Corso di Laurea Magistrale in Design, Comunicazione Visiva e Multimediale - Sapienza Università di Roma

Interaction Design
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2 – HCI Basics

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Human-Computer Interaction

- Human-Computer Interaction (HCI) studies the ***users***, the ***computers*** (in particular their interactive applications) and ***how they interact***.
- A ***user*** is whoever tries to get the job done using the technology, and can be:
  - an *individual user*,
  - a *group of users* working together,
  - a *sequence of users*, each dealing with a part of the task.
- The ***computer*** is any interactive technology used to accomplish something.
  - It ranges from the general desktop computer to an embedded system.
- The ***interaction*** is any direct or indirect communication between a user and computer.
  - ***Direct interaction*** involves a dialog with feedback and control throughout the whole performance of the task.
  - ***Indirect interaction*** may involve intelligent sensors controlling the environment.

Key factors of HCI

- While there is no general/unified theory of HCI, there is an *underlying principle* forming the basis of any views on HCI:
  - *The key idea of HCI is to bring the computers/systems/applications **closer to the user** and not vice-versa by making them more **usable**.*
  - *If the system forces the user to adopt an unacceptable mode of work then **it is not usable**.*

- Key Factors of HCI:
  - User (cognitive and physical capabilities) -- *Who*
  - Technology -- *By*
  - Usability -- *How*
  - User’s Tasks -- *What*
  - Context of Use -- *Where*

Who is involved in HCI?

- HCI is a *multi-disciplinary* field. The ideal designer of an interactive system would have expertise in a range of topics:
  - *psychology* and *cognitive science* to give her knowledge of the user's perceptual, cognitive and problem-solving skills;
  - *ergonomics* for the user's physical capabilities;
  - *sociology* to help her understand the wider context of the interaction;
  - *computer science* and *engineering* to be able to build the necessary technology;
  - *business* to be able to market it;
  - *graphic design* to produce an effective interface presentation;
  - *technical writing* to produce the manuals.
- There is obviously too much expertise to be held by one person!
  - However, it is not possible to design effective interactive systems from one discipline in isolation. **Input is needed from all sides**.
  - We will understand in this course how to be multi-disciplinary and practical to design interactive systems!

Human User

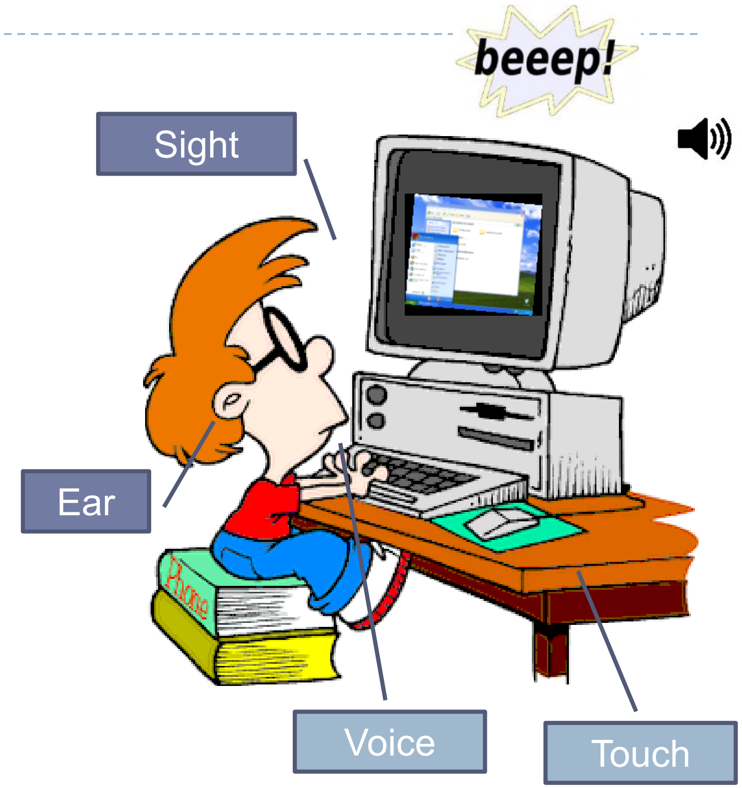
Input and Output Channels

- A person's interaction with the surrounding world occurs through information being received and sent via a number of **input** and **output** channels:
  - visual channel
  - auditory channel
  - haptic channel
  - movement

- **Input** in the human occurs mainly through the **senses** and **output** through the motor control of the **effectors**.
  - 3 out of 5 senses are fundamental for HCI: ***sight***, ***hearing***, ***touch***.
  - Several effectors, including the ***fingers***, ***eyes***, ***head*** and ***vocal system***.
  - In the interaction with a technology, ***sight*** is the primary source of information, while the ***fingers*** and (in general) the ***movement*** play the primary role to provide output.

Using Input and Output Channels
Traditional PC

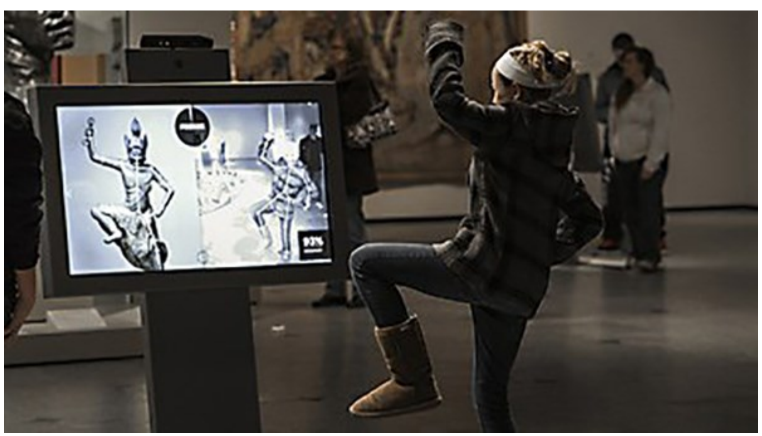
Example



- *Imagine using a personal computer (PC) with a mouse and a keyboard. The application you are using has a graphical interface, with menus, icons and windows.*
- *In your interaction with this system* ***you receive information primarily by sight****, from what appears on the screen.*
- *However, you may also* ***receive information by ear****: for example, the computer may 'beep' at you if you make a mistake or to draw attention to something, or there may be a voice commentary in a multimedia presentation.*
- ***Touch*** *plays a part too in that you will feel the keys moving or the orientation of the mouse, which provides feedback about what you have done. You* ***send information to the computer using your hands****, either by hitting keys or moving the mouse.*
- ***Sight*** *and* ***hearing*** *do not generally play a direct role in sending information.* ***Voice*** *can be used to send commands to the PC.*

Using Input and Output Channels
Smart Environment

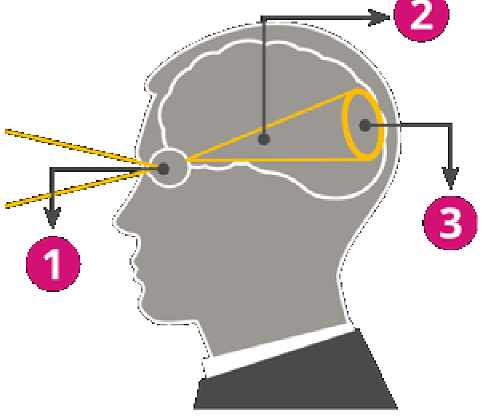
Inputs
Sight & Ear



Outputs
Touch,
Movement,
Voice

Human vision

- Visual perception can be divided in two stages:
  1. ***physical reception*** of stimulus from the outside world;
  2. ***processing*** and ***interpretation*** of the collected stimulus.



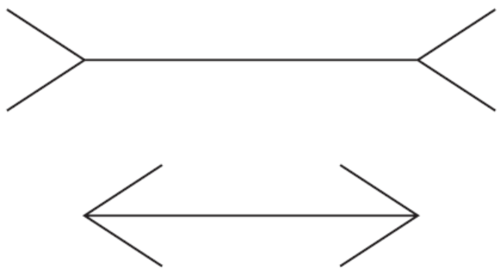
- Vision begins with ***light***. The **eye** is a mechanism for receiving the light reflected from objects in the world and transform it into electrical signals that are passed to the brain for being interpreted.
- While there are certain things that cannot be seen by the human, the ***interpretative capabilities*** of **visual processing** allow images to be *constructed from incomplete information*, *recognize coherent scenes*, *disambiguate relative distances* and *differentiate color*.

Visual Processing

- Visual processing involves the **transformation** and **interpretation** of a complete image, from the light that is thrown onto the retina.
- Our ***expectations*** affect the way an image is perceived.
  - For example, if we know that an object has a particular size, we will perceive it as that size no matter how far it is from us (**law of size constancy**).

- Visual processing **compensates for the movement of the image on the retina** which occurs as we move around and as the object which we see moves.
  - Although the retinal image is moving, the image that we perceive is stable.
  - Similarly, color and brightness of objects are perceived as constant, in spite of changes in luminance of the environment.
  - **This ability to interpret our expectations can be used to resolve ambiguity.**

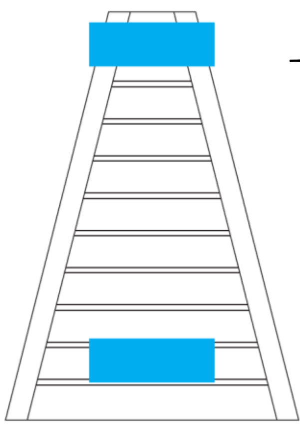
Expectations and Optical Illusions



The Muller-Lyer Illusion

Which line is longer? Most people would say that the top line is longer than the bottom….

BUT…the two lines have the same length! The mistake may be due to a false application of the ***law of size constancy***: the top line appears like a concave edge (and seems far from us), the bottom like a convex edge (closer to us).



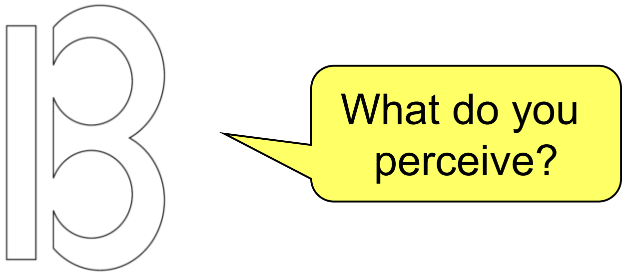
The Ponzo Illusion

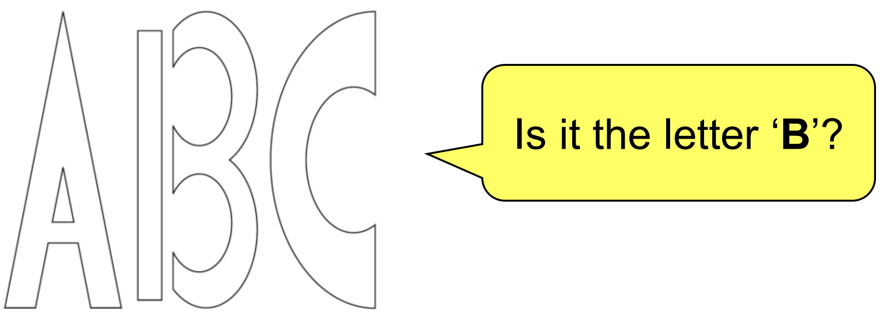
Do the blocks have the same size? **YES!**

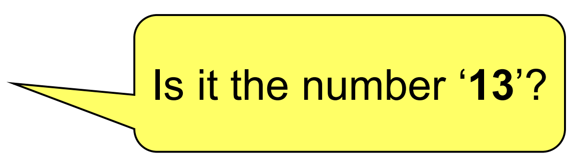
These illusions demonstrate that **our perception of size is not completely reliable**!

An ambiguous shape?

- The **context** in which the object appears allows our expectations **to clearly disambiguate the interpretation of the object**, as either a B or a 13.







Hearing

- The auditory system captures information about our environment.
  - What sounds can you hear? Where are they coming from? What is making them?
  - The ear can recognize **familiar sounds** without concentrating attention on the sound source.
- The human ear can hear frequencies from about 20 Hz to 15 kHz.
  - It can distinguish frequency changes of less than 1.5 Hz at low frequencies but is less accurate at high frequencies.
- The auditory system performs some filtering of the sounds received, allowing us to ignore background noise and focus on important information.
  - We can pick out our name spoken across a crowded noisy room.
  - If sounds are too loud, or frequencies too similar, we are unable to differentiate sound.

Using sound in user interfaces

- Sound was rarely used to its potential in interface design, usually being confined to warning sounds and notifications…
- …but in the last 5 years, there was a more extensive use of sound in the design of user interfaces:
  - **Vocal interfaces** can be used to convey information. This is useful for any application where the user's attention has to be divided (for example, power plant control, flight control, etc.).
  - **Multimedia**, which may include music, voice commentary and sound effects.
  - **Attention**, to attract the user's attention to a critical situation or to the end of a process, for example.
  - **Status information** – continuous background sounds can be used to convey status information. For example, monitoring the progress of a process (without the need for visual attention).
  - **Confirmation** – a sound associated with an action to confirm that the action has been carried out. For example, associating a sound with deleting a file.

Touch

- Touch is an important means of feedback when interacting with computer systems.
  - For example, feeling buttons depress (*input*) is an important part of the task of pressing the button (*output*).
- Touch is **fundamental** when we interact with a mobile device.
- While for the average person haptic perception is a secondary source of information, for those whose other senses are impaired, it may be vitally important.
  - For such users, interfaces such as braille may be the primary source of information in the interaction.
- Touch plays a particular role in virtual reality.
  - The users can see the computer-generated objects which they need to manipulate but they have no physical sensation of touching them.

Movement

- The way we move affects our interaction with computers.
  - *A simple action such as hitting a button in response to a question involves a number of processing stages:*
    - The stimulus (of the question) is received through the sensory receptors and transmitted to the brain.
    - The question is processed and a valid response generated.
    - The brain then tells the appropriate muscles to respond.
    - Each of these stages takes time, which can be roughly divided into ***reaction time*** and ***movement time***.
  - Time taken to respond to stimulus: ***reaction time*** + ***movement time***
    - Movement time dependent on age, fitness etc.
    - Reaction time dependent on stimulus type:
      - ***Visual*** ~ 200ms -- ***Auditory*** ~ 150 ms -- ***Pain*** ~ 700ms
  - A combined signal will result in the quickest response.
    - Factors such as skill or practice can reduce reaction time, and fatigue can increase it.
    - Increasing reaction time decreases accuracy in the unskilled operator but not in the skilled operator.

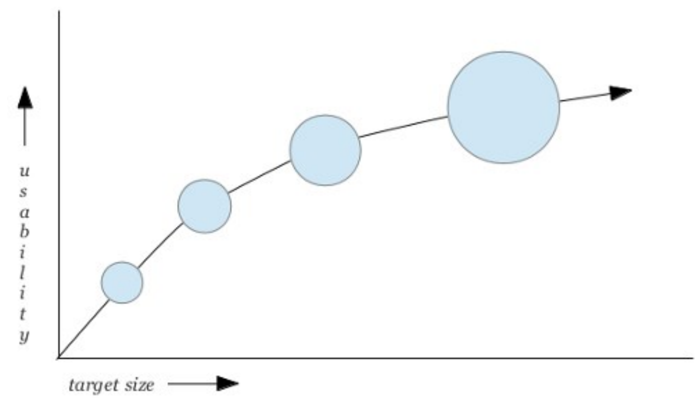
Fitts' Law

- Fitts' Law is a predictive model of human movement that describes the time taken to hit a screen target:

$$Mt = a + b \log2(D/S + 1)$$

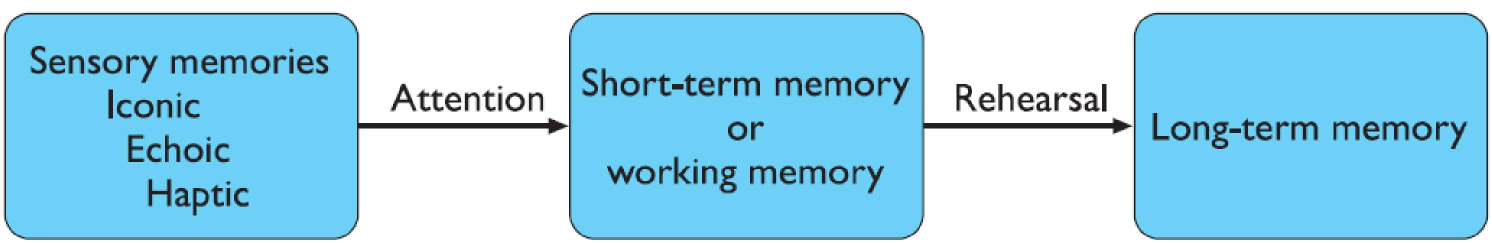
- a and b are empirically determined constants
- Mt is movement time
- D is Distance to the target
- S is Size of target

- It predicts that the *time required to rapidly move to a target area is a function of the ratio between the distance to the target and the width of the target.*
- Fitts' Law affects the type of target we design.
  - Since users find more difficult to manipulate small objects, targets should generally be **as large as possible** and the **distance to be moved as small as possible**.



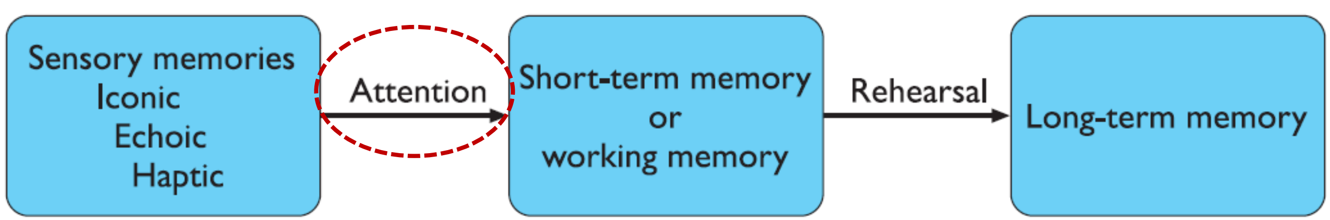
The Human Memory

- **Memory** is the second part of the model of the human as an information-processing system.
- Much of our everyday activity relies on **memory**, which **contains our knowledge of actions or procedures**.
  - Memory allows us to **repeat actions**, to **use language**, and to **use new information received via our senses**.
  - Memory gives us our **sense of identity**, by preserving information from our **past experiences**.
- It is generally agreed that there are three types of interacting memory functions: ***sensory memories***, ***short-term memory*** (or *working memory*), and ***long-term memory***.



Sensory Memories

- A sensory memory exists for each sensory channel. Sensory memories act as buffers for stimuli received through the senses:
  - *iconic memory* for visual stimuli
  - *echoic memory* for aural stimuli
  - *haptic memory* for touch
- Constantly overwritten by new information coming from senses.
- Information is passed from sensory memories to short-term memory by ***attention***.
  - ***Attention*** is the concentration of the mind on one out of a number of competing stimuli. It filters the stimuli to only those which are of interest at a given time
  - We are able to focus our attention ***selectively***, choosing to attend to one thing rather than another, due to the limited capacity of our senses/memory.

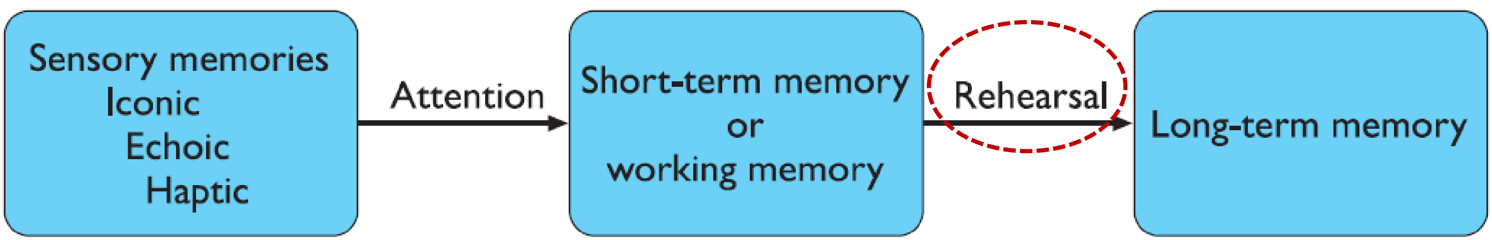


Short-Term Memory (STM)

- Short-term memory acts as a 'scratch-pad' for temporary recall of information.
  - It can be accessed rapidly: ~ 70 ms.
  - It also decays rapidly: ~ 200 ms.
  - It has a limited capacity. It has been measured that the length of a sequence which can be remembered in order is 7 ± 2 digits.
- Look at the following sequence: **265397620853**
  - How many digits could you remember? If you remembered between five and nine digits your ***digit span*** is **average**.
- Now try the following sequence: **44 113 245 8920**
  - Did you recall that more easily? Here the digits are grouped or *chunked*. A generalization of the 7 ± 2 rule is that we can remember 7 ± 2 chunks of information.
  - Therefore **chunking information** can **increase the short-term memory capacity** and **optimize its use**.

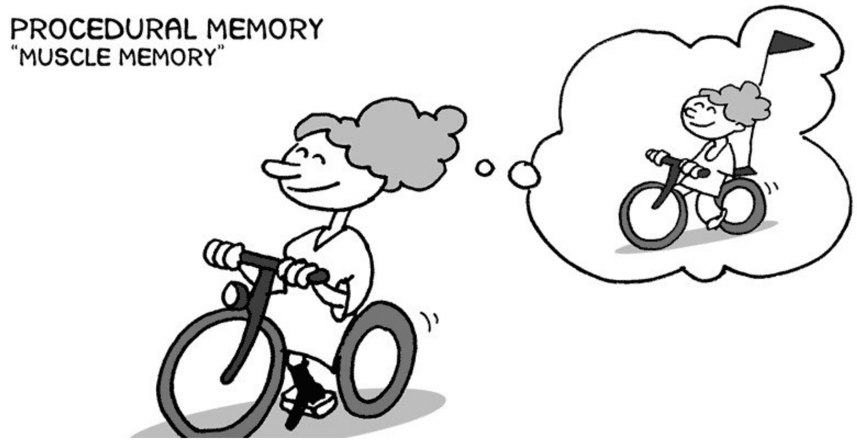
Long-Term Memory (LTM)

- Long-term memory is intended for the **long-term storage** of everything that we ‘know’, hence factual information, experiential knowledge and procedural rules of behavior.
- It differs from short-term memory in a number of ways:
  1. It has a huge, if not unlimited, capacity.
  2. It has a relatively slow access time ~ 1/10 second.
  3. It has slow decay, if any. Long-term recall after minutes is the same as that after hours or days.
- Information from STM is stored in LTM by ***rehearsal*** (*storage of information*). Other processes related to LTM are ***forgetting*** and ***information retrieval***.



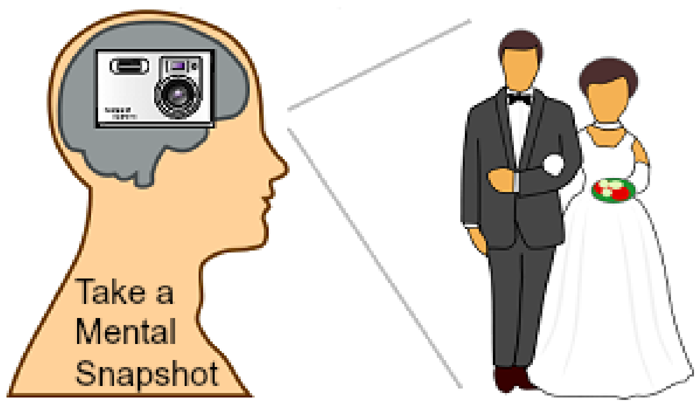
LTM - Procedural Memory

- There are **two types of long-term memories**: **procedural memory** and **declarative memory** (consisting of ***episodic memory*** and ***semantic memory***).
- **Procedural memory** stores information on how to perform certain procedures, such as walking, talking and riding a bike.
  - It is responsible for knowing ***how to do things***, also known as motor skills.
  - Procedural memory is accessed without the need for conscious control or attention.



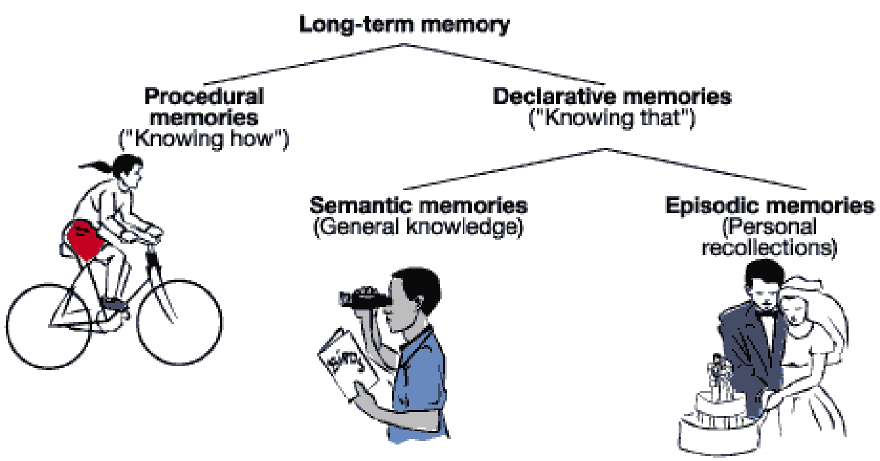
LTM - Episodic Memory

- ***Episodic memory*** represents our *memory of events* and *experiences* in a serial form, which is used to reconstruct the actual events that took place at a given point in our life.
  - Episodic memory is accessed with the need of conscious recall.

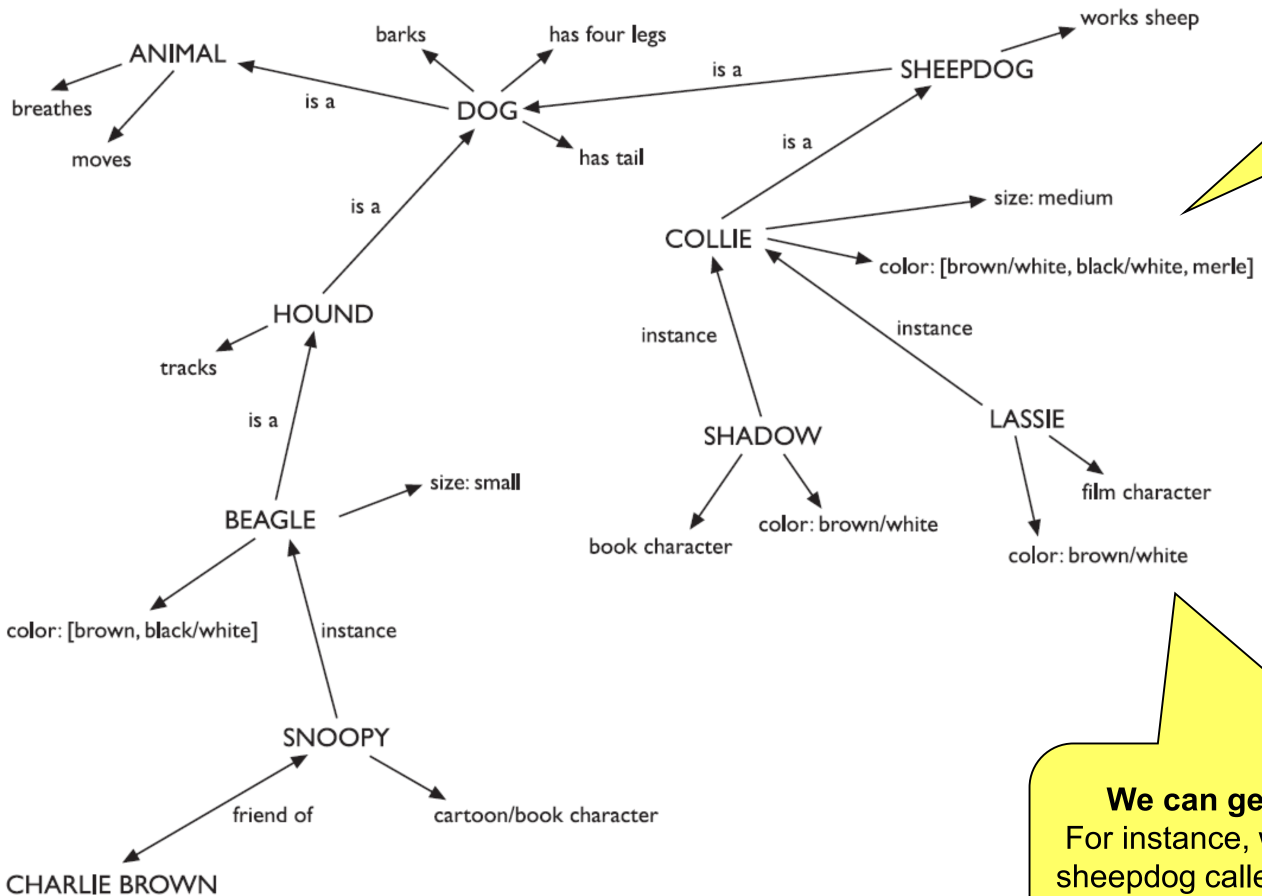


LTM - Semantic Memory

- ***Semantic memory*** is a *structured record* of *facts*, *concepts* and *skills* that we have acquired.
  - The information in semantic memory is *derived from that in our episodic memory*, in order to learn new facts from our experiences.
  - Semantic memory is accessed with the need of conscious recall.
  - Semantic memory can be structured as a ***semantic network***, which represents the associations and relationships between single items in memory.
  - A semantic network allows access to information, **representation of relationships** between pieces of information, and **inference**.



Semantic Network (knowledge about dogs)



Specific breed attributes may be stored with each given breed, while general dog information is stored at a higher level.

We can generalize about specific cases. For instance, we may not have been told that the sheepdog called "Lassie" has 4 legs and 1 tail, but we can infer this information from our general knowledge about sheepdogs and dogs in general.

LTM Processes: Reharsal (Storage of Information)

- The **repeated exposure** to a stimulus or the **rehearsal** of a piece of information transfers it into long-term memory.
- Rehearsal can be optimized in a number of ways:
  - ***total time hypothesis****:* the amount of information learned is directly proportional to the amount of time spent learning.
  - ***distribution of practice effect****:* learning time is most effective if it is distributed over time.
- However, repetition **is not enough** to learn information well.
  - If information is not meaningful it is more difficult to remember.
  - This is related to the ***semantic structuring*** of long-term memory: if information is meaningful and familiar, it can be related to existing structures and more easily incorporated into memory.

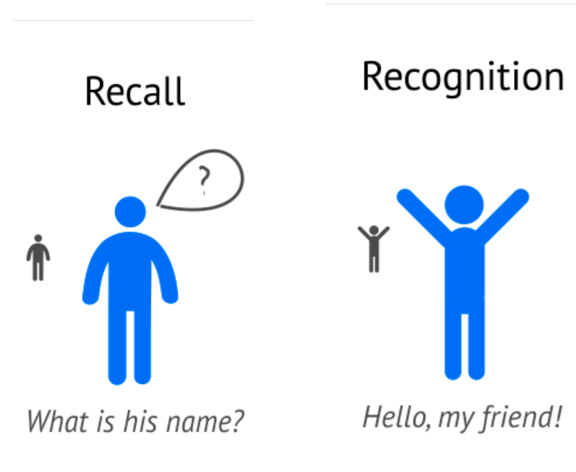
structure, meaning and familiarity -> information easier to remember

LTM Processes: Forgetting

- There are two main theories: ***decay*** and ***interference***.
  - ***Decay***. The information held in LTM decays gradually but very slowly. Hence, it may eventually be forgotten.
  - ***Interference***.
    - *Retroactive interference*: new information acquired replaces old one.
      - When a telephone number is changed, learning the new number makes it more difficult to remember the old one (the new association masks the old).
    - *Proactive inhibition*: sometimes the "old memory" trace breaks through and interferes with new information.
      - When you find yourself driving to your old house rather than your new one.
- Forgetting is also affected by emotional factors.
  - We tend to remember positive information rather than negative (hence nostalgia for the 'good old days'), and highly emotive events.
- **It is impossible** to prove that we do forget at all an information.
  - However, there is evidence (proactive inhibition, recognition, "tip of the tongue") to suggest that **we may not lose information completely** from LTM.

LTM Processes: Information Retrieval

- Information retrieval can be performed through ***recall*** and ***recognition***.
  - In ***recall***, the information is reproduced from memory.
  - In ***recognition***, the presentation of the information provides the knowledge that the information has been seen before.



- Recognition is the less complex cognitive activity since the information is provided as a cue.
- However, recall can be assisted by the provision of *retrieval cues*, which enable the subject quickly to access the information in memory.
  - For example, you may intend to watch a movie by 9:30 pm. Your cue for watching the movie is the time 9:30 pm.

Memorable or Secure? /1

Example

- The average active internet user may have separate passwords and user names for several email accounts, e-shopping, e-banking, etc.

  - **Remembering passwords is not easy!**
  - From a security perspective **<u>it is important</u>** that passwords are constructed from random strings of letters and numbers. Words and names are very easy to crack!

- But in reality these are the **hardest things for people to commit to memory!**
  - Many people uses the same password for all their online activities and chooses a word or a name that is easy for them to remember, in spite of the obviously increased security risks.

Security here is in conflict with memorability!

Memorable or Secure? /2

- A solution to this is to construct a nonsense password out of letters or numbers **<u>that will have meaning to you</u>** but will not make up a word in a dictionary.

initials of names …
numbers from significant dates…

- Then **<u>what is remembered is the meaningful rule for constructing the password</u>**, and not a meaningless string of alphanumeric characters.

Thinking: Reasoning and Problem Solving

- Thinking separates humans from other information-processing systems, both artificial and natural. We consider two categories of thinking: ***reasoning*** and ***problem solving.***

- **Reasoning** (deductive, inductive and abductive) is the process by which we use what is already known to:
  - draw conclusions;
  - infer something new about the domain of interest.

- **Problem solving** is the process of finding a solution to an unfamiliar task, using the knowledge we have.

Deductive Reasoning

- **Deductive reasoning** derives the **logically needed conclusion from the given premises**.

If it is Friday then she will go to work
It is Friday
Therefore she will go to work.

- Logical conclusion is not necessarily true:

It is a **valid deduction**, even though it conflicts with our knowledge of what is true in the world.

If it is raining then the ground is dry
It is raining
Therefore the ground is dry

- Deductive reasoning is therefore often misapplied:

This is an **invalid deduction**, since we are not told that all babies are people.

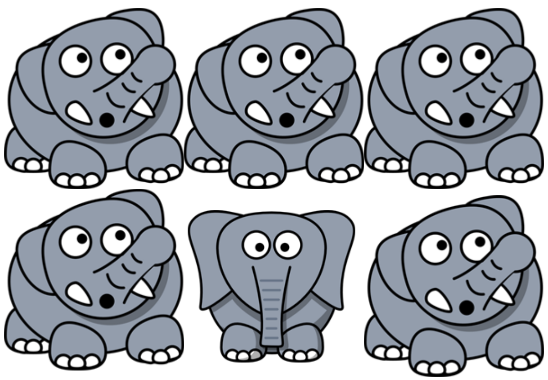
Some people are babies
Some babies cry
Some people cry

It is therefore logically possible that the babies who cry are those who are not people.

- When truth and validity clash, human deduction is poorest.
  - People bring their world knowledge into the reasoning process. If validity rather than truth was preferred, all premises would have to be made explicit.

Inductive Reasoning

- **Inductive reasoning** generalizes from cases we have seen to **infer information** about cases we have not seen.



  - *For example, if every elephant we have ever seen have fangs, we **infer that all elephants have fangs**.*
  - *Of course, this inference is **unreliable** and cannot be proved to be true; **it can only be proved to be false**.*
  - *We can **disprove** the inference simply by producing an elephant without fangs.*

- The best that we can do with inductive reasoning is **gather evidence** to support our inductive inference.
- In spite of its unreliability, induction is a useful process, which we use constantly in **learning about our environment**.
  - Even if we saw an elephant without fangs, we would be unlikely to move from our position that ‘All elephants have fangs’, since we are better at using positive than negative evidence.

Abductive Reasoning

- ***Abductive reasoning*** starts from a fact to derive the action or state that caused it. This is the method we use to **derive explanations** for the events we observe.

For example, suppose we know that Sam always drives too fast when he is drunk.

If we see Sam driving too fast we may infer that he has been drinking.

*Of course, **this is unreliable** since there may be another reason why he is driving fast (he may have been called to an emergency).*

- In spite of its unreliability, <u>people do generally infer explanations in this way</u>, and hold onto them until they have evidence to support an alternative theory or explanation.
- **This can lead to problems in using interactive systems**.
  - If an event always follows an action, the user will infer that the event is caused by the action. If, however, the event and the action are unrelated, confusion and error often result.

Problem Solving

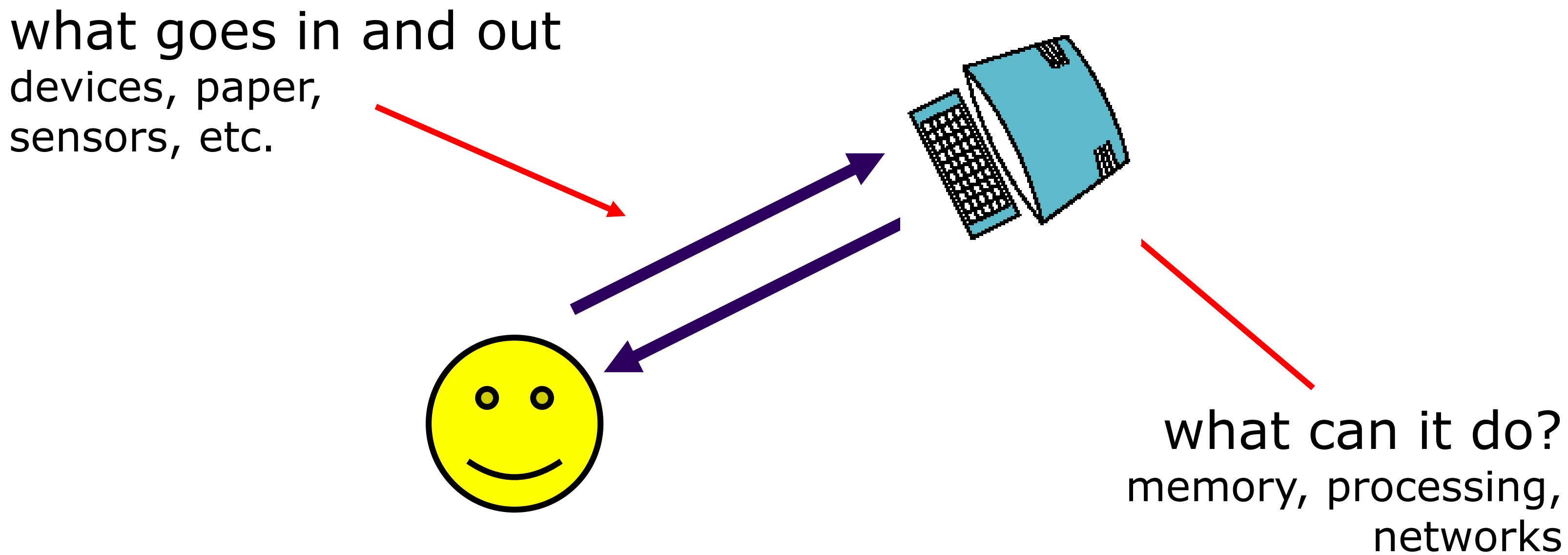
- ***Problem solving*** is characterized by the ability to adapt the information we have to deal with new situations.
- There are a number of different views of how people solve problems. **Two major theories** exist:
  - the ***Gestalt view***: problem solving involves **reuse of knowledge** and **insight**. Hence it combines ***productive*** and ***reproductive*** problem solving.
    - *Reproductive problem solving* draws on previous experience.
    - *Productive problem solving* involves insight and restructuring of the problem.
    - Indeed, reproductive problem solving could be a obstacle to finding a solution, since a person may 'fixate' on the known aspects of the problem and so be unable to see novel interpretations that might lead to a solution.
  - the ***problem space theory*** (1970): problem solving involves generating **problem states** using legal state transition operators.
    - The problem has an initial state and a goal state and people use the operators to move from the former to the latter.
    - Such problem spaces may be huge, and so heuristics are employed to select appropriate operators to reach the goal.

Computer

(and other interactive technologies)

Interacting with Computers

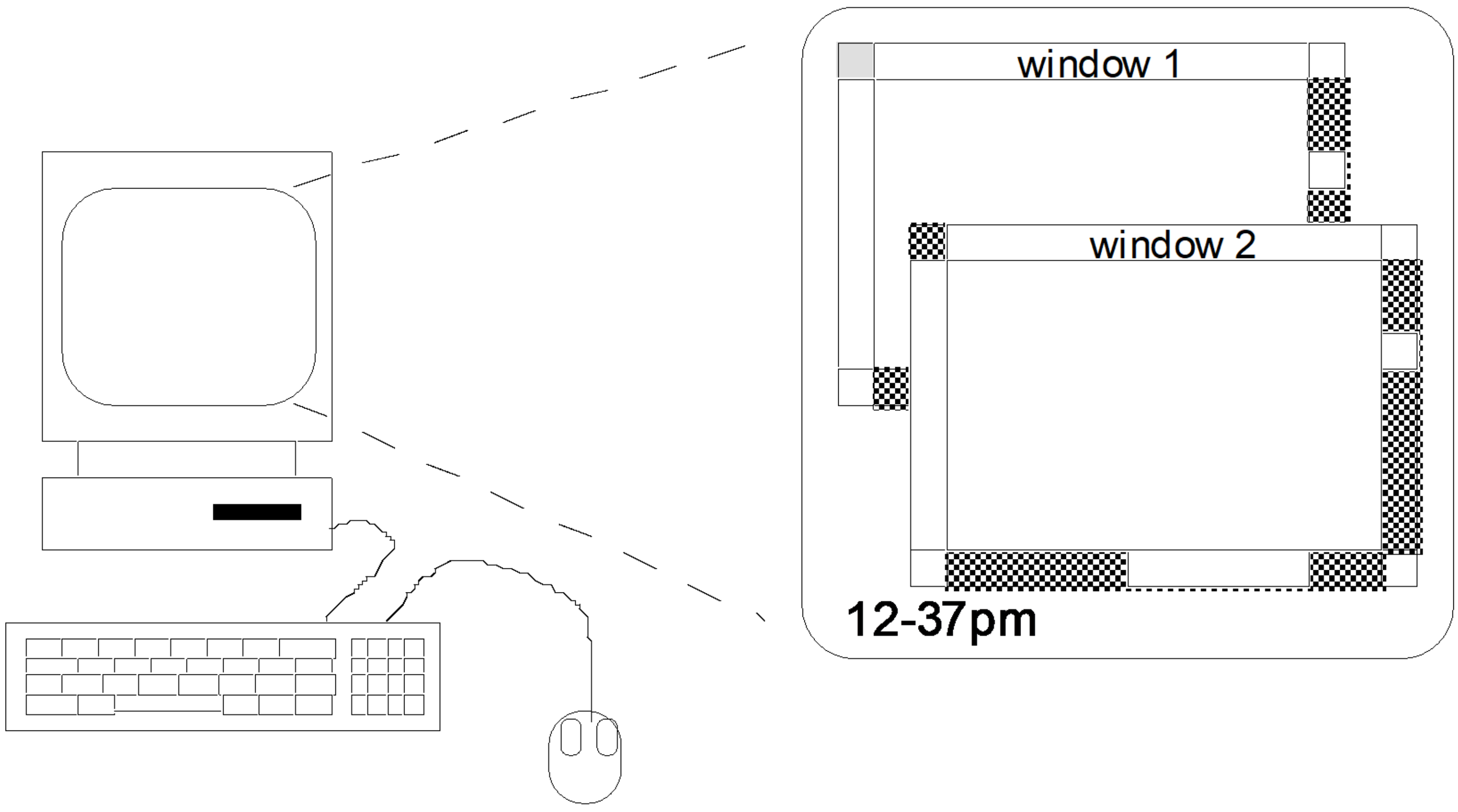
- Interaction is a **process of information transfer**, from the user to the computer and from the computer to the user.
- Hence, to understand human–computer interaction … **need to understand computers**!



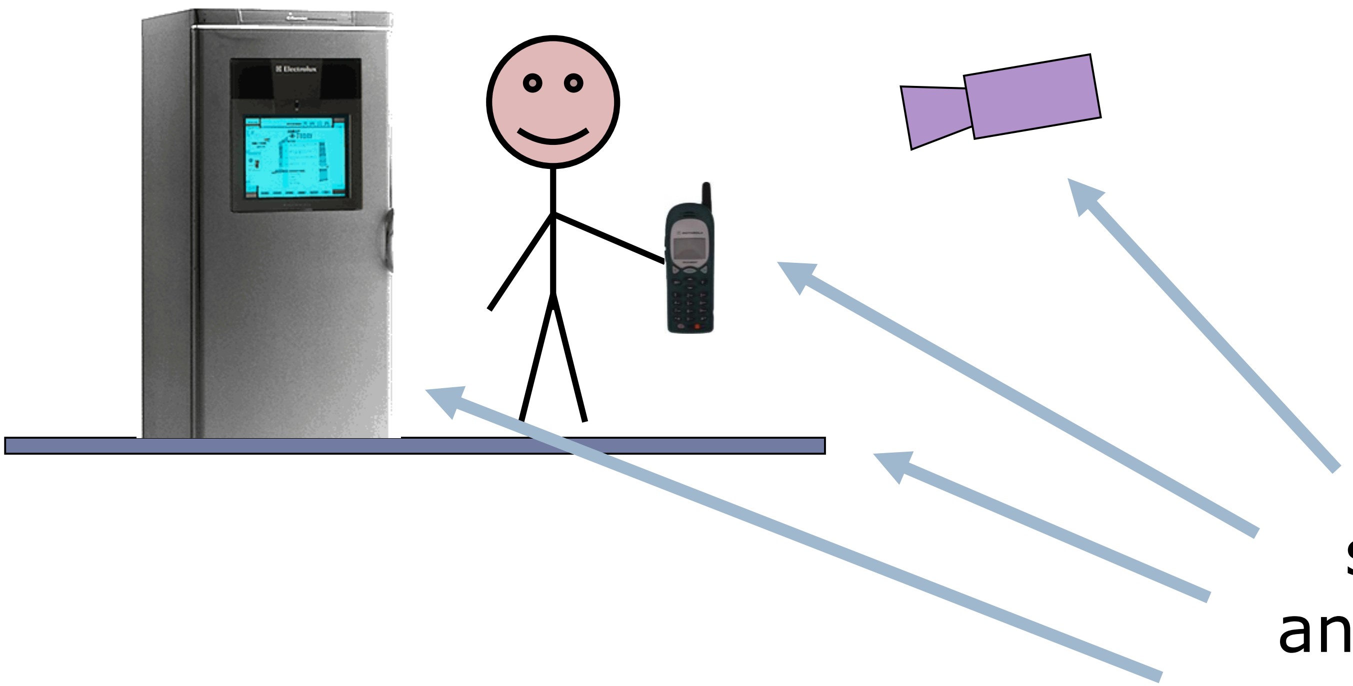
Elements of a Computer

- An interactive system or technology is made up of various elements that may affect the interaction:
  - ***input devices*** – text entry and pointing
  - ***output devices*** – screen (small/large), projector
  - ***virtual reality*** – special interaction and display devices
  - ***physical interaction*** – e.g. vocal, touch screens, bio-sensing
  - ***paper*** – as output (print) and input (scan)
  - ***memory*** – RAM and permanent media, capacity and access
  - ***processing*** – speed of processing, networks
- The interface designer needs to be aware of the properties of the devices with which a system is built.
  - This includes not only input and output devices, but **all the factors that influence the behavior of the interface**, since all of these influence the nature and style of the interaction.

A Typical Computer System



Richer Interaction



sensors
and devices
everywhere

Interaction

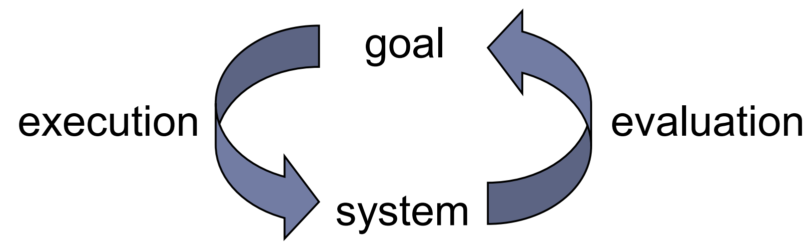
The terms of interaction

- The purpose of an interactive system is to help a user in accomplishing ***goals*** from some application ***domain***.
- A ***domain*** defines an ***area of expertise*** and ***knowledge*** in some real-world activity, and consists of ***concepts*** that highlight its important aspects.
  - For example, in a **graphic design domain**, some of the important concepts are ***geometric shapes***, a ***drawing surface*** and a ***drawing utensil***.
- ***Tasks*** are operations to manipulate the concepts of a domain.
  - One **task** within the graphic design domain is the **construction** of a specific geometric shape on the drawing surface.
- A ***goal*** is the desired output from a performed task.
  - A **goal** is to **produce** a solid red triangle centered on the canvas.

Donald Norman’s Model

- It is perhaps the most influential model of interaction in HCI.
- It consists of an *interactive cycle* that captures the user’s view of the interface. It consists of two major phases: *execution* and *evaluation*.

The user **formulates a plan of action**, which is then **executed** at the computer interface. Then, the user **observes the interface** to **evaluate the result** of the executed plan, and to **determine further actions**.



- The two major phases can be subdivided into further 7 stages:
  - user establishes the goal
  - formulates intention
  - specifies actions at interface
  - executes action
  - perceives system state
  - interprets system state
  - evaluates system state with respect to goal

Using Norman's Model

- It can be used to **demonstrate why some interfaces cause problems** to their users. Norman describes these in terms of the ***gulfs of execution*** and ***gulfs of evaluation***.
- The ***gulf of execution*** is the **difference** between the user's formulation of the actions to reach the goal and the actions allowed by the system.
  - If the actions allowed by the system correspond to those intended by the user, the interaction will be effective.
  - ***The interface should therefore aim to reduce this gulf.***
- The ***gulf of evaluation*** is the **distance** between the physical presentation of the system state and the user expectation.
  - If the user can readily evaluate the presentation in terms of his goal, the gulf of evaluation is small.
  - ***The more effort is required to the user for interpreting the presentation, the less effective the interaction.***

Human errors – Slips and Mistakes

- Human errors are often classified into **slips** and **mistakes**. We can distinguish these using Norman's gulf of execution.
- ***If you understand a system well*** you may know exactly what to do to satisfy your goals. However, perhaps you mistype or you accidentally press the mouse button at the wrong time. These are called ***slips***; *you have formulated the right action, but fail to execute that action correctly*.
- However, ***if you don't know the system well*** you may not even formulate the right goal. *For example, you may think that the zoom icon is the 'find' function, but in fact it is to zoom the text.* This is called a ***mistake***.
- If we discover that an interface is leading to errors **it is important to understand whether they are slips or mistakes**.
  - **Slips may be corrected** by, for instance, *better screen design*, perhaps putting more space between buttons.
  - However, **mistakes need users to have a better understanding of the systems**, so will require far more radical redesign or improved training.

Ergonomics

- Study of the **physical characteristics** of interaction:
  - how the controls are designed?
  - in which physical environment the interaction takes place?
  - how are the layout and physical characteristics of the screen?
- A **primary focus** of ergonomics is on **user performances** and how the interface enhances or detracts such performances.

- In the context of HCI, ergonomics is very good at defining standards and guidelines for constraining the way we design certain aspects of systems.

Physical arrangement of controls and displays

- It is **crucial** that the physical layout of controls and parts of the display are **grouped logically** to allow rapid access by the user.
  - In ***safety-critical applications*** such as plant and air traffic control, users are under pressure and are faced with a huge range of displays and controls.
  - In ***less critical PC applications***, inappropriate placement of controls and displays can lead to inefficiency and frustration (for example, a poor design frequently leads to inadvertent removal actions).
- The exact organization of the layout depends on the domain and the application, but possible organizations include the following:
  - **functional** controls and displays are organized so that those that are functionally related are placed together;
  - **sequential** controls and displays are organized to reflect the order of their use in a typical interaction (this may be especially appropriate in domains where a particular task sequence is enforced, such as aviation);
  - **frequency** controls and displays are organized according to how frequently they are used, with the most commonly used controls being the most easily accessible.

The physical environment of the interaction

- Ergonomics is also concerned with the **design of the work environment** in which the system is used.
  - Where will the system be used?
  - By whom will it be used?
  - Will users be sitting, standing or moving about?
- The design of the work environment:
  - depends largely on the domain.
    - It is more critical in specific control and operational settings than in general computer use.
  - influences how well the system is accepted and even the health and safety of its users.
    - all users should be comfortably able to see and use critical displays and controls.
    - In any system the smallest user should be able to reach all the controls (this may include a user in a wheelchair), and the largest user should not be cramped in the environment.
  - should therefore be considered in all design!

The use of color

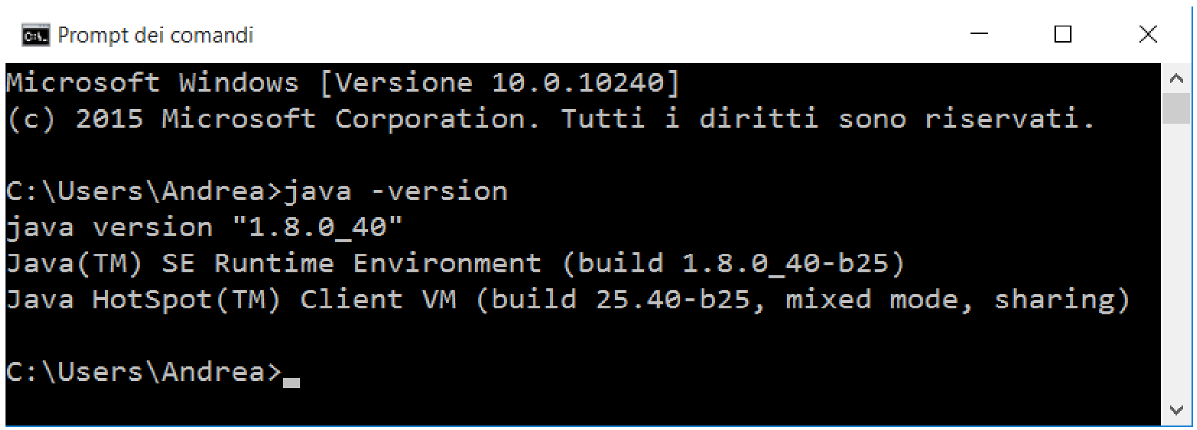
- The **use of color** in displays is an ergonomics issue.
  - The **human visual system has some limitations** with regard to the number of colors that are distinguishable and the relatively **low blue acuity**.
- Some ergonomic guidelines:
  - Colors used in the display should be **as distinct as possible** and the distinction should **not be affected by changes in contrast**.
  - If color is used as an indicator it should not be the only cue: additional coding information should be included.
  - The colors used should correspond to **common conventions** and **user expectations** (which should not be violated without very good cause).
    - **Blue** should not be used to display critical information.
    - **Red**, **green** and **yellow** are colors frequently associated with stop, go and standby respectively. Therefore, **red** may be used to indicate emergency and alarms; **green**, normal activity; and **yellow**, standby and auxiliary function.
  - Color conventions are **culturally determined**; awareness of such conventions is very important in designing systems for a global market.
    - For example, **red** is associated with danger and warnings in most western cultures, but in China it symbolizes happiness and good fortune.

Interaction Styles

- The choice of interface style can have a profound effect on the nature of the HCI.
- There are a number of traditional interface styles including:
  - command line interface
  - menus
  - question/answer and query dialogue
  - form-fills and spreadsheets
  - point and click
  - WIMP
  - Tactile, vocal, 3D interfaces and many more!

Command line interface

- It was the **first interactive** dialog style to be commonly used.
  - In spite of the availability of GUIs, it is still widely used by experienced users for accelerated access to the system's functionality.
  - It provides a means of expressing instructions to the computer directly, using function keys or whole-word commands.



  - It is **flexible**: a command often has a number of options or parameters that will vary its behavior, allowing the command to be applied to many objects at once, making it useful for repetitive tasks.
  - It may be **complex** to be used: commands must be remembered, as no cue is provided to indicate which command is needed.

Menu Interfaces

- In a menu-driven interface, the options available to the user are displayed on the screen and selected with the mouse or numeric/alphabetic keys.
  - This form of interaction is **less demanding for the user**, which relies on recognition rather than recall.
  - However, menu options need to be **meaningful** and **logically grouped** to aid recognition.

```
PAYMENT DETAILS                P3-7

please select payment method:
   1. cash
   2. check
   3. credit card
   4. invoice

   9. abort transaction
```

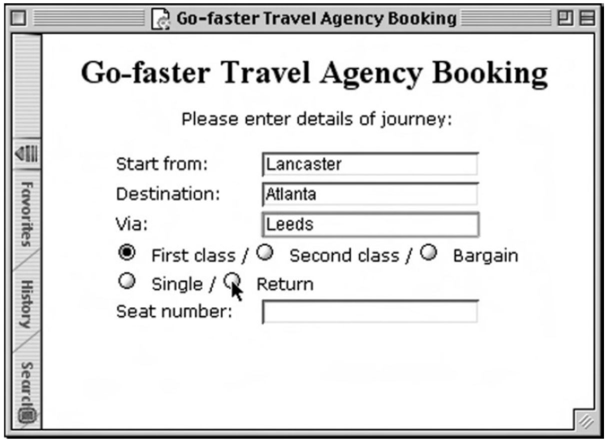
- Often menus are hierarchically ordered and the option required is not available at the top layer of the hierarchy.
  - Grouping and naming of menu options then provides the only cue for the user to find the required option.

Question/answer and query dialog

- **Question and answer dialog** is a simple mechanism for providing input to an application in a specific domain.
  - **The user is asked a series of questions** (mainly with yes/no responses and multiple choices) and **is led through the interaction step by step**. An example of this would be *web questionnaires*.
  - These interfaces are **easy to learn and use**, but are ***limited in functionality*** and are appropriate for restricted domains.
- **Query languages** are used to construct queries to retrieve information from a database.
  - They use natural-language-style phrases, but require **specific syntax**, as well as knowledge of the database structure.
  - Most query languages **do not provide direct confirmation** of what was requested, and the only validation the user has is the result of the search.
  - The effective use of query languages therefore requires some **experience**. A specialized example is the web search engine.

Form-fills and Spreadsheets

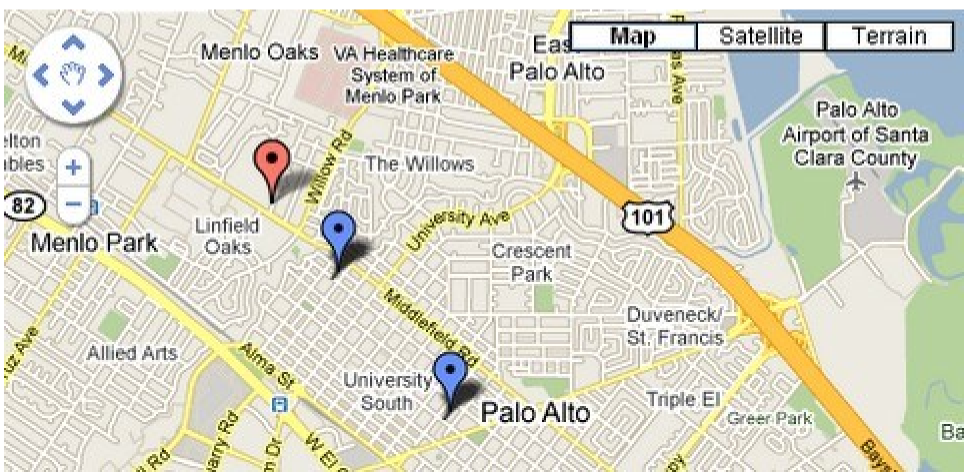
- **Form-filling interfaces** are used primarily for data entry but can also be useful in data retrieval applications.
  - The user is presented with a display resembling a form, with slots to fill in.
    - The user works through the form, filling in appropriate values. The data are then entered into the application in the correct place.
    - The dialog style is useful primarily for data entry applications and, as it is easy to learn and use, for novice users.



- Spreadsheets are a sophisticated variation of form filling.
  - They comprise a grid of cells, each of which can contain a value or a formula that can be altered in any order, making the interface more natural.
  - The system maintains consistency amongst the values displayed, ensuring that all formulae are obeyed.

Point and Click Interfaces

- In most multimedia systems and in web browsers, virtually all actions take only a single click of the mouse button.
  - If you point at a city on a map, when you click a window opens, showing you tourist information about the city.
- The point-and-click style is not tied to mouse-based interfaces, and is also **extensively used in touchscreen information systems**.



WIMP

- It is the default interface style for the majority of interactive computer systems in use today:
  - Microsoft Windows
  - MacOS for Apple
  - Linux Ubuntu

- WIMP stands for:
  - Windows
  - Icons
  - Menus
  - Pointers
- There are many additional interaction objects and techniques commonly used in WIMP interfaces, called *widgets*:
  - buttons, toolbars, palettes and dialog boxes.

Windows

- Areas of the screen that behave as if they were independent
  - can contain text or graphics, and can be moved or resized.
- **More than one window** can be on a screen at once, allowing separate tasks to be visible at the same time.
  - Users can direct their attention to the different windows as they switch from one thread of work to another.
  - Windows can overlap and obscure each other, or can be laid out next to one another (tiled).
- Usually, windows have various things associated with them that increase their usefulness.
  - **Scrollbars** allow the user to move the contents of the window up and down or from side to side.
  - **Title bars** describe the name of the window.
  - **Special boxes** in the corners of the window to aid resizing, closing, or making as large as possible.

Icons

- Windows can be shrunk to a very reduced representation, known as an *icon*.
  - Through icons, **many windows are available on the screen at the same time**, and can be expanded to their full size by clicking on the icon.
  - **Icons can take many forms**: they can be realistic representations of the objects that they stand for, or they can be highly stylized.

Pointers

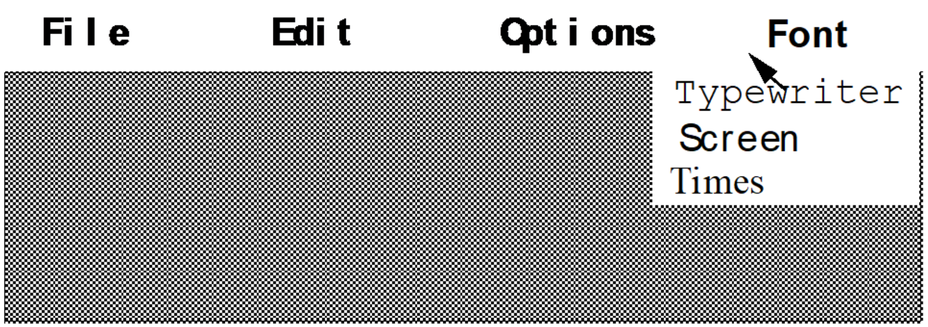
- The interaction style required by WIMP relies very much on **pointing** and **selecting** things such as icons.
  - The mouse provides an input device capable of such tasks.
  - The user is presented with a cursor on the screen that is controlled by the input device.
- There exist a variety of pointer cursors:

Cursors are **also used to tell the user about system activity**, for example a hour-glass cursor may be displayed when the system is busy reading a file.

Pointer cursors are like icons, being small images, but in addition all cursors have a *hot-spot*, the location to which they point.

Menus

- Choice of operations or services offered on the screen
- Required option selected with pointer
- **PROBLEM** – take a lot of screen space
  - Solution – pop-up: menu appears when needed
  - Contextual menus appear where you are
  - Pie-menus
  - Cascading menus
- Menu Design Issues
  - which kind to use
  - what to include in menus at all
  - words to use (action or description)
  - how to group items
  - choice of keyboard accelerators



User-Centered Design

Defining User-Centered Design (UCD)

- The design of usable interactive systems requires the use of “**user centered**” (or “**human centered**”) design techniques.
  - The UCD process is ***iterative*** and focuses on ***users*** through all the life-cycle phases of the design process in order to realize usable systems.
  - UCD is largely based on ***prototypes*** and requires a ***multidisciplinary design team***.
  - "UCD is an iterative process whose goal is the development of usable systems, achieved through involvement of potential users of a system in system design." [J. Karat: User Centered Design: Quality or Quackery? ACM/SIGCHI magazine. 1996]

The standard ISO 13407

- There is an international standard that forms the basis for UCD (**ISO 13407**: **Human centred design process for interactive systems**).

- *"Human-centred design is an approach to interactive system development that **focuses specifically on making systems usable**. It is a **multi-disciplinary activity** which incorporates **human factors** and **ergonomics knowledge** and **techniques**. The application of human factors and ergonomics to interactive systems design enhances effectiveness and efficiency, improves human working conditions, and counteracts possible adverse effects of use on human health, safety and performance."*

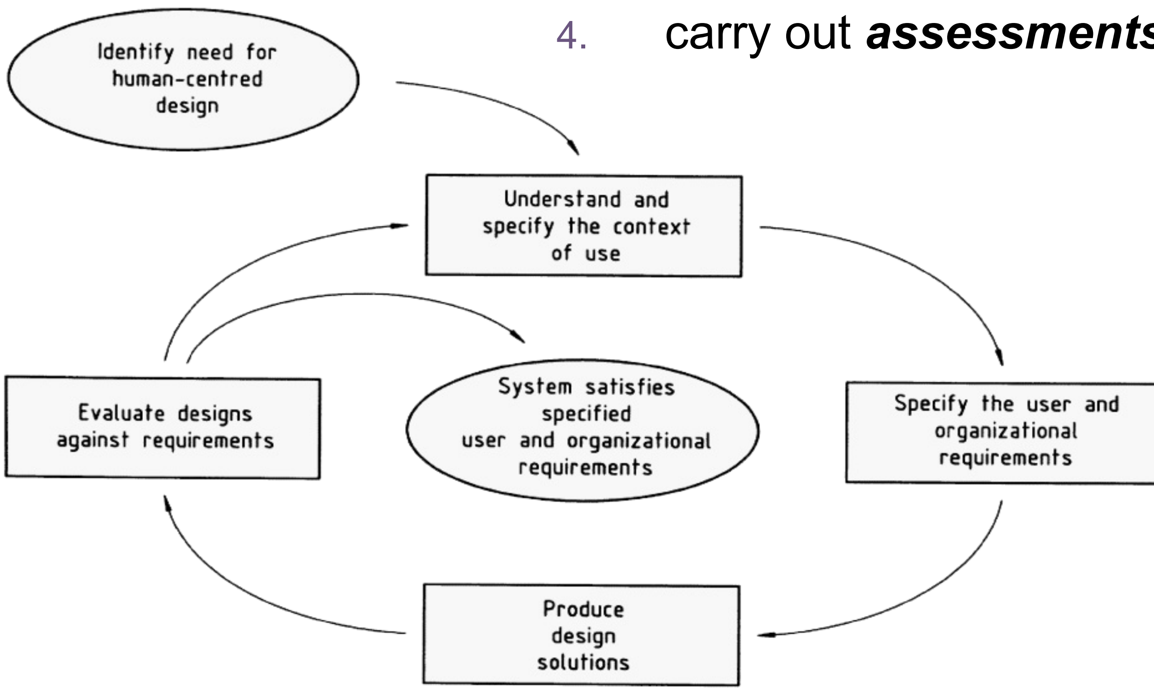
Characteristics of UCD (ISO 13407)

1. Know your users
   - characteristics, tasks, context/organization/environment in which they use the system.
2. Actively involve users early and continuously.
3. Rapid and frequent iteration of designs with usability assessments
4. Multidisciplinary team
   - development team is made up from representatives of all the groups who have a 'stake' in the proposed software (stakeholders) e.g. domain experts, usability specialists, software engineers, etc.

UCD Activities (ISO 13407)

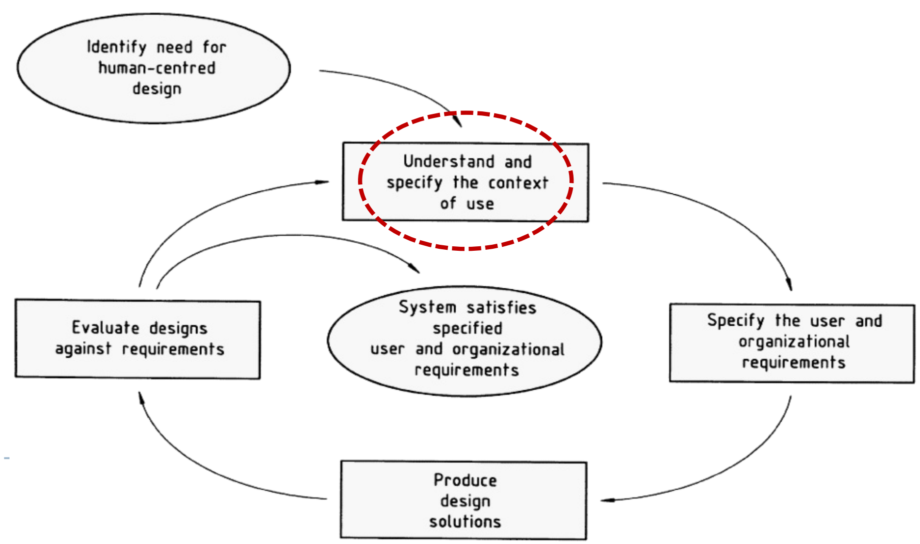
- According to the ISO 13407 standard, there are 4 essential UCD activities which should be undertaken to incorporate usability requirements into the software development process:

  1. understand and specify the ***context of use***
  2. specify the user and organizational ***requirements***
  3. produce ***designs and prototypes***
  4. carry out ***assessments/evaluations***



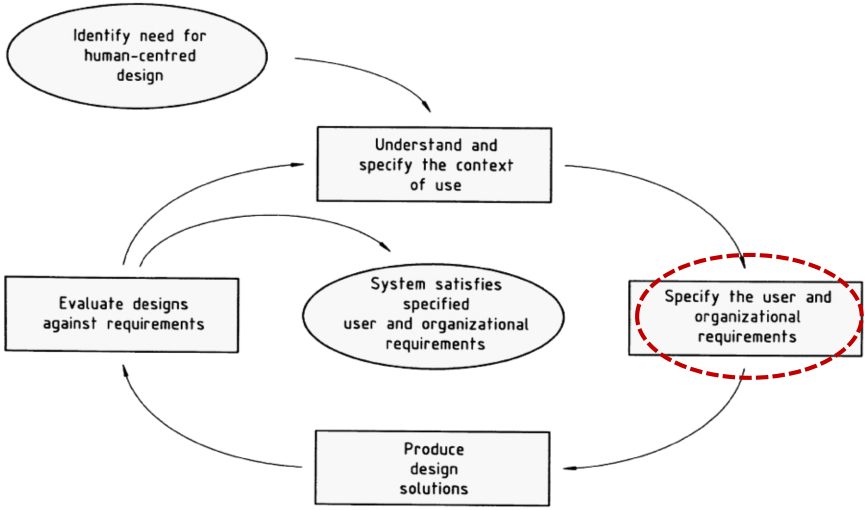
1. Understand and specify the context of use

- The quality of use of a system depends very much upon the context in which a system will be used.
  - In some cases contextual information may already be known; although, where a new product or system is to be introduced, then it is necessary to **collect the relevant contextual information**:
    - the ***characteristics*** of the ***intended users***;
    - the ***tasks*** the users will perform, and ***allocation of activities*** between users and system;
    - ***Any kind of constraint*** (social, legal, characteristics of the technological environment in which the users will use the system).
  - The results of this first activity are embodied in a **document** which describes the **context of use** for the proposed software. The document is:
    - checked and validated by the users;
    - revised cyclically;
    - influential for the system's design.



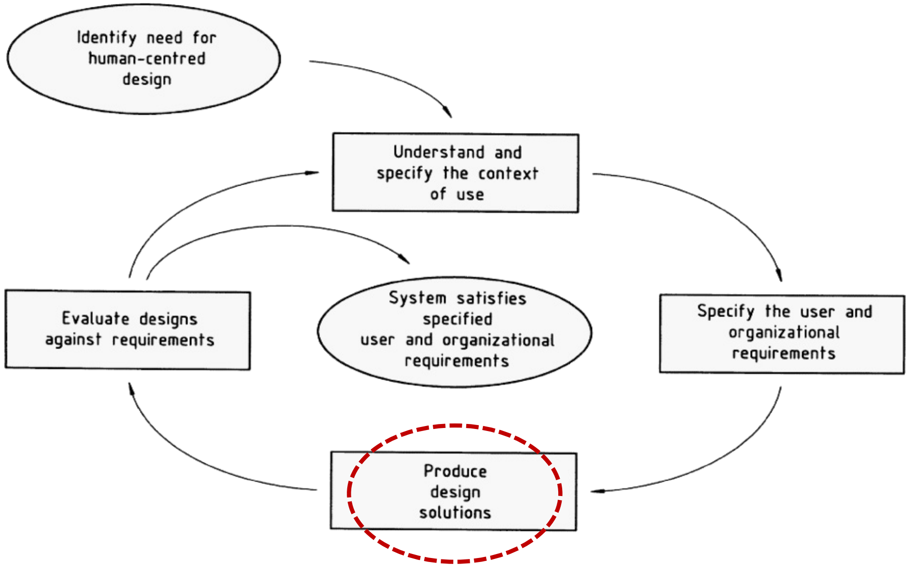
2. Specify the user and organizational requirements

- Building on the context of use description obtained previously, an **explicit statement** of the **user-centered requirements** for the new software should be formulated:
  - identification of the range of ***relevant users*** in the design;
  - provision of a clear statement of ***design goals***;
  - an indication of ***appropriate priorities*** among different conflicting requirements;
  - ***evidence of acceptance*** of the mandatory and legislative requirements (health, safety, etc.) by the stakeholders.



3. Produce designs and prototypes

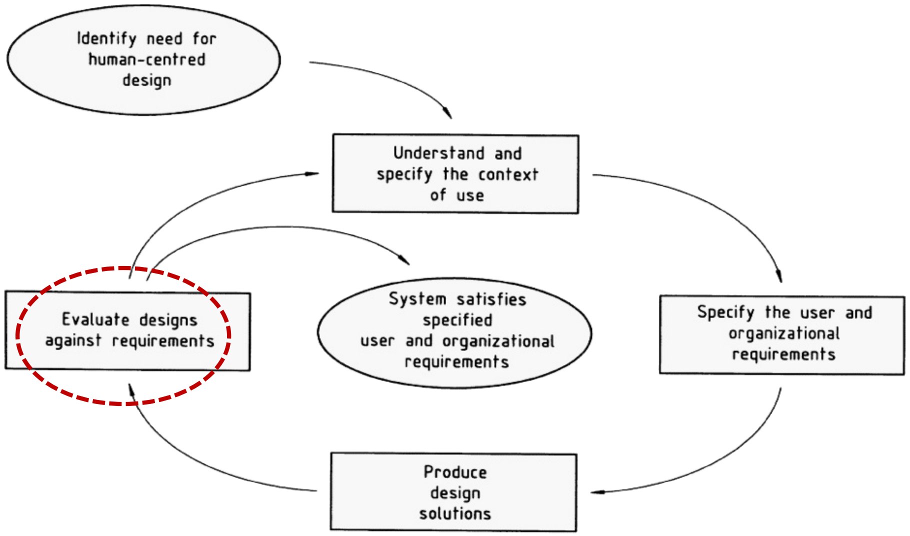
- The key goal is to simulate the design solution(s) using ***paper*** or ***computer-based mock-ups*** of the proposed system…
  - …and then **later** presenting them to a representative sample of users.
  - **Involve users early** in order to explore and refine design choices.
  - **Iterate design solutions** until the design/usability goals and requirements are met.



4. Carry out assessments/evaluations

- **The usability evaluation of design decisions is crucial!**
- Develop an **evaluation plan** covering each of system lifecycle stages (with or without users):
  - ***identify anomalies*** and ***defects*** most relevant at any stage;
  - ***select the best solution*** for the system in light of the requirements at the current stage;
  - ***report the results*** and ***recommendation*** for refining the design at this stage; the refine design becomes the design in the next stage!

- The evaluation process is iterated until design and usability requirements and goals are met.



Understanding UCD

- UCD intends to ensure that the **user is at the center during the design process** in order to realize products that meet usability requirements.
  - Often HCI professionals complain that they are called in too late, when a system has been already designed and built, and **has been proved unusable.**
  - In many companies **usability is wrongly seen as equivalent to testing** – checking whether people can use it and fixing problems, rather than making sure they can from the beginning.
- Note that the ISO 13407 standard defines a general process for including human-centered activities throughout a development life-cycle, but **does not dictate the specific methods**.

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- A. Dix, J.E. Finlay, G.D. Abowd, R. Beale: *Human-Computer Interaction* (3rd Edition), Pearson