for Web Sites

- A technique to establish groupings of information for Web sites.

- Briefly, the process is as follows:
    - ✓ From previous analyses, identify about 50 content topics and inscribe them on index cards. Limit topics to no more than 100.
    - ✓ Provide blank index cards for names of additional topics the participant may want to add, and colored blank cards for groupings that the participant will be asked to create.
    - ✓ Number the cards on the back.
    - ✓ Arrange for a facility with large enough table for spreading out cards.
    - ✓ Select participants representing a range of users. Use one or two people at a time and 5 to 12 in total.
    - ✓ Explain the process to the participants, saying that you are trying to determine what categories of information will be useful, what groupings make sense, and what the groupings should be called.
    - ✓ Ask the participants to sort the cards and talk out loud while doing so. Advise the participants that additional content cards may be named and added as they think necessary during the sorting process.
    - ✓ Observe and take notes as the participants talk about what they are doing. Pay particular attention to the sorting rationale.
    - ✓ Upon finishing the sorting, if a participant has too many groupings ask that they be arranged hierarchically.
    - ✓ Ask participants to provide a name for each grouping on the colored blank cards, using words that the user would expect to see that would lead them to that particular grouping.
    - ✓ Make a record of the groupings using the numbers on the back of each card.
    - ✓ Reshuffle the cards for the next session.
    - ✓ When finished, analyze the results looking for commonalities among the different sorting sessions.

INDIRECT METHODS

- An indirect method of requirements determination is one that places an intermediary between the developer and the user. This intermediary may be electronic or another person

Problems of Indirect Method

- First, there may be a filtering or distortion of the message, either intentional or unintentional.

- Next, the intermediary may not possess a complete, or current, understanding of user's needs, passing on an incomplete or incorrect message.
- Finally, the intermediary may be a mechanism that discourages direct user-developer contact for political reasons.

MIS Intermediary

- A company representative defines the user's goals and needs to designers and developers.
- This representative may come from the Information Services department itself, or he or she may be from the using department.

Paper Survey or Questionnaire

- A survey or questionnaire is administered to a sample of users using traditional mail methods to obtain their needs.
- **Advantage**
    - Questionnaires have the potential to be used for a large target audience located most anywhere, and are much cheaper than customer visits.
    - They generally, however, have a low return rate
- **Disadvantage**
    - They may take a long time to collect and may be difficult to analyze.
- Questionnaires should be composed mostly of closed questions
- Questionnaires should be relatively short and created by someone experienced in their design.

Electronic Survey or Questionnaire

- A survey or questionnaire is administered to a sample of users using e-mail or the Web to obtain their needs.
- In creating an electronic survey:
    - Determine the survey objectives.
    - Determine where you will find the people to complete the survey.
    - Create a mix of multiple choice and open-ended questions requiring short answers addressing the survey objectives.
    - Keep it short, about 10 items or less is preferable.
    - Keep it simple, requiring no more than 5–10 minutes to complete
- **Iterative survey**

- Consider a follow-up more detailed survey, or surveys, called *iterative surveys*. Ask people who complete and return the initial survey if they are willing to answer more detailed questions. If so, create and send the more detailed survey.
- A third follow-up survey can also be designed to gather additional information about the most important requirements and tasks
- Iterative surveys, of course, take a longer time to complete.

Electronic Focus Group

- A small group of users and a moderator discuss the requirements online using workstations.
- advantages
  - advantages of electronic focus groups over traditional focus groups are that the discussion is less influenced by group dynamics; has a smaller chance of being dominated by one or a few participants; can be anonymous, leading to more honest comments and less caution in proposing new ideas
- **Disadvantages**
  - The depth and richness of verbal discussions does not exist and the communication enhancement aspects of seeing participant's body language are missing.

Marketing and Sales : Company representatives who regularly meet customers obtain suggestions or needs, current and potential.

Support Line : Information collected by the unit that helps customers with day-to-day problems is analyzed (Customer Support, Technical Support, Help Desk, etc.).

E-Mail or Bulletin Board: Problems, questions, and suggestions from users posted to a bulletin board or through e-mail are analyzed.

User Group : Improvements are suggested by customer groups who convene periodically to discuss software usage. They require careful planning.

Competitor Analyses : A review of competitor's products or Web sites is used to gather ideas, uncover design requirements and identify tasks.

Trade Show : Customers at a trade show are presented a mock-up or prototype and asked for comments.

Other Media Analysis : An analysis of how other media, print or broadcast, present the process, information, or subject matter of interest.

System Testing: New requirements and feedback are obtained from ongoing product testing

Requirements Collection Guidelines

- Establish 4 to 6 different developer-user links.
- Provide most reliance on direct links.

Determining Basic Business Functions

- A detailed description of what the product will do is prepared. Major system functions are listed and described, including critical system inputs and outputs. A flowchart of major functions is developed. The process the developer will use is summarized as follows:
    - Gain a complete understanding of the user's mental model based upon:
        - The user's needs and the user's profile.
        - A user task analysis.
    - Develop a conceptual model of the system based upon the user's mental model. This includes:
        - Defining objects.
        - Developing metaphors.

Understanding the User's Mental Model

- A goal of task analysis, and a goal of understanding the user, is to gain a picture of the user's mental model. A mental model is an internal representation of a person's current conceptualization and understanding of something.
- Mental models are gradually developed in order to understand, explain, and do something. Mental models enable a person to predict the actions necessary to do things if the actions have been forgotten or have not yet been encountered.

Performing a Task Analysis

- User activities are precisely described in a task analysis. Task analysis involves breaking down the user's activities to the individual task level. The goal is to obtain an understanding of why and how people currently do the things that will be automated.
- Knowing why establishes the major work goals; knowing how provides details of actions performed to accomplish these goals. Task analysis also provides information concerning workflows, the interrelationships between people, objects, and actions, and the user's conceptual

frameworks. The output of a task analysis is a complete description of all user tasks and interactions.

- One result of a task analysis is a listing of the user's current tasks. This list should be well documented and maintained. Changes in task requirements can then be easily incorporated as design iteration occurs. Another result is a list of objects the users see as important to what they do. The objects can be sorted into the following categories:
    - Concrete objects—things that can be touched.
    - People who are the object of sentences—normally organization employees, customers,
    - for example.
    - Forms or journals—things that keep track of information.
    - People who are the subject of sentences—normally the users of a system.
    - Abstract objects—anything not included above.

Developing Conceptual Models

- The output of the task analysis is the creation, by the designer, of a conceptual model for the user interface. A conceptual model is the general conceptual framework through which the system's functions are presented. Such a model describes how the interface will present objects, the relationships between objects, the properties of objects, and the actions that will be performed.
- The goal of the designer is to facilitate for the user the development of useful mental model of the system. This is accomplished by presenting to the user a meaningful conceptual model of the system. When the user then encounters the system, his or her existing mental model will, hopefully, mesh well with the system's conceptual model.

Guidelines for Designing Conceptual Models

- **Reflect the user's mental model not the designer's:** A user will have different expectations and levels of knowledge than the designer. So, the mental models of the user and designer will be different. The user is concerned with the task to be performed, the business objectives that must be fulfilled.
- **Draw physical analogies or present metaphors:** Replicate what is familiar and well known. Duplicate actions that are already well learned. A metaphor, to be effective, must be widely applicable within an interface.
- **Comply with expectancies, habits, routines, and stereotypes:** Use familiar associations, avoiding the new and unfamiliar. With color, for example, accepted meanings for red, yellow, and green are already well established. Use words and symbols in their customary ways.

- **Provide action-response compatibility:** All system responses should be compatible with the actions that elicit them. Names of commands, for example, should reflect the actions that will occur.
- **Make invisible parts and process of a system visible:** New users of a system often make erroneous or incomplete assumptions about what is invisible and develop a faulty mental model. As more experience is gained, their mental models evolve to become more accurate and complete. Making invisible parts of a system visible will speed up the process of developing correct mental models.
- **Provide proper and correct feedback:** Be generous in providing feedback. Keep a person informed of what is happening, and what has happened, at all times, including:
    - Provide visible results of actions.
    - Display actions in progress.
    - Provide a continuous indication of status.
    - Present as much context information as possible.
    - Provide clear, constructive, and correct error messages.
- **Avoid anything unnecessary or irrelevant:** Never display irrelevant information on the screen. People may try to interpret it and integrate it into their mental models, thereby creating a false one.
- **Provide design consistency:** Design consistency reduces the number of concepts to be learned. Inconsistency requires the mastery of multiple models. If an occasional inconsistency cannot be avoided, explain it to the user.
- **Provide documentation and a help system that will reinforce the conceptual model:** Do not rely on the people to uncover consistencies and metaphors themselves. The help system should offer advice aimed at improving mental models.
- **Promote the development of both novice and expert mental models :** Novices and experts are likely to bring to bear different mental models when using a system.

Defining Objects

- Determine all objects that have to be manipulated to get work done. Describe:

  — The objects used in tasks.

  — Object behavior and characteristics that differentiate each kind of object.

  — The relationship of objects to each other and the people using them.

— The actions performed &The objects to which actions apply.

— State information or attributes that each object in the task must preserve, display, or allow to be edited.

- Identify the objects and actions that appear most often in the workflow.
- Make the several most important objects very obvious and easy to manipulate.

Developing Metaphors

- A metaphor is a concept where one's body of knowledge about one thing is used to understand something else. Metaphors act as building blocks of a system, aiding understanding of how a system works and is organized.
- Real-world metaphors are most often the best choice. Replicate what is familiar and well known. A common metaphor in a graphical system is the desktop and its components,
    - Choose the analogy that works best for each object and its actions.
    - Use real-world metaphors.
    - Use simple metaphors &Use common metaphors.
    - Multiple metaphors may coexist.
    - Use major metaphors, even if you can't exactly replicate them visually.
    - Test the selected metaphors.

Design Standards or Style Guides

- A design standard or style guide documents an agreed-upon way of doing something. It also defines the interface standards, rules, guidelines, and conventions that must be followed in detailed design.

Value of Standards and Guidelines

- Developing and applying design standards or guidelines achieve design consistency.
- This is valuable to users because the standards and guidelines:
    - Allow faster performance & Reduce errors,Reduce training time.
    - Foster better system utilization.
    - Improve satisfaction& system acceptance.
- They are valuable to system developers because they:
    - Increase visibility of the human-computer interface.
    - Simplify design.
    - Provide more programming and design aids, reducing programming time.

- Reduce redundant effort &Reduce training time.
- Provide a benchmark for quality control testing.

Document Design

- Include checklists to present principles and guidelines.
- Provide a rationale for why the particular guidelines should be used.
- Provide a rationale describing the conditions under which various design alternatives are appropriate.
- Include concrete examples of correct design.
- Design the guideline document following recognized principles for good document design.
- Provide good access mechanisms such as a thorough index, a table of contents, glossaries, and checklists.

Design Support and Implementation

- Use all available reference sources in creating the guidelines.
- Use development and implementation tools that support the guidelines.
- Begin applying the guidelines immediately.

System Training and Documentation Needs

Training

- System training will be based on user needs, system conceptual design, system learning goals, and system performance goals.
- Training may include such tools as formal or video training, manuals, online tutorials, reference manuals, quick reference guides, and online help.
- Any potential problems can also be identified and addressed earlier in the design process, reducing later problems and modification costs.

Documentation

- System documentation is a reference point, a form of communication, and a more concrete design—words that can be seen and understood based on user needs, system conceptual design, and system performance goals.

It will also be Creating documentation during the development progress will uncover issues and reveal omissions that might not otherwise be detected until later in the design process.

Obstacles(difficulties) and Pitfalls(Drawbacks) in the Development Path:

Developing a computer system is never easy. The path is littered with obstacles and traps, many of them human in nature. Gould (1988) has made these general observations about design :

- Nobody ever gets it right the first time.
- Development is chock-full of surprises.
- Good design requires living in a sea of changes.
- Making contracts to ignore change will never eliminate the need for change.
- Even if you have made the best system humanly possible, people will still make
- mistakes when using it.
- Designers need good tools.
- You must have behavioral design goals like performance design goals.

Pitfalls in the design process exist because of a flawed design process, including a failure to address critical design issues, an improper focus of attention, or development team organization failures. **Common pitfalls are**:

- No early analysis and understanding of the user's needs and expectations.
- A focus on using design features or components that are "neat" or "glitzy."
- Little or no creation of design element prototypes.
- No usability testing.
- No common design team vision of user interface design goals.
- Poor communication between members of the development team

Designing for People: The Five Commandments (instructions):

The complexity of a graphical or Web interface will always magnify any problems that do occur. While obstacles to design will always exist, pitfalls can be eliminated if the following design commandments remain foremost in the designer's mind.

Gain a complete understanding of users and their tasks. The users are the customers.

Today, people expect a level of design sophistication from all interfaces, including Web sites. The product, system or Web site must be geared to people's needs, not those of the developers. A wide gap in technical abilities, goals, and attitudes often exists between users and developers. A failure to understand the differences will doom a product or system to failure.

Solicit early and ongoing user involvement. Involving the users in design from the beginning provides a direct conduit to the knowledge they possess about jobs, tasks, and needs. Involvement also allows the developer to confront a person's resistance to change, a common human trait. People dislike change for

a variety of reasons, among them fear of the unknown and lack of identification with the sys-tem. Involvement in design removes the unknown and gives the user a stake in the system or identification with it. One caution, however: user involvement
should be based on job or task knowledge, not status or position. The boss seldom knows what is really happening out in the office.

Perform rapid prototyping and testing. Prototyping and testing the product will quickly identify problems and allow you to develop solutions. The design process is complex and human behavior is still not well understood. While the design guidelines that follow go a long way toward achieving ease of use, all problems cannot possibly be predicted. Prototyping and testing must be continually performed during all stages of development to uncover all potential defects.

If thorough testing is not performed before product release, the testing will occur in the user's office. Encountering a series of problems early in system use will create a negative first impression in the customer's mind, and this may harden quickly, creating attitudes that may be difficult to change.

It is also much harder and more costly to fix a product after its release. In many instances, people may adapt to, or become dependent upon, a design, even if it is inefficient. This also makes future modifications much more difficult.

Modify and iterate the design as much as necessary. While design will proceed through a series of stages, problems detected in one stage may force the developer to revisit a previous stage. This is normal and should be expected. Establish user performance and acceptance criteria and continue testing and modifying until all design goals are met.

Integrate the design of *all* the system components. The software, the documentation, the help function, and training needs are all important elements of a graphical system or Web site and all should be developed concurrently. A system is being constructed, not simply software. Concurrent development of all pieces will point out possible problems earlier in the design process, allowing them to be more effectively addressed. Time will also exist for design trade-offs to be thought out more carefully.

USABILITY:

Bennett (1979) was the first to use the term *usability* to describe the effectiveness of human performance. In the following years a more formal definition was proposed by Shackel (1981) and modified by Bennett (1984). Finally, Shackel (1991) simply defined usability as

"the capability to be used by humans easily and effectively, where,
easily = to a specified level of subjective assessment,
effectively = to a specified level of human performance."

Usability Assessment in the Design Process

Usability assessment should begin in the early stages of the product development cycle and should be continually applied throughout the process. The assessment should include the user's entire experience, and all the product's important components.

Common Usability Problems:

Mandel (1994) lists the 10 most common usability problems in graphical systems as reported by IBM usability specialists. They are:

1. Ambiguous menus and icons.
2. Languages that permit only single-direction movement through a system.
3. Input and direct manipulation limits.
4. Highlighting and selection limitations.
5. Unclear step sequences.
6. More steps to manage the interface than to perform tasks.
7. Complex linkage between and within applications.
8. Inadequate feedback and confirmation.
9. Lack of system anticipation and intelligence.
10. Inadequate error messages, help, tutorials, and documentation

Some Practical Measures of Usability:

Usability, or the lack thereof, can often be sensed by a simple observation of, or talking to, people using an interface. While these measures lack scientific rigor, they do provide an indication that there may be usability problems.

Are people asking a lot of questions or often reaching for a manual?

Many questions or frequent glances at manuals are signs that things are not as clear and intuitive as they should be. When in doubt, the first reaction of many people is to ask someone for assistance. When no one is around, then we look in a manual

Are frequent exasperation responses heard? "Oh damn!" or similar reactions are usually used to express annoyance or frustration. Their frequency, and loudness, may foretell a strong rejection of a product. The absence of exasperation, however, may not represent acceptance. Some people are not as expressive in their language, or are better able to smother their feelings.

Are there many irrelevant actions being performed?

Are people doing things the hard way? Are there incidental actions required for, but not directly related to, doing a job? These include excessive mouse clicks or keyboard strokes to accomplish

something, or going through many operations to find the right page in a manual or the right window or page in the display.

Are there many things to ignore?

Are there many elements on the screen that the user must disregard? Are there many "doesn't pertain to me" items? If so, remember, they still consume a portion of a person's visual or informationprocessing capacities, detracting from the capacities a person could devote to relevant things.

Do a number of people want to use the product?

None of us goes out of our way to make our own lives more difficult. (Unfortunately, other people may, however.) We tend to gravitate to things easy to work with or do. If a lot of people want to use it, it probably has a higher usability score. Attitudes may be a very powerful
factor in a system's or Web site's acceptance.

Some Objective Measures of Usability:

Shackel (1991) presents the following more objective criteria for measuring usability.

How *effective* is the interface? Can the required range of tasks be accomplished:

- At better than some required level of performance (for example, in terms of speed and errors)?
- By some required percentage of the specified target range of users?
- Within some required proportion of the range of usage environments?

How *learnable* is the interface? Can the interface be learned:

- Within some specified time from commissioning and start of user training?
- Based on some specified amount of training and user support?
- Within some specified relearning time each time for intermittent users?

How *flexible* is the interface? Is it flexible enough to:

- Allow some specified percentage variation in tasks and/or environments beyond those first specified?

What are the *attitudes* of the users? Are they:

- Within acceptable levels of human cost in terms of tiredness, discomfort, frustration, and personal effort? Such that satisfaction causes continued and enhanced usage of the system?