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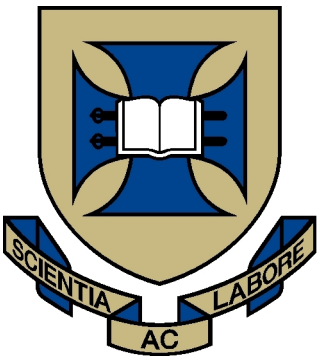

University of Queensland

DECO2500 – Human Computer Interaction Design

Textbook Summary

Table of Contents

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.