HCI103 Interactive technologies

Designing user experiences

Objective of this course is to introduce techniques of designing interactive technologies. It includes introduction to the user-centered design of interactive systems and good practices for design

course: HCI103

Interactive Technologies

Instructors

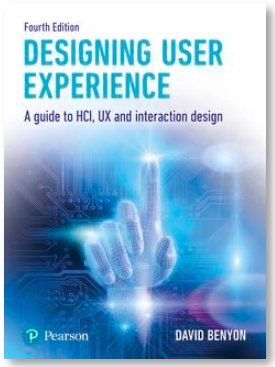
Nikos Avouris

Christos Sintoris

Irene Mavromati

course: HCI103

Interactive Technologies



Main textbooks

- D. Benyon, Designing Interactive Systems (4th Ed.)

- B. Shneiderman, Designing the user interface (6th Ed.)

Interactive Technologies

Course outline

- w1 Orientation week

Part A on the design cycle

- w2 unit01 Introduction - framework for experience design / slides, Benyon ch. 1-2
- w3 unit02 Design process - usability / Benyon chapters 3-4, Preece sect.2.1
- w4 unit03 UCD / Affordances, Norman/slides
- w5 unit04 Discover - the process of understanding /slides, Benyon chapt. 7, ethnography primer
- w6 unit05 Design -techniques for envisioning / Benyon chapters 8-9, slides
- midterm
- w7 presentations (essay #1)
- w8 unit06 Evaluation / Benyon chapter 10 – project first presentations

Part B on specific design challenges

- w9 unit07 Visual interface design (GUI, direct manipulation, navigation)
- w10 unit08 Multimodal interface design (Spoken languages, command languages, devices, and collaborative systems) Shneiderman chapters 9,10,11
- w11 unit09 Design apps and websites (Display design, animations, color, errors, system response time expectations) - project second presentation, Shneiderman chapters 12,13
- w12 project presentations
- w13 essay #2 presentations - review

Unit 01.
Introduction – a framework for experience design

Designing interactive technologies

There are many different types of interactive services and products.

- **web services** that will run on a computer at work.
- **apps, games, interactive products** such as home control systems, digital cameras and applications for portable devices
- **interactive systems, products and services** for home, for work or to support communities.
- **whole environments**, such as new retail spaces, in which devices and services communicate with one another and through which people interact with one another.

Example 1: The iPhone

- In 2007, Apple Inc. changed the face of mobile technologies when they introduced the iPhone/, while in 2008 introduced the 'app store'.
- Discuss the novel aspects introduced.

Example 2: Nest Home control

A ‘smart thermostat’ to control central heating in people’s houses was developed by a company called **Nest** in 2014. it connects to the home heating, as well as the wifi and smart phone application. In 2015 it was acquired by Google

Discuss the notion of ecology of devices

Example 3: A smart retail shop

Burberry is an up-market brand of clothing manufacturer and retailer, at Regent Street, London.

- There are mirrors that can turn instantly into screens so that customers can see what they would look like in a particular garment without trying it on.
- Alternatively, they can try on a physical garment and see it in different colors.
- Digital signage displays content in key areas and staff with iPad apps can provide purchase history and customer preferences to enable a personalized shopping experience.

Example 4: i Robo-Q domestic toy robot

- The i Robo-Q domestic toy robot is an example of the new children's toys that are increasingly available.
- Toys are using all manner of new technologies to enhance the experiences of children at play. They use robotics, voice input and output and a variety of sensors to provide novel and engaging interactions.

Summary

- These examples of interactive systems capture many of the features that the interaction designer has to work with.
- The designer needs to understand the possibilities that exist for **new forms of interaction**, with **fixed devices** or **mobiles**, for **people on their own** or for **connecting people** to each-other.

Challenge 1

- Consider one of the following interactive products or services that you use: a coffee machine, a particular smartphone app, a theme park, a TV service, a computer game or a news web service that you use.
- Find a colleague and agree on the product/service to discuss.
- Next separatelly from each-other :
  - Consider the interaction / the interface/ the whole experience and not just the functions
  - Write down what it is that you like about it and what it is that you do not like.
  - Think about the content that each provides: Is it what you want? Is it fun to use?
- Then with your colleague discuss the issues. Criticism and design are social activities that are best done with others. What do you agree on? What do you disagree on? Why?

Aspects of interaction design

- Design of interactive systems covers a very wide range of activities.
- Sometimes designers will be working on both the hardware and the software for a system, in which case the term '**product design**' seems to be most appropriate to describe what they are doing.
- Sometimes the designer will be producing a piece of **software** to run on a computer, on a programmable device or over the Internet, part of **software design**.
- Sometimes the designer will be working on providing a connected group of facilities that are available over a number of devices, design of '**service design**'.

The key concerns of the interaction/UX designer

1. **Design**. What is design and how should you do it?
2. **Technologies**. The interactive systems, products, devices and components to design.
3. **People**. The designer needs to consider who will use the systems and services and whose lives would they like to make better through their designs.
4. **Activities** and contexts. UX is about what people want to do, about their goals, feelings and achievements.

1. Design

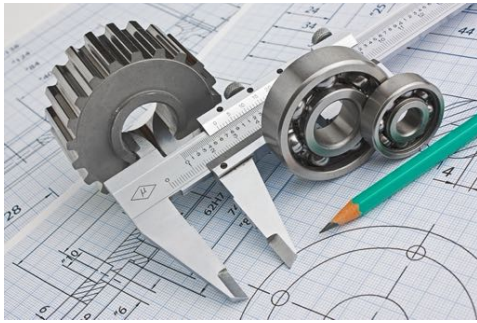
The term ‘design’ refers :

- to the **creative process** of specifying something new
- to the **representations** that are produced during the process.

Design is where you stand with a foot in two worlds – **the world of technology** and **the world of people and human purposes** – and you try to bring the two together (Winograd 1996).

Approaches in design

- At one end of a spectrum is **engineering design** (such as the design of a bridge, a car or a building) where **scientific principles** and **technical specifications** are employed to produce **formal models** before construction starts.



- At the other end of this spectrum is **creative or artistic design** where **innovation**, **imagination** and **conceptual ideas** are the key ingredients.

- Somewhere in the middle lies ‘design as craft’ which draws upon both **engineering and creative approaches**.

2. Technologies: Interactive systems

- **Interactive systems** cover components, devices, products, services and software systems that are primarily concerned with **interactively processing information content**.
- **Interactive systems** deal with the transmission, display, storage or transformation of content that people can perceive and respond dynamically to people's actions.
- '**Content**' includes all ways of presenting information including text, graphics, video, audio, 2D or 3D animation.

Interactive systems examples

- **Mobile phones**
- **Websites**
- **Integrated systems**, e.g. consisting of web services, a smartphone apps, sensors, etc.
- Interactive components included in other products (such as **clothes**, **buildings** and **means of transport**) working together forming **device ecologies.** (see Internet of Things)

3. People and technologies

- We will discuss how we should take a **people-centred view in design**

Many designers still take a machine-centred view because it is quicker and easier for them, though not for the person who will use the product.

Machine- and people-centered views

View	People are	Machines are
Machine-centred	Vague Disorganized Distractible Emotional Illogical	Precise Orderly Undistractible Unemotional Logical
People-centred	Creative Compliant Attentive to change Resourceful Able to make flexible decisions based on content	Dumb Rigid Insensitive to change Unimaginative Constrained to make consistent decisions

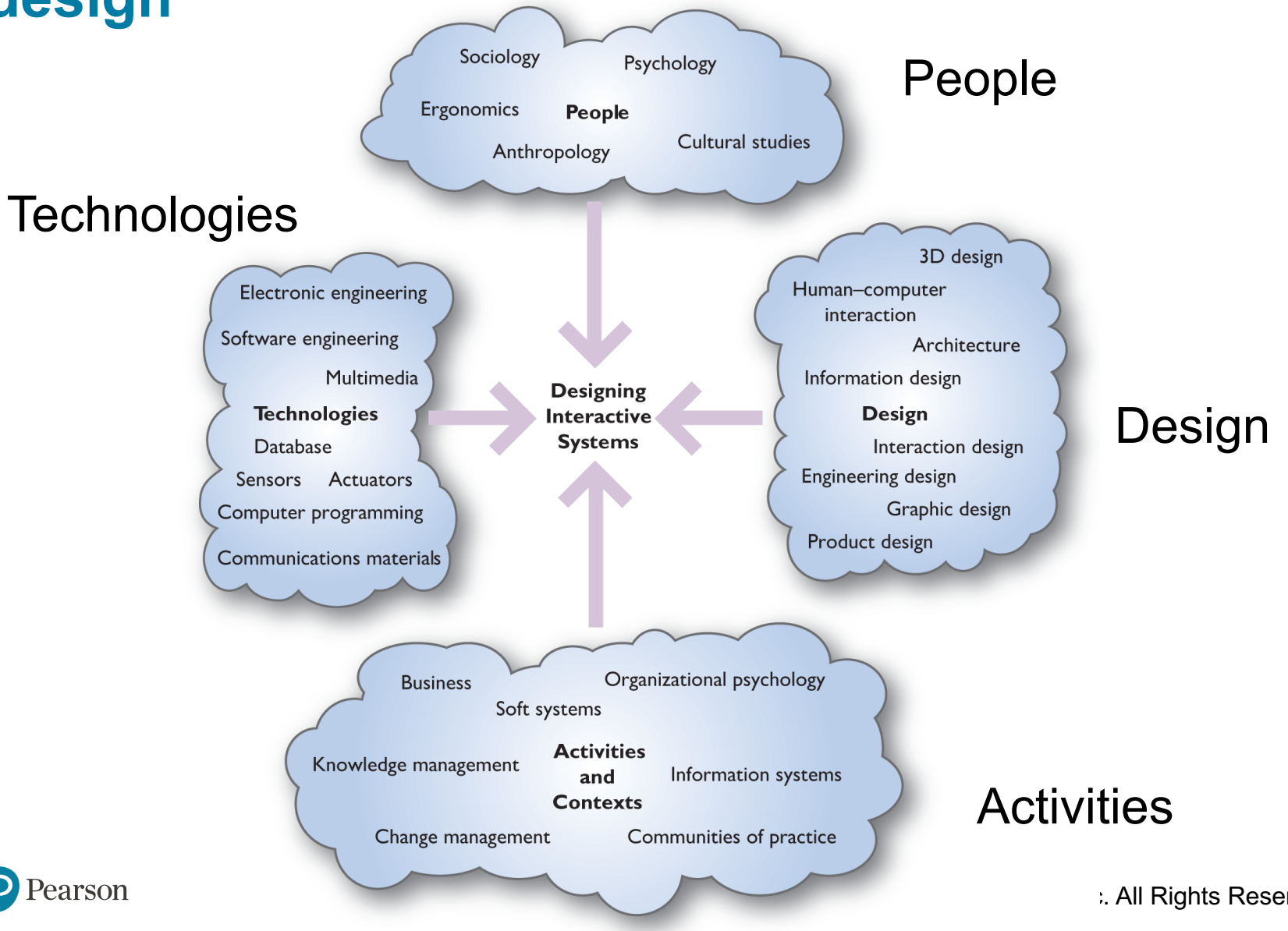
4. Activities and contexts

- Interaction will usually take place in the context of some '**community of practice**'. This term is used to denote groups of people who have shared interests and values and engage in similar activities.

- In business communities and organizations, information systems methods have developed over the years to ensure that information systems are developed that are effective and meet the needs of people who work there.
- Soft systems methodology – SSM (Checkland 2001) provides a very useful framework for focusing on organizational process modeling.

- **Social and organizational psychology** are needed to look at the effects of technological change on organizations, and knowledge management and **social computing** have become important areas.

Disciplines contributing to interactive systems design



The interface

- The interface needs to provide some mechanisms so that people can provide instructions and enter data into the system: '**input**'.
- It also needs to provide some mechanisms for the system to tell people what is happening by providing **feedback and mechanisms for displaying the content**: '**output**'.

user interfaces

From interface design to user experiences (UX) design

- Interactive systems consist often of many interconnected devices, some worn by people, some embedded in the fabric of buildings and some carried.
- Interaction designers are concerned with connecting people through devices and channels; they need to consider the whole environment they are creating.

Human-centred design

- Being human-centred is about:
  - Thinking about what people want to do rather than what the technology can do.
  - Designing new ways to connect people with people.
  - Involving people in the design process.
  - Designing for diversity.

http://www.designkit.org/human-centered-design

Human-Centred Design (HCD)

Human-centred design is an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, 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(Part E)]

Challenge #2

- The design company IDEO undertakes a wide range of projects in UX design.
- Some projects explore different ideas of changing concepts such as identity, others aim to produce new products and others look to see how people use technologies in their daily lives.
- Visit the website of IDEO and look at their projects. Talk about the ideas with a colleague.

http://www.designkit.org/case-studies

Is human-centered design worth it?

- Being human-centred in design is expensive.
- It involves observing people, talking to people and trying ideas out with people, and all this **takes time**.
- Being human-centred is an additional cost to any project, so businesses rightly ask whether taking so much time to talk to people, produce prototype designs and so on is worthwhile.
- The answer is a fundamental ‘yes’.
- Taking a human-centred approach to the design of interactive systems is advantageous for a number of reasons.

Return on investment (ROI)

- Williams *et al*. (2007) provide details of a number of case studies looking at the costs of taking a human-centred approach to interactive systems design and at the benefits that arise.
- Paying attention to the needs of people, to the usability of the product and to the overall UX results in reduced calls to customer helplines, fewer training materials, increased throughput, increased sales and so on.
- Involving people closely in the design of their systems will help to ensure acceptability.
- Systems will be more effective if they are designed from a human-centred perspective and people will be more productive.
- Nowhere is the economic argument more pertinent than in Web design and e-commerce sites.
- Jared Spool and his company User Interface Engineering have a number of reports demonstrating the importance of good UX to e-commerce and claim that sales can be increased by 225 per cent by turning ‘browsers’ into ‘buyers’.

Safety

In the early 1980s, there was an accident at a nuclear power plant at Three Mile Island in the United States of America that almost resulted in a 'meltdown'.

- Reportedly one of the problems was that the control panel indicated that **a valve was closed when it was in fact open** and **another indicator was obscured by a tag** attached to another control: two fundamental design errors – one technical and one organizational – that human-centred design techniques would help avoid.
- Other accidents include a number of plane and train disasters that have been attributed to faulty displays or to operators not understanding or interpreting displays correctly.
- Systems have to be designed for people and for contexts. It is no good claiming 'human error' if the design was so bad in the first place.

Ethical aspects of design

The ACM (Association of Computing Machinery) code of ethics gives good advice on ethical design.

- Designers have power over other people and must exercise that power in an ethical fashion.
- Inform users on use of data for purposes other than what it was intended for
- Security of user data is significant feature of good design
- People need to trust systems and be in a position to make choices about privacy and how they are represented.
- The issue of intellectual property – not giving proper acknowledgement for source of media and inspiration.

Sustainability

discuss issues related to sustainabiltiy of interactive technologies and the impact of interaction design.

- Interactive systems have a big impact on the world, and designers should approach interaction design from the perspective of what is sustainable.
- Millions of mobile phones and other devices are thrown away each year and they contain metals that are potentially dangerous to the environment, while large displays and projectors use a lot of power.
- Cultures get swamped by the views and values of the dominant suppliers of hardware and software, and local languages die out when all information is in English, Chinese or Hindi.
- Human-centred design needs to recognize diversity and design to enhance human values.

A framework for human-centered interaction design

A framework for design

Human-centred design is based on a framework for thinking about the design problem that considers **People, Activities, Contexts,** and **Technologies**

- Designers need to understand the **people** who will use their systems and products.
- They need to understand the **activities** that people want to undertake and the **contexts** in which those activities take place.
- Designers also need to know about the features of interactive **technologies** and how to approach designing interactive systems.

Examples

People use **technologies** to undertake **activities** in **contexts**.

- Teenagers use mobile phones to send messages to their friends whilst sitting on a bus.
- Secretaries use Microsoft Word to write documents in a firm of solicitors.
- Air traffic controllers work together to ensure the smooth operation of an airport.
- 70+ year old women press various buttons to set the intruder alarms in their house.
- People use WhatsApp to make contact with other people when sitting in a café.

Activities and technologies

- In all these settings, we see people using technologies to undertake activities in contexts
- The variety of each of these elements (people, technologies, activities, contexts) makes designing interactive systems a difficult and fascinating challenge.
- If the technologies change, then the nature of the activities will also change.

The design cycle

- Activities (and the contexts within which they take place) establish **requirements** for technologies that in turn offer opportunities that **change the nature of activities**.
- The changed activity results in **new requirements** for technologies and so on. And the cycle continues.
- Designers need to keep this cycle in mind as they attempt to understand and design for some domain.

Example of design cycle

- Originally email was all in text only but now it is in full colour with pictures and video embedded. Other items can be attached to emails easily.
- This has led to a need for better facilities for managing it and for organizing pictures, documents and addresses.
- Software now keeps track of threads of emails and links between emails.

Example of changing activities due to changing technology

People

People characteristics

- Physical characteristics
- Psychological characteristics
- Social characteristics.

Physical characteristics

- People differ in physical characteristics such as height and weight. They also variate in their five senses – sight, hearing, touch, smell and taste.
- Examples of variation:
  - **Color blindness** (usually the inability to correctly distinguish between red and green colors) affects about 8% of western males
  - **Short-sightedness** and **long-sightedness** affect many and many people are hearing impaired.
  - **Wheelchair users** (In Europe, there are 2.8 million so designers must consider where technologies are placed)
  - **Dexterity impairments** involving the use of their fingers.

Ergonomic design

- Ergonomics has a longer history than HCI.
- Ergonomics support the design of interactive devices such as mobile games consoles.
- Such devices are faced with ergonomic design challenges.
- For example, we all have relatively fat fingers compared with how small buttons can be made.
- In the world of mobile computing, small is good but too small is bad.
- Ergonomics can put numbers on what constitutes small and usable and what is too small and unusable.
- The best known example of ergonomic knowledge being applied to HCI issues is Fitts' law.

Fitts' law

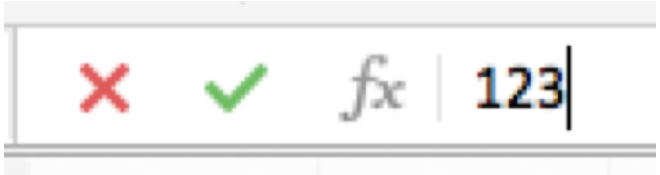
- Fitts' law is a mathematical formula which relates the time required to move to a target as a function of the distance to the target and the size of the target itself, say moving a pointer using a mouse to a particular button.
- It is expressed mathematically as follows:
  - $T_{(\text{time to move})} = k \log_2(D/S + 0.5)$
  - where k ~ 100 ms, D is the distance between the current (cursor) position and the target and S is the size of the target.
- Thus one can calculate the time to move a distance of 15 cm to a button of size 2 cm as follows:
  - $T = 100 \log_2(15/2 + 0.5) = 0.207$ seconds.
- Fitts' law describes motor control.
- The smaller the target and the greater the distance, the longer it will take to hit the target.

Psychological differences

- People with good **spatial ability** will find it much easier to navigate in a website.
- Designers should design for people with poor ability by providing good signage and clear directions.
- **Language differences** are also crucial to understanding.
- **Cultural differences** affect how people interpret things.

Cultural differences: example

In the Microsoft Excel spreadsheet application, there are two buttons, one labeled with a cross and the other a tick.



In the United States, a tick is used for acceptance and a cross for rejection, but in other countries, a tick or a cross can be used to show acceptance (e.g. a cross on a voting paper).

Psychological tests

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

Myers-Brigg type Indicators

Big five personality traits

The Big Five personality traits, also known as the five-factor model (FFM) and the OCEAN model, is a taxonomy for personality traits.

- Openness to experience (inventive/ curious vs. consistent/ cautious)
- Conscientiousness (efficient/organized vs. easy-going/ careless)
- Extraversion (outgoing/ energetic vs. solitary/reserved)
- Agreeableness (friendly/ compassionate vs. challenging/ detached)
- Neuroticism (sensitive/ nervous vs. secure/ confident)

Personality traits and learning

- GPA and exam performance are both predicted by conscientiousness
- neuroticism is negatively related to academic success
- openness predicts utilizing synthesis-analysis and elaborative-processing learning styles
- neuroticism negatively correlates with learning styles in general
- openness and extraversion both predict all four learning styles.

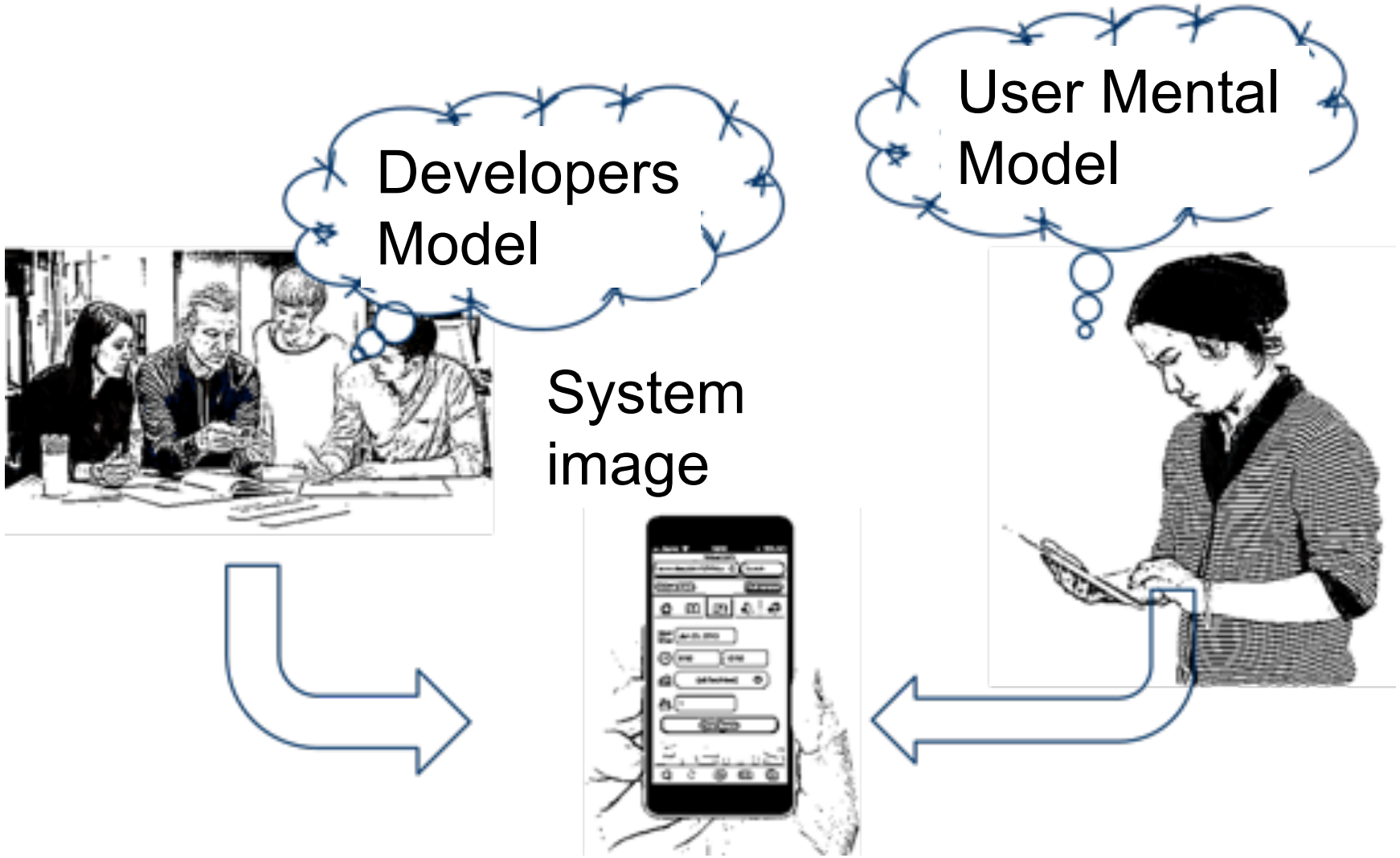
Key cognitive differences

- 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.
- **short term memory capacity** (we cannot remember long numbers or complicated instructions).
- We are better at **recognizing** things than they are at **remembering** things.
- 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**.

Mental models

- The understanding and knowledge that we possess of something we interact with is often referred to as a '**mental model**' (e.g. Norman, 1998). What is the mental model of an ATM?
- We develop mental models of software systems as well as of domestic systems such as central heating systems, thermostats and so on.
- Mental models are useful for using an appliance or system, but also for recovering from errors.
- 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 a mental model



Developing a mental model

- People develop mental models through the **system image**:
  - Interacting with system interface elements
  - Observing the relationship between their actions and the behaviours 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

- The designers have some conception (**developers' mental model**) of the system they have produced.
- This is based on assumptions about the users' understanding of the system operation. 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 behaviours 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 '**user 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 mental model of the system.

The nature of mental models (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' behaviour.
- People are willing to take **shortcuts to minimize mental effort**, for example 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 behaviour.
- 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 behaviour.
- 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.

Device models

- Kieras and Bovair (1984) investigated the role of a device model (a person's mental model of a device) in learning how to operate a mock-up of the weapons control panel of the USS Enterprise from Star Trek.
- In their first experiment, subjects learned how to operate the 'phasers' either by means of rote learning (press this button, then turn that knob to the second position) or by learning the underlying principles (the energy booster takes power from the ship) which required the subjects to infer the procedures.
- Kieras and Bovair found that learning, retention and use of 'shortcuts' were all enhanced for the group that learned the principles, demonstrating that knowledge of how the system worked enables people to infer how to operate it.
- Kieras and Bovair concluded by making two key points: firstly, for a device model to be useful, it must support inference about exact and specific control actions, and secondly, the model need not be very complete or thorough.

Social characteristics

- 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 experts

- 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
- A **novice** user will need to be guided through an interaction.
- There are also people who do not have to use a system (sometimes called '**discretionary** users') They often are quickly put off if things are difficult to do.

Similarity amongst 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, on the other hand, can be designed to meet the particular needs of particular people.
- Representatives from a relatively homogeneous group – secretaries or managers or laboratory scientists,– could be made part of the design team and so provide much more detailed input as to their particular requirements.

Activities

Activities

- The term is used for very simple tasks as well as highly complex, lengthy activities, so designers need to be careful when considering the characteristics of activities.
- First and foremost, the designer should focus on the **overall purpose** of the activity.
- After that the main features are as follows:
  - Temporal aspects
  - Cooperation
  - Complexity
  - Safety-critical
  - The nature of the content

Temporal aspects of activities

- Temporal aspects cover how **regular or infrequent** activities are.
- 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.

Continuous vs interrupted activities

- 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.

Temporal aspects: system response

- As a general rule, the **response time needed** from the system should be as follows:
- - Users expect a response time of about 100 milliseconds (**0.1 sec**) for **hand–eye coordination activities**
- They expect onne second (**1 sec**) response for a **cause–effect feedback** such as clicking a button and something happening.
- A delay of more than **5 seconds** will make them feel frustrated and confused (Dix, 2003), so feedback of system status should be provided.

Group vs individual activities

- Can the activity be carried out individually or whether it involves working with others?
- In group activities the following issues become important:
  - awareness of others
  - communication and
  - coordination

well-defined vs vague activities

- Well-defined tasks need different designs from more vague tasks.
- If an 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.

Content of activities: Data and media requirements

- If large amounts of alphabetic data have to be input as part of the activity (e.g. recording names and addresses), then a keyboard is almost certainly needed.
- In other activities, there may be a need to display video or high quality colour graphic displays.
- Some activities, however, require very modest amounts of data and can make use of other technologies.
- A library, for example, just needs to scan a bar code or two, so the technology can be designed accordingly.
- Just as important as data is the media that an activity requires.

Contexts

Contexts

- Activities always happen in a context, so there is a need to analyse 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.
- 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.

Example: ATM context

For an activity such as ‘withdraw cash from an ATM’, define the context

- **Physical context of the device** (often as a ‘hole-in-the-wall’), 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.
- 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.

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.
- The circumstances under which activities happen (time, place and so on) also vary widely and need to be taken into consideration.

Technology

Technologies

- Interactive systems typically consist of **hardware and software components** that communicate with one another and transform some input data into some output data.
- Interactive systems can perform various functions and typically contain data or information **content**.
- People using such systems engage in interactions, and physically, devices have various styles and aesthetics.
- Designers of interactive systems need to understand the materials they work with just as designers in other areas of design such as interior design, jewelry design, etc.

Classifying technologies

- Interactive technologies change at a fast rate and designers need to keep abreast of the options available.
- It is also very difficult to classify technologies as they are continually being grouped in new ways and different combinations facilitate quite different types of interactions, e.g.
  - technologies that allow visual interaction
  - technologies that allow multimodal interaction
  - mobile apps and websites
  - social and collaborative environments
  - AI components
- Designers need to be aware of various possibilities for **input, output, communication and content**.

Input

- Input devices are concerned with how people enter data and instructions into a system securely and safely.
- **Switches and buttons** facilitate a simple and direct method of issuing instructions (such as ‘turn on’ or ‘turn off’) but they take up space.
- On small mobile devices, there is **not enough space** to have many buttons, so designers have to be careful in designing which functions have their own button.
- On the iPhone, for example, a **button on the side of the device** is allocated to turning the sound off and on.
- The designers decided that this was such an important and often used function that it should have its own button.

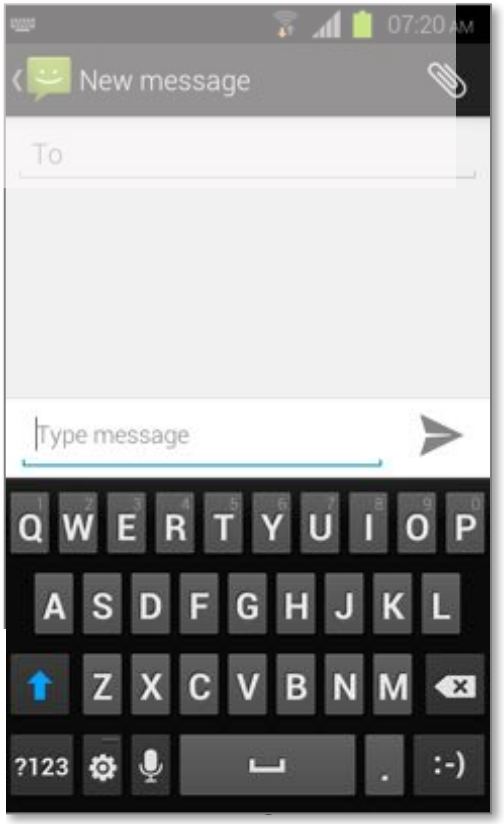
the ubiquitous button

Janlert, L. E. (2014). The ubiquitous button. *interactions*, *21*(3), 26-33.

Input methods: keyboards

- Alphanumeric data is usually input to an interactive device through a **'QWERTY' keyboard**, invented by C. L. Sholes in 1868!
- QWERTY is still used widely.

1868 → 2019
150+ years



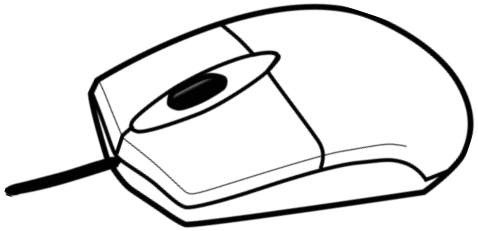
Input methods: touch screens

- **Touchscreens** are sensitive to the touch of a finger. They function through either infrared sensitivity or electrical capacitance.
- They are suitable for applications intended for public places and present an appearance of simplicity and ease of use.
- Many touchscreens only recognize a single touch, but **multi-touch screens** enable zooming and rotating of images and text.

Input: pointing

- Touchscreens make use of the **person's finger** as the input device which has the obvious benefit that people always have their fingers with them.
- The **light pen** was, arguably, the original pointing device. When it is pointed at the screen, it returns information about the screen location to a computer which allows the item pointed at to be identified.
- Light pens are less expensive than touchscreens, can be armoured (made very robust) and can be sterilized. They have a number of industrial and medical applications.
- Other forms of pointing devices include the **stylus** which is used on very small displays where a finger is too big to be used as the input device.

Input: the mouse



- One of the most ubiquitous of input devices is the mouse, developed at Stanford University Research Laboratory in the mid-1960s.
- The mouse consists of a palm-sized device that is moved over a flat surface such as the top of a desk.
- One or two buttons sit on top of the mouse and are operated with the person's fingers.
- More contemporary mouse design includes a **thumbwheel** for scrolling through documents or web pages.
- A mouse may be cordless, using infrared to communicate with the host computer.

Input: trackball

- A **trackball** is another pointing device which is best described as a mouse lying on its back. To move the pointer, the user moves the ball. Like all other pointing devices, there are one or more buttons which can be used to select on-screen items. Trackballs are often found in public access kiosks because they are difficult to steal and do not require a flat surface to rest upon.

SlimBlade Trackball Mouse.

Input: joystick

- A **joystick** is a handle which pivots from a central point. Viewing the joystick from above, it may be moved north, south, east and west (and all points between) to control an on-screen pointer, spaceship or any other on-screen object. Joysticks are used mostly for computer games but they are also found in conjunction with CAD/CAM (computer aided design/ manufacture) systems and VR (virtual reality) applications.

Pointing from a distance

- With the introduction of the Nintendo Wii in 2007, a whole new generation of input became possible.
- The Wii uses infrared to register the movement.
- This allows gestures to be recognized.
- Virtual reality and augmented reality systems define and recognize new gestures, like 'air tap' in HoloLens

https://www.youtube.com/watch?v=kwn9Lh0E_vU&feature=youtu.be

Gestures In Augmented reality

Sensors as input devices

- There are many different types of sensor that are now available as input mechanisms.
- Air pressure sensors, acoustic sensors, vibration detectors, infrared motion detectors and accelerometers are all readily available for designers to detect specific aspects of an interaction.
- Wilson (2012) lists sensors for detecting **occupancy**, **movement** and **orientation**, **object distance** and **position**, **touch**, **gaze** and **gesture**, human **identity** (biometrics), **context** and **affect**.

Wilson, A. (2012) Sensor and recognition-based input for interaction. In J.A. Jacko (ed) *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications,* 3rd edn. CRC Press, Taylor and Francis

brain and speech

- Brain activity can also be sensed allowing for Brain-Computer Interfaces (BCI), an exciting development and research area.
- Speech input is becoming increasingly accurate, particularly if people are willing to spend a few minutes (7–10, say) training a system to recognize their voice. We expect spoken interfaces to become much more common over the next years.

Output

- Technologies for displaying content to people rely primarily on the three perceptual abilities of **vision, hearing and touch**.
- The most fundamental output device is the screen or monitor.
- Even a few years ago the default monitor used cathode ray tube (CRT) technology that required a large heavy box positioned on a desk or table.
- Nowadays flat screen monitors using plasma or TFT (thin film transistor) or LCD (liquid crystal display) technologies can be mounted on walls.
- Some of these can deliver very large displays that results in a significantly different interactive experience.

Other displays

- The physical dimensions of display devices are, however, only one of the factors involved in the resulting output.
- The output device is driven by hardware – a graphics card – that will vary with respect to the screen resolutions and palette of colours it can support.
- More generally, designing interactive systems to work with any and all combinations of hardware is very difficult. Typically, applications and games specify minimum specifications.
- One way past the problems with restrictive display 'real-estate' is to use a **data projector**. While the resolution is usually less than that of a monitor, the resulting projected image can be huge.

Multi-touch surfaces

- Data projectors are shrinking in size at a remarkable rate and there are now mobile data projectors.
- These promise to have a big impact on interaction design as they get small enough to be built into phones and other mobile devices.
- Images can be projected onto any surface and pointing and other gestures can be recognized by a camera.
- In this way, any surface has the potential to become a multi-touch display.

Sound

- Sound is an output medium that is significantly underused.
- Earcons and audio icons can be used to create an entire soundscape.
- Speech output is also an increasingly popular option (e.g. in satellite navigation systems).
- With effective text to speech (TTS) systems, simply sending a text message to the system results in clear spoken output.

Haptics

- Haptics refer to the sense of touch.
- Perhaps the most widespread haptic devices are those games controllers that incorporate the so-called force-feedback that is intended to convey feedback from typically game environments back to the person engaged.
- A significantly more serious application of force-feedback is NASA's 'Softwalls' initiative in response to the 9/11 terrorist attacks on New York in 2001.
- Other examples include the 'silent alert' vibration of a mobile phone and even the feel of a key when pressed.

Communication

- Communications between people and between devices is an important part of designing interactive systems.
- Here issues such as **bandwidth** and **speed** are critical.
- Also, **feedback** to people is critical so that they know what is going on and indeed that something is going on! In some domains, the transmission and storage of large amounts of data become a key feature.
- Each device has a unique address, its IP (Internet Protocol) address, that enables data to be routed to the correct device.

Content

- Content concerns the data presented to the user and the form it takes. Good content needs to be **accurate, up-to-date, relevant** and **well presented**.
- There is little point in having a sophisticated information retrieval system if the information, once retrieved, is out of date or irrelevant.
- The content that a technology can support is also critical.
- In some technologies, **content** is very important (e.g. websites are often all about content). Other technologies are more concerned with **function** (e.g. a remote control for a TV).
- Most technologies have a **mixture of function and content**.

Data characteristics

- Content can be retrieved when required (known as **pull technology**) or it can be **pushed** from a server to a device.
- RSS feeds on websites provide automatic updates when a website's content is changed.
- The characteristics of the data are important for choosing input methods.
- Bar codes, for example, are only sensible if the data does not change often.
- Touchscreens are useful if there are only a few options to choose from.
- Speech input is possible if there is no noise or background interference, if there are only a few commands that need to be entered or if the domain is quite constrained.

Media characteristics

- Stream outputs such as video, music and speech have different characteristics from media such as icons, text or still photographs.
- Most important, is that **stream media do persist**.
- Instructions given as speech output, for example, have to be remembered, whereas if displayed as a piece of text, they can be read over again.
- Animations are also popular ways of presenting content.

Using the PACT framework

Use of PACT framework

- The aim of human-centred interactive systems design is to arrive at the best combination of the PACT elements with respect to a particular domain.
- Designers need to get the right mix of technologies to support the activities being undertaken by people in different contexts.
- A PACT analysis is useful for both **analysis** and **design** activities: understanding the current situation, seeing where possible improvements can be made or envisioning future situations.

Use of PACT framework

- To do a PACT analysis, the designer studies the variety of people, activities, contexts and technologies that are possible, or likely, in a domain.
- This can be done using brainstorming and other envisionment techniques and by working with people through observations, interviews and workshops.
- The designer should look for trade-offs between combinations of PACT and think about how these might affect design.

Use of PACT framework

- For **people**, designers need to think about the physical, psychological and social differences and how those differences change in different circumstances and over time. They should 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 need to think about the physical, social and organizational setting.
- For **technologies**, they concentrate on input, output, communication and content.

an example

You have been asked by a university department to consider developing a system controlling access to their laboratories. Perform a PACT analysis.

PACT Example: People

- The PACT analysis might include the following people:
  - Students, lecturers and technicians are the main groups.
  - These are all well educated and understand things such as swipe cards, passwords and so on.
  - People in wheelchairs need to be considered as do other design issues such as colour blindness.
  - There may be language differences.
  - Both visitors and frequent visitors need to be considered.
- However, there are other stakeholders who need access to rooms, such as cleaning staff and security personnel.
- What are the motivations for management wanting to control access in the first place?

PACT Example: Activities

- The overall purpose of the activity is to enter some form of security clearance and to open the door.
- This is a very well-defined activity that takes place in one step.
- It happens very frequently with peaks at the start of each laboratory session.
- The data to be entered is a simple numeric or alpha-numeric code.
- It is an activity that does not require cooperation with others (though it may be done with others, of course).
- It is not safety-critical, though security is an important aspect.

PACT Example: Contexts

- Physically, the activity takes place indoors but people might be carrying books and other things that makes doing anything complicated quite difficult.
- Socially, it may happen in a crowd but also may happen late at night when no one else is about.
- Organizationally, the context is primarily about security and who has access to which rooms and when they can gain access.
- This is likely to be quite a politically charged setting.

PACT Example: Technologies

- A small amount of data has to be entered quickly.
- It must be obvious how to do this to accommodate visitors and people unfamiliar with the system.
- It needs to be accessible by people in wheelchairs.
- The output from the technology needs to be clear that the security data has been accepted or not and the door has to be opened if the process was successful.
- Communication with a central database may be necessary to validate any data input but there is little other content in the application.

Summary of Unit 01- part a

- The design of interactive systems is concerned with people, the activities they are undertaking, the contexts of those activities and the technologies that are used, the PACT elements.
- There is considerable variety in each of these and it is this variety – and all the different combinations that can occur – that makes the design of interactive systems so fascinating.
- People vary in terms of physical characteristics, psychological differences and in their usage of systems.
- Activities vary in terms of temporal aspects, whether they involve cooperation and complexity, whether they are safety-critical and the nature of the content they require.
- Contexts vary in terms of physical, social and organizational.
- Technologies vary in terms of the input, output, communication and content that they support.
- Undertaking a PACT analysis of a situation is a useful way of scoping a design problem.

Design challenge #3

Design a new changing room for a retail shop. Imagine all possible innovation that you can.
Re-design user activities based on the new room design

David Kelley/ Ted Talk (2007) / Human Centered Design

t=3:52 https://www.ted.com/talks/david_kelley_on_human_centered_design/transcript

Design challenge #4

A cubicle is a partially enclosed office workspace that is separated from neighboring workspaces by partitions that are usually 1.5 to 1.8 m tall. Its purpose is to isolate office workers and managers from the sights and noises of an open workspace so that they may concentrate with fewer distractions.
You are asked to design a cubicle for a high tech company.

David Kelley/ Ted Talk (2007) / Human Centered Design

t=7:51 https://www.ted.com/talks/david_kelley_on_human_centered_design/transcript

Project work

Select one of the slides or sections of a slide with a 'to study' icon.
Write a short essay (max 4 pages, ACM interim template) and prepare a power point presentation (10 min talk) introducing the subject and elaborating the idea.

* You can select one such subject from the material of the first two weeks. To be delivered in week 5.

https://www.acm.org/publications/proceedings-template