# CHAPTER 2

## Human Characteristics

# Overview

- Humans are limited in their capacity to process information. This has important implications for design.
- Emotion influences human capabilities.
- Users share common capabilities but are individuals with differences, which should not be ignored.
- Information is received and responses given via a number of input and output channels: visual channel, auditory channel, haptic channel, movement.
- Information is stored in memory: sensory memory, short-term (working) memory, long-term memory.
- Information is processed and applied: reasoning, problem solving, skill acquisition, error.

# Aims

- An essential part of our approach to designing interactive systems is that it should put people first; it should be human-center.
- Designers need to understand the people (profile) who will use their systems and products (monitor, cognitive, sense, etc.)
- They need to understand the activities that people want to undertake and the contexts in which those activities take place.
- Designers can consider the differences between individual in term of preferences, satisfaction and expectation.

# Learning Objectives

- Ergonomics
- Individual Differences
- Human Center Design
- Input-Output Channels
- Activities and Context

Source: Interaction Design Foundation

# The Importance of People

# INTRO

- How humans perceive the world around them?
- How they store and process information
- How they solve the problems?
- How they physically manipulate objects?
- People differ from one another from variety ways:
  - Physical Differences
  - Psychological Differences
  - Social Differences

# Physical Differences

- People differ in physical characteristics such as height and weight.
- Variability in the five senses – sight, hearing, touch, smell and taste – has a huge effect on how accessible, how usable and how enjoyable using a technology will be for people in different contexts.
- For example, color blindness (usually the inability to correctly distinguish between red and green colors) affects about 8 percent of western males, short-sightedness and long-sightedness affect many, and many people are hearing impaired.
- In Europe there are 2.8 million wheelchair users so designers must consider where technologies are placed, and many people have dexterity impairments involving the use of their fingers.
- All of us have relatively large fingers compared to the small size we can make buttons.

# Ergonomics

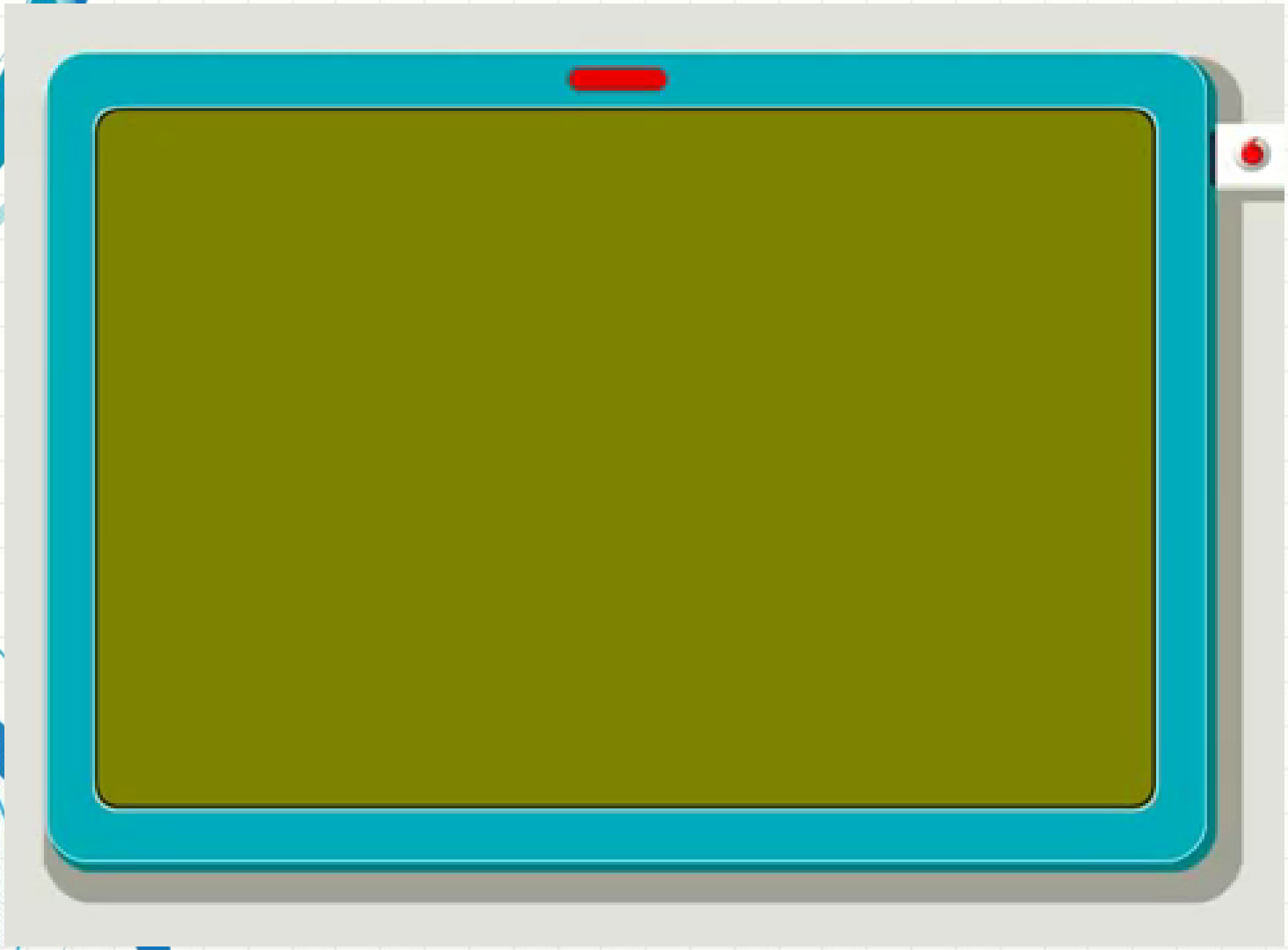
- The term ‘ergonomics’ was coined in 1949 by K. F. H Murrell as a combination of two Greek words, εργον (ergon), meaning ‘work ‘, and νομος (nomos) meaning ‘law’.
- At that time technically advanced weapons systems were being rapidly developed which required that their design matched human and environmental factors if they were to be used effectively and, paradoxically, safely.
- The environment includes the ambient environment (temperature, humidity, atmospheric pressure, light levels, noise and so on) and the working environment too (the design of machines, health and safety issues – e.g. hygiene, toxicology, exposure to ionizing radiation, microwaves, etc.).

# Ergonomics (cont.)

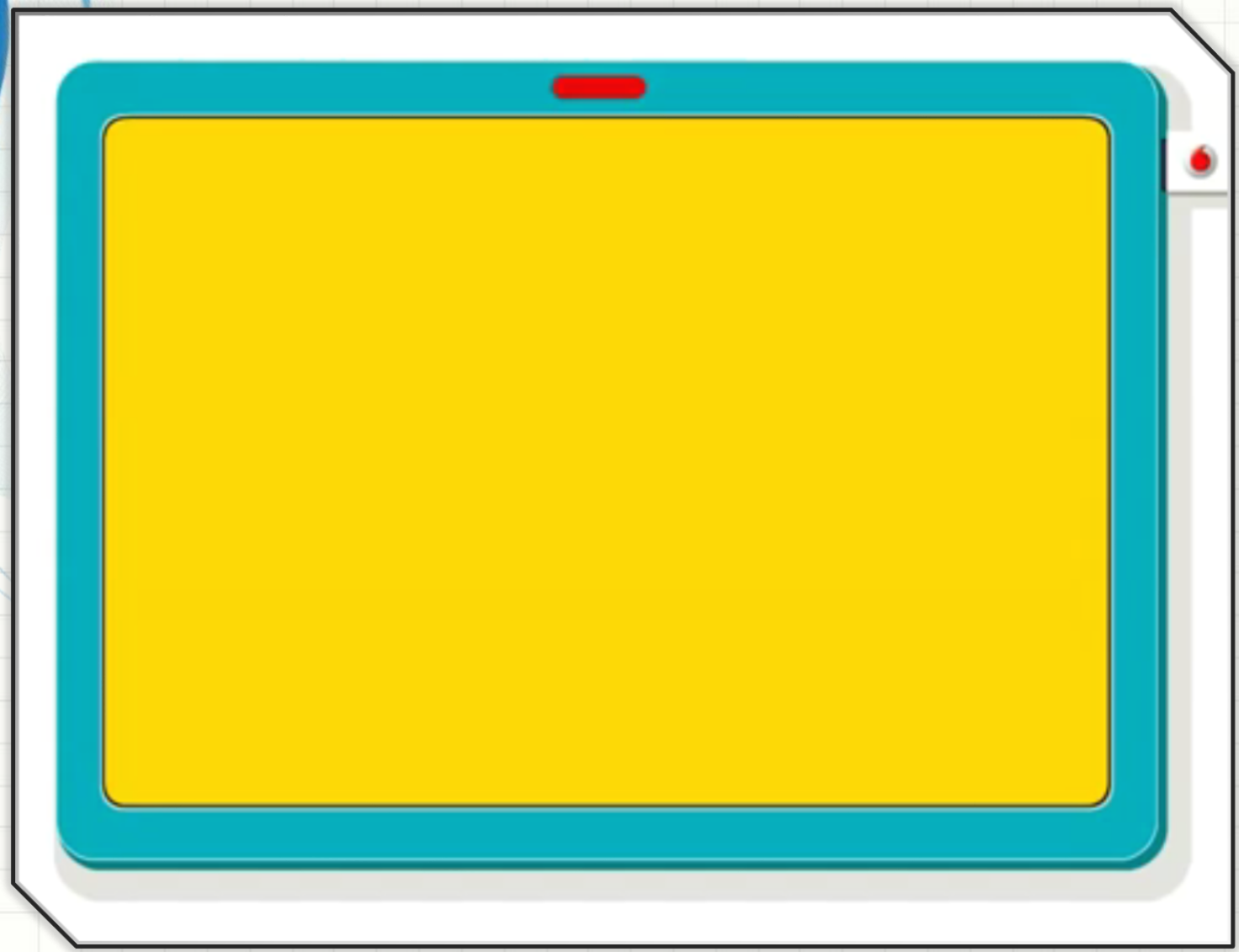
In short, ergonomics (also known as human factor) is the process of designing or arranging workplaces, products and systems so that they fit the people who use them or we also can said as the scientific discipline concern with the understanding of the interactions among humans and other elements of a system (International Ergonomics Association, 2010)

# Ergonomics Design

- **Fitt's Law**: predictive model to calculate 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 (Paul Fitts, 1954).
- **Steering Law**: predictive model of human movement that describes the time required to navigate, or *steer*, through a 2-dimensional tunnel (Rashevsky, 1959; Drury, 1971; Accot and Zhai, 1997).
- **Rohmert's Law**: predictive model to calculate "maximum holding time" for any particular task, in which maximum force one's muscles can exert decreases exponentially from the time one begins continuously exerting the force (Walter Rohmert, 1960).



Source: Stephen Watkins



Source: Stephen Watkins

# Psychological Differences

- For example, people with good spatial ability will find it much easier to find their way around and remember a website than those with poor ability.
- Designers should design for people with poor ability by providing good signage and clear directions.
- Language differences are of course crucial to understanding.
- Cultural differences affect how people interpret things.
- For example, in the Microsoft Excel spreadsheet application there are two buttons, one labeled with a cross and the other a tick. In the US a tick is used for acceptance and a cross for rejection, but in Britain a tick or a cross can be used to show acceptance (e.g. a cross on a voting paper).

# More…

- Some people have a good memory, others less so.
- Some people can find their way around environments better than others, or mentally rotate objects more quickly and accurately.
- Some are good at words, others are good at numbers.
- There are differences in personality, emotional make-up and ability to work under stress.
- People also have different needs and abilities when it comes to attention and memory and these can change depending on factors such as stress and tiredness.
- Nobody can remember long numbers or complicated instructions.
- All people are better at recognizing things than they are at remembering things.

# And More…

- Some people can quickly grasp how something works whereas for others it can take much longer.
- People have had different experiences and so will have different conceptual ‘models’ of things.
- For example, an individual is not likely to notice a slight, gradual increase in the volume of music if the change in volume remains below the threshold of detection.
- Importantly, individuals can also differ not only in their current state, but in the magnitude or even direction of response to a given stimulus.

# Psychological Test

- Many tests have been designed to measure these differences.
- For example the Myers-Brigg Type Indicator is a series of tests that results in people being classified as one of 16 personality types.
- Others classify people as one of five personality types known as OCEAN: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism.
- Designers need to consider the range of differences between people and the demands that their designs make on people's psychological abilities.

# Mental Model

- The understanding and knowledge that we possess of something is often referred to as a ‘mental model’ (e.g. Norman, 1998).
- If people do not have a good mental model of something, they can only perform actions by route.
- If something goes wrong they will not know why and will not be able to recover.
- This is often the case with people using software systems, but it is also the case with ‘simpler’ domestic systems such as central heating systems, thermostats and so on.
- A key design principle is to design things so that people will form correct and useful mental models of how they work and what they do.

# Developing Mental Model

People develop mental models through:

- Interacting with systems directly and indirectly.
- Observing the relationship between their actions and the behaviors of the system.
- Reading any manuals or other forms of explanation that come with a system.
- So, it is important that designers provide sufficient information in the interface (and any accompanying documentation) for people to form an accurate mental mode.

# The Mental Model Problem

- Designers have some conception of the system they have produced.
- This may or may not be the same as what the system actually does.
- Moreover in a system of any large size, no single designer will know everything that the system does.
- Designers design a system's image that they hope will reveal the designer's conception.
- The problem is that it is only through the system image – the interface, the behaviors of the system and any documentation – that the designer's conception can be revealed.
- People interact with the system image and from this have to derive their conception (their 'mental model') of what the system is and what it does.
- A clear, logical and consistent conceptual design will be easier to communicate to people who use the system and hence they will develop a clearer conception of the system themselves.

# The Nature of Mental Model (Norman, 1983)

- Mental models are incomplete. People will understand some parts of a system better than others.
- People can ‘run’ (or try out) their models when required, but often with limited accuracy.
- Mental models are unstable – people forget details.
- Mental models do not have firm boundaries: similar devices and operations get confused with one another.
- Mental models are unscientific, exhibiting ‘superstitious’ behavior.
- Mental models are parsimonious. People are willing to undertake additional physical operations to minimize mental effort, e.g. people will switch off the device and start again rather than trying to recover from an error.

# Stephen Payne's View

- He describes how mental models predict behavior (2003).
- The claim is that, in many situations, a great deal of explanatory work can be done by a description of what people know and believe, and how this affects their behavior.
- Inferences can be made by 'mental simulation'.
- Mental models can support reasoning about devices, or the physical world in general, by running simulations in the mind's eye.

# Social Differences

- People make use of systems, products and services for very different reasons.
- They have different goals in using systems.
- They have different motivations for using systems.
- Some people will be very interested in a particular system, others will just want to get a simple task completed. These motivations change at different times.

# Novice and Expert

- Novice and expert users of a technology will typically have very different levels of knowledge and hence requirements for design features.
- Experts use a system regularly and learn all sorts of details, whereas a beginner will need to be guided through an interaction.
- There are also people who do not have to use a system, but who the designer would like to use the system. These people (sometimes called ‘discretionary users’) are often quickly put off if things are difficult to do.
- Designers need to entice these people to use their systems.

# Similarity Between People

- Designing for homogeneous groups of people – groups who are broadly similar and want to do much the same things – is quite different from designing for heterogeneous groups.
- Websites have to cater for heterogeneous groups and have particular design concerns as a result.
- A company's intranet, however, can be designed to meet the particular needs of particular people.
- Representatives from a relatively homogeneous group – secretaries or managers or laboratory scientists, say – could be made part of the design team and so provide much more detailed input as to their particular requirements.

# What is Human Center Design?

source: nisecorporation

# Human Center Design

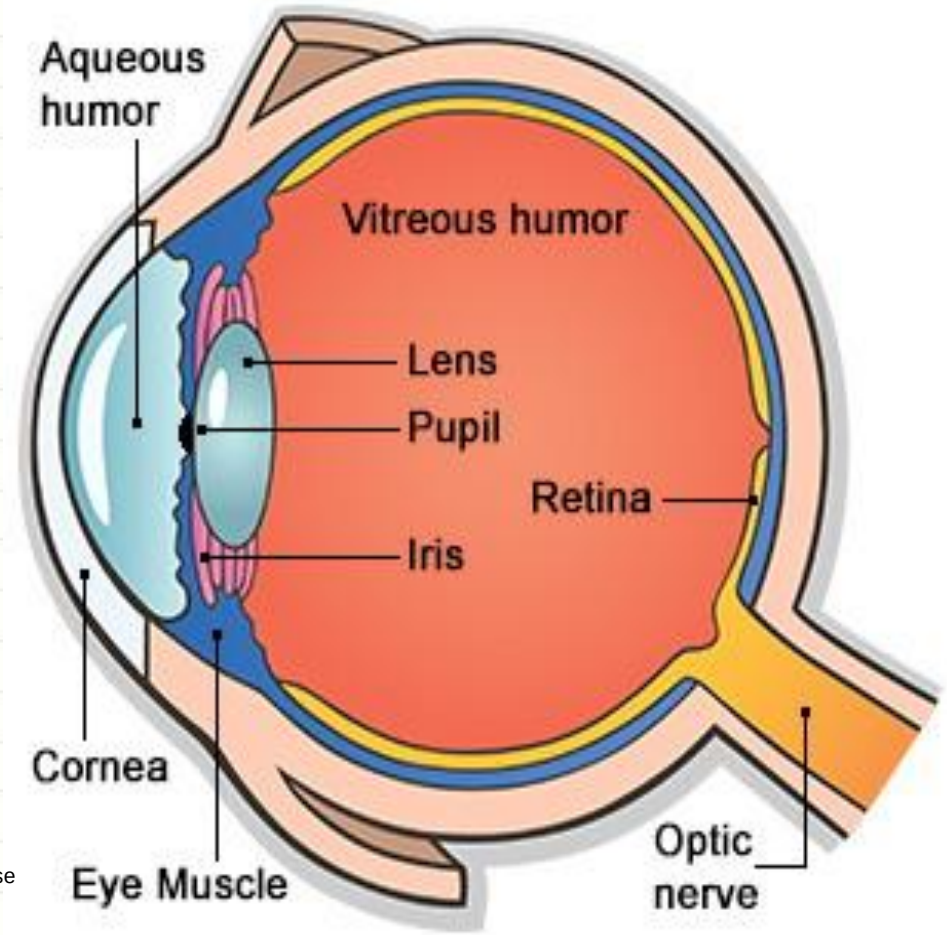
Human-centered design is a creative approach to interactive systems development that aims to make systems usable and useful by focusing on the users, designing around their needs and requirements at all stages, and by applying human factors/ergonomics, usability knowledge, and techniques. This approach enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and sustainability; and counteracts possible adverse effects of use on human health, safety and performance. (ISO 9241-210:2010)

# Human Center Design (cont.)

- It is inspired by behaviors rather than demographics.
- It takes place in natural contexts versus controlled settings.
- It relies on dynamic conversations rather than scripted interviews.

# Input-Output Channel

- Human vision is a highly complex activity with a range of physical and perceptual limitations, yet it is the primary source of information for the average person.
  - ❑ Human Eye
    - ✓ Sensitivity to Light
    - ✓ Saturation
    - ✓ Ambiguity or Illusion
  - ❑ Visual Perception
    - ✓ Perceiving Size and Depth
    - ✓ Perceiving Brightness
    - ✓ Perceiving Color
  - ❑ Reading
    - ✓ Word Pattern
    - ✓ Reference Decoded
    - ✓ Semantic Analysis
    - ✓ Syntactic Analysis

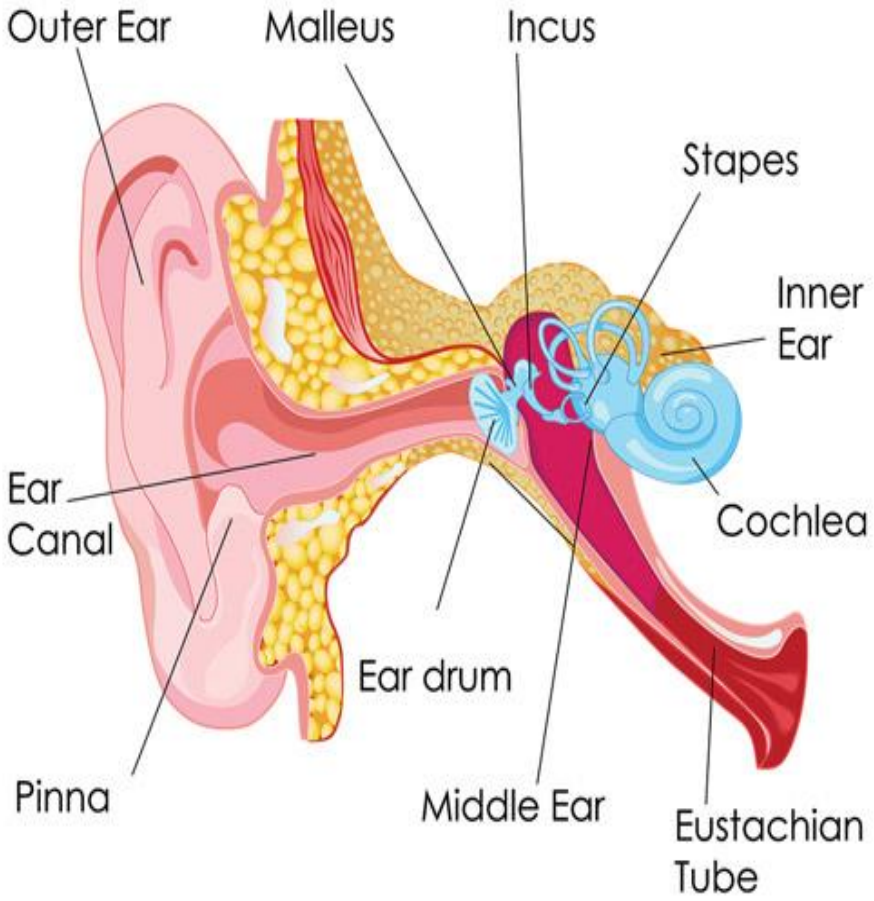


# Input-Output Channel (cont.)

- 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.
- The way that objects are composed together will affect the way we perceive them, and we do not perceive geometric shapes exactly as they are drawn. For example, we tend to magnify horizontal lines and reduce vertical. So a square needs to be slightly increased in height to appear square and lines will appear thicker if horizontal rather than vertical.
- Adults read approximately 250 words a minute. It is unlikely that words are scanned serially, character by character, since experiments have shown that words can be recognized as quickly as single characters. Instead, familiar words are recognized using word shape. This means that removing the word shape clues (for example, by capitalizing words) is detrimental to reading speed and accuracy.

# Input-Output Channel (cont.)

- Human hearing is often considered secondary to sight, but we tend to underestimate the amount of information that we receive through our auditory system.
  - ❑ Human Ear
    - ✓ Vibration
    - ✓ Impulse
    - ✓ Amplifier
    - ✓ Transmitter
  - ❑ Processing Sound
    - ✓ Notification
    - ✓ Sound Effect
    - ✓ Frequency Changes
    - ✓ Noises
    - ✓ Intensity



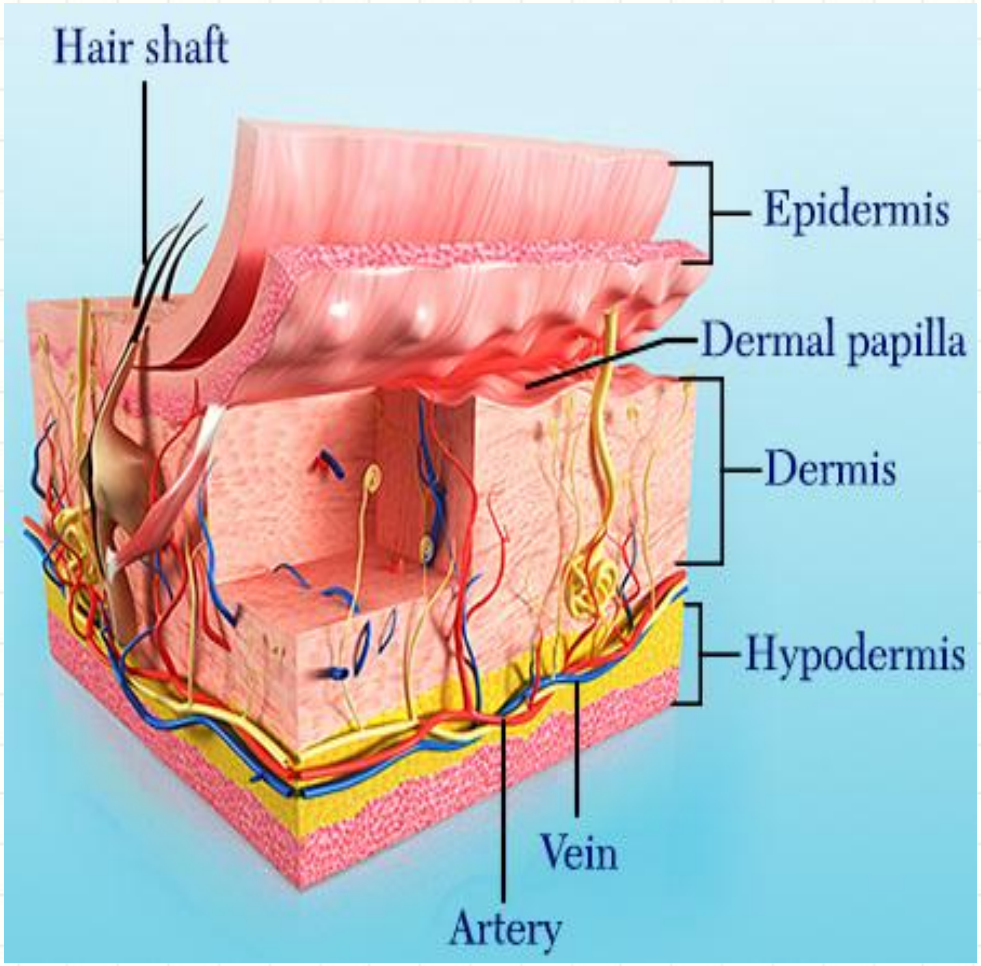
# Input-Output Channel (cont.)

- The ear can differentiate quite subtle sound changes and can recognize familiar sounds without concentrating attention on the sound source. This suggests that sound could be used more extensively in interface design, to convey information about the system state, for example.
- 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. Different frequencies trigger activity in neurons in different parts of the auditory system, and cause different rates of firing of nerve impulses.
- It has a number of characteristics which we can differentiate. *Pitch* is the frequency of the sound. A low frequency produces a low pitch, a high frequency, a high pitch. *Loudness* is proportional to the amplitude of the sound; the frequency remains constant. *Timbre* relates to the type of the sound: sounds may have the same pitch and loudness but be made by different instruments and so vary in timbre.

# Input-Output Channel (cont.)

- Human touch provides us with vital information about our environment. It tells us when we touch something hot or cold, and can therefore act as a warning. It also provides us with feedback when we attempt to lift an object.
- The skin contains three types of sensory receptor: *thermoreceptors* respond to heat and cold, *nociceptors* respond to intense pressure, heat and pain, and *mechanoreceptors* respond to pressure. It is the last of these that we are concerned with in relation IxD.
- Two aspects in haptic perception are *tactile acuity or sensitivity*: sensations arising from stimulus to the skin and *kinesthesis*: awareness of the position of the body or limb.

# Input-Output Channel (cont.)




There is a different balance of position and force control when we are exploring an environment (e.g., lightly touching a surface) versus manipulating an object. In the latter case we might be going through a preprogrammed sequence of movements and relying only subconsciously, if at all, on the touch sense. A haptic designer needs to be aware of the way a user is going to grasp a handle or probe; consider the possibilities of grip suggested by the different handles (MacLean, 2008)

# Input-Output Channel (cont.)

- Human movement is dependent largely on the physical characteristics of the subjects: their age and fitness, for example. Reaction time varies according to the sensory channel through which the stimulus is received. A person can react to an auditory. signal in approximately 150 ms, to a visual signal in 200 ms and to pain in 700 ms. However, a combined signal will result in the quickest response. Factors such as skill or practice can reduce reaction time, and fatigue can increase it.
- Speed and accuracy of movement are important considerations in the design of interactive systems, primarily in terms of the time taken to move to a particular target on a screen. The target may be a button, a menu item or an icon, for example.
- It is generally agreed that there are three types of human memory: *sensory buffers*, *short-term memory* or *working memory*, and *long-term memory*. The sensory memories act as buffers for stimuli received through the senses. Short-term memory acts as a 'scratch-pad' for temporary recall of information. Long-term memory is intended for the long-term storage of information. Information is placed there from working memory through rehearsal.

# Human Center Design (Product)

When people think of design, they often first think about expensive, stylish products. But thoughtful product design is just as important in social innovation. Not only are all people deserving of well-designed products, but challenges that arise when there are limited resources, services, or infrastructure require new approaches and elegant solutions

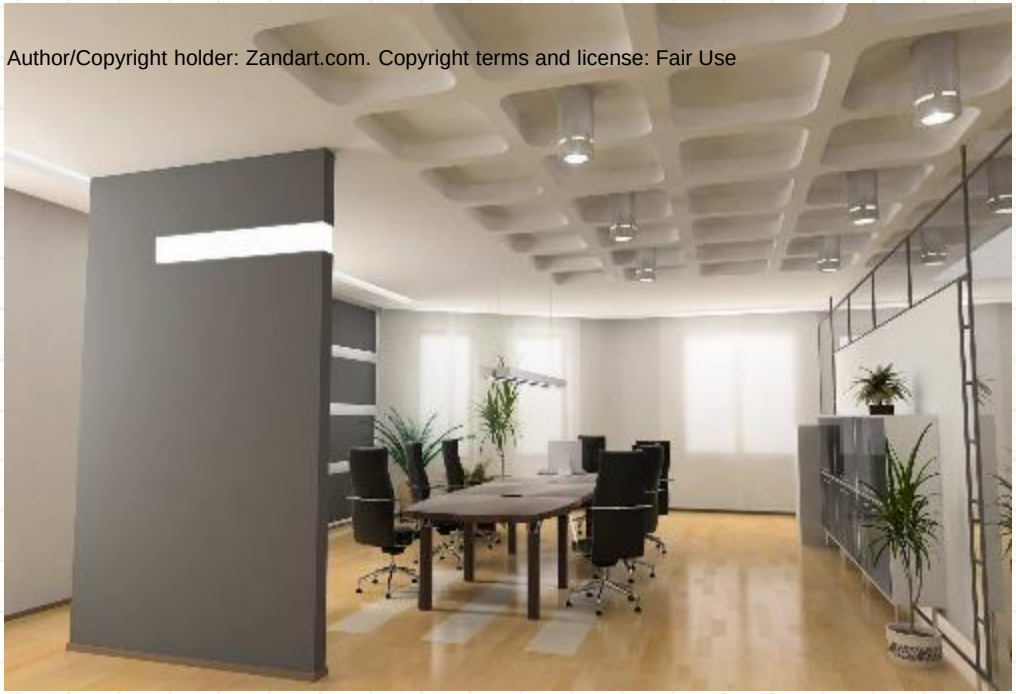

- How might we design a cookstove that reduces the amount of smoke inhaled by the user?
- How might we build an irrigation pump that can run without the electricity grid?
- How might we design a toilet for families living in areas with no sanitation infrastructure?

Source: plusacumen.org

# Human Center Design (Spaces)

Physical environments give people signals about how to behave and influence how they feel. By rethinking the design of hospitals, classrooms, public transportation, banks, libraries, and more, we can create new experiences and interaction in these spaces. Human-centered design can help make the emotional parts of a space as important as the functional.





- How might we design hospital waiting rooms to mitigate the transmission of airborne diseases?
- How might we redesign the common areas of a community housing structure to encourage connecting and cooperating among neighbors?
- How might we make the space inside a bank less intimidating for first-time savers signing up for a new account?

Source: plusacumen.org

# Human Center Design (Services)

For a service to be effective, it needs to be considered from end-to-end: from how it's advertised to how it's delivered. For a service to have the desired impact, it's essential to gain a deep understanding of the people you will be serving—not only what they need and desire, but what limitations they face, what motivates them, and what's important to them.



- How might we design a water delivery service providing clean drinking water along with health and nutrition products?
- How might we design new services engaging low-income parents in afterschool education for their children?
- How might we design a sustainable business model for a pit latrine emptying service?

Source: plusacumen.org

# Human Center Design (System)

Designing systems is about balancing the complexity of many different stakeholder needs with the needs of the social enterprise. For example, if your were designing a new type of school, there are the needs of the students, parents, staff and faculty, community, and perhaps investors. System design often involves setting high-level strategy such as stating visions, priorities, policies, and key communications around these ideas.


- How might we redesign the school lunch program for an entire city while providing for differences in individual schools?
- How might we design a system linking social entrepreneurs from around the world?
- How might we redesign a banking system for low-income citizens who have limited knowledge of banks?

Source: plusacumen.org

# Temporal Aspects

- Temporal aspects covers how regular or infrequent activities are.
- Something that is undertaken every day can have a very different design from something that happens only once a year.
- People will soon learn how to make calls using a mobile phone, but may have great difficulties when it comes to changing the battery.
- Designers should ensure that frequent tasks are easy to do, but they also need to ensure that infrequent tasks are easy to learn (or remember) how to do.
- Other important features of activities include time pressures, peaks and troughs of working. A design that works well when things are quiet can be awful when things are busy.

# More Temporal Aspects

- Some activities will take place as a single, continuous set of actions whereas others are more likely to be interrupted.
- If people are interrupted when undertaking some activity, the design needs to ensure that they can ‘find their place’ again and pick up.
- It is important then to ensure that people do not make mistakes or leave important steps out of some activity.
- The response time needed from the system must be considered.
- As a general rule people expect a response time of about 100 milliseconds for hand–eye coordination activities and one second for a cause–effect relationship such as clicking a button and something happening. Anything more than 5 seconds and they will feel frustrated and confused (Dix, 2003).

# Cooperative and Complex Activities

- Another important feature of activities is whether they can be carried out alone or whether they are essentially concerned with working with others.
- Issues of awareness of others and communication and coordination then become important.
- Well-defined tasks need different designs from more vague tasks.
- If a task or activity is well defined it can be accomplished with a simple step-by-step design.
- A vague activity means that people have to be able to browse around, see different types of information, move from one thing to another and so on.

# Safety-Critical Activities

- Some activities are ‘safety-critical’, in which any mistake could result in an injury or a serious accident. Others are less so.
- Clearly where safety is involved designers must pay every attention to ensuring mistakes do not have a serious effect.
- In general it is vital for designers to think about what happens when people make mistakes and errors and to design for such circumstances.

# Context

- Activities always happen in a context, so there is a need to analyze the two together.
- Three useful types of context are distinguishable:
  - The organizational context,
  - The social context
  - The physical circumstances under which the activity takes place.
- Context can be a difficult term.
- Sometimes it is useful to see context as surrounding an activity.
- At other times it can be seen as the features that glue some activities together into a coherent whole.

# Physical Environment

- The physical environment in which an activity happens is important.
- For example, the sun shining on an ATM display may make it unreadable.
- The environment may be very noisy, cold, wet, or dirty.
- The same activity – for example, logging on to a website – may be carried out in geographically remote environments where Internet access is slow, or with all the facilities of a large city and fast networks.

# Social Context

- The social context within which the activity takes place is also important.
- A supportive environment will offer plenty of help for the activity.
- There may be training manuals available, tuition or experts to hand if people get into trouble.
- There may be privacy issues to consider, and an interaction can be very different if the person is alone than if they are with others.
- Social norms may dictate the acceptability of certain designs.
- For example, the use of sound output is often unacceptable in an open-plan office environment, but might be quite effective where a person is working alone.

# Organizational Context

- Finally the organizational context is important as changes in technology often alter communication and power structures and may have effects on jobs such as deskilling.
- There are many books devoted to the study of organizations and the impact of new technologies on organizations. We cannot do justice to this subject here.
- The circumstances under which activities happen (time, place, and so on) also vary widely and need to be taken into consideration.

# Case Study

- For an activity such as ‘withdraw cash from an ATM’.
- An analysis of physical context would include things such as the location of the device (often as a ‘hole-in-the-wall’), visibility barrier from the others, the effect of sunshine on the readability of the display, and security considerations.
- Social considerations would include the time spent on a transaction or the need to queue or the language use in the menu.
- The organizational context for this activity would take into consideration the impact on the bank’s ways of working and its relationships with its customers.
- It is important to consider the range of contexts and environments in which activities can take place.

# Today's Point

1. People attached to activities and context, which are varied
2. What are the motivations for design?
3. Brainstorming: Observation, Interview, Workshop, etc.

# Summary

- For people, designers need to think about the physical, psychological and social differences and how those differences change in different circumstances and over time.
- It is most important that designers consider all the various stakeholders in a project.
- For activities they need to think about the complexity of the activity (focused or vague, simple or difficult, few steps or many), the temporal features (frequency, peaks and troughs, continuous or interruptible), cooperative features and the nature of the data.
- For contexts they think about the physical, social and organizational setting.

# Reference Books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