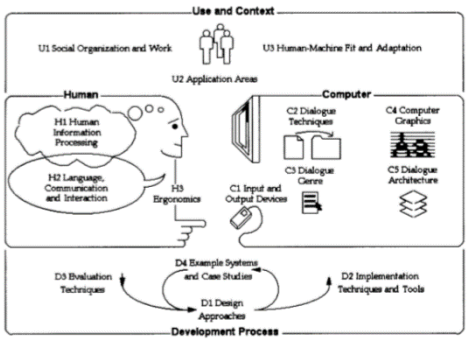
HCI OVERVIEW

HUMAN COMPUTER INTERACTION

- **The term HCI was adopted in the mid-1980s: Association for Computing Machinery (ACM):** "discipline concerned with the design, evaluation & implementation of interactive computer systems for human use & with the study of major phenomena surrounding them" (1992).
- **Carroll:** "HCI is the study and practice of usability. It is about understanding and creating software and other technology that people will want to use, will be able to use, and will find effective when used." (2002).
- **Human:** Individual user, a group of users working together, a sequence of users in an organization.
- **Computer:** Desktop computer, large-scale computer system, Pocket PC, embedded system (e.g., photocopier, microwave oven), software (e.g., search engine, word processor).
- **User interface:** Parts of the computer that the user contacts with.
- **Interaction:** Usually involve a dialog with feedback & control throughout performing a task (e.g., user invokes "print" command and then interface replies with a dialog box).
- **Use & Context:** Find application areas for computers.
- **Human:** Study psychological & physiological aspects e.g., study how a user learns to use a new product, study human typing speed.
- **Computer:** Hardware & software offered e.g., input & output devices, speed, interaction styles, computer graphics Development: Design, implementation & evaluation.



HCI GOALS

- At **physical level**, HCI concerns the selection of the most appropriate input devices and output devices for a particular interface or task.
- Determine the best style of interaction, such as **direct manipulation, natural language (speech, written input), WIMP (windows, icons, menus, pointers)**, etc.
- Develop or improve.
- **Safety** - protecting the user from dangerous conditions and undesirable situations.
- **Utility**
- **Effectiveness**
- **Efficiency** - a measure of how quickly users can accomplish their goals or finish their work using the system.
- **Usability** – ease of learning and ease of use
- **Appeal** of systems that include computers – how well the user likes the system.
- **Users**
  - Nuclear energy plant or bomb-disposal – operators should interact with computer-based systems remotely.
  - Medical equipment in intensive care unit (ICU)
- **Data**
  - Prevent user from making serious errors by reducing risk of wrong keys/ buttons being mistakenly activated.
  - Provide user with means of recovering errors.
  - Ensure privacy (protect personal information such as habits and address) & security (protect sensitive information such as passwords, VISA card numbers).

HCI BENEFITS

- **Gaining market share**
  - People intend to buy/use products with higher usability e.g., Google's search engine has the largest market share because it is easy to use with higher efficiency.

- **Improving productivity**
  - Employees in a company perform their jobs in a faster manner e.g., Workers in a mainland company needed to press a lengthy sequence of buttons in performing a task. An IAS student helped to increase their productivity via writing a batch program for the button pressing operation e.g., Intranet can increase employees' efficiency.
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WHY IS HCI RELEVANT?

- The study of our interface with information.
- It is not just **how big should I make buttons** or **how to layout menu choices**.
- It can affect:
  - Effectiveness
  - Productivity
  - Morale
  - Safety
- HCI takes advantage of our everyday knowledge of the world to make software and devices more understandable and usable for everyone. *For example, using a graphic of a miniature folder in a computer's interface helps the user understand the purpose of the folder, as everyone has experience with real paper folders in their everyday lives.*
- Ultimately, if a system is well designed with HCI techniques, the user should not even have to think about the intricacies of how to use the system. Interaction should be **clear, intuitive, and natural**.

DESIGN RULES FOR HCI

- **Design principles**
  - high-level and context-free design goals based on theories of human computer interaction.
- **Design guidelines**
  - specific and usually context dependent rules for designers to follow in order to achieve the principles.
- Improve users task performance and reduce their effort.
  - User activity depends on memory and attention.
  - Automate or partially automate the user activity and to do so with minimal user effort.
- Often compromises in functionality produce higher usability.
- Strive for fit between the information representation needed and presented.
  - **Representation:** a simplified depiction of a real-world phenomenon.
  - **Functionality:** the set of activities.
  - **Usability:** a measure of ease.
  - **Cognitive fit:** system's representation of the problem supports the user's strategies for performing the task.
- Provide and constrain affordances to capture real-world knowledge.
  - **Affordance**: the aspects of an object that the user perceives as indicating how to use the object, *e.g., the handle of a teapot.*
- Design for error
  - **Error:** a faulty action due to incorrect intention (mistake) or to incorrect or accidental implementation of the intention (slip), *e.g., one can use the 'reply all' in an email by mistake, not knowing that everyone on the list will see the reply, or accidentally clicking on the wrong icon because of lack of sufficient attention.*

DESIGN GUIDELINES

Issue I: Consistency Guidelines

- Consistency has been one of the cardinal rules of design. If the interface is consistent (even if poorly designed), the

end user can adapt to it. Is consistency as important as it appears?

- There are several types of consistency.
  - **Internal consistency**: the same appearance, meaning and operation holds true for all the user's interactions within the same application.
  - **Analogical consistency**: the correspondence between the system's representation and the real-world phenomenon in terms of appearance, meaning and operation.
  - **External consistency**: the same appearance, meaning and operation holds true for the user's interactions across applications. *Example - Use of Cut, Copy, Paste shortcut keys has same operation in all the applications.*

DESIGN RULES FOR CONSISTENCY

- Standardization of interface designs: follow accepted (usually published) guidelines whenever possible.
- **Stability**: do not change something unless it really needs changing.
- **Training:** add new skills to the user's skill set rather than expecting the user to modify existing skills. If you must change, make it a large and obvious one.
- Consistent interpretation of user behavior by the system is more important than consistent system objects or behaviors.

Issue II – User control and feedback

- Control and feedback go hand in hand. Providing feedback is probably the most accepted guideline in the design of any interaction.
- However, it is important to understand the rationale for each specific feedback instance.
- Feedback can support three important factors of user activity: motivation, control, and learning.

DESIGN RULES FOR FEEDBACK TO PROMOTE CONTROL

- Feedback should correspond to goals and intentions.
- Feedback should help evaluate goal accomplishment.
- Feedback should be sufficiently specific to control user activity.
- Feedback should help develop accurate mental models.
- Feedback should fit the task representation (verbal and visual).
- Feedback should fit the type of behavior (controlled, automatic).

Issue III – Metaphors

- **Metaphor:** the use of familiar terms and associations to represent a new concept.
  - The metaphor of the 'Desktop' is one of the most commonly used metaphors in HCI.

Metaphors

Metaphor	Application
Typewriting (typing, using keyboard)	Word processor
Document (elements of a document and their attributes and operations).	Desk top publishing
Ledger sheet (matrix structure for numbers)	Spreadsheet
Drawing (with paper, pencil and palettes).	Drawing and painting
Table of data (managing data organized in rows and columns).	Database

Issue IV – Direct Manipulation

- **Direct manipulation**: an interaction style in which objects are represented and manipulated in a manner analogous to the real world *(e.g. by directly pointing at an object and dragging it to a location rather than issuing logical instructions to bring about the same effect).*
- The general guideline is to use direct manipulation whenever possible.

Issue V – Aesthetics in Screen Design

- Designs should be aesthetically pleasing ideally without compromising on the usefulness and usability of the system.

USER-CENTERED DESIGN

WHAT IS USER-CENTERED DESIGN

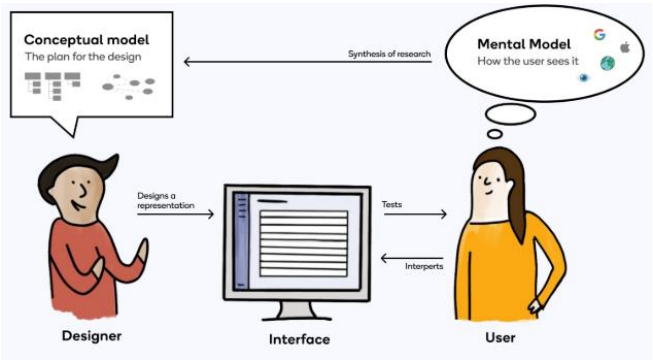
- **User-centered design (UCD)** is a collection of processes that focus on putting users at the center of product design and development. You develop your digital product taking into account your user's requirements, objectives, and feedback.
- **User-centered design (UCD)** is an iterative design process in which designers and other stakeholders focus on the users and their needs in each phase of

the design process. UCD calls for involving users throughout the design process via a variety of research and design techniques so as to create highly usable and accessible products for them.

— Definition of user-centered design (UCD) by the Interaction Design Foundation

THE ESSENTIAL ELEMENTS OF USER-CENTERED DESIGN

- **Visibility**: Users should be able to see from the beginning what they can do with the product, what is it about, how they can use it.
- **Accessibility:** Users should be able to find information easily and quickly.
- **Legibility:** Text should be easy to read.
- **Language:** Short sentences are preferred here.
- Design is a quest to find the best possible match between the user's **mental model** that they have in their mind, and the **conceptual model** that you're presenting to them with your product.
- These two models run through all resolutions of design — everything from developing a product system to crafting a single button.



WHAT IS A MENTAL MODEL

- A 'mental model' refers to a **user's underlying expectations about how something should work.** It is formed based on what they already do, prior experiences with similar products, or by assumptions they've made based on how it appears (also known as perceived affordances).
- It is important to remember that a person's mental model is constantly evolving and subject to change. It is influenced by new experiences with your product, other technologies, and day to day life.

WHAT IS CONCEPTUAL MODEL

- A conceptual model is created by the designer as a high-level plan for how the product will work and fit together.

ELEMENTS THAT CONTRIBUTE TO THE CONCEPTUAL MODEL OF YOUR PRODUCT INCLUDE:

- **Information architecture** — How are the different areas being grouped and structured? Where are your customers expecting to find the answers to their mental model within your product? Does that match their expectations?
- **Terminology** — Is the user familiar with the words being used? Are they broad terms that infer what you can do in each part of the product? How closely do they match the terms the customers use every day?
- **Content strategy** — What are the guiding concepts or rules for the types of content appearing on each page?
- **Channel strategy** — Are you creating consistent, continuous, or complementary experiences?
- **Interaction models** — Are you using well known patterns? Introducing something new? How are people interacting with the system?

METAPHOR

- As Merriam-Webster notes, a **metaphor** is a rhetorical device "in which a word or phrase literally denoting one kind of object or idea is used in place of another to suggest a likeness or analogy between them."

THE PRINCIPLE OF METAPHOR

- The principle of Metaphor states that an interface should implemented behavior from system that the users are familiar with. It increases the understandability of even most complex application by introducing the element of being familiar with the environment user has been working.
- The most well-known metaphor in HCI is the desktop metaphor, which represents the user interface in a way that is similar to interactions concerning certain objects, tasks, and behaviors encountered in physical office environments.

- **text editing** as using a **typewriter**
- **voice mail** as **answering machine or mailbox**
- **data** as **files** (in folders or directories), represented as icons on desktop/in windows
- **deleting a file** as throwing it in the **trash**
- **applications** as **tools** (sometimes w/ icons)
- **programming** as **building objects**

7 DEEP METAPHORS

An effective marketing strategy, **the Zaltmans** argue, should consider how to tap into these seven *deep metaphors:*

- **balance**—which focuses on justice, equilibrium, and the interplay of elements.
- **transformation**—including changes in substance and circumstances.
- **journey**—involving the meeting of past, present, and future.
- **container**—encompassing inclusion, exclusion, states of being, and other boundaries.
- **connection**—which focuses on the need to relate to oneself and others.
- **resource**—involving acquisitions and their consequences.
- **control**—the sense of mastery, vulnerability, and well-being.

HCI DESIGN APPROACHES

ANTHROPOMORPHIC APPROACH

- it involves designing a user interface to possess human-like qualities.
- the interface may be designed with significant interactions with the user and the system and communicate with users in a human-like presentation.
- ***Example***: Interface error messaging is often written this way, such as, “We’re sorry, but that page cannot be found.”

AFFORDANCES

- Affordances are the perceivable potential actions that an individual may do with an object.
- It is the action that the design of an object suggests the users.
- ***Examples:*** Zoom slider, drop-down menus, yes or no buttons

CONTRAINTS

- Constraints indicates limitations of user actions.
- It can be used to avoid operator errors or minimize the information to be remembered.
- Error message alerts often mean that there was an error, and that the procedure could not proceed.

COGNITIVE APPROACH

- In designing a user interface, this method takes into account the human brain's ability and sensory experience.
- In this approach, it helps ease the inability of the user to form a mental picture of the interface presented in the computer screen.

METAPHORIC DESIGN

- Metaphors may be a good way to communicate a technique to people who are not familiar with it.
- It relies on the user's familiarity with another concept as well as affordances to help them understand the actions they should take.
- using metaphors in design allows the users who are already familiar with the metaphor can find it easy to learn a new system.

ATTENTION AND WORKLOAD MODELS

- When designing an interface, it's important to consider the user's attention span and the mental workload involved in completing a task.
- It is important to note that certain users can only focus on one task at a time.
- The mental workload is minimized by splitting this data into individual parts or different pages.

HUMAN INFORMATION PROCESSING (HIP) MODEL

- HIP describes the movement of information from the environment into the human mind and back into the world.
- By remembering or recognizing information that has been stored in long-term memory, humans may recover it.
- The quality of information recall is determined by how information was

originally encoded by the senses and environmental factors.

EMPIRICAL APPROACH

- This approach to is useful for examining and comparing the usability of multiple conceptual designs.
- This testing may be done during pre-production by counterbalancing design concepts and conducting usability testing on each design concept.

HUMAN TASK PERFORMANCE MEASURES

- measuring users' task performance is important for determining how intuitive and user-friendly a web page is.
- Users may be given one or more conceptual designs to test in a lab setting to see which is the most user-friendly and intuitive.

A/B TESTING

- A/B Testing, also known as Split Testing, is a technique for comparing different versions of a template or interface to see which one gets the most conversions.
- Half of the users will use one version of the graphical user interface, and the other half will use another, all while tracking indicators to see which one is more effective at getting them to do what you want.

PREDICTIVE MODELING APPROACH

- Analyzes the individual components of a user interface in terms of the time it takes to effectively achieve an objective using a process called **GOMS (Goals, Operators, Methods, and Selection Rules)**.
- It is a model for evaluating the usability of an interface by eliminating unsuccessful or unnecessary interactions.
- **Goals** are the tasks assigned to users, such as sending emails to customers.
- **Operators** are the user's activities that help them accomplish a task.
- **Methods** are a series of operators and sub-goals that the user uses to accomplish a task.
- **Selection Rules** are a user's personal decision on which method to achieve a goal in a given situation.

THE USER INTERFACE

USER INTERFACE

- The user interface (UI) of a computer program is the part that handles the output to the display and the input from the person using the program.
- The user interface has been recognized as one of the most important elements of a software project. It had been estimated that 48% of work on a project goes into the design and implementation of the user interface depends, among other things, on the designer's creativity.

EFFICIENCY OF A USER INTERFACE

- There are two types of efficiency at play in a user interface. The first is the ease with which it allows a user to perform a task, as perceived by the user. Time plays only a minor role. This type of efficiency can be enhanced by providing sensible defaults, choices adapted to the user's expectations and shortcuts.
- Efficiency in a more technical sense is the time required to perform a certain action: how fast can a menu be drawn, how fast a typed sentence can be parsed.
- Clearly, efficiency is something to strive for. But there is the strange effect that computers can sometimes be too fast. At least that is sometimes claimed with the following example: *slow compilers force programmers to think more about their code, resulting in fewer edit compile cycles than programmers who rely on the compiler to find errors, eventually leading to faster development.*

EFFICIENCY OF USER INTERFACE:

- **Task completion time** - this refers to the duration it takes for a user to complete a specific task within a system or application.
- **Error rate** – these measures how often users make mistakes while completing tasks within a system or application.
- **Learnability** – this refers to how easy it is for users to familiarize themselves with the interface and navigation.
- **Subjective user impact** – how pleasant the interface is to users.
- **Efficiency matrix** – it is the systematic evaluation of interface in aspect of

efficiency and areas that need to be improved.

- **Feasibility testing** – it aims to determine whether the proposed interface is technically possible or feasible in delivering the desired performance or functions.

TYPES OF USER INTERFACE

- Paradigms, metaphors, mental models, and personas are driving forces behind the user interface and design employed in a particular system. There are three commonly recognized user interfaces in use today.
- **Graphical User Interface (GUI)** – This interface allows users to interact with computer programs and systems through graphical icons and other visual indicators.
- **Command-Line Interface (CLI)** – This interface is a text-based interface used to interact with a computer programs or operating system through commands into a terminal or command prompt.
- **Natural Language User Interface (NLUI)** – This interface allows users to interact with computer through natural language such as spoken or written language instead of typing commands or clicking buttons.
- **Touch Screen User Interface** – This interface allows users to interact with devices by directly touching the screen, typically with fingers or a stylus.
- **Voice User Interface (VUI)** – This allows the users to interact through spoken commands. The following is the components of VUI:
    - Speech recognition
    - Natural language understanding
    - Dialogue Management
    - Response generation
    - Speech synthesis (Text-to-Speech)
    - Context Management
    - Error handling (misinterpretation)
    - Integration with other system
- **Gestures User Interface** - This allows the users to interact with their devices through gestures, typically using hand movements or body motions.
- **Virtual Reality (VR) and Augmented Reality (AR) User Interface** – These interfaces are designed to facilitate interaction within virtual and augmented reality. Both UIs are designed to create an environment that blends the digital world with user's physical surroundings.
- **Multi-Modal User Interface** – This interface allows users to interact with a computer program or devices using multiple input modalities interchangeably. These modalities may include combination of touch, voice, gestures, etc.

GRAPHICAL USER INTERFACE

- Graphical user interfaces make computing easier by separating the logical threads of computing from the presentation of those threads to the user, through visual content on the display device. This is commonly done through a window system that is controlled by an operating system's window manager.
- The WIMP (Windows, Icons, Menus, and Pointers) interface is the most common implementation of graphical user interfaces today.

VOICE USER INTERFACE

- Voice User Interfaces (VUIs) use speech technology to provide people with access to information and to allow them to perform transactions.
- VUI development was driven by customer dissatisfaction with touchtone telephony interactions, the need for cheaper and more effective systems to meet customer needs, and the advancement of speech technology to the stage where it was robust and reliable enough to deliver effective interaction.
- A Voice User Interface is what a person interacts with when using a spoken language application. Auditory interfaces interact with the user purely through sound. Speech is input by the user, and speech or nonverbal audio is output by the system.
- Auditory interfaces provide an opportunity to use non-verbal audio such as background music and earcons to create an auditory environment for the user, thus creating a unique —sound and feel for a business or application.
- Aside from speech recognition systems, other speech technologies include Text-to-Speech Synthesis and Speaker Verification.
- Speaker Verification involves collecting a small amount of a person's voice to create

a voice template, which is used to enroll a person into a system and then compare future conversations.

- The system can be used, for example, to replace personal identification numbers.
- Text-to-speech technology, on the other hand, synthesizes text into speech. The technology has improved significantly in recent times, and although it does not yet duplicate the quality of recorded human speech, it is still a good option for creating messages from text that cannot be predicted, such as translating web pages for blind users.
- **VUIs are comprised of three main elements:**
  - Prompts, also known as system messages, are the recorded or synthesized speech played to the user during the interaction.
  - Grammars are the possible responses users can make concerning each prompt. The system cannot understand anything outside of this range of possibilities.
  - Dialog logic determines the actions the system can take in the user's response to a prompt.

MULTI-MODAL USER INTERFACE

- Multi-modal interfaces attempt to address the problems associated with purely auditory and purely visual interfaces by providing a more immersive environment for human-computer interaction.
- A multimodal interactive system relies on the use of multiple human communication channels to manipulate the computer.
- These communication channels translate to a computer's input and output devices.
- The value of an interface that can interpret a user's emotions has applications in fields ranging from business management, safety, and productivity, to entertainment and education. For example, if a program could recognize that the user was getting frustrated, it could modify its behavior to compensate.
- When evaluating the text-and-GUI-based Mentor System application used by students from Curtin University to assist with their assignments, Marriott [2003] found that personality conflict occurred between the system and some users.
- *For example, one user became intensely annoyed at the beeping sound the program made, while another user found the program to be discourteous. Marriott suggests that incorporating a dynamically adjusting module into the user interface could eliminate or reduce some of these problems.*

OTHER USER INTERFACE

- Many other paradigms for human-computer interaction exist. Perhaps one of the best-known paradigms is the World Wide Web. The web itself did not provide any technological breakthroughs, because all the required functionality, such as transmission protocols, hypertext, and distributed file systems, already existed. The breakthrough came with the advent of the browser and HTML, which enabled easy access to information on the internet, first through academia and then through business and leisure circles.

USER INTERFACE PRINCIPLES

- User Interface Principles comprises mainly **of User Familiarity, Consistency, Minimal Surprise, Recoverability, User Guidance and User Diversity** help guide the design of user interfaces. When making user interface design decisions, the human factors are the critical factor for the design principles.
- The following principles are fundamental to the design and implementation of effective interfaces, whether for traditional GUI environment for the web

THE PRINCIPLE OF USER PROFILING

- One of the main objectives of User Profiling is to create user interfaces to make the work of the user easier. The interface is the key to providing the user with the ease of making use of even the most complex applications in an efficient and simplified manner. User models work on the theory of creating profiles of all the possible users. As a result, a detailed description of the user's specification such as the user's goal, user's skill, user's experience, and user's needs, etc. can be formulated in an organized manner.

THE PRINCIPLE OF EXPOSURE

- The principle of Exposure says that the user should be aware of all the functions & functionality that is available to him via the interface. The interface is to provide an environment that should be able to concentrate and the sensory details of the environment rather than the perfection of abstraction. The interface should be designed in such a way that it is Sensible to the general population, rather than being only Intuitive.

THE PRINCIPLE OF COHERENCE

- There's been some argument over whether interfaces should strive to be Intuitive, or whether an Intuitive interface is even possible. However, it is certainly arguable that an interface should be coherent in other words logical, consistent and easily followed.
- Internal Consistency means that the program's behaviors make sense with respect to other parts of the program.
- External Consistency means that the program is consistent with the environment in which it runs

THE PRINCIPLE OF STATE VISUALIZATION

- Each change in the behavior of the program should be accompanied by a corresponding change in the appearance of the interface. One of the big criticisms of modes in interfaces is when a program that many of the class is bad example programs have modes that are visually indistinguishable from one another.

THE PRINCIPLE OF SHORTCUT

- The principle of Shortcut says that in order to achieve a task or to get a work done, the accessing methods should not only be abstract but concrete too. Once a user has become experienced with an application, she/he will start to build a mental model of that application. She/he will be able to predict with high accuracy what the results of any particular user gesture will be in any given context

THE PRINCIPLE OF FOCUS

- The principle of Focus states that some aspects of the User Interface enjoy more attention of the user than others. The user finds same attributes and aspects of the user interface more attractive as compared to others. The human mind is a highly non-linear and has a perfect coordination with the eyes. Thus our eyes are more observant towards animated areas rather than the static are in an application.

THE PRINCIPLE OF HELP

- There are five basic types of Help: **Goal-Oriented, Descriptive, Procedural, Interpretive and Navigational**. A help browser or tool tips can be useful in responding to questions related to procedural help, but these can sometimes be more efficiently addresses using cue card', interactive guides, or wizards which guide the user through the process step – by-step.

THE PRINCIPLE OF SAFETY

- The principle of Safety states that the interface should develop confidence amongst the user by providing them a feeling of safety. The User Interface should ensure that the novice user should not feel him at risk while accessing the program: i.e. he should not feel unsafe while navigating, accessing or a doing a task. A certain level of comfort should be provided to the user, in almost all the situation.

THE PRINCIPLE OF CONTEXT

- The principle of Context states that the user's activity should be limited to a well-defined context unless significant reason is there to support his freedom to access more.
- Each user action takes place within a given context the current document, the current selection, the current dialog box.

THE PRINCIPLE OF USER TESTING

- The principle of User Testing states that the inevitable defects in the design of the user interface should be spotted. Generally, it is the fundamental defects in a user interface that the designer of the interface can spot. There are however various kinds of defects that are not easy to spot. The testing of user interface is actually the process of testing of the interface using actual end users.

HUMAN FACTORS BASED USER INTERFACE DESIGN

- Before designers start designing of user interface they need information about the target users. These factors can be very important in other development activities, primarily in analysis and design, as many early design decisions are based on these specifications. Considering human factors early in the development process goes a long way toward improving quality of the system.
- Specifying details about users and contexts is important as designers should become familiar with users' psychological characteristics(for example ,cognitive abilities, motivation), level of experience, domain and task characteristics, cultural background, as well as their physical attributes (for example, age, vision, and hearing)