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DECO2500 – Human Computer Interaction Design

Textbook Summary

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Chapter 1 – What is Interaction Design

- Explain the difference between good and poor interaction design
- Describe what interaction design is and how it relates to human-computer interaction and other fields
- Explain the relationship between the user experience and usability
- Describe what and who is involved in the process of interaction design
- Outline the different forms of guidance used in interaction design
- Enable you to evaluate an interactive product and explain what is good and bad about it in terms of the goals and core principles of interaction design

What is Interaction Design

> *"designing interactive products to support the way people communicate and interact in their everyday and working lives"*

Interaction design is used in:

- Academic Disciplines
- Ergonomics
- Psychology/Cognitive Science
- Design
- Informatics
- Engineering
- Computer Science/Software Engineering
- Social Sciences (e.g. Sociology, Anthropology)
- Ubiquitous Computing
- Human Factors (HF)
- Cognitive Engineering
- Human-Computer Interaction (HCI)
- Cognitive Ergonomics
- Computer-Supported Cooperative Work (CSCW)
- Information Systems
- Film Industry
- Industrial Design
- Artist-Design
- Product Design
- Graphic Design

The Process of Interaction Design

1. Establishing requirements
2. Designing alternatives
3. Prototyping
4. Evaluating

The User Experience (UX)

Nielsen and Norman (2014) define it as encompassing "all aspects fo the end-user's interaction with the company, its services, and its products." You cannot design a user experience, you can only design for the user experience. There are many aspects of the user experience that can be considered and ways of taking them into account when designing interactive products.

- Usability
- Functionality
- Aesthetics
- Content
- Look and Feel
- Sensual
- Emotional
- Fun

- Health
- Social Capital
- Cultural Identity

Four Core Threads

McCarthy and Wright propose four core threads that make up our holistic experiences:

- **The sensual thread**. This is concerned with our sensory engagement with a situation and is similar to the visceral level of Norman's model. It can be equated with the level of absorption people have with various technological devices and applications, most notable being computer games, smartphones, and chat rooms, where users can be highly absorbed in their interactions at a sensory level. These can involve thrill, fear, pain, and comfort.
- **The emotional thread**. Common examples of emotions that spring to mind are sorrow, anger, joy and happiness. In addition, the framework points out how emotions are intertwined with the situation in which they arise – e.g. a person becomes angry with a computer because it does not work properly. Emotions also invoke making judgements of value. For example, when purchasing a new cell phone, people may be drawn to the ones that are most cool-looking but be in an emotional turmoil because they are the most expensive. They can't really afford them but they really would like one of them.
- **The compositional thread**. This is concerned with the narrative part of an experience, as it unfolds, and the way a person makes sense of it. For example, when shopping online, the options laid out to people can lead them in a coherent way to making a desired purchase or they can lead to frustrating experiences resulting in no purchase being made. When in this situation, people ask themselves questions such as: What is this about? What would happen if. . . ? The compositional thread is the internal thinking we do during our experiences.
- **The spatio-temporal thread**. This refers to the space and time in which our experiences take place and their effect upon those experiences. There are many ways of thinking about space and time and their relationship with one another: for example, we talk of time speeding up, standing still, and slowing down, whilw we talk of space in terms of public and personal places, and needing one's own space.

Usability Goals

- effective to use (effectiveness)
- efficient to use (efficiency)
- safe to use (safety)
- having good utility (utility)
- easy to learn (learnability)
- easy to remember how to use (memorability)

Design Principles

Design principles are used by interaction designers to aid their thinking when designing for the user experience.

- **Feedback:** products should be designed to provide adequate feedback to the users to ensure they know what to do next in their tasks
- **Findability:** the degree to which a particular object is easy to discover or locate – be it navigating a website, moving through a building, or finding the delete image option on digital camera
- **Visibility:** the more visible functions are, the more likely it is that users will be able to know to do next
- **Constraints:** the design concept of constraining refers to determining ways of restricting the kinds of user interaction that can take place at a given moment (e.g. greying a menu item)
- **Consistency:** design interfaces to have similar operations and use similar elements for achieving similar tasks
- **Affordance:** used to refer to an attribute of an object that allows people to know how to use it (e.g. a mouse button invites pushing, in doing so activating clicking, by the way it is physically constrained)

Summary

Key points

- Interaction design is concerned with designing interactive products to support the way people communicate and interact in their everyday and working lives
- Interaction design is multidisciplinary, involving many inputs from wide-ranging disciplines and fields
- The notion of the user experience is central to interaction design
- Optimizing the interaction between users and interactive products requires taking into account a number of interdependent factors, including context of use, types of activity, accessibility, cultural differences, and user groups

- Identifying and specifying relevant usability and user experience goals can help lead to the design of good interactive products
- Design principles, such as feedback and simplicity, are useful heuristics for analysing and evaluating aspects of an interactive product

Examples

Marble Answering Machine (Durrel Bishop, 1995)

Incoming messages are represented using physical marbles. The number of marbles that have moved into the pinball-like chute indicates the number of messages. Dropping one of these marbles into a slot in the machine causes the recorded message to play. Dropping the same marble into another slot on the phone dials the caller who left the message

Minuum Online Keyboard

Easy way of typing using minimal buttons. Similar to Wii remotes where you point to a row of keys and type that way. This is faster to use on a small device, especially with one hand

Chapter 2 – Understanding and Conceptualizing Interaction

- Explain what is meant by the problem space
- Explain how to conceptualize interaction
- Describe what a conceptual model is and how to begin to formulate one
- Discuss the use of interface metaphors as part of a conceptual model
- Outline the core interaction types for informing the development of a conceptual model
- Introduce paradigms, visions, theories, models, and frameworks informing interaction design

Understanding the Problem Space and Conceptualizing Interaction

Having a good understanding of the problem space greatly helps design teams to then be able to conceptualize the design space. Primarily this involves articulating the proposed system and the user experience. The benefits of conceptualizing the design space early on are:

- **Orientation** – enabling the design team to ask specific kinds of questions about how the conceptual model will be understood by the targeted users
- **Open-mindedness** – preventing the design team from becoming narrowly focused early on
- **Common ground** – allowing the design team to establish a set of common terms that all can understand and agree upon, reducing the chance of misunderstandings and confusion arising later on

Conceptual Models

In a nutshell, a conceptual model provides a working strategy and a framework of general concepts and their interrelations. The core components are:

- Metaphors and analogies that convey to people how to understand what a product is for and how to use it for an activity (e.g. browsing, bookmarking)
- The concepts that people are exposed to through the product, including the task – domain objects they create and manipulate, their attributes, and the operations that can be performed on them (e.g. saving, revisiting, organizing)
- The relationships between those concepts (e.g. whether one object contains another, the relative importance of actions to others, and whether an object is part of another)
- The mappings between the concepts and the user experience the product is designed to support or invoke (e.g. one can revisit through looking at a list of visited sites, most-frequently visited, or saved websites)

Design Concept

Design concept is essentially a set of ideas for a design. Typically is comprises of scenarios, images, mood boards, or text-based documents.

Interface Metaphors

Metaphors are considered to be a central component of a conceptual model. They provide a structure that is similar in some way to aspects of a familiar entity (or entities) but also have their own behaviours and properties. More specifically, an interface metaphor is one that is instantiated in some way as part of the user interface.

Metaphors and analogies are used in three main ways:

1. As a way of conceptualizing what we are doing (e.g. surfing the web)
2. As a conceptual model instantiated at the interface (e.g. the card metaphore)
3. As a way of visualizing an operation (e.g. an icon of a shopping cart into which we place items we wish to purchase on an online shopping site)

Interaction Types

The way a user will interact with a product or application. Four main types of interaction:

- **Instructing** – where users issue instructions to a system. This can be done in a number of ways, including: typing in commands, selecting options from menus in a windows environment or on a multitouch screen, speaking aloud commands, gesturing, pressing buttons, or using a combination of function keys
- **Conversing** – where users have a dialog with a system. Users can speak via an interface or type in questions to which the system replies via text or speech output
- **Manipulating** – where users interact with objects in a virtual or physical space by manipulating them (e.g. opening, holding, closing, placing). User can hone their familiar knowledge of how to interact with objects
- **Exploring** – where users move through a virtual environment or a physical space. Vritual environments include 3D worlds, and augmented and virtual reality systems. They enable users to hone their familiar knowledge of physically moving around. Physical spaces that use sensor-based technologies include smart rooms and ambient environments, also enabling people to capitalize on familiarity

Paradigms, Visions, Theories, Models, and Frameworks

(Carrol, 2003)

- **Paradigm** refers to a general approach that has been adopted by a community of researchers and designers for carrying out their work, in terms of shared assumptions, concepts, values, and practices
- **Vision** is a future scenario that frames research and development in interaction design – often depicted in the form of a film or a narrative
- **Theory** is a well-substantiated explanation of some aspect of a phenomenon
- **Model** is a simplification of some aspect of human-computer interaction intended to make it easier for designers to predict and evaluate alternative designs
- **Framework** is a set of interrelated concepts and/or a set of specific questions that are intended to inform a particular domain area (e.g. collaborative learning), online communities, or an analytic method (e.g. ethnographic studies)

Summary

Key Points

- It is important to have a good understanding of the problem space, specifying what it is you are doing, why, and how it will support users in the way intended
- A fundamental aspect of interaction design is to develop a conceptual model
- A conceptual model is a high-level description of a product in terms of what users can do with it and the concepts they need in order to understand how to interact with it
- Decisions about conceptual design should be made before commencing physical design (e.g. choosing menus, icons, dialog boxes)
- Interface metaphors are commonly used as part of a conceptual model
- Interaction types (e.g. conversing, instructing) provide a way of thinking about how best to support the activities users will be doing when using a product or service
- Paradigms, visions, theories, models, and frameworks provide different ways of framing and informing design and research

Examples

The Star (Xerox, 1981)

The Star interface revolutionized the way interfaces were designed for personal computing. Based on the conceptual model of an office; paper, folders, filing cabinets, mailboxes.

Direct Manipulation (Shneiderman, 1983)

Proposes that digital objects be designed at the interface so that they can be interacted with in ways that are analogous to how physical objects in the physical world are manipulated. Users feel that they are directly controlling the digital objects. The benefits of direct manipulation:

- helping beginners learn basic functionality rapidly
- enabling experienced users to work rapidly on a wide range of tasks
- allowing infrequent users to remember how to carry out operations over time
- preventing the need for error messages, except very rarely
- showing users immediately how their actions are furthering their goals
- reducing users' experiences of anxiety
- helping users gain confidence and mastery and feel in control

Ubiquitous Technology (Weiser, 1991)

He proposed that computers would become part of the environment, embedded in a variety of everyday objects, devices, and displays. The technology would be able to enter our attention when needed and leave when it was finished, constantly running unnoticed in the background

Apple's 1987 Knowledge Navigator

Presented a scenario of a professor using a touch-screen tablet with a speech-based intelligent assistant reminding him of what he needed to do that day while answering the phone and helping him prepare his lectures. It was 25 years ahead of its time (set in 2011), the actual year that Apple launched its speech system, Siri

New Challenges, Themes, and Questions (Rogers, 2006, Harper et al, 2008)

Many new challenges, themes, and questions have been articulated through these visions, including:

- How to enable people to access and interact with information in their work, social, and everyday lives, using an assortment of technologies
- How to design user experiences for people using interfaces that are part of the environment but where there are no obvious controlling devices
- How and in what form to provide contextually relevant information to people at appropriate times and places to support them while on the move
- How to ensure that information that is passed around via interconnected displays, devices, and objects is secure and trustworthy

Relationship between conceptual model and user's understanding (Norman, 1988)

- The designer's model – the model the designer has of how the system should work
- The system image – how the system actually works is portrayed to the user through the interface, manuals, help facilities, and so on
- The user's model – how the user understands how the system works

Chapter 3 – Cognitive Aspects

- Explain what cognition is and why it is important for interaction design
- Discuss what attention is and its effects on our ability to multitask
- Describe how memory can be enhanced through technology aids
- Explain what mental models are
- Show the difference between classic internal cognitive frameworks (e.g. mental models) and more recent external cognitive approaches (e.g. distributed cognition) that have been applied to HCI
- Enable you to try to elicit a mental model and be able to understand what it means

What is Cognition?

There are many different kinds of cognition, such as thinking, remembering, learning, daydreaming, decision making, seeing, reading, writing, and talking. Norman (1993) distinguishes between two general modes: experiential and reflective cognition. Kahneman (2011) describes them in terms of fast and slow thinking. Cognition has also been described in terms of specific kinds of processes:

- attention
- perception
- memory
- learning
- reading, speaking, and listening

- problem solving, planning, reasoning, and decision making

Attention

Heavy multitaskers are likely to be those who are easily distracted and find it difficult to filter out irrelevant information.

- Make information salient when it needs attending to at a given stage of a task
- Use techniques like animated graphics, color, underlining, ordering of items, sequencing of different infromation, and spacing of items to achieve this
- Avoid cluttering the interface with too much information. This especially applies to the use of color, sound, and graphics: it is tempting to use lots, resulting in a mishmash of media that is distracting and annoying rather than helping the user attend to relevant information
- Search engines and form fill-ins that have simple and clean interfaces are easier to use

Perception

Perception refers to how information is acquired from the environment via the different sense of organs - eyes, ears, fingers - and transformed into experiences of objects, events, sounds, and tastes (Roth, 1986). Representations of information need to be designed to be perceptible and recognizable across different media:

- Icons and other graphical representations should enable users to readily distinguish their meaning
- Bordering and spacing are effective visual ways of grouping information that makes it easier to perceive and locate items
- Sounds should be audible and distinguishable so users understand what they represent
- Speech output should enable users to distinguish between the set of spoken words and also be able to understand their meaning
- Text should be legible and distinguishable from the background (e.g. it is okay to use yellow text on a black or blue background but not on a white or green background)
- Tactile feedback used in virtual environments should allow users to recognize the meaning of the various sensations being emulated. The feedback should be distinguishable so that, for example, the sensation of squeezing is represented in a tactile form that is different from the sensation of pushing

Memory

It seems we remember less about objects when we have photographed them than when we observe them just with the naked eye (Henkel, 2014)

- Do not overload users' memories with complicated procedures for carrying out tasks
- Design interfaces that promote recognition rather than recall by using menus, icons, and consistently placed objects
- Provide users with a variety of ways on encoding digital information (e.g. files, emails, images) to help them access them again easily, through the use of categories, color, tagging, time stamping, icons, etc

Learning

- Design interfaces that encourages exploration
- Design interfaces that constrain and guide users to select appropriate actions when initially learning
- Dynamically link concrete representations and abstract concepts to facilitate the learning of complex material

Reading, Speaking, and Listening

Specific differences between the three modes include:

- Written language is permanent while listening is transient. It is possible to re-read information if not understood the first time around. This is not possible with spoken information that is being broadcast
- Reading can be quicker than speaking or listening, as written text can be rapidly scanned in ways not possible while listening to serially presented spoken words
- Listening requires less cognitive effort than reading or speaking. Children, especially, often prefer to listen to narratives provided in multimedia or web-based learning material than to read the equivalent text online
- Written language tends to be grammatical while spoken language is often ungrammatical. For example, people often start talking and stop in mid-sentence, letting someone else start speaking
- Dyslexics have difficulties understanding and recognizing written words, making it hard for them to write grammatical sentences and spell correctly

Many applications have been developed either to capitalize on people's reading, writing, and listening skills, or to support or replace them where they lack or have difficulty with them. These include:

- Interactive books and web-based materials that help people to read or learn foreign languages

- Speech-recognition systems that allow users to interact with them by using spoken commands (e.g. word-processing dictation, Google Voice Search app, and home control devices that respond to vocalized requests)
- Speech-output systems that use artificially generated speech (e.g. written-text-to-speech systems for the blind)
- Natural-language systems that enable users to type in questions and give text-based responses (e.g. the Ask search engine)
- Cognitive aids that help people who find it difficult to read, write, and speak. Numerous special interfaces have been developed for people who have problems with reading, writing, and speaking
- Customized input and output devices that allow people with various disabilities to have access to the web and use word processors and other software packages
- Interaction techniques that allow blind people to read graphs and other visuals on the web through the use of auditory navigation and tactile diagrams (Petrie et al, 2002)

Summary

- Keep the length of speech-based menus and instructions to a minimum. Research has shown that people find it hard to follow spoken menus with more than three or four options. Likewise, they are bad at remembering sets of instructions and directions that have more than a few parts
- Accentuate the intonation of artificially generated speech voices, as they are harder to understand than human voices
- Provide opportunities for making text large on a screen, without affecting the formatting, for people who find it hard to read small text

Problem Solving, Planning, Reasoning, and Decision Making

- Provide additional hidden information that is easy to access for users who wish to understand more about how to carry out an activity more effectively (e.g. web searching)
- Use simple and memorable functions at the interface for computational aids intended to support rapid decision making and planning that takes place while on the move

Cognitive Frameworks

Internal:

1. Mental Models
2. Gulfs of Execution and Evaluation
    - Execution
        1. Intentions
        2. Action Specification
        3. Interface Mechanism
    - Evaluation
        1. Interface Display
        2. Interpretation
        3. Evaluation
3. Information Processing
    1. Input or Stimuli
    2. Encoding (stage 1)
    3. Comparison (stage 2)
    4. Response Selection (stage 3)
    5. Response Execution (stage 4)
    6. Output or Response

External:

1. Distributed Cognition
    - A distributed cognition analysis typically involves examining:
        - The distributed problem solving that takes place (including the way people work together to solve a problem)
        - The role of verbal and non-verbal behaviour (including what is said, what is implied by glances, winks, and the like, and what is not said)
        - The various coordinating mechanisms that are used (e.g. rules, procedures)

- The various ways communication takes place as the collaborative activity progresses
    - How knowledge is shared and accessed
2. External Cognition
    - External cognition is concerned with explaining the cognitive processes involved when we interact with different external representations (Scaife and Rogers, 1996). A main goal is to explicate the cognitive benefits of using different representations for different cognitive activities and the processes involved. The main ones include:
        1. Externalizing to reduce memory load
        2. Computational offloading
        3. Annotating and cognitive tracing
            - Annotating involves modifying external representations, such as crossing off or underlining items
            - Cognitive tracing involves externally manipulating items into different orders or structures
3. Embodied Interaction

Summary

- Cognition comprises many processes, including thinking, attention, learning, memory, perception, decision making, planning, reading, speaking, and listening
- The way an interface is designed can greatly affect how well people can perceive, attend, learn, and remember how to carry out their tasks
- The main benefits of conceptual frameworks and cognitive theories are that they can explain user interaction, inform design, and predict user performance

Examples

Seven Plus Or Minus Two (Miller, 1956)

Seven plus or minus two chunks of information can be held in short-term memory at any one time. By short-term memory he meant a memory store in which information was assumed to be processed when first perceived. By chunks he meant a range of items like numbers, letters, or words. According to Miller's theory, therefore people's immediate memory capacity is very limited. They are able to remember only a few words or numbers that they have heard or seen. According to a survey by Bailey (2000), several designers have been led to believe the following guidelines and have even created interfaces based on them:

- Have only seven options on a menu
- Display only seven icons on a menu bar
- Never have more than seven bullets in a list
- Place only seven tabs at the top of a website page
- Place only seven items on a pull-down menu

All of these are wrong

Relationship Handler (Sas and Wittaker, 2013)

Suggested new ways of harvesting digital materials connected to a broken relationship through using various automatic methods, such as face recognition, that dispose of them without the person needing to personally go through them and be confronted with painful memories. They also suggest that during a separation, people could create a collage of their digital content connected to the ex, so as to transform them into something more abstract, thereby providing a means for closure and helping with the process of moving on

Cook's Collage (Tran et al, 2005)

Cameras were mounted underneath cabinets to capture still images of a cooking activity. These were then displayed as a series of images, in the form of a cartoon strip, on a flat-panel display mounted on an eye-level kitchen cabinet

Dynalinking (Rogers and Scaife, 1998)

Abstract representations, such as diagrams, are linked together with a more concrete illustration of what they stand for, such as a simulation. Changes in one are matched by changes in the other, enabling a better understanding of what the abstraction means. An early example of its use was software developed for learning about ecological concepts, such as food webs. A concrete simulation showed various organisms swimming and moving around and occasionally an event where one would eat another

Human Processor Model (Card et al, 1983)

One of the first HCI models to be derived from the information processing theory. Modelled the cognitive processes of a user interacting with a computer. Cognition was conceptualized as a series of processing stages, where perceptual, cognitive, and motor processors are organized in relation to one another. The model predicts which cognitive processes are involved when a user interacts with a computer, enabling calculations to be made of how long a user will take to carry out various tasks.

Chapter 4 – Social Interaction

- Explain what is meant by social interaction
- Describe the social mechanisms that are used by people when communicating and collaborating
- Discuss how social media have changed the ways in which we keep in touch, make contact, and manage our social and working lives
- Explain what is meant by telepresence
- Give an overview of shareable technologies and some of the studies showing how they can facilitate collaboration and group participation

Face-to-face Conversation

Rules for conversation (Sacks et al, 1978)

- **Rule 1:** the current speaker chooses the next speaker by asking a question, inviting an opinion, or making a request
- **Rule 2:** another person decides to start speaking
- **Rule 3:** the current speaker continues talking

Key Points

- Social interaction is central to our everyday life
- Social mechanisms have evolved in face-to-face and remote contexts to facilitate conversation, coordination, and awareness
- Talk and the way it is managed are integral to coordinating social interaction
- Many kinds of computer-mediated communication systems have been developed to enable people to communicate with one another when in physically different locations
- Keeping aware of what others are doing and letting others know what you are doing are important aspects of collaboration and socializing
- Social media has brought about significant changes in the way people keep in touch and manage their social lives

Examples

Xerox's Media Space

Allowed people to communicate socially while remaining at their desks

Cruiser

Cruiser consisted of audio and video equipment on a person's desktop that allowed those connected to 'glance' at who was in their office and whether they wanted to talk or have coffee (Fish, 1989). The idea was to allow people to interact with each other via the video technology in a similar way to how they do when walking down a physical hallway.

Hydra

Hydra used spatialized audio-video to enhance communication with a group of colleagues – separate units were place at different places on someone's desk, one assigned to each person connected to the system (Sellen et al, 1992)

VideoWindow (Bellcore, 1989)

Shared space that allowed people in different locations to carry on a conversation as they would do if drinking coffee together in the same room. Two lounge areas that were 50 miles apart were connected by a 3 foot by 5 foot picture-window onto which video images of each location were projected. The large size enabled viewers to see a room of people roughly the same size as themselves. A study of its use showed that many on the conversations that took place between the remote conversants were indeed indistinguishable from similar face-to-face interactions – with the exception that they spoke a bit louder and constantly talked about the video system (Kraut et al, 1990)

Clearboard
Designed to enable facial expressions of participants to be made visible to others by using transparent board that showed their face to the others (Ishii et al, 1993)

HyperMirror
Synthesized and projected mirror reflections of people in different places onto a single screen, so that they appeared side by side in the same virtual space (Morikawa and Maesako, 1998). Observations of people using the system showed how quickly participants quickly became sensitized to the importance of virtual personal space, moving out of the way if they perceived they were overlapping someone else on the screen

BiReality
Used a teleoperated robotic surrogate to visit remote locations as a substitute for physical travel (Jouppi et al, 2004). Much attention was paid to its design. An underlying principle was to make it seem like the person was actually there by making the surrogate look and sound like the remote person. Specifically, the robot had a life-size head shaped as a cube, with each side displaying a view of the remote person's face. The head sat on a human-shaped body base that was coloured blue to match the colour of business clothing. Multichannel bidirectional audio was also used to project the remote person's voice. To move in the physical space, the remote person would steer their surrogate using a console from inside their home linked into the remote meeting room. The real people in the meeting room would leave a gap at the table for the surrogate to sit with them

Reactable Experience (2010)
The Reactable Experience (2010) was designed for groups of children, families, or adults to create music together in public spaces and institutions, such as museums and science centres. Based on the original Reactable (Jorda et al, 2005), colourful tangible pucks are moved and rotated on the surface of a translucent tabletop, which results in various digital annotations appearing and connecting them. A synthesizer creates immediate sounds in response to the various tabletop interactions. One of the main ideas behind the design was to enable groups to create music together on the fly. This is achieved through making visible everyone's interactions at the tabletop surface and by providing real-time feedback about what is currently happening.

React Table
The table monitors and analyses ongoing conversations using embedded microphones in front of each person and represents this in the form of increasing numbers of coloured LEDs.

Babble (David Smith)
Provided a dynamic visualization of the participants in an ongoing chat room. A large 2D circle was depicted using coloured marbles on each user's monitor. Marbles inside the circle conveyed those individuals active in the current conversation. Marbles outside the circle showed users involved in other conversations. The more active a participant was in the conversation, the more the corresponding marble moved towards the centre of the circle. Conversely, the less engaged a person was in the ongoing conversation, the more the marble moved towards the periphery of the circle.

Sococo
Virtual office system, that uses the spatial metaphor of a floor plan of an office to show where people are, who is in a meeting, and who is chatting with whom. It provides a bird's eye view of each floor so that everyone connected can see where everyone is at any given time. It also makes it easy to pop in and say hello to someone – in the same way office workers might do if they were in the same building.

Opinionizer
Designed with the aim of encouraging people in an informal gathering to share their opinions visually and anonymously (Brignull ang Rogers, 2003). The collective creation of opinions via a public display was intended to provide a talking point for the people standing beside it. Users submitted their opinions by typing the in at a public keyboard. To add colour and personality to their opinions, a selection of small cartoon avatars and speech bubbles were available. The screen was also divided into four labeled quadrants representing different backgrounds (techie, softie, designer)

The Dynamo
Enables communities to readily share and exchange a variety of media on a large shared display by hooking up their memory sticks, laptops, cameras, and other devices in the vicinity of the display (Izadi et al, 2003). A study of its deployment in a sixth form common room in the UK showed how students often used it as a conversational prop while displaying and

manipulating media on the shared display, which in turn led to impromptu conversations between those sitting in the room (Brignull et al, 2004)

The Red Nose Game

5 by 5 meter screen, the game starts with red blobs splattered on the screen. The objective of the game is for passers-by to push the blobs together by using their bodies, which are tracked by a live camera feed embedded in the display. When the camera image of a player touches a red nose blob, it enables that person to push it around the screen towards other blobs. The game ends when all the small blobs become one large blob. A study conducted by O'Hara et al (2008) showed that people were reluctant to play in case they made a fool of themselves in front of the other members of the public. If often required a compere to cajole people into playing the game. However once in the game, people worked closely together as groups, developing effective strategies to move their blobs together, such as linking arms and sweeping the blobs together across the screen

Break-time Barometer

Designed to persuade people to come out of their offices for a break to meet others they might not talk with otherwise (Kirkham et al, 2013). An ambient display, based on a clock metaphor, shows how many people are currently in the common room; if there are people present, it also sends an alert that it would be a good time to join them for a break. While the system nudged some people to go for a break in the staff room, it also had the opposite effect on others who used it to determine when breaks weren't happening so that they could take a break without their colleagues being around for company.

Chapter 5 – Emotional Interaction

- Explain how our emotions relate to behaviour and user experience
- Provide examples of interfaces that are both pleasurable and usable
- Explain what expressive and annoying interfaces are and the effects they can have on people
- Introduce that area of automatic emotion recognition and emotional technologies
- Describe how technologies can be designed to change people's attitudes and behaviour
- Give an overview on how anthropomorphism has been applied in interaction design
- Enable you to critique the persuasive impact of an online agent on customers

Emotions and the User Experience

People express themselves through; facial expressions, body language, gestures, and tone of voice. Baumeister et al (2007) argue that the role of emotion is more complicated than a simple cause and effect model; emotions can be both simple and short-lived or complex and long-lasting.

Expressive Interfaces

Expressive forms like emoticons, sounds, icons, and virtual agents have been used at the interface to:

1. convey emotional states and/or
2. elicit certain kinds of emotional responses in users, such as feeling at ease, comfort, and happiness

Ways fo conveying the status of a system are through the use of:

- Dynamic icons (e.g. a recycle bin expanding when a file is placed in it and paper disappearing in a puff when emptied)
- Animations (e.g. a beach ball whirling to say the computer is busy)
- Spoken messages, using various kinds of voices, telling the user what needs to be done (e.g. GPS navigation system instructing you politely where to go after having taken a wrong turn)
- Various sonifications indicating actions and events (e.g. whoosh for window closing, schlook for a file being dragged, ding for a new email arriving)
- Vibrotactile feedback, such as distinct smartphone buzzes that specifically represent special messages from friends and family

Detecting Emotions and Emotional Technology

Six fundamental emotions are classified based on the face expressions; sadness, happiness, disgust, fear, surprise, and anger.

Anthropomorphism and Zoomorphism

Anthropomorphism is the propensity people have to attribute human qualities to animals and objects while zoomorphism is the shaping of an object or design in animal form. For example, people sometimes talk to their computers as if they were humans, treat their robot cleaners as if they were their pets, and give all manner of cute name to their mobile devices, routers, and so on.

Summary

- Emotional aspects of interaction design are concerned with how to facilitate certain states (e.g. pleasure) or avoid certain reations (e.g. frustration) in user experiences
- Well-designed interfaces can elicit good feelings in people
- Aesthetically pleasing interfaces can be a pleasure to use
- Expressive interfaces can provide reassuring feedback to users as well as be informative and fun
- Badly designed interfaces often make people frustrated, annoyed, or angry
- Emotional technologies can be designed to persuade people to change their behaviours or attitudes
- Anthropomorphism is the attribution of human qualities to objects
- Virtual agents and robot pets have been developed to make people feel motivated, reassured, and in a good mood

Examples

Emotion and Behaviour Model (Ortony et al, 2005)

Couched in terms of different levels of the brain. At the lowest level are parts of the brain that are pre-wired to automatically respond to events happening in the physical world. This is called the visceral level. At the next level are the brain processes that control our everyday behaviour. This is called the behavioural level. At the highest level are brain processes that contemplate. This is called the reflective level. The visceral level responds rapidly, making judgments about what is good or bad, safe or dangerous, pleasurable or abhorrent. It also triggers the emotional responses to stimuli (e.g. fear, joy, anger, and sadness) that are expressed through a combination of physiological and behavioural responses

Nest

The designs are simple, round, and use bright colors – this makes them cute and aesthetically pleasing to the eye. The Nest thermostat provides an intelligent way of controlling how your house is heated or cooled.

Sproutling

The design are simple, round, and use bright colors – this makes them cute and aesthetically pleasing to the eye. The Sproutling is a band that is wrapped around a baby's ankle that senses heart rate, skin temperature, motion, and position. It communicates with a smartphone app to let parents know if their baby is sleeping soundly or if something is wrong – using cute baby emoticons

Moon Phrases

An app that has been developed to help people reflect upon their emotional well-being (do Choudhury et al, 2013). The app allows people to think about their emotional states and feelings via analysing what they say in their postings on Twitter. The aim is to help them cope better with stress and anxiety by recognizing the triggers that cause them to occur. The tool works by analysing the way users express themselves in social media – through the types of words, mood hashtags, emoticons, and expressions used and their frequency. It then visualizes this data in terms of a series of moon icons conveying positive and negative affect, representing each day for a period of several months; full moons indicate positively, while half or quarter moons reflect more negativity. By looking back at their history of moons, users can start to identify patterns that could help them understand more about themselves and what might be causing their mood swings.

Nintendo's Pokemon Pikachu

People had a pet pikachu and had to walk to generate steps. Steps resulted in watts that could be used to buy presents for the pikachu. If the pikachu didn't get presents it would get unhappy and refuse to play

WaterBot

The system was developed using a special monitoring and feedback device, but for adults as a way of reducing their usage of water in their homes (Arroyo et al, 2005). There is much evidence to suggest that people are wasteful with water, often leaving the tap running continuously for long periods of time while cleaning their teeth or washing. The research team thought that the use of monitoring technology could help persuade householders to change their behaviour to be more conservative in their water usage. To this end, they used the theory of positive reinforcement to inform their design, which states that activities are likely to be repeated if some kind of reward is given occasionally and randomly (similar to the reward system used in slot machines). A sensor-based system was developed where positive auditory messages and chimes were sounded when the tap was turned off. The water was also lit with a random pattern of colour as a reward for consistent water-saving behaviour. Two illuminated bar graphs were also presented alongside the tap, showing how much water a person had used relative to others in the household. Here, the idea was to encourage peer pressure and for the members of the household to talk to each other about their water usage. Informal feedback of the prototype system in a small number of people's homes suggested that the most effective method of persuassion was the constantly changing bar graph. It drew people's attention to the tap, leading them to make quick comparisons between their and the others' water consumption. The rewards of chimes and coloured water had less impact, especially as their novelty wore off.

HAPIfork

It is intended to help someone monitor and track their eating habits. If it detects they are eating too quickly, it will vibrate (similar to the way asmartphone does when on silent mode) and an ambient light will appear at the end of the fork, providing the eater with real-time feedback intended to slow them down. The assumption is that eating too fast results in poor digestion and poor weight control, and that making people aware that they are gobbling their food down can help them think about how to eat more slowly at a conscious level. Other data is collected about how long it took them to finish their meal, the amount of fork servings per minute, and the time between them. These are turned into a dashboard of graphs and statistics so the user can see each week whether their fork behaviour is improving.

Chapter 13 – Introducing Evaluation

- Explain the key concepts and terms used in evaluation
- Introduce a range of different types of evaluation methods
- Show how different evaluation methods are used for different purposes at different stages of the design process and in different contexts of use
- Discuss some of the practical challenges that evaluators have to consider when doing evaluation
- Illustrate through short case studies how methods discussed in more depth in Chapters 7 and 8 are used in evaluation and describe some methods that are specific to evaluation

The Why, What, Where, and When of Evaluation

Why Evaluate

"User experience encompasses all aspects of the end-user's interaction … the first requirement for an exemplary user experience is to meet the exact needs of the customer, without fuss or bother. Next come simplicity and elegance, which produce products that are a joy to own, a joy to use"

Where to Evaluate

Testing in natural settings can sometimes be referred to as "in the wild"

When to Evaluate

If the product is new, then considerable time is usually invested in market research and establishing user requirements. Once these requirements have been established, they are used to create initial sketches, a storyboard, a series of screens, or a prototype of the design ideas. These are then evaluated to see if the designers have interpreted the users' requirements correctly and embodied them in their designs appropriately. The designs will be modified according to the evaluation feedback and new prototypes developed and subsequently evaluated.
When evaluations are done during design to check that a product continues to meet users' needs, they are known as formative evaluations. Formative evaluations cover a broad range of design processes, from the development of early sketches and prototypes through to tweaking and perfecting an almost finished design.
Evaluations that are done to assess the success of a finished product are known as summative evaluations. If the product is being upgraded then the evaluation may not focus on establishing a set of requirements, but may evaluate the existing product to ascertain what needs improving. Features are then often added, which can result in new usability problems. Other times, attention is focussed on improving specific aspects, such as enhanced navigation.

Types of Evaluation

1. **Controlled settings involving users** (examples are laboratories and living labs): users' activities are controlled in order to test hypotheses and meaure or observe certain behaviours. The main methods are usability testing and experiments

2. **Natural settings involving users** (examples are online communities and products that are used in public places): there is little or no control of users' activities in order to determine how the product would be used in the real world. The main method used is field studies
3. **Any settings not involving users**: consultants and researchers cirtique, predict, and model aspects of the interface in order to identify the most obvious usability problems. The range of methods includes inspections, heuristics, walkthroughs, models, and analytics

Natural Settings Involving Users

The aim of field studies is to evaluate people in their natural settings. They are used primarily to:

1. help identify opportunities for new technology
2. establish the requirements for a new design
3. facilitate the introduction of technology, or inform deployment of existing technology in new contexts

Choosing and Combining Methods

1. Field study to evaluate initial design ideas and get early feedback
2. Make some design changes
3. Usability test to check specific design features
4. Field study to see what happens when used in natural environment
5. Make some final design changes

How do you choose between using a controlled and uncontrolled setting? There are obviously pros and cons for each one. The benefits of controlled settings include being able to test hypotheses about specific features of the interface, where the results can be generalized to the wider population. A benefit of uncontrolled settings is that unexpected data can be obtained that provides quite different insights into people's perceptions and their experiences of using, interacting, or communicating through the new technologies in the context of their everyday and working lives.

Language of Evaluation

- **Analytics:** Data analytics refers to examining large volumes of raw data with the purpose of drawing inferences about that information. Web analytics is commonly used to measure website traffic through analysing users' click data
- **Analytical evaluation:** Evaluation methods that model and predict user behaviour. This term has been used to refer to heuristic evaluation, walkthroughs, modelling, and analytics
- **Bias:** The results of an evaluation are distorted. This can happen for several reasons. For example, selecting a population of users that has already had experience with the new system and describing their performance as if they were new users
- **Controlled experiment:** A study that is conducted to test hypotheses about some aspect of an interface or other dimension. Aspects that are controlled typically include the task that participants are asked to perform, the amount of time available to complete the tasks, and the environment in which the evaluation study occurs
- **Crowdsourcing:** A web-based method that provides the opportunity to enable potentially hundreds, thousands, or even millions of people to evaluate a product or take part in an experiment. The crowd may be asked to perform a particular evaluation task using a new product, or to rate or comment on the product
- **Ecological validity:** A particular kind of validity that concerns how the environment in which an evaluation is conducted influences or even distorts the results
- **Expert review or crit:** An evaluation method in which one or more people with usability expertise and knowledge of the user population review a product looking for potential problems
- **Field study:** An evaluation study that is done in a natural environment such as in a person's home, or in a work or leisure place
- **Formative evaluation:** An evaluation that is done during design to check that the product fulfills requirements and continues to meet users' needs
- **Heuristic evaluation:** An evaluation method in which knowledge of typical users is applied, often guided by heuristics, to identify usability problems
- **Informed consent form:** A form describing what a participant in an evaluation study will be asked to do, what will happen to the data collected about them, and their rights while involved in the study
- **In the wild study:** A field study in which users are observed using products or prototypes within their everyday context
- **Living laboratory:** A place that is configured to measure and record people's everyday activities in a natural setting,

such as the home
- **Predictive evaluation:** Evaluation methods in which theoretically based models are used to predict user performance
- **Reliability:** The reliability or consistency of a method is how well it produces the same results on separate occasions under the same circumstances
- **Scope:** Refers to how much the findings from an evaluation can be generalized
- **Summative evaluation:** An evaluation that is done when the design is complete
- **Usability laboratory:** A laboratory that is specially designed for usability testing
- **Usability testing:** Involves measuring users' performance on various tasks
- **User studies:** A generic term that covers a range of evaluations involving users, including field studies and experiments
- **Users or participants:** These terms are used interchangeably to refer to the people who take part in evaluation studies
- **Validity:** Validity is concerned with whether the evaluation method measures what it is intended to measure

Some Things that Influence how you Interpret Data

Reliability

The reliability or consistency of a method is how well it produces the same results on separate occasions under the same circumstances. Another evaluator or researcher who follows exactly the same procedure should get similar results. Different evaluation methods will have high reliability.

Validity

Validity is concerned with whether the evaluation method measures what it is intended to measure. This encompasses both the method itself and the way it is implemented.

Ecological Validity

Ecological validity is a particular kind of validity that concerns how the environment in which an evaluation is conducted influences or even distorts the results.

Biases

Bias occurs when the results are distorted.

Scope

The scope of an evaluation study refers to how much its findings can be generalized.

Summary

- Evaluation and design are very closely integrated
- Some of the same data gathering methods are used in evaluation as for establishing requirements and identifying users' needs, e.g. observation, interviews, and questionnaires
- Evaluations can be done in controlled settings such as laboratories, less controlled field settings, or where users are not present
- Usability testing and experiments enable the evaluator to have a high level of control over what gets tested, whereas evaluators typically impose little or no control on participants in field studies
- Different methods are usually combined to provide different perspectives within a study
- Participants are made aware of their rights through an informed consent form
- It is important not to over-generalize findings from an evaluation

Examples

Living Labs

Developed to evaluate people's everyday lives – that would be simply difficult to assess in usability labs. For example, research has been conducted to investigate people's habits and routines over a period of several months. An early example of a living lab was the Aware Home, which was a technology-rich, experimental house that enabled research into people's lives to be conducted in an authentic yet experimental setting (Abowd et al, 2000). The house was embedded with a complex network of sensors and audio/video recording devices that recorded their movements throughout the house and their use of technology. This enabled the occupants' behaviour to be monitored and analysed (e.g. their routines and deviations).

A primary motivation was to evaluate how real families would respond and adapt to such a setup, over a period of several months. However, it has proved difficult to get participant families to agree to leave their own homes and live in a living lab home for a period of time. Nowadays, many Living Labs have become more like commercial enterprises, which offer facilities, infrastructure, and access to participating communities, bringing together users, developers, researchers, and other stakeholders.

Crowdsourcing

Imagine having access to hundreds of thousands of participants who will perform tasks or provide feedback on a design or experimental task quickly and almost immediately. The service Mechanical Turk, hosted by Amazon, has thousands of people registered (known as Turkers), who have volunteered to take part by performing various activities, online, known as human intelligence tasks (HITs) for a very small reward. HITs are submitted by researchers or companies who pay from $0.01 for simple tasks (such as tagging photos) to a few dollars (for taking part in an experiment). An advantage of using crowdsourcing in HCI is that it can be less expensive to run than traditional lab studies (where typically a participant is paid between $15 and $30, depending on the length of the experiment). Another benefit is that potentially many more participants can be recruited.

Chapter 14 – Evaluation Studies: From Controlled to Natural Settings

- Explain how to do usability testing
- Outline the basics of experimental design
- Describe how to do field studies

Usability Testing

Types of data

- Time to complete a task
- Time to complete a task after a specified time away from the product
- Number and type of errors per task
- Number of errors per unit of time
- Number of navigations to online help or manuals
- Number of users making a particular error
- Number of users completing a task successfully

Conducting Experiments

Hypotheses Testing

Independent variable is what the investigator manipulates. Dependent variable is a measure of the user performance.

Experimental Design

A concern in experimental design is to determine which participants to involve for which conditions in an experiment. The experience of participating in one condition will affect the performance of those participants if asked to participate in another condition.

The name given for the different designs are:

- Different-participant design
  - A single group of participants is allocated randomly to each of the experimental conditions, so that different participants perform in different conditions. Another term used for this experimental design is between-subjects design. An advantage is that there are no ordering or training effects caused by the influence of participants' experience of one set of tasks on their performance in the next, as each participant only ever performs in one condition. A disadvantage is that large numbers of participants are needed so that the effect of any individual differences among participants, such as differences in experience and expertise, is minimized. Randomly allocating the participants and pre-testing to identify any participants that differ strongly from the others can help
- Same-participant design
  - Also called within subjects design, all participants perform in all conditions so only half the number of participants is needed; the main reason for this design is to lessen the impact of individual differences and to see how performance varies across conditions for each participant. It is important to ensure that the order in which participants perform tasks for this set up does not bias the results. For example, if there are two tasks, A and B, half the participants should do task A followed by task B and the other half should do task B followed by task A. This is known as counterbalancing. Counterbalancing neutralizes possible unfair effects of learning from the first task, known as the order effect

- Matched-pair design
  - Also known as pair-wise design, participants are matched in pairs based on certain user characteristics such as expertise and gender. Each pair is then randomly allocated to each experimental condition. A problem with this arrangement is that other important variables that have not been taken into account may influence the results. For example, experience in using the web could influence the results of tests to evaluate the navigability of a website. So web expertise would be a good criterion for matching participants

Summary

- Usability testing takes place in usability labs or temporary makeshift labs. These labs enable evaluators to control the test setting
- Usability testing focuses on performance measures such as how long and how many errors are made, when completing a set of predefined tasks. Indirect observation (video and keystroke logging) is conducted and supplemented by user satisfaction questionnaires and interviews
- Remote testing systems have been developed that are more affordable than usability labs and also more portable. Many contain mobile eye-tracking and other devices
- Experiments aim to test a hypothesis by manipulating certain variables while keeping other constant
- The experimenter controls independent variable(s) in order to measure dependent variable(s)
- Field studies that involve the deployment of prototypes or technologies in natural settings may also be referred to as 'in the wild'
- Sometimes the findings of a field study are unexpected, especially for in the wild studies in which the aim is usually to explore how novel technologies are used by participants in their own homes, places of work, or outside

Examples

GoToMeeting

An easy remote control system including a remote eye-tracker, and a mobile head-mounted eye-tracker. The latter is fitted to a helmet or lightweight cap so that the system offers complete portability for research in sports, usability studies, and a variety of other disciplines. There are also mobile eye-tracking and eye-gaze systems available that can be used

Ensuring Accessibility and Section 508 Compliance for the Recovery.gov Website (Lazar et al, 2010b)

The American Recovery and Reinvestment Act (informally known as 'the Stimulus Bill') became law on February 17, 2009, with the intention of infusing $787 billion into the US economy to create jobs and improve economic conditions. The Act established an independent board, the Recovery Accountability and Transparency Board, to oversee the spending and detect, mitigate, and minimize any waste, fraud, or abuse. The law required the Board to establish a website to provide the public with information on the progress of the recovery effort. A simple website was launched the day that the Act was signed into law, but one of the immediate goals of the Board was to create a more detailed website, with data, geospatial features, and Web 2.0 functionality, including data on every contract related to the Act. The goal was to provide political transparency at a scale not seen before in the US federal government so that citizens could see how money was being spent.

A major goal in the development of the Recovery.gov website was meeting the requirement that it be accessible to those with disabilities, such as perceptual (visual, hearing) and motor impairments. It had to comply with guidelines specified in Section 508 of the Rehabilitation Act. At a broad level, three main approaches were used to ensure compliance:

- Usability testing with individual users, including those with perceptual and motor impairments
- Routine testing for compliance with Section 508 of the Rehabilitation Act, done every 3 months, using screenreaders such as JAWS, and automated testing tools such as Watchfire
- Providing an online feedback loop, listening to users, and rapidly responding to accessibility problems

UbiFit Garden

Another early example of an in the wild study was the UbiFit Garden project (Consolvo et al, 2008), which evaluated activity sensing in the wild to address the growing problem of people's sedentary lifestyles. A mobile device was designed to encourage physical activity that used on-body sensing and activity inferencing. The personal mobile display had three components: a fitness devices that monitored different types of fitness activities, an interactive application that kept detailed information, including a journal of the individual's activities, and a glanceable display that ran on cell phones. The system worked by inferring what the wearer was doing, in terms of walking, running, cycling, and using gym equipment based on data detected from accelerometer and barometer sensors. The sensor data was processed and then communicated to the cell phone using Bluetooth. The data analysed and used as input from the glanceable display that depicted the UbiFit Garden. The display depicted a garden that bloomed throughout the week as the user carried out the various physical activities. A healthy regime of physical exercise was indicated by a healthy garden full of flowers and butterflies. Conversely, an unhealthy garden with not much growth or butterflies indicated an unhealthy lifestyle

Chapter 15 – Evaluation: Inspections, Analytics, and Models

- Describe the key concepts associated with inspection methods
- Explain how to heuristic evaluation and walkthroughs
- Explain the role of analytics in evaluation
- Describe how to use Fitts' Law – a predictive model

Heuristic Evaluation

In heuristic evaluation, experts, guided by a set of usability principles known as heuristics, evaluate whether user-interface elements, such as dialog boxes, menus, navigation structure, online help, and o on, conform to tried and tested principles. These heuristics closely resemble high-level design principles.

- **Visibility of system status** – The system should alway keep users informed about what is going on, through appropriate feedback within reasonable time
- **Match between system and the real world** – The system should speak the users' language, with words, phrases, and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order
- **User control and freedom** – Users often choose system functions by mistake and will need a clearly marked emergency exit to leave the unwanted state without having to go through an extended dialog. Support undo and redo
- **Consistency and standards** – Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions
- **Error prevention** – Even better than good error messages is a careful design that prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action
- **Recognition rather than recall** – Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialog to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate
- **Flexibility and efficiency of use** – Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions
- **Aesthetic and minimalist design** – Dialogs should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialog competes with the relevant units of information and diminishes their relative visibility
- **Help users recognize, diagnose, and recover from errors** – Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution
- **Help and documentation** – Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large

Web Heuristics

- **Clarity** – Make the system as clear, concise, and meaningful as possible for the intended audience
  - Write clear, concise copy
  - Only use technical language for a technical audience
  - Write clear and meaningful labels
  - Use meaningful icons
- **Minimize unnecessary complexity and cognitive load** – Make the system as simple as possible for users to accomplish their tasks

  - Remove unnecessary functionality, process steps, and visual clutter
  - Use progressive disclosure to hide advanced features
  - Break down complicated processes into multiple steps
  - Prioritize using size, shape, colour, alignment, and proximity
- **Provide users with context** – Interfaces should provide users with a sense of context in time and space
  - Provide a clear site name and purpose
  - Highlight the current section in the navigation
  - Provide a breadcrumb trail
  - Use appropriate feedback messages
  - Show number of steps in a process
  - Reduce perception of latency by providing visual cues (e.g. progress indicator) or by allowing users to complete other tasks while waiting
- **Promote a pleasurable and positive user experience** – The user should be treated with respect and the design should be aesthetically pleasing and promote a pleasurable and rewarding experience
  - Create a pleasurable and attractive design
  - Provide easily attainable goals
  - Provide rewards for usage and progression

Eight Golden Rules

Schneiderman's eight golden rules, a set of guidelines first developed in the mid-1980s, are also frequently adapted for use with different types of systems and environments and used as heuristics for identifying usability problems (Schneiderman and Plaisant, 2010)

1. **Strive for consistency.** Consistent sequences of actions should be required in similar situations: identical terminology should be used in prompts, menus, and help screens; and consistent color, layout, capitalization, fonts, and so on should be employed throughout. Exceptions, such as required confirmation of the delete command or no echoing of passwords, should be comprehensible and limited in number
2. **Cater to universal usability.** Recognize the needs of diverse users and design for plasticity, facilitating transformation of content. Novice to expert differences, age ranges, disabilities, and technological diversity each enrich the spectrum of requirements that guides design. Adding features for novices, such as explanations, and features for experts, such as shortcuts and faster pacing, can enrich the interface design and improve perceived system quality
3. **Offer informative feedback.** For every user action, there should be system feedback. For frequent and minor actions, the response can be modest, whereas for infrequent and major actions, the response should be more substantial. Visual presentation of the objects of interest provides a convenient environment for showing changes explicitly
4. **Design dialogs to yield closure.** Sequences of actions should be organised into groups with a beginning, middle, and end. Informative feedback at the completion of a group of actions gives operators the satisfaction of accomplishment, a sense of relief, a signal to drop contingency plans from their minds, and an indicator to prepare for the next group of actions. For example, e-commerce websites move users from selecting products to the checkout, ending with a clear confirmation page that completes the transaction
5. **Prevent errors.** As much as possible, design the system such that users cannot make serious errors; for example, grey out menu items that are not appropriate and do not allow alphabetic characters in numeric entry fields. If a user makes an error, the interface should detect the error and offer simple, constructive, and specific instructions for recovery. For example, users should not have to retype an entire name-address form if they enter an invalid zip code, but rather should be guided to repair only the faulty part. Erroneous actions should leave the system state unchanged, or the interface should give instructions about restoring the state
6. **Permit easy reversal of actions.** As much as possible, actions should be reversible. This feature relieves anxiety, since the user knows that errors can be undone, and encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data-entry task, or a complete group of actions, such as entry of a name-address block
7. **Support internal locus of control.** Experienced users strongly desire the sense that they are in charge of the interface and that the interface responds to their actions. They don't want surprises or changes in familiar behaviour, and they are annoyed by tedious data-entry sequences, difficulty in obtaining necessary information, and inability to produce their desired result

8. **Reduce short-term memory load.** Humans' limited capacity for information processing in short-term memory (the rule of thumb is that we can remember 'seven plus or minus two chunks' of information) requires that designers avoid interfaces in which users must remember information from one screen and then use that information on another screen. It means that smartphones should not require re-entry of phone numbers, website locations should remain visible, multiple-page displays should be consolidated, and sufficient training time should be allotted for complex sequences of actions

Walkthroughs

The steps involved in cognitive walkthroughs are:

1. The characteristics of typical users are identified and documented and sample tasks are developed that focus on the aspects of the design to be evaluated. A description, mockup, or prototype of the interface to be developed is also produced, along with a clear sequence of the actions needed for the users to complete the task
2. A designer and one or more expert evaluators come together to do the analysis
3. The evaluators walk through the action sequences for each task, placing it within the context of a typical scenario, and as they do this they try to answer the following questions:
    - Will the correct action be sufficiently evident to the user? (Will the user know what to do to achieve the task?)
    - Will the user notice that the correct action is available? (Can users see the button or menu item that they should use for the next action? Is it apparent when it is needed?)
    - Will the user associate and interpret the response from the action correctly? (Will users know from the feedback that they have made a correct or incorrect choice of action?)
      In other words: will the users know what to do, see how to do it, and understand from feedback whether the action was correct or not?
4. As the walkthough is being done, a record of critical information is compiled in which:
    - The assumptions about what would cause problems and why are identified
    - Notes about side issues and design changes are made
    - A summary of the results is compiled
5. The design is then revised to fix the problems presented
    - As with heuristic and other evaluation methods, developers and researchers can modify the method to meet their own needs more closely, or adapt the process so that it applies to particular features of mobile or other new technologies

Pluralistic Walkthroughs

"Pluralistic walkthroughs are another type of walkthrough in which users, developers and usability experts work together to step through a (task) scenario, discussing usability issues associated with dialog elements involved in the scenario steps" (Nielsen and Mack, 1994)

Predictive Models

Similar to inspection methods and analytics, predictive models evaluate a system without users being present. Rather than involving expert evaluators role-playing users as in inspections, or tracking behaviour as in analytics, predictive models use formulas to derive various measures of user performance. Predictive modelling provides estimates of the efficiency of different systems for various kinds of task.

Fitts' Law

Predicts the time it takes to reach a target using a pointing device. It was originally used in human factors research to model the relationship between speed and accuracy when moving towards a target on a display.

$$T = k \times \log_2\left(\frac{D}{S} + 1\right)$$

Where:

- T = time to move the pointer to a target
- D = distance between the pointer and the target
- S = size of the target
- k is a constant of approximately 200 ms/bin

Summary

- Inspections can be used for evaluating a range of representations including requirements, mockups, functional prototypes, or systems
- User testing and heuristic evaluation often reveal different usability problems
- Other types of inspections used in interaction design include pluralistic and cognitive walkthroughs
- Walkthroughs are very focused and so are suitable for evaluating small parts of a product
- Analytics involves collecting data about the interactions of users in order to identify which parts of a website or prototype are underused
- When applied to websites, analytics are often referred to as 'web analytics.' Similarly, when applied to learning systems, they are referred to as 'learning analytics'
- Fitts' Law is an example of a predictive model that can be used to predict performance involving the selection of virtual or physical objects
- Predictive models require neither users nor usability experts to be present, but the evaluators must be skilled in applying the models
- Predictive models like Fitts' Law are used to evaluate systems with limited, clearly defined, functionality such as data entry applications, and key-press sequences for smartphones and other handheld devices