Human computer interaction

Arguments concerning first partial exam

What is interaction design

Everyday we interact with many different interfaces, but often the interaction is unsatisfactory
Not all the interfaces are designed with a focus on the user
A core concern for interaction design is to develop interactive products that are usable
• easy to learn
• effective to use
• enjoyable UX
Analyzing examples of poor and good design is a good starting point
Example of poor design: **Voice-Mail System**

You see a red light blinking,
you pick up and follow some
instruction over the phone…
…you read further
instructions on the instruction
card close to the phone, but
can't access the message
and…
…need to call the reception
for help

-Inefficient
-Difficult to use
-No clear help
-Low visibility

Example of good design: **The Marble Answering Machine**
• Familiar physical objects to quickly indicate the number of messages left
• one-step actions to perform core tasks
• simple and elegant design
But → It may not be appropriate for all the settings, e.g., public places with shared phone
The context of use does matter.

What do design

WHO
is going to use the system
HOW
are they going to use the system
WHERE
are they going to use the system
WHAT

kind of ACTIVITIES

IoT allows control of multiple devices remotely opening up countless opportunities for interaction. The question is what are the appropriate ones?
Interfaces in everyday consumer items are increasingly turning from physical to digital (i.e., consumer electronics) → introducing new kinds of customer interaction

What is Interaction Design?

Designing interactive products to support the way people communicate and interact in their everyday and working lives
UI – Web design – User-centered design – UX design – Product design
are all **INTERACTION DESIGN**
Multidisciplinary field: Each discipline may differ for the methods employed and the scope and problems addressed

Who is involved in Interaction Design?

Multidisciplinary teams covering different areas, e.g., engineers, designers, psychologists, marketing people, product managers
who is actually involved depends on several factors:
- company's design philosophy
- company size
- type of product

Pros: more and more creative and original ideas, more methods
Cons: communication difficulties generated from different backgrounds, perspectives and language

User eXperience | UX

"all aspects of the end- user's interaction with the company, its services, and its products." Nielsen & Norman (2014)
We can't design *a* user experience, when can design *for* a user experience
We can't design a sensual experience, but we can create the design features that evoke it

«It is not enough that we build products that function, that are understandable and usable, we also need to build joy and excitement, pleasure and fun, and yes, beauty to people's lives.» Don Norman (2004)

There are several aspects of UX that can be considered:
- usability (functionality, predictability, intuitivity)
- aesthetics (look) (trust, harmony, mood)
- emotional appeal (feel) (joy of use, interaction, reaction)

Cultural identity also plays an important role (e.g., age, ethnicity, disability, social status, education)

Hassenzahl's Model of UX: **Pragmatic** & **Hedonic**

Pragmatic
How evocative and stimulating the interaction is to them
Hedonic
How practical simple and obvious it is for the user to achieve their goals

Understanding Users

It is of key importance understanding the people in the context in which they will use the technology for pursuing designs that meet their needs
This doesn't mean only designing for their cognitive and perceptual abilities, but also for their sensitivities
Older adults may be reluctant to adopt "big-buttons" devices, because they find them stigmatizing
Cultural differences are another aspect that is important to consider
For example, in the US the date is written mm/dd/yy, but in other countries it's written as dd/mm/yy.
The "ok" symbol in sign language means different things if read in english instead of russian or japanese.

Accessibility and Inclusiveness

Accessibility
The extent to which the product is accessible by as many people as possible. The focus is on disability.
Inclusiveness
The extent to which the product is fair, open and equal to everyone. Overarching approach pushing for designing products that accommodate the needs of the widest possible number of people.

Disability is a condition that changes over time.
Disability in this context is to be conceived as the interaction between the persona and the context. With that respect the technology can be a barrier or a facilitator for one's actions
inclusive technology (google home) and assistive technology (robotic wheelchair)

Usability and UX goals

Can be distinguished, but are not to be conceived as a strictly separate
Usability goals
Generally refers to ensuring that interactive products are easy to learn, effective to use and enjoyable
Effectiveness: how good a product is at doing what it is supposed to do
Efficiency: the way the product supports the user in the task
Safety: protecting the user from potential dangers
Utility: the extent to which the product provides the needed functionalities
Learnability: how easy a system is to learn
Memorability: how easy it is to use the system after a period of non use

USABILITY CRITERIA: specific objectives that enable the usability assessment in terms of performance improvement. For example, time to complete the task
Strictly connected with Usability guidelines.

UX goals

Usability and UX goals can be overlapping, still UX goals are more subtle and difficult to assess and more dependent on the context.

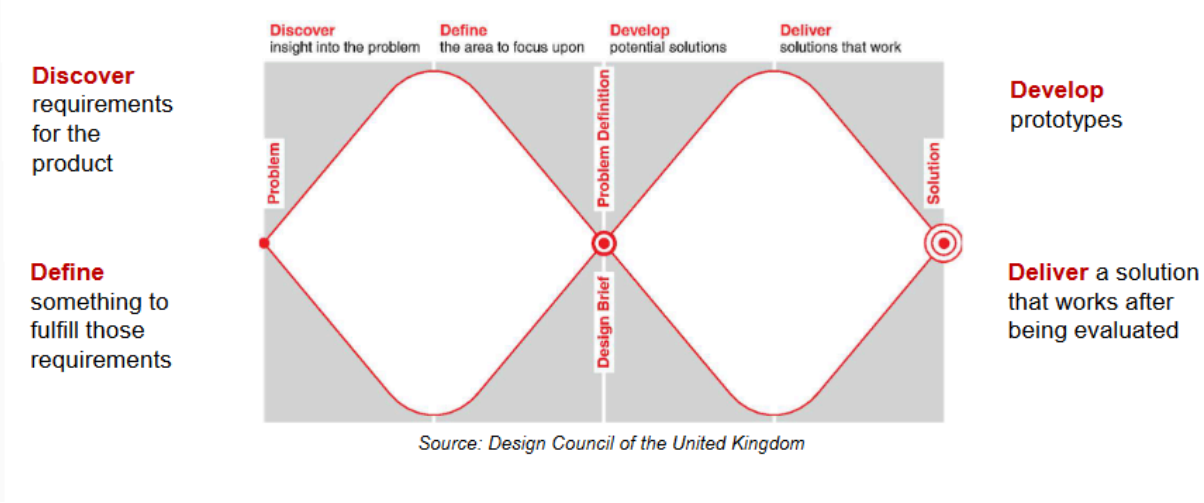
- Functionality-oriented meant to save the user's effort (and time)
- Smooth, flow-like experience to promote the user exploration of the website

Design principles

VISIBILITY
The more visible the functions, the easier will be for the user to know what to do and to understand the possible actions (e.g. download bar when installing something).
Is user has a mental model of how the machine works, it'll be easier to use
FEEDBACK
Sending back information about what action has been done and what has been accomplished to facilitate the progress of the activity
CONSTRAINTS
Ways for determining which kind of actions can be undertaken at any given moment.
Relevant for safety and security. Strong way to design to avoid errors
(PERCEIVED) AFFORDANCE
The attribute of an object that allows to understand how to use it (e.g. light switch)

The process of interaction design

Double diamond model of design



Source: Design Council of the United Kingdom

In interaction design we usually start by doing **user research**
Understanding who the user is, what he has to do, what he needs, where and how.
1. Discover: Designers try to gather insights about the problem.
2. Define: Designers develop a clear brief that frames the design challenge
3. Develop: Solutions or concepts are created, prototyped, tested, and iterated
4. Deliver: The resulting project is finalized, produced, and launched (programmers, bad :( )

Understanding the problem space

Exploring the context of use
Understanding the **problem space** is the key to understand how to design the interface
USER e.g., demographics, skills, desiderata…
CONTEXT OF USE e.g., on the move, working, multitasking, level of noise, brightness

The importance of involving users

Involving users in development is important because it's the best way to ensure that the end product is usable and that it will be used. Hard to balance users' expectations (expectation management) and leverage their knowledge.
It is likely to increase the sense of ownership

Participatory design | Co-design

Users are not passive recipients of the technology, rather they are directly involved in the process of design.

User-centered approach

Not only technology requirements, but also **user requirements** drive the design of the product. A well designed product will make the most out of human skills and judgements John Gould and Clayton Lewis enounced three principles for a “useful and easy to use computer system.”

“Early focus on users and tasks”
• Understand who the users will be
• Involve them in the design process

“Empirical measurements”
• Measure and analyze the reactions and performance of users both early in development and after with prototypes of the interface

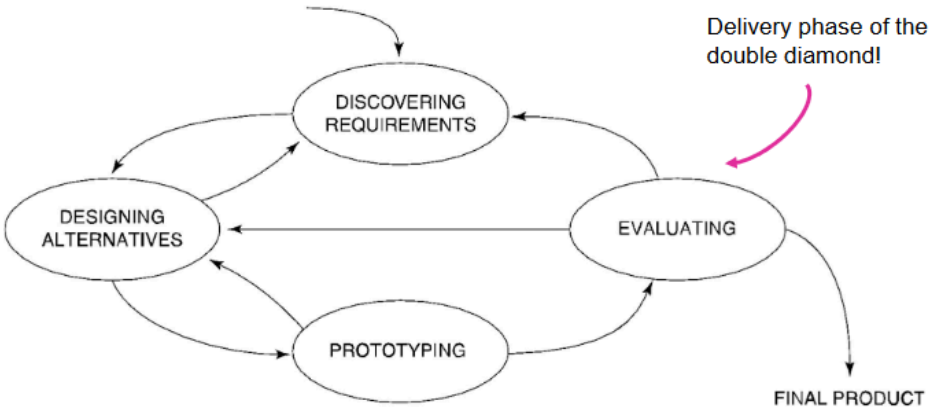
“Iterative design”
• Problems found in user testing are fixed and observed and tested again to see the effects of the fixes

Early focus on users and tasks
• Users’ **tasks** and **goals** are the driving force behind the development
• Users’ behavior and **context** of use are studied, and the system is designed to support them
• Users’ **characteristics** are captured and designed for
• Users are consulted throughout development **from earliest phases** to the latest
• All design decisions are taken within the **context of the users**, their **activities**, and their **environment**

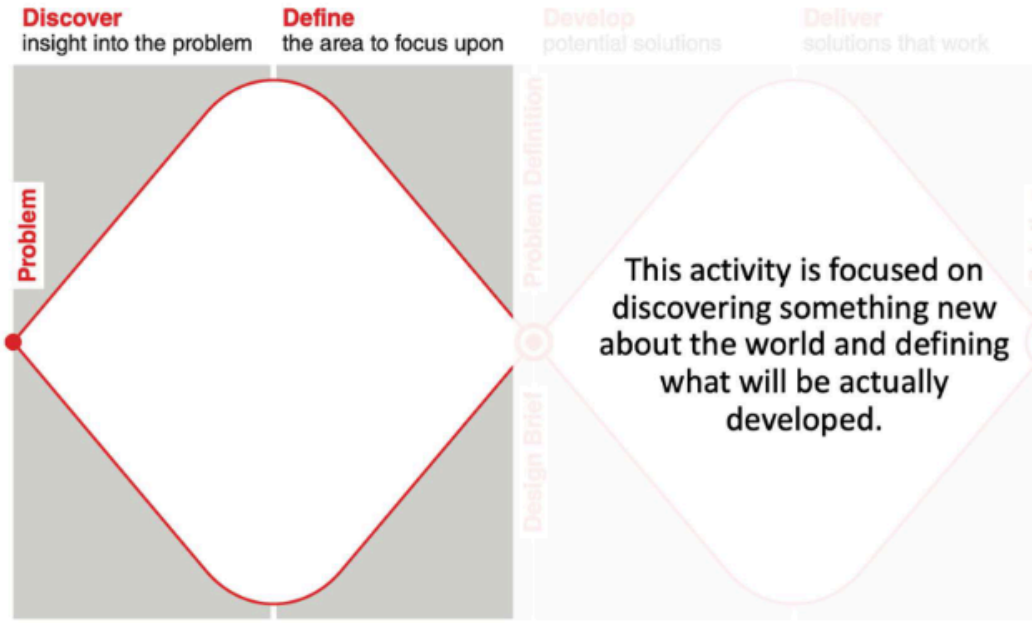
Empirical measurement
• Where possible, users’ behaviors should be measured (e.g., accomplishment time)

Iterative design
• Iteration requires design to be refined based on feedback

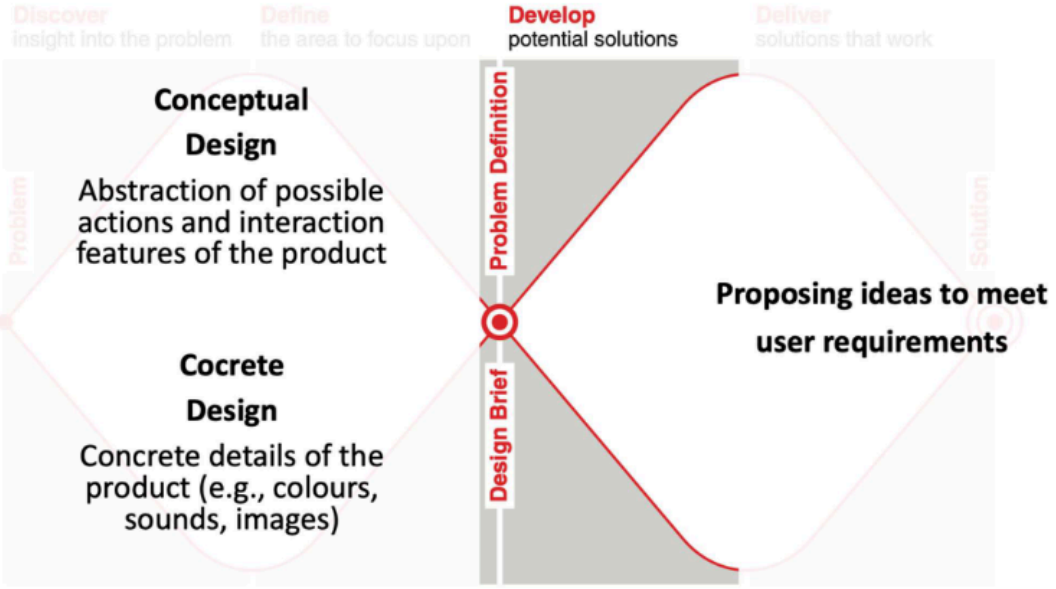
A simple lifecycle model for interaction design

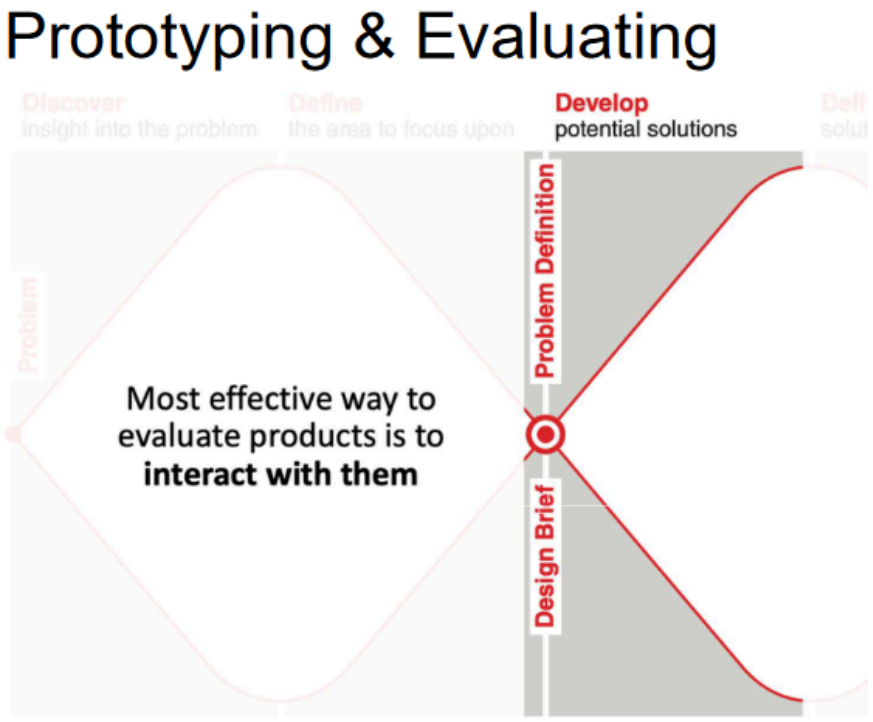


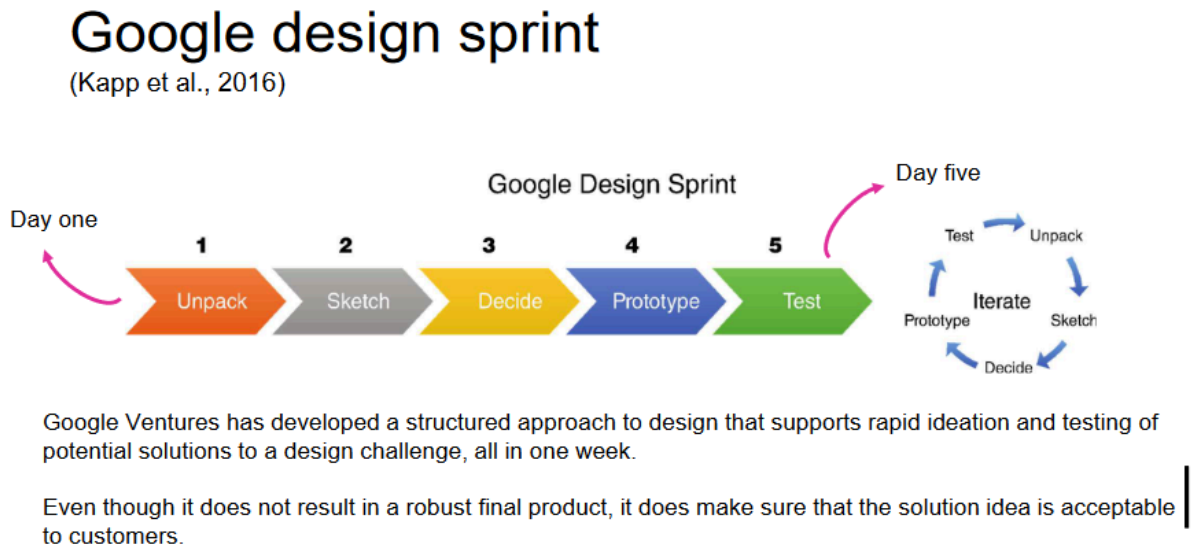
Discovering requirements



Designing alternatives







Google Ventures has developed a structured approach to design that supports rapid ideation and testing of potential solutions to a design challenge, all in one week.

Even though it does not result in a robust final product, it does make sure that the solution idea is acceptable to customers.

Research in the Wild

(Rogers & Marshall, 2017)
The in-the-wild approach emphasizes the development of novel technologies that are not necessarily designed for specific user needs, but to augment people, places, and settings. It investigates a theory about a behavior or other phenomenon using existing ones or developing a new one. It is concerned with evaluating in situ an existing device or novel research-based prototype when placed in various settings or given to someone to use over a

period of time. It covers the design space of an experience.

Users

(final) Users – Stakeholders

What are the users' needs?

In some cases simply asking "what do you need?" may be misleading.
It is much better to deeply analyze the context and understand what can be improved.

How to choose among alternative designs: A/B testing

A/B testing, also known as split testing, is a method used in marketing and product development to compare two versions of something (like a webpage, email, or app) to see which one performs better. It involves showing version A to one group and version B to another, then analyzing data to determine which version produces better results, such as higher click-through rates or more conversions. This helps businesses make data-driven decisions to optimize their strategies and improve performance.

Conceptualizing the interaction

At the initial stages of the design process, it is useful to conceptualize ideas → Proof of concepts
useful for:
- understanding the feasibility
- reasoning on clarity and users' needs
- defining the building blocks of the product

Conceptualizing the interaction

ASSUMPTIONS: taking something for granted that requires extra investigation
CLAIMS: something that is true, when it is still an open question
Explaining people's **assumptions** and **claims** about why they think might be a good idea enables the design team to view multiple perspectives on the design space and reveal conflicting ones. Should be done **early** and throughout the project

Need to conceptualize the design space > articulating the proposed solutions as a **conceptual model** → it can become a shared blueprint leading to a testable proof of concept

Multiple benefits:
- ORIENTATION > the team can ask specific questions about the model
- OPEN-MINDEDNESS > the team can explore a range of different ideas
- COMMON GROUND > the team establishes a common and agreed language

Conceptual model

“a high-level description of how a system is organized and operates”
Johnson & Henderson (2002)
Abstraction outlining what people can do with a product and what concepts are needed to understand how to interact with it.
METAPHORS AND ANALOGIES > convey how the product is to be understood
CONCEPTS > to which people are exposed through the product
RELATIONSHIPS BETWEEN CONCEPTS
MAPPINGS BETWEEN CONCEPTS AND UX
The organization of the components determines **UX**

The best conceptual model are those that appear **obvious** and **simple**
Complex conceptual models can be the result of multiple releases and improvements →
Users may stick to the well-known models and be reluctant to accept new ones
Most interface applications are actually based on well-established conceptual models.
Disruptive (cambiamenti radicali, rivoluzionari) conceptual models
Desktop → Prior to desktop users needed to know a command language. This made many tasks accessible to all
Digital spreadsheet → Made accounting highly flexible and easier
World Wide Web → Allowed anyone to browse a network of info remotely
Design concepts > set of ideas for a design, typically it consists of scenarios, images, mood boards, text-based docs

Interface metaphors

• They provide a structure that is similar to aspects of a familiar entity, but they also have their own behaviors and properties
• They are meant to provide familiar entities that enable people to readily understand the conceptual model

Cards (e.g. twitter interface)

Cards are familiar and allow to organize contents into meaningful chunks. They can be easily manipulated, and sorted

1. conceptualizing what we are doing: «Internet surfing»
2. instantiated a conceptual model at interface level
3. Visualizing an operation

Interaction types

• The ways in which a person interacts with a product or application
• Defining the interaction mode will help designers to better formulate the conceptual model
INSTRUCTING → CONVERSING → MANIPULATING → EXPLORING → RESPONDING

INSTRUCTING

the user issues instructions to the system → “Telling the system what to do”
When the interaction is designed on issuing instructions it results quick and efficient.
It is particularly fitting if frequent need to repeat actions performed on multiple objects (find and replace)

CONVERSING

the user and the system are having a conversation (two-way communication)
A conversational style of interaction allows people to interact with a system in a way that is familiar to them.
It is commonly used if user needs to find out specific kinds of information or wants to discuss issues. (siri, live chat bot)

MANIPULATING

manipulating objects based on users’ knowledge about the physical world
Human actions can be enabled by direct manipulation or through the usage of physical controllers or gestures.
Direct manipulation enable users to feel in control of the digital object:
• Continuous representation of the object and the action
• Rapid actions with immediate feedback
• Physical (direct) actions
BENEFITS
• helpful for beginners
• enable experts to work fast
• helpful for infrequent users (memorability)
• immediate feedback
DRAWBACKS
• not all tasks can be described by objects
• not all actions can be undertaken directly
• some activities are more suitable with commands issuing

EXPLORING

involves users moving through virtual/physical environments
Sensors embedded to enable natural exploration and interaction with an environment. It exploits the knowledge of existing space

RESPONDING

involves the system to take initiative e.g., alert or show something that it thinks can be relevant for the user.
Systems that prompts the user without being solicited (suggestion/notification from an app)

Paradigms, Visions, Theories, Models and Frameworks

Other sources of conceptual inspiration and knowledge used to inform design and guide research
PARADIGM → general approach that has been adopted by a community, and involves shared assumption, values, practices
Adopting a set of practices upon which a community has agreed
1980s: User-centered applications for desktop. WIMP (Windows, Icons, Menus, Pointer) and GUI paradigm
1990s: Ubiquitous computing
It's a computing paradigm that aims to seamlessly integrate digital technology into people's everyday lives, making it ubiquitous and easily accessible anywhere and anytime. Calm technology that stays in the background and activates unobtrusively when needed.
2000s: Big Data & IoT
Small and affordable sensors enable the collection and processing of large amount of data e.g., receiving notification about pollution level
VISION → future scenario that frames research and development
Apple Knowledge Navigator was as vision in 1987 and it became reality in 2011 with the launch of Siri. AI is expected to take over on many decisions that humans have to make (e.g., in-house temperature control) Concerns around transparency and accountability
THEORY → well-substantiated explanation of some aspect of a phenomenon
Integration of theories from cognitive science into design to come up with systems better suited for humans.
MODEL → simplification of some aspect of HCI meant to make it easier for designers to predict and evaluate
Don Norman (1988) developed models of user interaction based on theories of cognitive processing. Recent models predict what information users want in their interactions and core components of the user experience.
FRAMEWORK → set of interrelated concepts meant to inform a particular domain
To help designers constrain and scope the UX. They can come in a variety of forms.
Traditionally based on human behavior, but are increasingly including actual design practice

Interfaces

Input interfaces and output interfaces.
Interfaces can be named based on a function (e.g., adaptive), on a style (e.g., GUI), or the input-output device used (e.g., gesture-based interface).
Distinctions are often based on convenience and should be considered soft. A smartphone can be considered mobile, wearable, touch-based interface.

Command-line interface

The user types in commands (typically abbreviations). In some cases, the commands are fixed parts of the keyboard (e.g., delete). Widely replaced by GUI, they resist for highly specialized users or tasks.

Graphical User Interface (GUI)

Originally called WIMP.
Window > sections that can be scrolled, stretched, overlapped and moved with the mouse
Icons > pictorial representing applications, objected and tools that can be activated by clicking on them
Menus > lists of options that can be scrolled
Pointing device > a mouse controlling the cursor as a point of entry
Today they have been adapted for smaller displays and for touch-screen interaction

Window design

The original purpose of windows was to enable the user to work on several applications at the same time. The consequent issue was to find an efficient way to make all of them visible
Scroll bars also allow to expand the space.
Dialog boxes are also a common tool that guide the interaction.
An open issue with windows is how to arrange multiple of them so that the user can quickly switch. Research shows that the average interaction time with a window is very little (about 20 sec)

Menu design

Mappings between concepts and intended user experience. Typically placed on the top row and hidden, they show options only when selected.
Options are ordered based on frequency or grouped by similarity.
Flat menus: Good for showing large number of options at the same time when display is small. Options are nested
Dropdown menus: show many options on a single screen
Dropdown menus - cascading: require precise control
Contextual menus: related options are shown only when clicking on an item
Pop up menus: When pressed, command key for relevant options
Mega menus: All options shown using 2D drop-down layout

Icon design

Icons are assumed to be easier to learn and remember compared to text labels, especially for non expert users. They are designed to be placed everywhere in the screen.
Today they are pervasive (they represent apps, status, abstract actions).
They can be designed to represent objects and operations.

Multimedia

Combines different media within the same interface → better ways for presenting info
easier for learning, better for understanding, more engaging, more pleasant

Other interfaces

Website design

1990ies: Largely based on text, need to increase usability
Today: More attention on aesthetics and UX
The spread of smartphones and tablets made required a strong revision of website design

Mobile devices

They also feature sensors that further amplify interaction opportunities

Appliances

Appliances include machines for everyday use in the home. They are used to get a specific thing done efficiently. Users are **unlikely** to be willing to explore the interface. Some are connected and controllable remotely.

Voice user interface

The user talks with the system, typically to retrieve a specific piece of information

Pen-based interfaces

Touchscreens

Multitouch enables group interaction, Gestures, Direct manipulation

Gesture-based systems

Very useful when touch can be cumbersome (dirty hands)
Possible fatigue issues (gorilla arm)
Possible generalizability issues (culture)
Possible recognition issues

Haptic interfaces

Tactile feedback to the user by applying vibration or force to provide e.g. feedback or guidance

Multimodal interfaces

Meant to enrich the UX by multiplying the way information is experienced and controlled at the interface through using different modalities, such as touch, sight, sound, and speech

Shareable interfaces

Meant to be used by multiple users at the same time (e.g. google doc)

Tangible interfaces

Tangible interfaces use **sensor-based interaction**, where physical objects, such as bricks, balls, and cubes, are coupled with digital representations

Virtual Reality

Computer-generated environment that enables the user to interact, creating engaging experiences. Depending on the technology in use, it can be more or less immersive and feature also audio and haptic stimulation. Generally, provide high Sense of presence

Augmented reality

seeing 3d object through your phone

Wearable

Devices that can be worn on the body

Brain computer interface

Provide a **communication pathway** between a person's brain waves and an external device, such as a cursor on a screen or a tangible puck that moves via airflow. Requires training

Smart interfaces

Devices designed to interact with users and other devices connected in a network. Typically, they reduce the likelihood of human error

Natural User Interfaces

• Designed to allow the user interact with a computer in the same way they interact with the physical world (e.g., voice, gesture)
• Depends on: Required learning, Interface complexity, Need for accuracy & speed (Norman, 2010).
• Sometimes a gesture > words; other times, a word > gestures.
• Key Factor: System's function support.
How natural is it?

Cognitive Aspects

What is cognition?

THINKING
REMEMBERING
LEARNING
DAY-DREAMING
DECISION MAKING
SEEING
READING
TALKING

EXPERIENTIAL
people perceive, act and react to events intuitively and effortlessly. Requires expertise and engagement e.g., driving, reading
REFLECTIVE
involved mental effort, attention, decision-making, can lead to new ideas and creativity e.g., designing, learning

FAST THINKING
instinctive, reflexive, effortless, no sense of voluntary control (e.g. 2+2)
SLOW THINKING
takes time, logical and demanding, requires concentration (e.g. 21*19)

Cognition can be also described in terms of processes, such as:
ATTENTION → PERCEPTION → MEMORY → LEARNING → READING, SPEAKING, LISTENING → PROBLEM SOLVING, REASONING
Interdependent processes

Attention

Selecting things on which to concentrate at a point in time from the mass of stimuli around us. Having a **clear goal** is crucial, because we will try to match available info with what we need.
Differently, we may simply skim through available info.
Information presentation is important because it can improve reading speed

Multitasking

We multitask when we frequently switch attention among different tasks. Is it possible to perform multiple tasks without one or more of them being **detrimentally affected**?
It depends on the nature of the tasks and how much attention each demands.
Lotteridge et al., 2015
Participants were asked to write an essay in two “distraction” conditions: relevant information (no impact) and irrelevant information (negative impact).
Irrelevant information:
• overloads people’s capacity to focus
• requires additional effort
• increases the time required to accomplish a task
However…
while heavy multitaskers are easily distracted, they can also put this to good use if the distracting sources are **relevant** to the task in hand

Modern workplaces increasingly require workers to multitask. For example, hospital workers have to attend to multiple screens in an operating room that provide different kinds of real-time multi-modal information.
They must keep constant attention to check if any data is unusual or anomalous. They need to develop new attention and scanning strategies looking out for anomalies
Interaction designers try to make it easier! For example, ambient displays activating only when something needs attention (i.e., flashing arrows)

Design implications

Consider context: Make information salient when it requires attention at a given stage of a task
Use techniques to achieve attention: Use animated graphics, color, underlining, ordering of items, sequencing of different information, and spacing of items.

Avoid cluttering too much information: especially for color and graphics which might distract and annoy rather than help
Design different ways for switching and returning to the interface: This could be done subtly, such as the use of pulsing lights gradually getting brighter, or abruptly, such as the use of alerting sounds or voice.

Perception

It refers to:
• How information is acquired from the world and transformed into experiences of objects
• It involves memory, attention and language
With respect to **interaction design** it is important to present information in a way that can be **readily perceived** in the manner it was intended

Design implications

• **Icons** should enable users to distinguish their meaning readily
• **Bordering and spacing** are effective visual ways of grouping information
• **Sounds** should be audible and distinguishable
• Research proper **color contrast** techniques when designing an interface
• **Haptic feedback** should be used judiciously
Besides general indications, we can find specific design implications involving perception in dedicated textbook and scientific articles e.g., here we can find 3 chapters on guidelines regarding visual perception.

Memory

It refers to:
Recalling various kinds of knowledge that allow people to act properly
Filtering data to decide what information gets further processed and memorized
Stages of memory:
Encoding is first stage of memory → More attention to something → More it is processed → More it is remembered

The effect of context

A factor that affects the extent to which information can be subsequently retrieved is the context in which it is encoded. It can be difficult for people to recall information that was encoded in a different context from the one in which they are at present:
You are on a train and someone comes up to you and says hello. You don't recognize this person for a few moments, but then you realize it is one of your neighbors. You are only used to seeing them in the hallway of your apartment building and seeing them out of context makes this person initially difficult to recognize

People do not process as much information about an object when taking photos of it (recognition) compared with when they are actually looking at it (recall). We focus more on framing the photo and less on the details of the object being photographed.

Personal information management

A growing problem for many users is that:
• They accumulate a **vast numbers of information** e.g. on a phone, on a computer, or in the cloud (Personal Information Management; PIM)
• They **struggle** remembering how they called a file or where they stored it
For **interaction design** it is important to find the best way of helping users organize their content so that it can be easily searched, for example, via folders, albums, or lists.

PIM: Apple's spotlight search tool

A number of search and find tools help users with searching files:
• By typing a partial name or even the first letter of a file that it then
• searching throughout the entire system, including the content inside documents, apps, games, emails, contacts, images, calendars, and applications
• Creating a list of files that Spotlight matched to the word cognition, categorized in terms of documents, mail and text messages, PDF documents, and so on

Online/mobile and phone banking now require users to provide information that only they know (ZIP code, birthplace, a memorable address etc.) to access their account known as multi factor authentication (MFA) for increased security.
However, the biggest problem is that it puts a big **memory load** on customers. Software companies have developed password managers to help reduce memory load. An example is LastPass.

Digital forgetting

When contents are emotionally painful to be reminded, you might wish to forget something that is online. Sas and Whittaker (2013) suggest ways of harvesting and deleting digital content:
• **facial recognition**, which dispose all the pictures related to someone without the person needing to go through them personally and be confronted with painful memories
• during a breakup, people could create a **collage** of their digital content connected to the ex, so as to transform them into something more abstract

Memory aids

Is a wearable device that intermittently takes photos without any user intervention, providing a record of the events that a person experienced. It has been found to improve people's memory, especially those suffering from dementia.

Design implications

• Reduce cognitive load by **avoiding long and complicated procedures** for carrying out tasks
• Design interfaces that **promote recognition** rather than recall
• Provide users with **various ways of labelling** digital information to help them easily identify it again

Learning

Intimately **related to memory**: it involves the accumulation of skills and knowledge that would be impossible to achieve without memory, and we would not be able to remember things unless we had learned them.
INCIDENTAL
It occurs **without any intention to learn**. E.g., learning about the world such as recognizing faces, streets, objects, and what you did today.
INTENTIONAL
It is **goal-directed** with the goal of being able to remember it E.g., studying for an exam, learning a foreign language, and learning to cook. This is **much harder** to achieve

Learning by doing

When it comes to intentional learning, people find it hard to learn by following instructions in a manual and prefer to learn by doing.

Design implications

• Design interfaces that **encourage exploration**
• Design interfaces that constrain and **guide** learners
• Dynamically **linking concepts** and representations can facilitate the learning of complex material

Reading, speaking and listening

Three forms of **language processing**. Specific differences between the three modes include the following:
• Written language is **permanent** while listening is **transient**. Moreover, written language tends to be grammatical, while spoken language is often ungrammatical.
• **Reading can be quicker** than speaking or listening, as written text can be rapidly scanned.
• Listening requires **less cognitive effort** than reading or speaking

Applications

• Speech-recognition systems: They allow people to interact with them by using spoken commands (e.g., Google Voice Search, Amazon Echo, Google Home)
• Speech-output systems that use artificially generated speech (for instance, written text-to speech systems for the blind)
• Natural-language interfaces that enable people to type in questions and get written responses (e.g., chatbots).
• Interactive apps that are designed to help people who find it difficult to read, write, or speak.
• Tactile interfaces that allow people who are visually impaired to read graphs (for example, Designboom’s braille maps for the iPhone).

Design implications

• Short speech-based menus and instructions (e.g., no more then 3-4 options in a menu)

• 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 formatting

Problem solving, planning, reasoning, and decision-making

• They are processes involving **reflective cognition**
• They include thinking about what to do, what the available options are, and what the consequences might be of carrying out a given action
• They often involve conscious processes
• Reasoning involves working through different scenarios and deciding which is the best option or solution to a given problem.
Research in cognitive psychology has shown how people tend to use **simple heuristics** when making decisions (Gigerenzer et al., 1999).

Design implications

We typically ignore most of the available information and rely only on a few important cues → Providing information and help pages that are easy to access for people who wish to understand more about how to carry out an activity more effectively
An effective design strategy is to make key information about a product highly salient → Using simple and memorable functions to support rapid decision-making and planning (One solution is to exploit new forms of augmented reality and wearable technology)

DILEMMA

The app mentality is generating difficulties for people to make their own decisions because they are becoming risk averse (Gardner and Davis, 2013). Instad, they rely on a multitude of apps.
• This makes them increasingly anxious
• They are unable to make decisions by themselves
• They need to resort to looking up info, getting other’s opinions on social media, and comparing notes

Cognitive frameworks

Used to **explain and predict user behavior** with the interface
Based on theories of behavior – Focus on mental processes that take place
Most well known:
• Mental models
• Gulfs of execution and evaluation
• Distributed cognition
• External and embodied cognition

Mental models

Mental models are used by people when they need to reason about a technology, in particular, to try to imagine what to do when something unexpected happens with it or when encountering unfamiliar products for the first time.
The more we learn about a product and how it works, the more our mental model develops.
Users develop an understanding of a system through learning about it and using it.
Knowledge is sometimes described as a mental model:
• How to use the system (what to do next)
• What to do with unfamiliar systems or unexpected situations (how the system works)
People make inferences using mental models of how to carry out tasks

Using UX to improve

People are resistant to spending much time learning about how things work, especially if it involves reading manuals or other documentation.
An alternative approach is to design technologies to be more transparent (intuitive to use), providing for:
- Clear and easy-to-follow instructions
- Appropriate online help, tutorials in the form of online videos and chatbot windows, where users can ask how to do something
- Background information that can be accessed to let people know how something works
- Affordances of what actions an interface allows (for example, swiping, clicking, or selecting)

Gulfs of execution and evaluation

Designers and users need to concern how to bridge gulfs to reduce cognitive effort needed to perform a task:
- designing the interface to match users' psychological characteristics
- learning to create goals to match the interface functioning

Information processing

The information processing model provides a basis from which to **make predictions about human performance**.
Hypotheses can be made about:
• how long someone will take to perceive and respond to a stimulus (reaction time)
• what bottlenecks occur if a person is overloaded with too much information.

Distributed cognition

Most cognitive activities involve people interacting with external kinds of representations.
Distributed cognition is meant to study the nature of the cognitive phenomena across individuals and artifacts, internal and external representations.
This approach focuses on what happens across a system of individuals and artifacts

External cognition

External cognition aims at explaining the cognitive processes involved when we interact with external representations.
The goal is to explain the cognitive benefits of using different representations for different cognitive activities and processes.
Reducing memory load: transforming knowledge into external representation to offload memory
Computational offloading: using a tool together with an external representation to carry out a computation
Cognitive tracing: reflecting changes that we want to mark

Embodied interaction

Practical engagement with the social and physical environment, involving creating, manipulating and making meaning through our engaged interaction with physical things.
In this perspective, out ability to think abstractly is the results of our sensorimotor experiences with the world.
Interacting with tools changes the way in which we think and perceive the environment.