Universidade de Aveiro
Departamento de Electrónica,
Telecomunicações e Informática

Usability Principles and Paradigms

(Donald Norman, Design of everyday things)

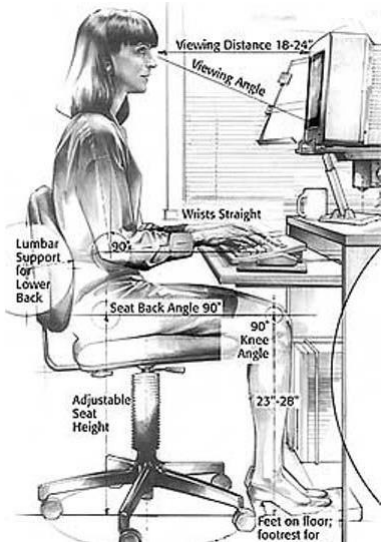
Beatriz Sousa Santos, 2023

- Introduction
- History
- Usability and standards
- Principles
- Paradigms

- During and after the World War II the following disciplines emerged:

Ergonomics – more focused on physical aspects

Human factors – also cognitive aspects



Ergonomics- The science of fitting workplace conditions and job demands to the capabilities of the working population
https://www.cdc.gov/niosh/topics/ergonomics/ergoprimer/default.html

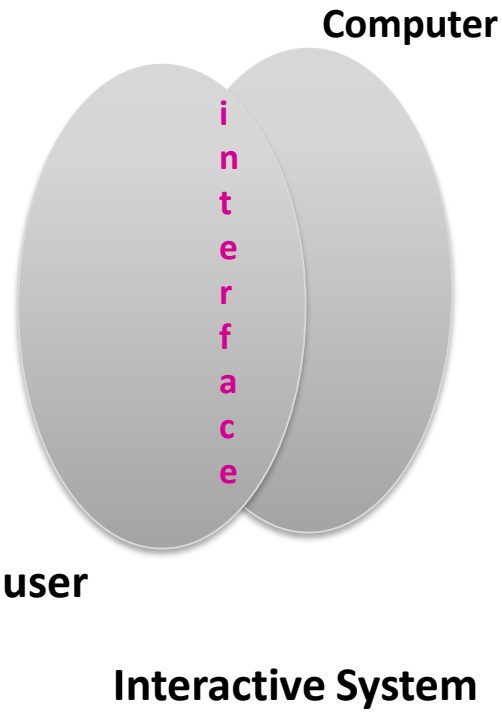
Ergonomics and Human Factors

- Interaction emerged as new independent field within Computing in the 80s, mainly due to:
  - Lower price of technology
  - Technology migration
  - Need to increase users' productivity

Man-Machine Interaction → (nighties) **Human-Computer Interaction**

- It expanded rapidly
- It is currently an interdisciplinary field
- Human-Centered Computing is an ACM scientific area within Computing (also at the University of Aveiro)

Interactive systems design



- Interactive systems include a “part” which we don´t control:

  The user, who:

  - is very complex
  - not well known
  - we cannot control

(and users may be very different)

This makes design difficult

- User Interface (UI) is the means by which the user and a computer system interact
- To the user **“the interface is the system”**
- The user interface design involves a considerable effort

Interactive system design – Human-Centered design

- Involves knowing:

  Methods

  Usability principles (independent from technology)

  Usability paradigms (more technology dependent)

  como para concorrerem a bolsas e posições,

- We must know the **success examples** (usability paradigms)

- Understand **why they work** (usability principles)

- Use the **adequate methods** (user-centered approach)

  \+ **Evaluation**

- And **test**, re-design,

  test, redesign

  …

  until we attain the usability goals

- **Usability** is, according to **ISO 9241-11**:

"the extent to which a product can be used by **specified users** to achieve specified goals with **effectiveness**, **efficiency** and **satisfaction** in a **specified context of use**"

- Effectiveness + efficiency -> **ease of use**

- **Satisfaction** is also very important

Standards evolve:

- ISO 9241-11's three factors of usability have become five in by **ISO 25010**'s **quality in** use factors:
- Effectiveness
- Efficiency
- Satisfaction
- Freedom from risk
- Context coverage

https://www.iso.org/standard/35733.html

- **User Experience (UX)** is:

“ person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service”

- UX includes all the users' emotions, preferences, perceptions, physical and psychological responses, … that occur before, during and after use

- UX is **broader than usability**, it includes other aspects…

- Usability criteria can be used to assess aspects of user experience.

https://www.iso.org/obp/ui/#iso:std:iso:9241:-210:ed-1:v1:en

Usability

- Is directly related to the system capacity to allow users **attaining their goals through its usage**

- Fundamental aspects:

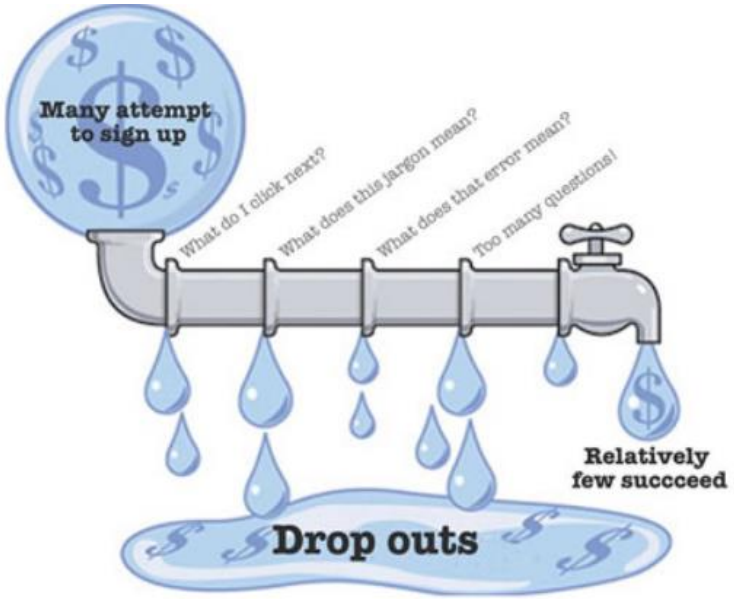
  - **easy to use** (fast and with few errors) (efficiency, efficacy-> performance)

  - **satisfaction**

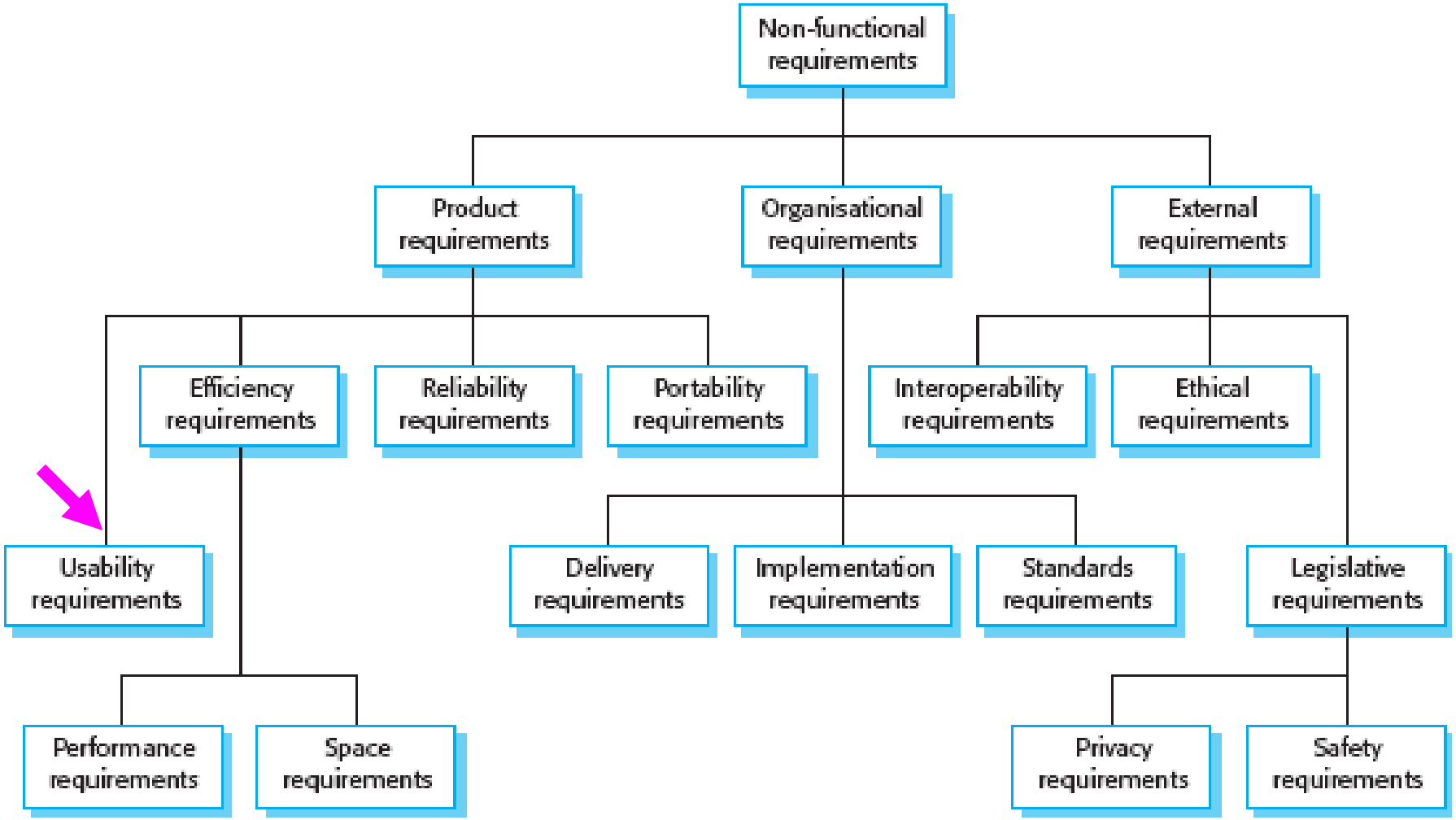
  Is defined in a **context of use**: is a system property of allowing specific users to perform specific tasks efficiently with efficacy and satisfaction

- Easy to learn and remember (learnability, memorability) is a related aspect

- Main usability benefits:
  - Higher user performance and satisfaction
  - Lower development costs
  - Lower support costs …
    - **Higher profits for everyone!**

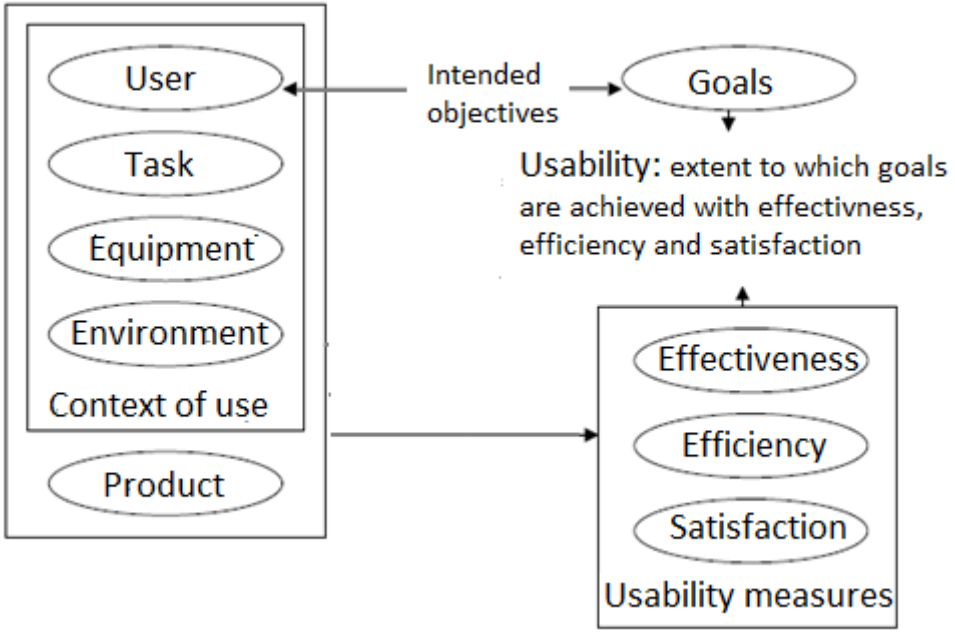


Usability is a non-functional requirement



Ian Sommerville, *Software Engineering*, 9th ed., Addison Wesley, 2011

Usability standards



- ISO 9241-11 **(1998)**

Ergonomic requirements for office work with visual display terminals
Part 11 : Guidance on usability

Explains how to identify the information needed to specify or evaluate usability in terms of measures of:

- performance
- satisfaction

- **ISO 13407 -> ISO 9241-210 (2010)**

Human-centred design processes for interactive systems

- And others related ISO 13.180 **Ergonomics**

- **ISO 13407 adresses:**

- **… Four Principles of Human-Centered Design:**

  - active involvement of users
  - appropriate allocation of function to system and to user
  - iteration of design solutions
  - multi-disciplinary design

- **... and Four Human-Centered Design Activities:**

  - understand and specify the context of use
  - specify user and organizational requirements
  - produce more than one candidate design solution
  - evaluate designs against requirements

- **ISO 9241-112:2017**
- **Ergonomics of human-system interaction — Part 112:**
- **Principles for the presentation of information**

- **…** establishes ergonomic design principles for interactive systems related to the software-controlled presentation of information by user interfaces.

- It applies to the three main modalities
  visual, auditory, tactile/haptic

- These principles apply to the perception and understanding of presented information
- are applicable in analysis, design, and evaluation of interactive systems
- **…**

https://www.iso.org/standard/64840.html

Paradigms

- Examples of creative insight that enhanced interaction along the history of computing
- Inspirations for a conceptual model
- General approach adopted by a community for carrying out research
  - Shared assumptions, concepts, values, and practices
  - For example, desktop, ubiquitous computing, in the wild

Some usability paradigms (along the history of computing)

(VDUs)

Video Display Unites (VDUs) (1950s)

Time sharing (1960s)

WIMP (Windows, Icons, Menus, Pointers) (1980s)

(WIMP)

Direct manipulation (1980s)

WWW (1990s)

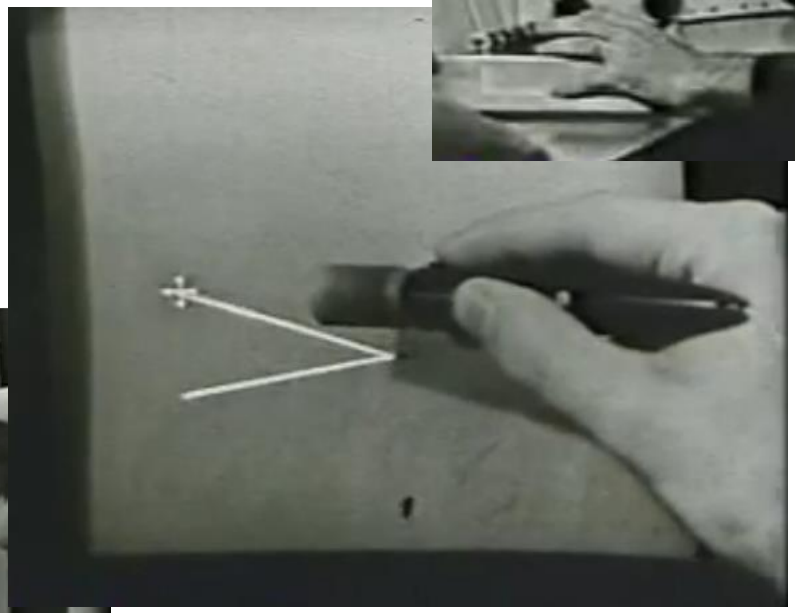
Ubiquitous computing (1990s)

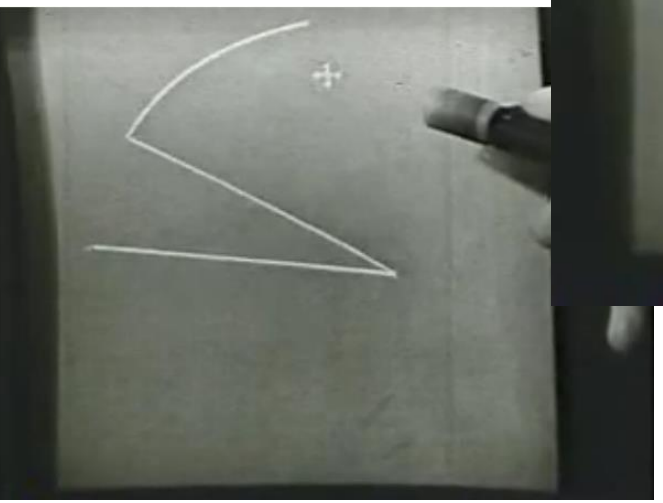
Wearable Computing (1990s)

(anytime, anywhere…)

(networking everything ...)

Sketchpad
(Ivan Sutherland, 1963)





https://www.youtube.com/watch?v=6orsmFndx_o

Alto and Macintosh

^

Apple Macintosh 512KB, 1984

< Xerox PARC, 1973

Ubiquitous computing (Ubicomp)

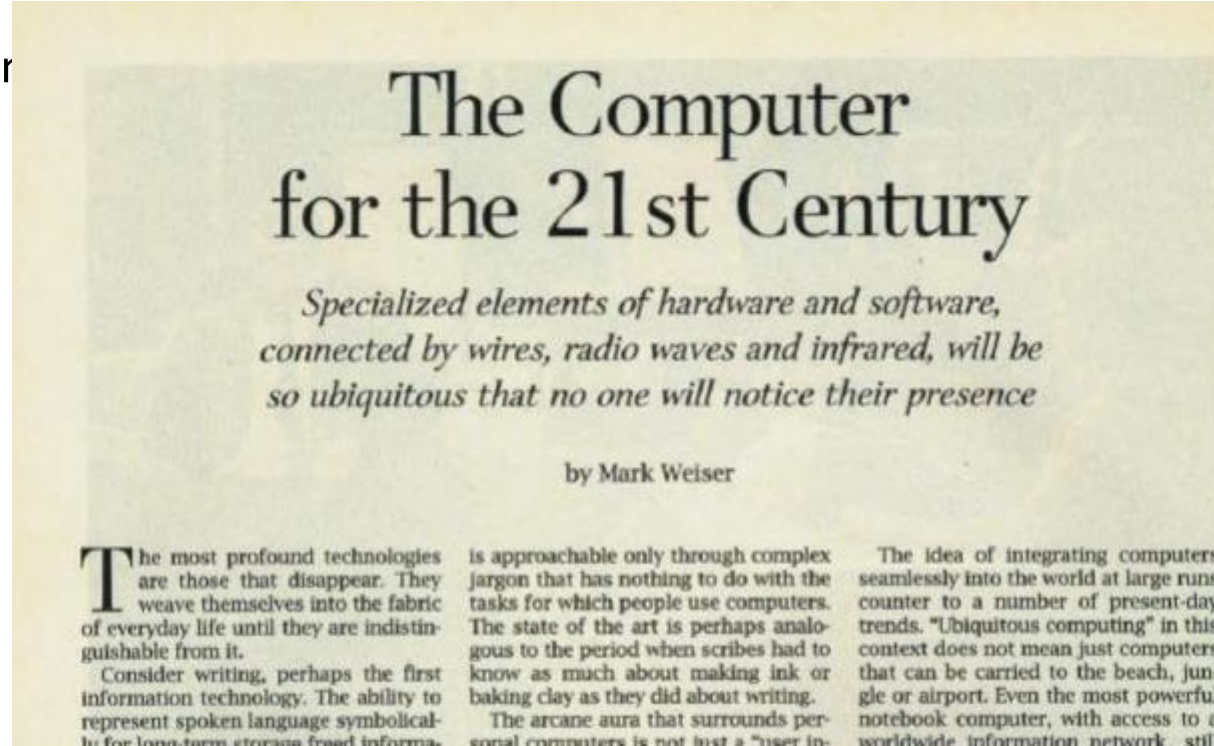
Mark Weiser, “The Computer for the 21st Century”, Scientific American, Sept 1991, pp. 94-104

https://www.ics.uci.edu/~corps/phaseii/Weiser-Computer21stCentury-SciAm.pdf

https://dl.acm.org/doi/10.1145/329124.329126

- Computing everywhere ar

- Related concepts:
  - Pervasive computing
  - Ambient intelligence
  - Cyber-physical computing
  - Internet of things
  - Haptic computing



The Computer for the 21st Century

Specialized elements of hardware and software, connected by wires, radio waves and infrared, will be so ubiquitous that no one will notice their presence

by Mark Weiser

The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

Consider writing, perhaps the first information technology. The ability to represent spoken language symbolically for long-term storage freed informa-

is approachable only through complex jargon that has nothing to do with the tasks for which people use computers. The state of the art is perhaps analogous to the period when scribes had to know as much about making ink or baking clay as they did about writing.

The arcane aura that surrounds per-

The idea of integrating computers seamlessly into the world at large runs counter to a number of present-day trends. "Ubiquitous computing" in this context does not mean just computers that can be carried to the beach, jun gle or airport. Even the most powerfu notebook computer, with access to a worldwide information network, stil

- Ubiquitous computing involves:

  - small, inexpensive, robust networked processing devices
  - distributed at all scales throughout everyday life

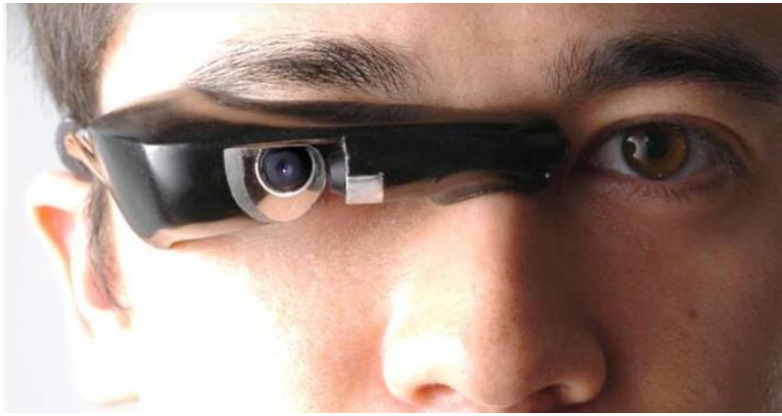
- Examples:
  - refrigerators "aware" of their suitably tagged contents
  - domestic control illumination and heating, continuously and imperceptibly considering the occupants

- Ubiquitous computing presents challenges across computer science:
  in systems design and engineering, in systems modelling , in user interfaces

https://www.youtube.com/watch?v=TrffIHzupTY

http://www.youtube.com/watch?v=CbGw1fX9tMk

Wearable computing



Steve Mann's 'GlassEye™' (aka EyeTap)

“the study or practice of inventing, designing, building, or using miniature body-borne computational and sensory devices. Wearable computers may be worn under, over, or in clothing, or may also be themselves clothes, i.e. "Smart Clothing" (Mann, 1996a).

Other terms: "Body-Borne Computing" or "Bearable Computing"

https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/wearable-computing

Usability principles (a possible list)

User compatibility

Task compatibility

Work-flow compatibility

Product compatibility

Feedback

Coherence

Familiarity

Simplicity

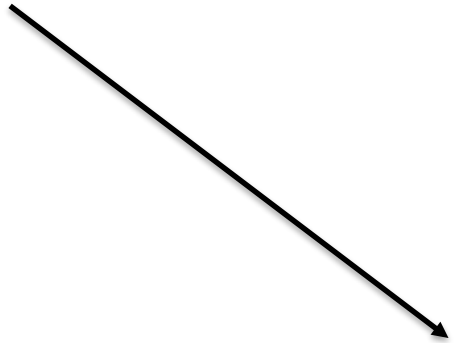
Flexibility

Control

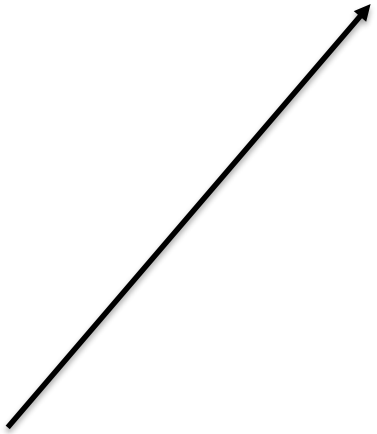
Technology invisibility

Robustness

Error protection



Usability goals:
Easy to learn and memorise
Easy to use
Satisfaction



Principles should be used in interactive computing systems…

More conventional …

other devices …

less conventional interactive computing systems…

and critical interactive computing systems…

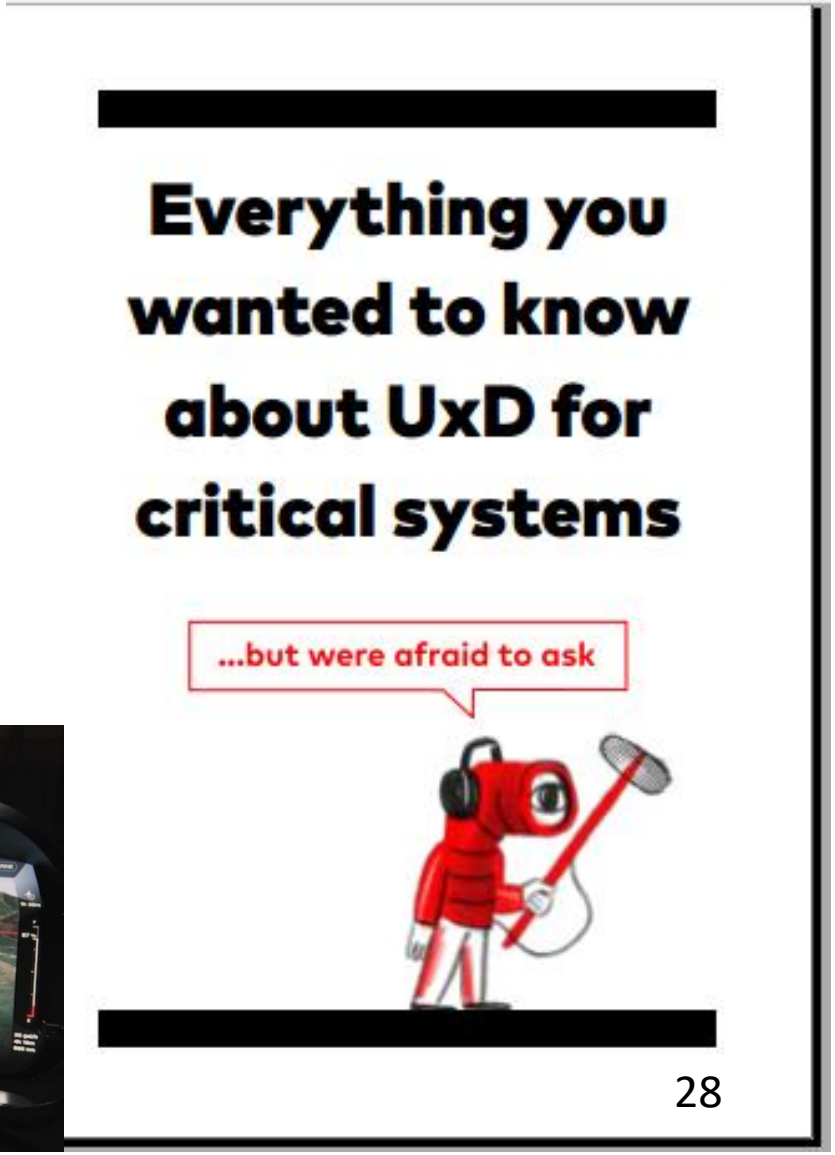
- E.g. medical devices:

https://criticalsoftware.com/en/news/uxd-taking-over-the-medical-device-industry

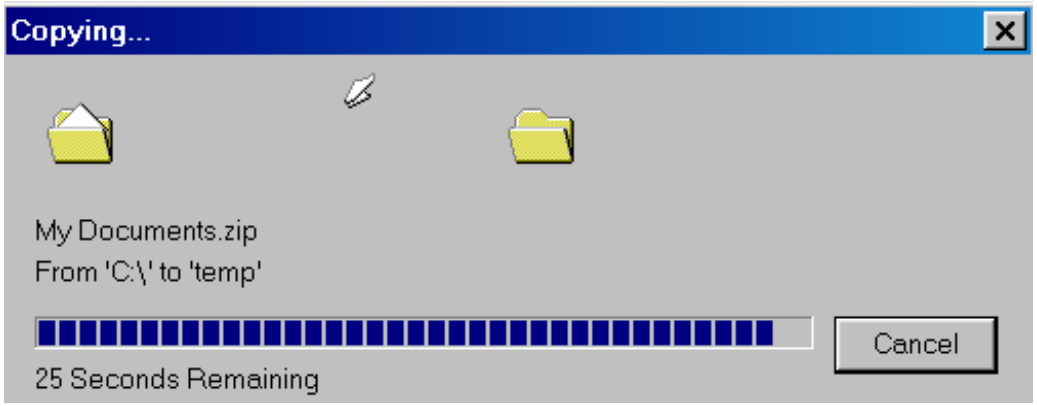
From the cockpit displays in planes to the dashboard layouts in cars, design can literally be a matter of life and death.

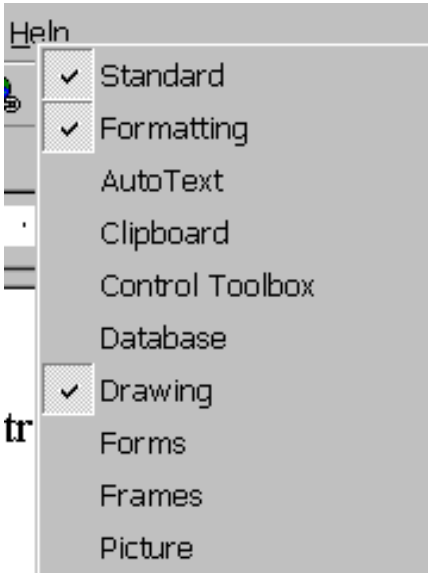
- or avionics:

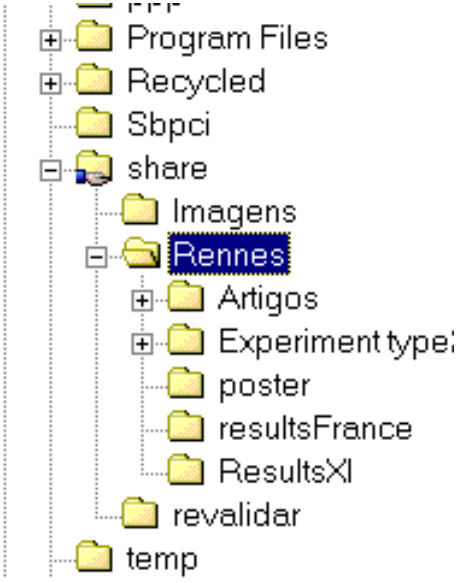
https://rightware.com/blog/modernizing-aircraft-cockpits-with-automotive-ui-design-knowhow/



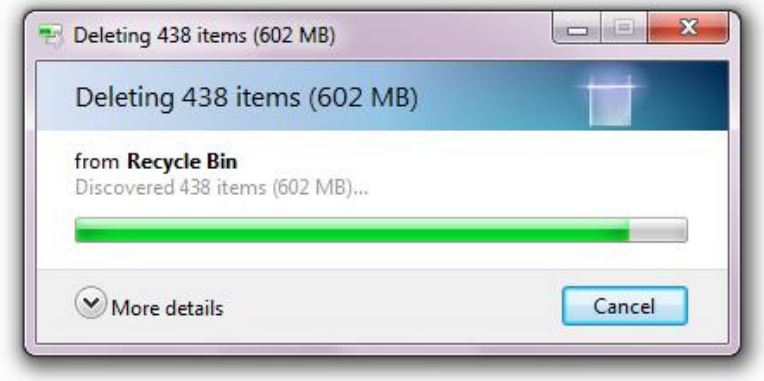
Feedback (the past)
Visibility of the system status

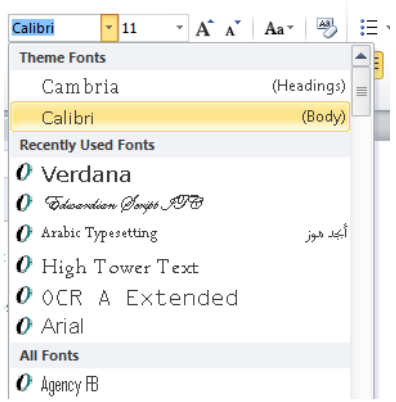


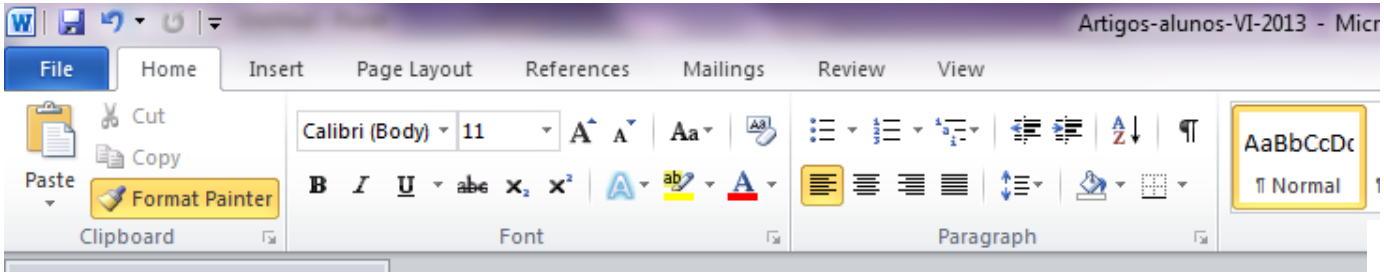


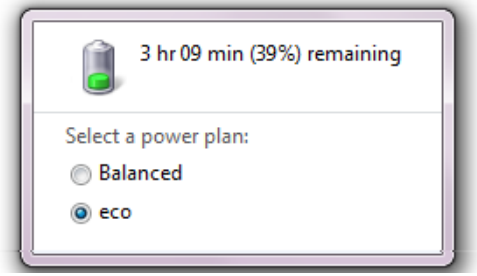


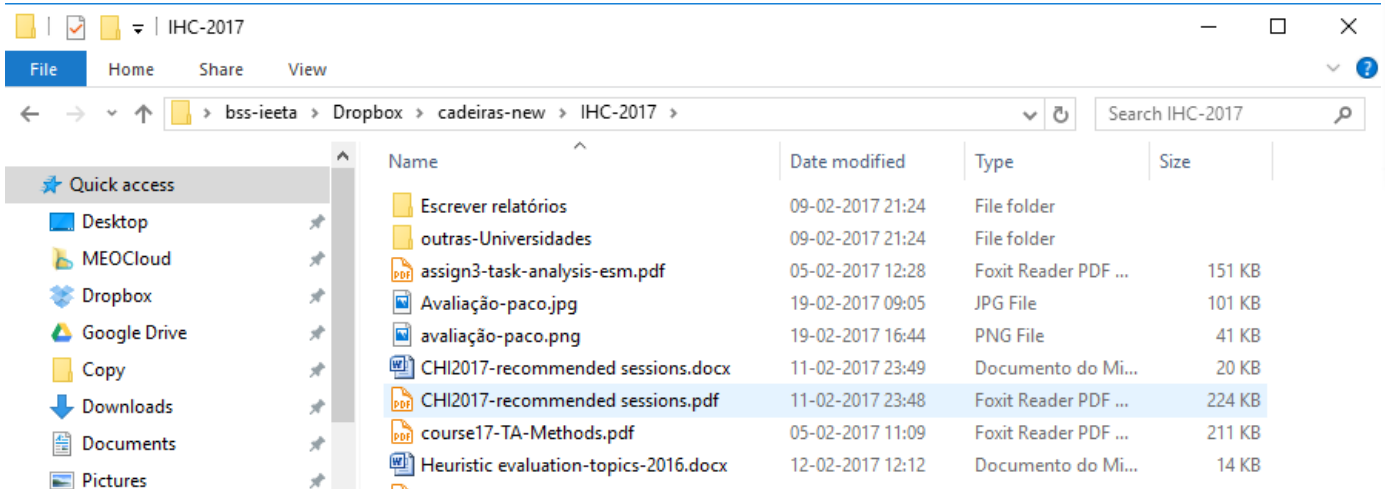
Visibility of the system status, Feedback (in more conventional platforms)

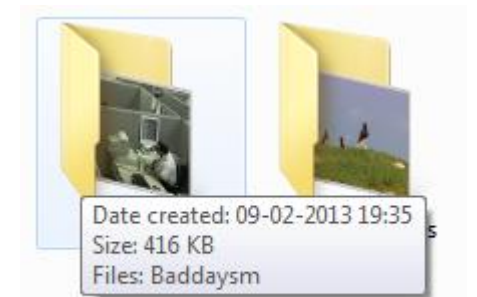












Feedback
Visibility of the system status

TV off

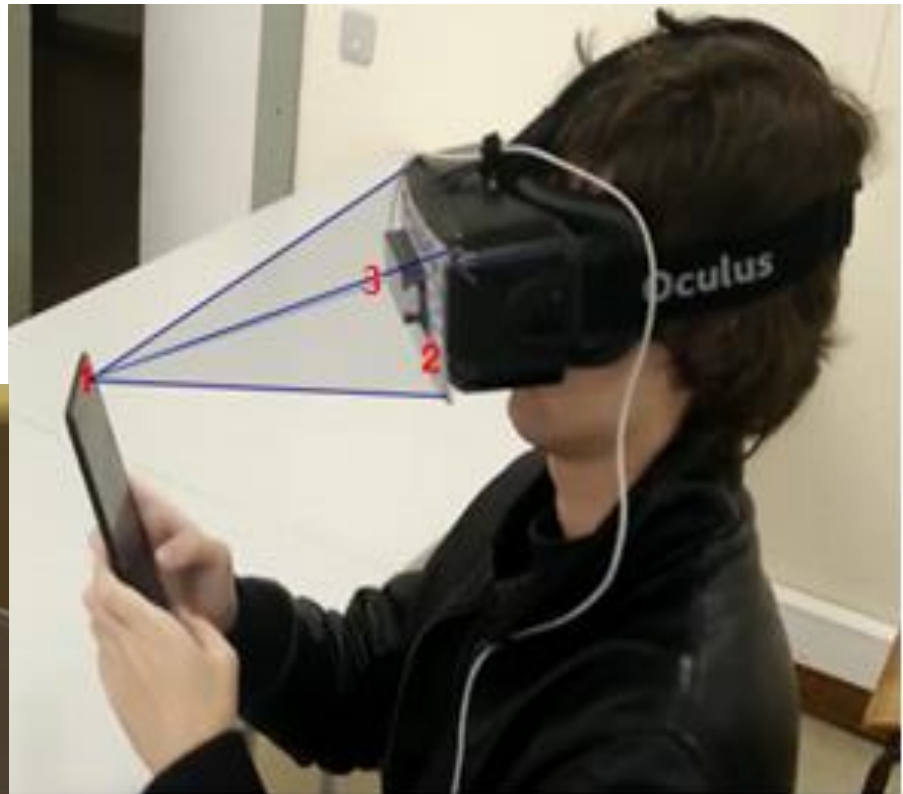
ON

TV on

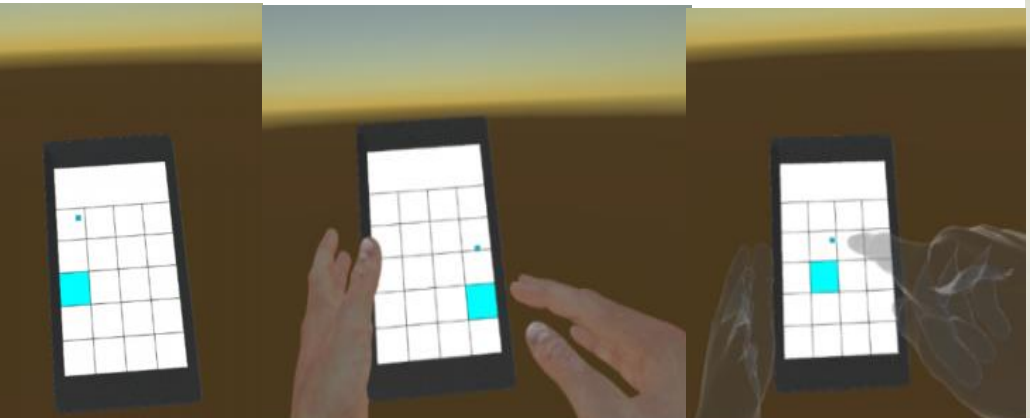
Feedback
Visibility of the system status

In a virtual reality system it is important to have:

- Feedback in tasks (navigation, manipulation, selection …)
- Visibility concerning body position (avatar)
- …

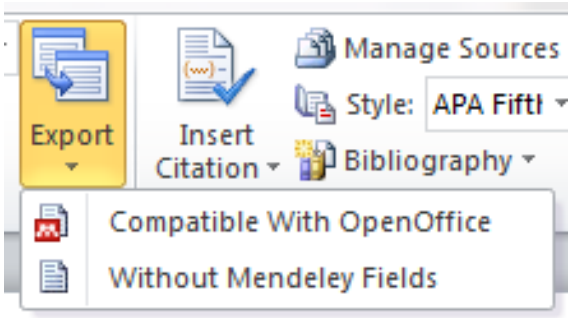


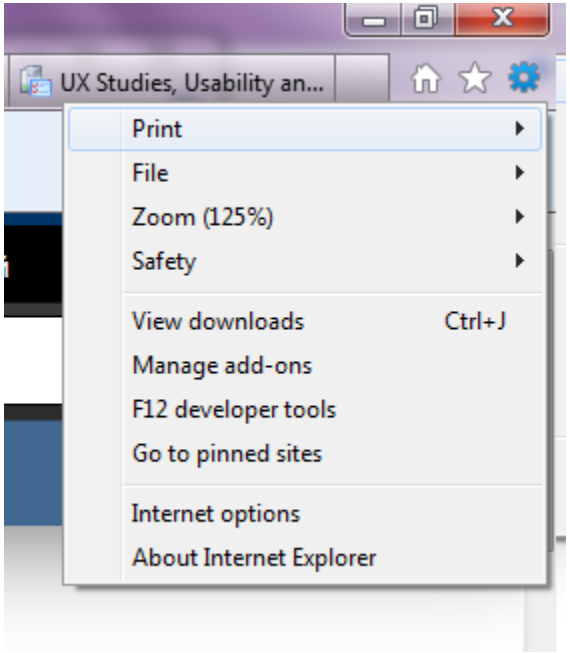
No avatar Realistic avatar Translucent avatar

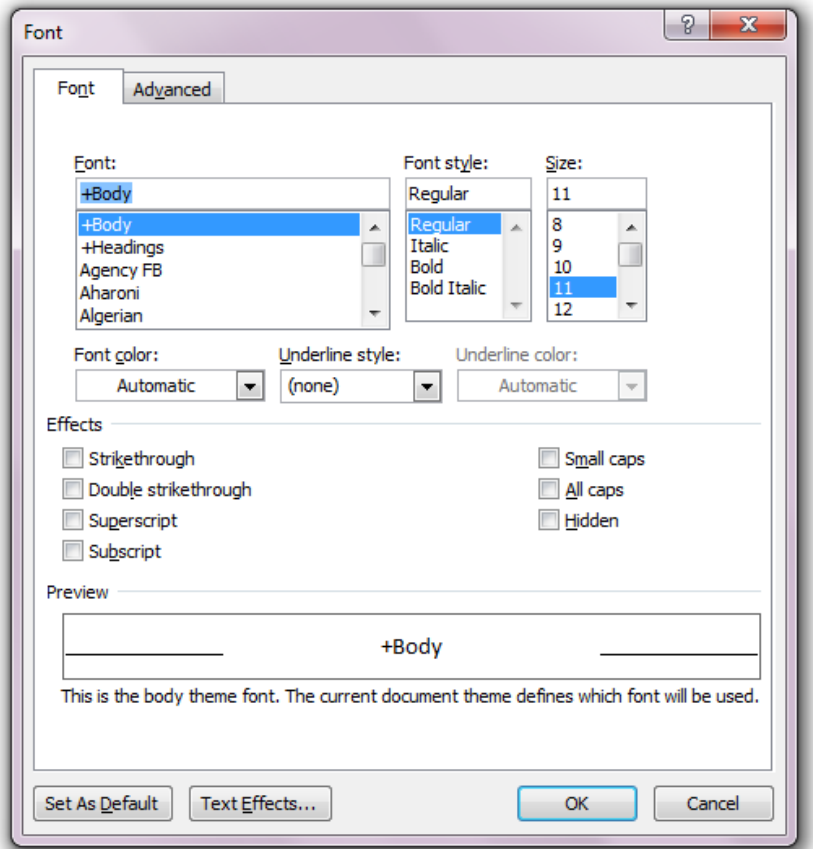


Simplicity
(hide complexity)

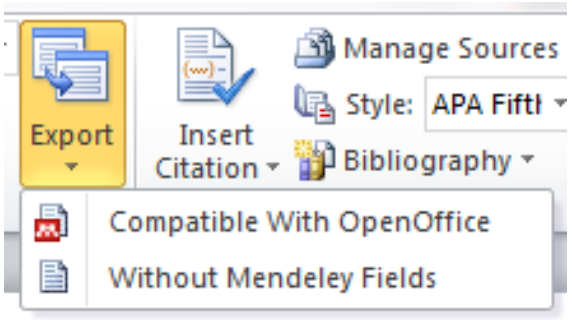
Avoid providing a large number of choices and try solving problems using the simplest solutions possible

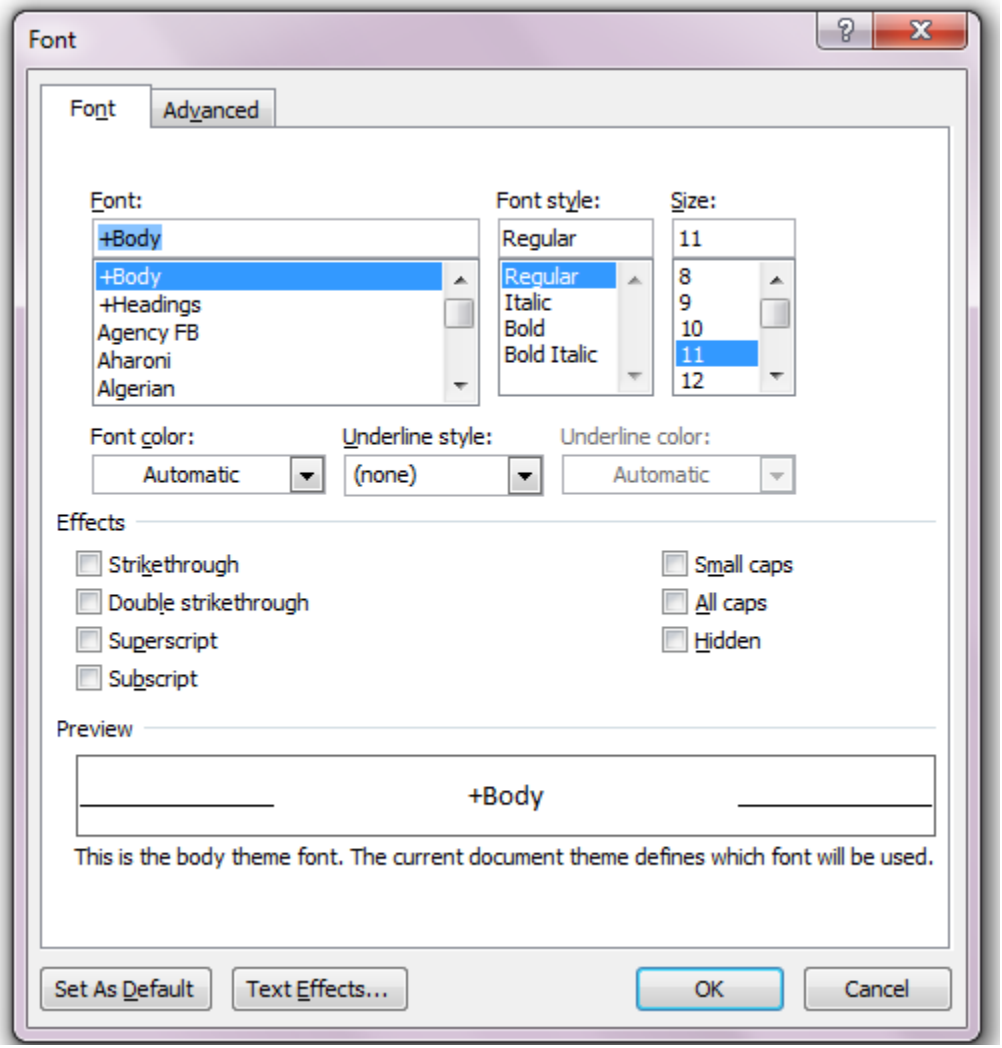


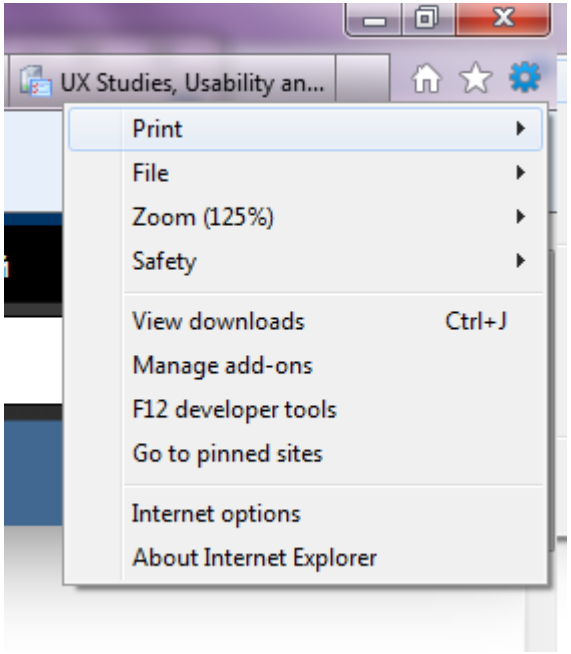




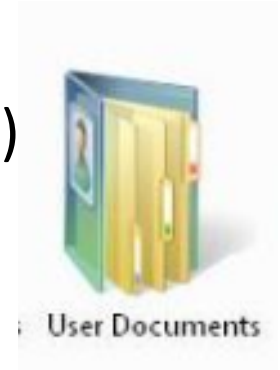
Simplicity
(defaults hide complexity)







Familiarity
(profit from the user's experience)



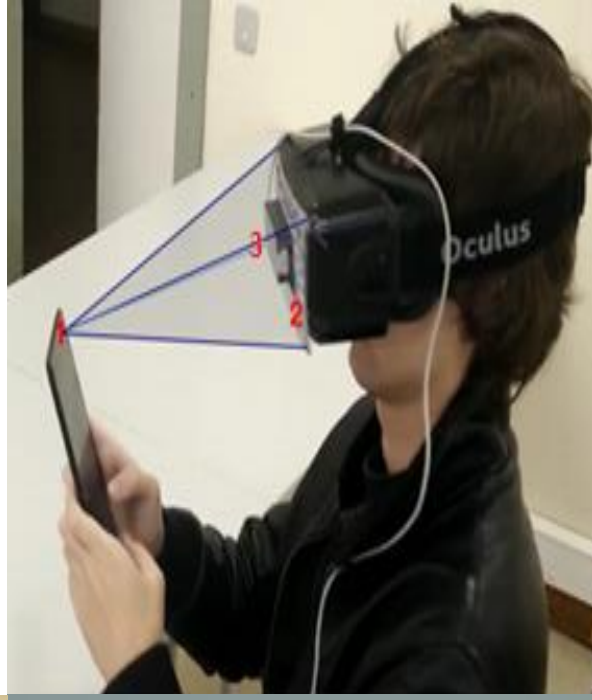
Familiarity

Familiar Icons

Familiarity

In less conventional interactive systems it is important to have:

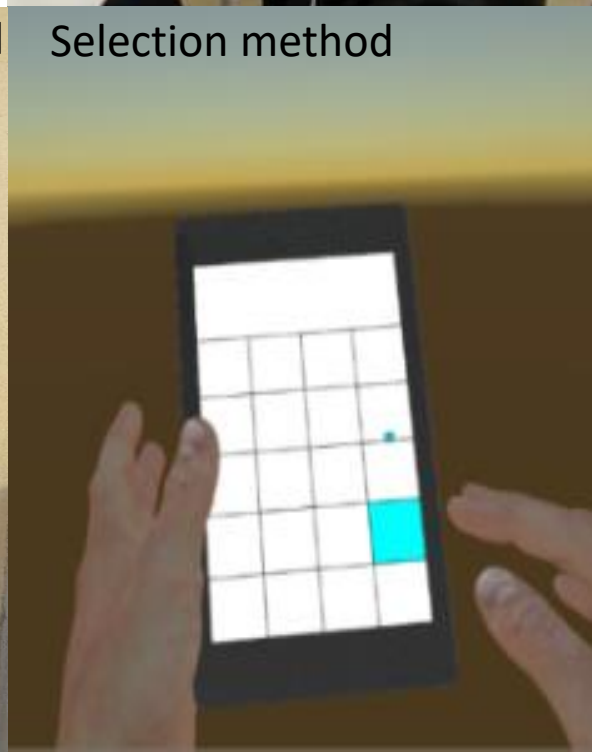
- Familiar gestures to perform tasks (navigation, manipulation, selection …)



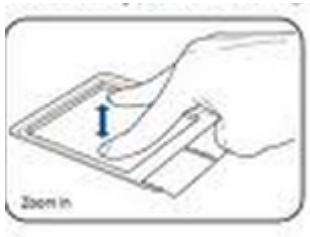
Manipulation method

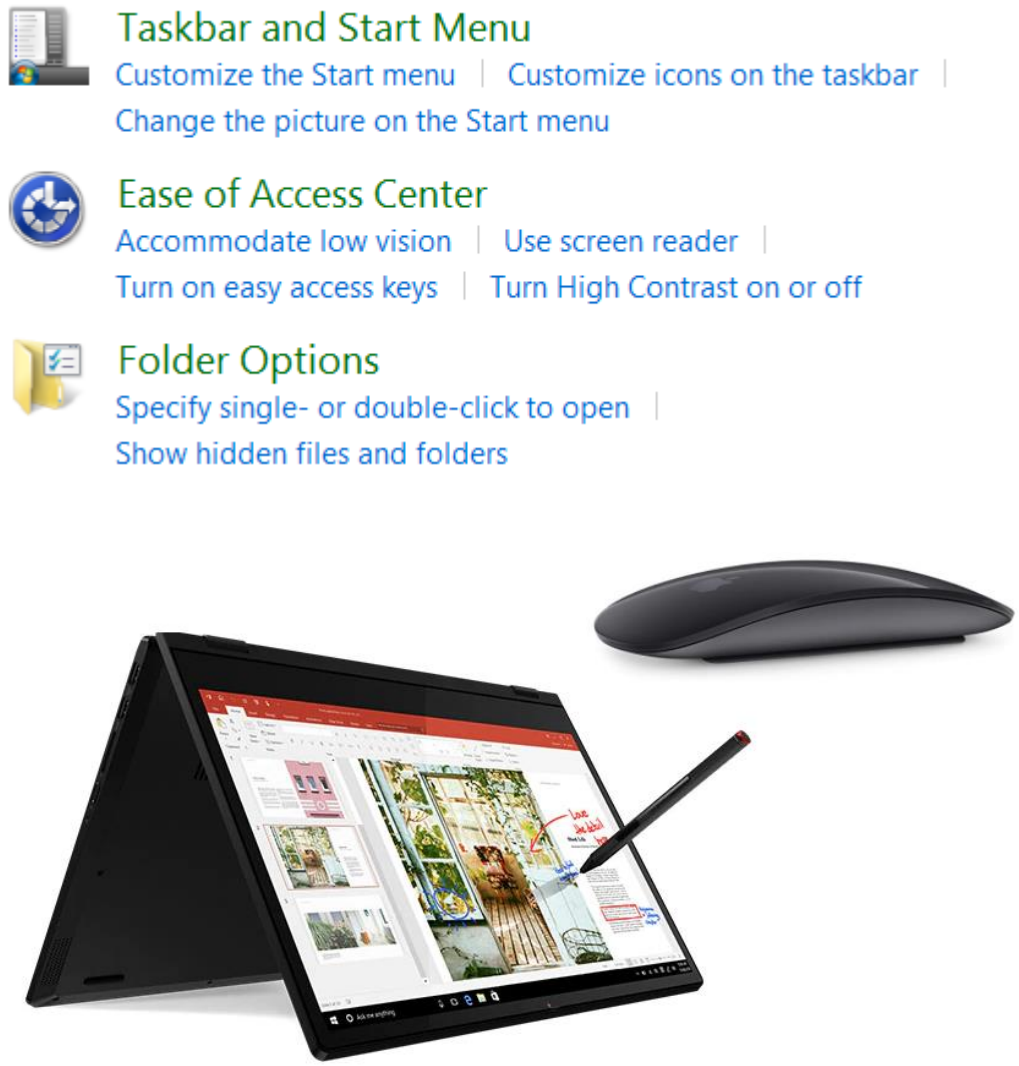
Bike navigation method

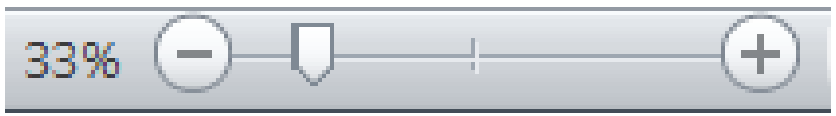
Selection method



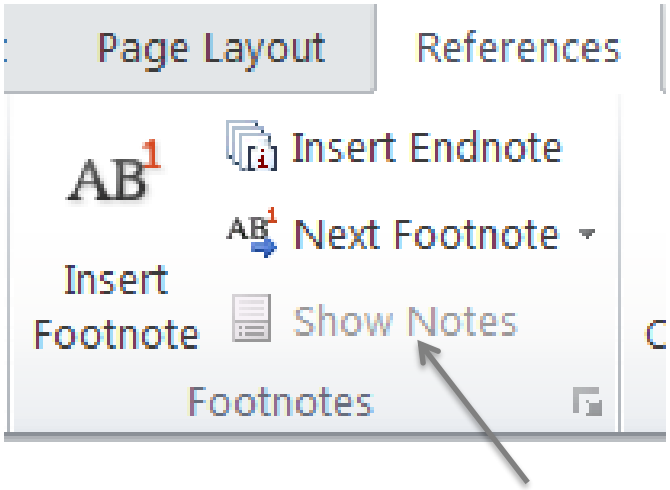
Flexibility
(let the user choose)



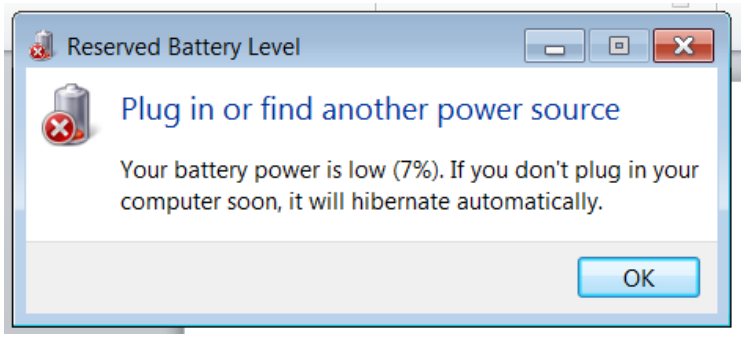


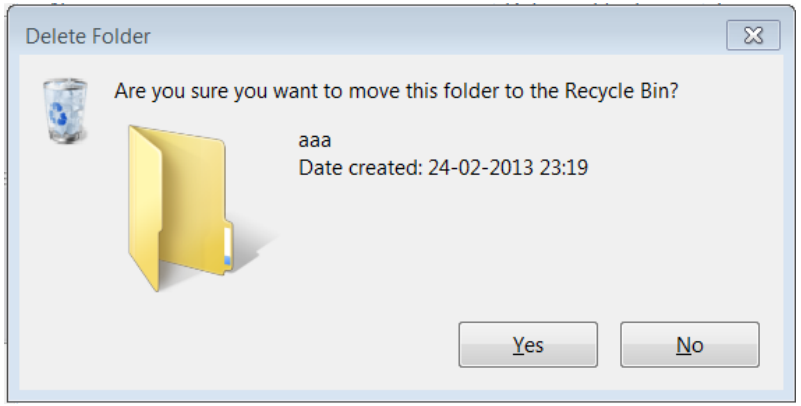


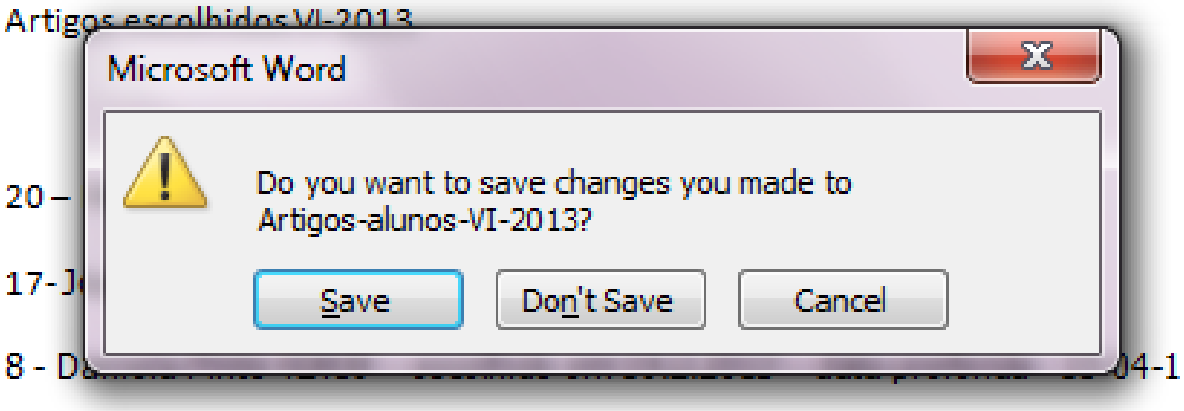
Robustness and error prevention



Not accessible (in grey)







Old usability problems @ DETI (already solved!)

Solved : lights control @ room 4.1.02

Usability problems @ home

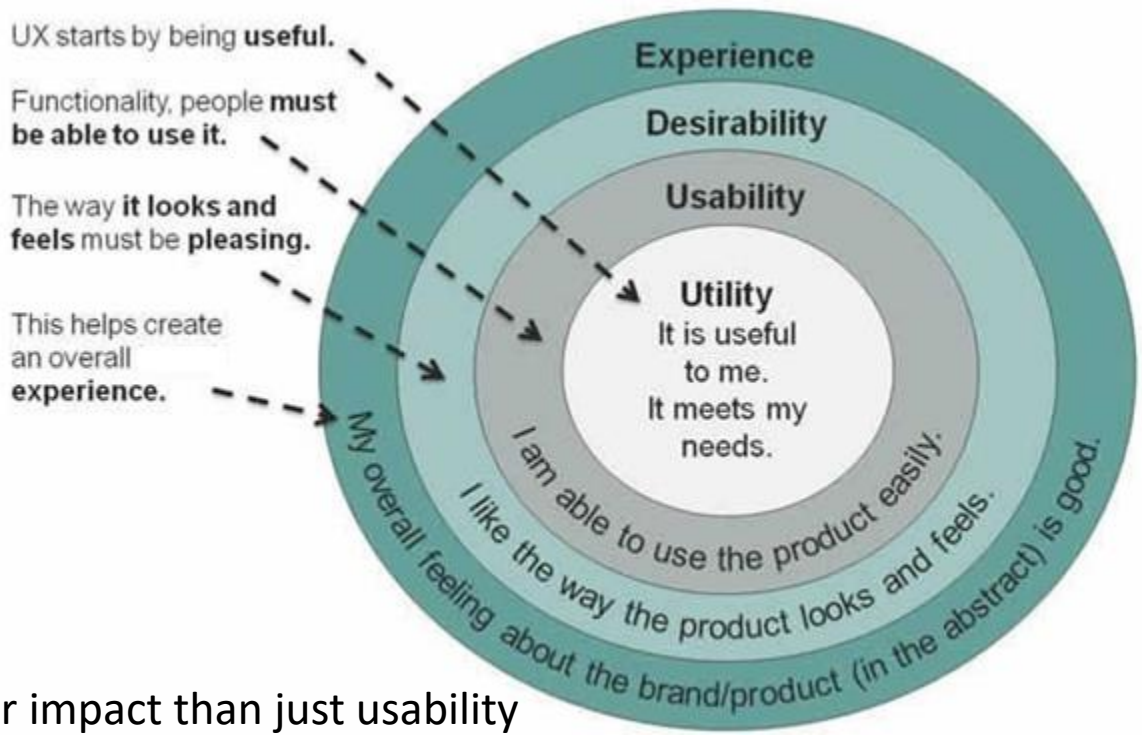
How does it open?

Wrong affordance!

User Experience (UX)

- The ease in which people interact with a system to achieve specific goals
- The experience a person has when he/she interacts with a product (encompasses all aspects)

Usability -> function



A positive UX has a much greater impact than just usability

https://www.nngroup.com/articles/ux-research-cheat-sheet/

- **Usability** is concerned with the “effectiveness, efficiency and satisfaction with which specified **users** achieve specified goals in particular environments”
- **User experience** is concerned with “all aspects of the **user's experience** when interacting with the product, service”

- User experience (UX) involves a person's:
  - behaviors,
  - attitudes,
  - and emotions about using a particular product, system or service

- It includes the practical, experiential, affective, meaningful and valuable aspects of human-computer interaction and product ownership

- and also a person’s perceptions of system aspects such as utility, ease of use and efficiency

- may be considered subjective and is dynamic as it is constantly modified over time

Main bibliography

- Sharp, H., Preece, J., and Rogers, Y., Interaction Design- beyond Human-Computer Interaction, Wiley, 2019
- Dix, A., J. Finley, G. Abowd, B. Russell, *Human Computer Interaction*, 3rd. ed., Prentice Hall, 2004
- Shneiderman, B., Plaisant, C., Cohen, M., and Jacobs, S., *Designing the User Interface: Strategies for Effective Human-Computer Interaction ,* 5th ed., Addison-Wesley, 2009
- The Encyclopedia of Human Computer Interaction, 2nd ed., Interaction Design Foundation. https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed