Introduction to Human Computer Interaction/Interaction Design

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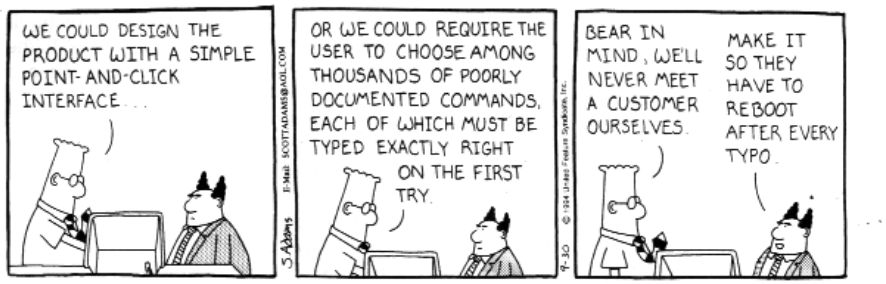
Who are "Users"?

- People who will use a product/system.
- As opposed to the "Designers" (people who create the system)
- Designers are not the users
- Have to make an effort to KNOW THE USER



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- Two common reasons when a project fails are the lack of
  - User input during the design and development process
  - Requirements that the final product/system should meet in the end
- A successful product is more than the development of and the knowledge about the latest technology

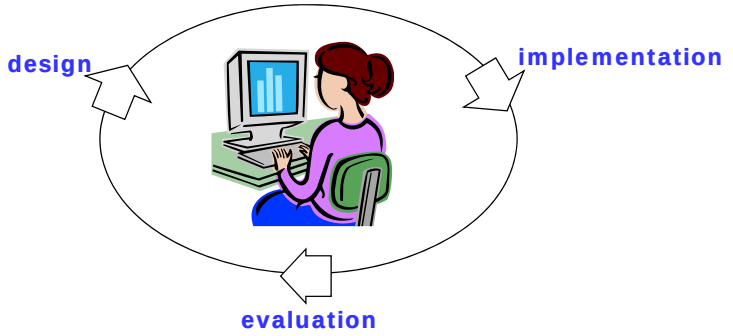
Technology-driven vs User-centred design

- You can have different starting points
  - The technology runs the design of the interface which give the user the functionality of the system
  - Users put demands on the functionality of the interface which runs the design of the technology

HCI/Interaction Design

HCI

- **"HCI (Human Computer Interaction) is a discipline concerned with the design, implementation, evaluation of interactive computing systems for human use and with the study of the major phenomena surrounding them." [ACM SIGCHI, 1992]**



HCI is Multi-Disciplinary

- Computer Science
- Cognitive Psychology
- Social and Organizational Psychology
- Ergonomics or Human Factors
- Interaction Design
- Linguistics
- Artificial Intelligence
- Philosophy, Sociology, and Anthropology
- Engineering
- Design

Goals of HCI

- A goal of HCI is to improve the interactions between users and computers by making computers more usable and receptive to the user's needs.
- "The goals of HCI are to develop or improve the **safety, utility, effectiveness, efficiency, and usability** of systems that include computers." [Interacting with Computers, 1989]
  - Safety (design of safety-critical systems)
  - Utility (the functionality of a system)
  - Effectiveness (user's ability to achieve goals)
  - Efficiency (a measure of how quickly users can accomplish their goals or finish their work using the system)
  - Usability (making systems easy to learn, easy to use, and user satisfaction)

Usability

- Key concept in HCI
- Can be broken down into the following goals
  - **Effectiveness** – How accurately and completely users can accomplish tasks
  - **Efficiency** – How quickly users can complete tasks
  - **Safety** – Avoid dangerous situations caused by interaction with technology
  - **Utility** – Provide enough functionality for users to accomplish necessary tasks
  - **Learnability** – How easy is it to learn to use technology
  - **Memorability** – How easy is it to remember how to use a technology once you have learned how to use it

Interaction Design

- **"Designing interactive products to support people in their everyday and working lives" [Sharp, Rogers and Preece, 2007]**
- **Creating user experiences that enhance and extend the way people work, communicate, and interact**
- Interaction design has a slightly different focus than HCI and involves broader range of areas
  - HCI is influenced by psychology and cognitive science
  - Interaction design is more open and includes areas such as graphic design, product design, photography, etc.
- Same fundamentals as HCI in terms of usability goals and design methodology, but is also concerned with other goals

User Experience

- Interaction design is also concerned with creating systems that are
  - **Satisfying**
  - **Enjoyable**
  - **Fun**
  - **Entertaining**
  - **Helpful**
  - **Motivating**
  - **Aesthetically pleasing**
  - **Supportive of creativity**
  - **Rewarding**
  - **Emotionally fulfilling**

Historical Highlights of HCI

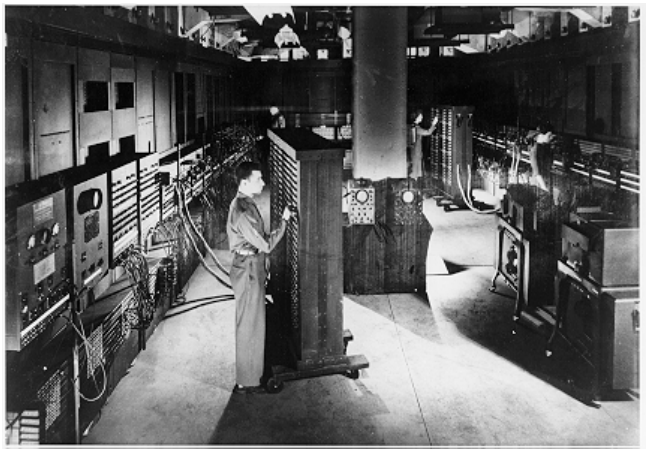
Input/Output Devices

	Input	*Output*
Early days	connecting wires	lights on display
	paper tape & punch cards	paper
	keyboard	teletype
Today	keyboard	scrolling glass teletype
	+ cursor keys	character terminal
	+ mouse	bit-mapped screen
	+ microphone	audio
Soon?	data gloves + suits	head-mounted displays
	computer jewelry	ubiquitous computing
	natural language	autonomous agents
	cameras	multimedia

- The lesson
  - keyboards & terminals are just artifacts of today's technologies
  - new input/output devices will change the way we interact with computers

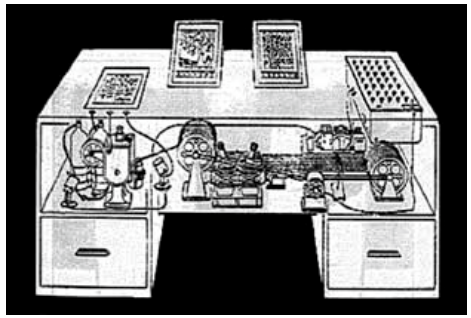
ENIAC (1943)

A general view of the ENIAC, **the world's first all electronic numerical integrator and computer**.



MEMEX (1945)

From Cruft Photo Laboratory.



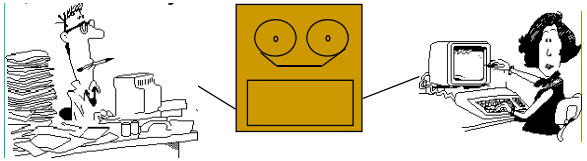
The **memex** by **Vannevar Bush** is the hypothetical proto-hypertext system described in *The Atlantic Monthly* article **As We May Think**. Bush envisioned the memex as a device in which individuals would compress and store all of their books, records, and communications, "mechanized so that it may be consulted with exceeding speed and flexibility". The memex would provide an "enlarged intimate supplement to one's memory". The concept of the memex influenced the development of early **hypertext** systems (**World Wide Web**) and personal knowledge base software.

Man-Computer Symbiosis (1960)

Man-Machine Symboisis, J.C.R. Licklider (1960), considered **the computer as an intelligent partner.** The first to write about the possibility of human-computer interactivity. "The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today."

Time-Sharing

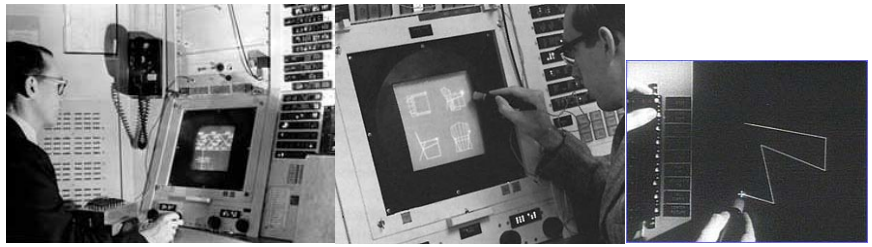
- Mid '60s
  - computers too expensive for a single person
- Time-sharing
  - the illusion that each user was on their own personal machine
  - led to immediate need to support human-computer interaction
    - dramatically increased accessibility of machines
    - afforded interactive systems and languages *vs.* batch "jobs"
    - community as a whole communicated through computers (and eventually through networks) via email, shared files, etc.



Spacewar (1961)

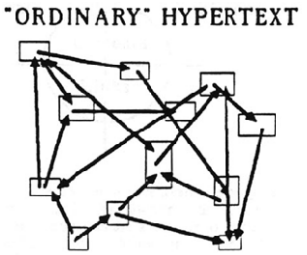
MIT student Steve Russell creates **Spacewar**, **the first interactive computer game**, on a Digital PDP-1 (Programmed Data Processor-1) computer. Spacewar used new teletype terminals with CRT screens to display the graphics. Program is 9K.

Sketchpad (1963)



Sketchpad: A Man-Machine Graphical Communication System was a revolutionary computer program written by Ivan Sutherland in 1963 in the course of his PhD thesis. It helped change the way people interact with computers. Sketchpad is the ancestor of modern computer-aided drafting (CAD) as well as a major breakthrough in the development of **computer graphics** in general. Sutherland demonstrated with it that computer graphics could be utilized for both artistic and technical purposes in addition to showing a novel method of **human-computer interaction**. Sketchpad was the first program ever to utilize a complete **graphical user interface**, using an x-y plotter display and a light pen.

Hypertext (1963)



Theodor Holm Nelson founded **Project Xanadu** in 1960 with the goal of creating a computer network with a simple user interface. Ted Nelson introduced the concept of the **hypertext** which would be a more flexible, more generalized, non-linear presentation of material on a particular subject (Vassar Miscellany News, Feb 3 1965). By hypertext mean nonsequential writing text that branches and allows choice to the reader, best read at an interactive screen.

Ted Nelson's Quote "A user interface should be so simple that a beginner in an emergency can understand it within 10 seconds."

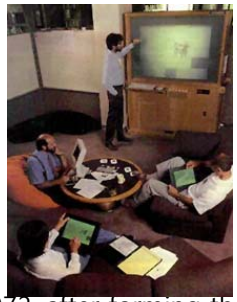
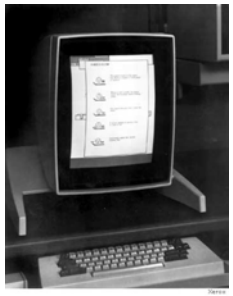
NLS (1968)


NLS (oNLine System) was a revolutionary computer collaboration system designed by **Douglas Engelbart** and the researchers at the Stanford Research Institute (SRI) during the 1960s. The NLS system was the first to employ the practical use of **hypertext links**, the **mouse** (co-invented by Engelbart and Bill English), **raster-scan video monitors**, **information organized by relevance**, **screen windowing**, **computer presentation** (such as PowerPoint), and other modern computing concepts. This historic prototype, unveiled in 1968 at the Fall Joint Computer Conference in San Francisco, influenced the development of the **first personal computer** and **the graphical user interface at Xerox PARC** in the early 1970s.

The Personal Computer

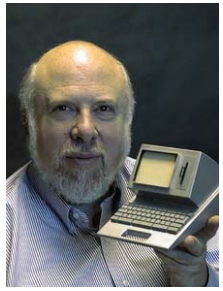
- Alan Kay (1969)
  - Dynabook vision (and cardboard prototype) of a notebook computer: "Imagine having your own self-contained knowledge manipulator in a portable package the size and shape of an ordinary notebook. Suppose it had enough power to out-race your senses of sight and hearing, enough capacity to store for later retrieval thousands of page-equivalents of reference materials, poems, letters, recipes, records, drawings, animations, musical scores..."
- Ted Nelson (1974)
  - "Computer Lib/Dream Machines" popular book describing what computers can do for people (instead of business!)

Graphical User Interface (1973)

In 1972, after forming the Learning Research Group at the Xerox PARC (Palo Alto Research Center), Alan Kay led what is considered the most crucial advancement of human-computer interactivity, **the graphical user interface (GUI)**. The GUI used **windows, icons, and menus** (including the first fixed drop-down menu) to support commands such as opening files, deleting files, moving files, etc. The **Xerox Alto** (later **Star**), an early personal computer developed at Xerox PARC in 1973, was the first computer to use the desktop metaphor and mouse-driven graphical user interface (GUI). **Star** greatly influenced future developments, for example at Apple, Microsoft and Sun Microsystems.

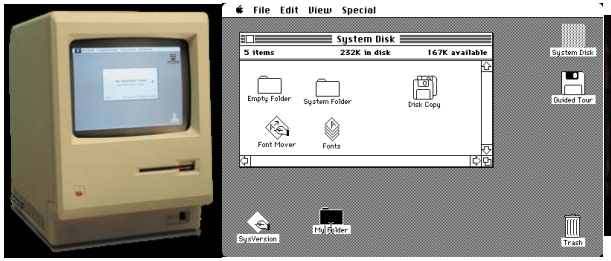
Macintosh (1979)




Jef Raskin, American human-computer interface expert, best known for **starting the Macintosh project** for Apple in the late 1970s, envisioned an **easy-to-use, low-cost computer for the average consumer**. He was an inventor of the term "**Information Appliance**".

Jef Raskin wrote "**The Humane Interface**: New Direction for Designing Interactive Systems (2000)" about the fundamental issues of interaction design for usability of any computer based system. He introduced the concept of **Zoom World**, a whole OS based on a **Zooming User Interface**.

Macintosh (1984)



Apple Macintosh was the first commercially successful personal computer to feature a mouse and a graphical user interface.

Macintosh was succeeded because:

-aggressive pricing ($2500)
-did not need to trailblaze
learnt from mistakes of Lisa and corrected them; ideas now "mature"
market now ready for them
-developer's toolkit encouraged 3rd party non-Apple software
-interface guidelines encouraged consistency between applications
-domination in desktop publishing because of affordable laser printer and excellent graphics

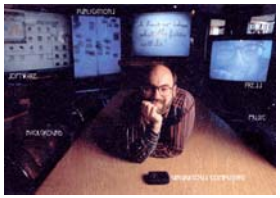
Virtual Reality (1985)

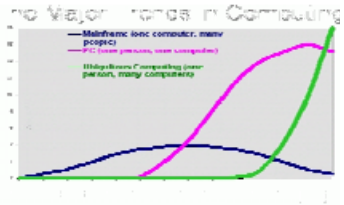
- Jaron Lanier, Thomas Zimmerman & VPL Research
  - **Term: Virtual Reality**
  - First company focused on VR products
  - Sold **VPL data gloves** in 1985 and eye phones in 1988

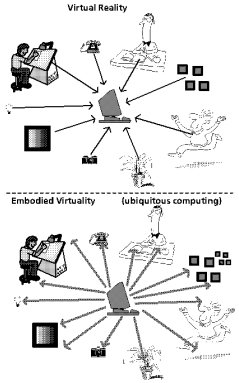
VPL Data Glove

VIEW system, NASA Ames Research Center

Ubiquitous Computing (1988)



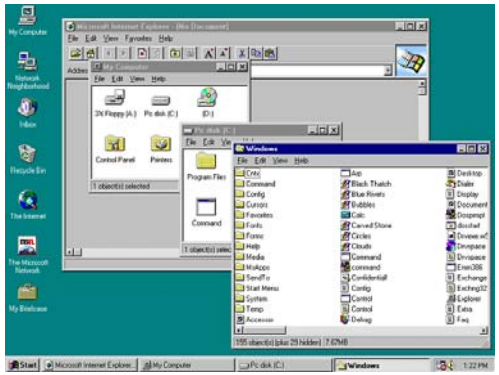




Ubiquitous computing (**ubicomp**) is a **post-desktop model of human-computer interaction** in which information processing has been thoroughly integrated into everyday objects and activities. **Mark Weiser** coined the phrase "ubiquitous computing" around 1988, during his tenure as Chief Technologist of the Xerox PARC.

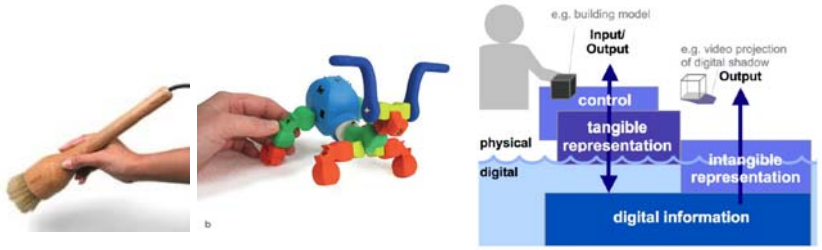
Ubiquitous computing is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing forces the computer to live out here in the world with people.

Microsoft Windows95 (1995)



In 1995 Microsoft released an enormous upgrade that finally gave the home user a stable sophisticated modern mostly **32-bit operating system** with protected memory and preemptive **multitasking** (features that would take another seven years to reach the Apple Mac).

Tangible User Interface (1998)



A **tangible user interface (TUI)** is a user interface in which a person interacts with digital information through the physical environment. The initial name was Graspable User Interface, which no longer is used. One of the pioneers in tangible user interfaces is **Hiroshi Ishii**, a professor in the MIT Media Laboratory who heads the Tangible Media Group. His particular vision for tangible UIs, called ***Tangible Bits***, is **to give physical form to digital information**, making bits directly manipulable and perceptible. Tangible bits pursues seamless coupling between these two very different worlds of bits and atoms.

SONY's Patent on BCI (2005)

From The Times

April 7, 2005

Sony takes 3-D cinema directly to the brain

By Michael Horsnell

RECOMMEND? (1)

THE cult sci-fi movie *The Matrix* might not have such an improbable plot after all.

The first step towards a real-life version, in which cyber-reality is projected into the brains of people via an electrode feed, could be just over the horizon.

Sony, the Japanese entertainment giant, has patented an idea for transmitting data directly into the brain, with the goal of enabling a person to see films and play video games in which they smell, taste and perhaps even feel things, *New Scientist* magazine says.

The patent is based purely on theory, not on any invention — but they used to say that man would never fly.

In Sony's patent, the technique would be entirely noninvasive. It would not use brain implants or other surgery. The patent has few details, describing only a device that would fire pulses of ultrasound at the head to modify the firing patterns of neurons in targeted parts of the brain.

The aim, it says, is to create "sensory experiences", ranging from moving images to tastes and sounds.

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TIMES RECOMMENDS
- How a gift horse revived island race
- The collective art of doing it on the cheap
- Helena Bonham Carter: 'I'm not a dirty person'

HUMAN FACE OF GANGS

An alternative view of London's mean streets

Natural User Interface

Nintendo Wii (2006)

Microsoft Xbox360 Kinect (2010)

Natural user interface, or **NUI** is the common parlance used by designers ar developers of human-machine interfaces to refer to a user interface that is (1 effectively invisible, or becomes invisible with successive learned interactions, to its users, and (2) is based on nature or natural elements (i.e. physics, also known as Natural Philosophy).

Microsoft NUI http://research.microsoft.com/en-us/about/feature/nui.asp

Smart Phone

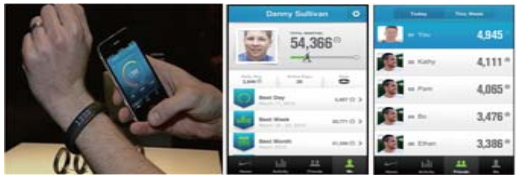
Touchscreen-based UI
Apple iPhone (2007)

Google Android (Linux-Based Operating System) (2005)

A **smartphone** is a mobile phone built on a mobile computing platform, with more advanced computing ability and connectivity than a feature phone. Today's models also serve to combine the functions of **portable media players, low-end compact digital cameras, pocket video cameras, and GPS navigation units**.

Smart Device

Smart Watch
Apple Watch (2015)



Smart Band
Nike Fuelband (2012)

Smart Glass
Google Glass (2013)

Life-logging Smart Camera
Narrative Clip (formerly known as Memoto) (2012)

Smart Speaker

Amazon Echo
using Alexa (2014)

Google Home
using Google Assistant (2016)

Apple Homepod
using Siri (2018)

Samsung Galaxy Home
Using Bixby (2018)

https://www.wired.com/story/best-smart-speakers/

Why HCI?

American Airlines Flight 965

- Crashed on the mountain near Cali, Colombia in 1995
  - Official cause: Pilot error
  - Real cause: Poor interaction design of flight management system
- Lessons
  - Expert users make mistakes
  - Feedback
  - Consistency
  - System state needs to match state expected by users

http://sunnyday.mit.edu/accidents/calirep.html

Mizuho Securities Stock Sale

Mizuho Securities Stock Sale

- Software used to trade in Tokyo Stock Exchange
  - Trader for Mizuho tried to sell
    - 1 share of J-Com for 610,000 yen
  - Instead he sold
    - 610,000 shares of J-Com for 1 yen each
  - Software warned him, but he ignored warning
  - Attempted to undo, but it was not possible
- Lessons
  - Busy people in a hurry more likely to make mistakes
  - Users rarely read warning messages because they rarely matter
  - Good designs expect mistakes to happen
  - Provide "undo" capabilities

Why is HCI Important?

- Productivity and safety are two reasons why good HCI design is crucial
  - Productivity – Introducing technology that does not support that work may cause reduced productivity
  - Safety – crashed air planes and nuclear power plant disasters have led to an understanding why HCI is important
- **Computers should be designed for the needs and capabilities of the people for whom they are intended.**

More Reasons

- The interface is NOT a "later problem (i.e., the part of the product that is developed last)"
- Products and systems cannot be developed and designed using the developers/designers themselves as the norm
- Users might not have a great interest in technology
  - Remember the productivity reason: in a workplace where users are more or less forced
  - To use a system or a product, it has to be designed to fit them, not the other way around
- Users rarely read manuals and instructions

HCI Design Principles

- **Know your user**
  - This can be hard when your user group is very general
- **Reduce cognitive load**
  - This concerns designing so that users don't have to remember large amounts of detail
- **Engineering for errors**
  - Engineering for errors includes forcing a user to prevent him or her from making an error – or at least make it more difficult
- **Maintain consistency and clarity**
  - You can maintain consistency by using standard operations and representations and from using appropriate metaphors that help to build and maintain a user's mental model of the system

Know Your User

- Cognitive and perception psychology
  - Gives you general knowledge about humans
- User analysis
  - Gives you valuable information about the specific user group
    - Are they beginners or experts?
    - Are you designing for kids or for old people?
- Two important reasons to know your user are
  - To minimize cognitive load
  - To use resources efficiently (system and user)

Reduce Cognitive Load

- **Make functions, objects and information visible**
  - Functions should be designed so that they remind the user of what is possible and how to do it
  - Objects can be designed so that information is stored in the design of the object
  - Information should be presented in a way where its easy to get an overview
  - Information should also be structured such a way where its easy to navigate
- Human brain is limited in its capacity: memory, attention
  - A fundamental finding in memory research is that we recognize things far more easily than we can recall them from memory
  - PC-specific example: UNIX (cat, grep, mv, lpr) vs. GUI (icons) Which ones are easiest to recognize/remember?

Reduce Cognitive Load

- Provide **clear conceptual models of the system**
  - Conceptualizing user's knowledge in terms of mental models can help designers to develop appropriate user interfaces
  - Using metaphors (e.g. the desktop metaphor) can help the user understanding a system more easily or better

Mental model [Don Norman]:

"The model people have of themselves, others, the environment, and the things with which they interact. People form mental models through experience, training and instruction."

Engineering for Errors

- Make it difficult for the user to make errors
  - E.g. menus give the user the possible alternatives (prevents errors but not mistakes), sound can indicate right or wrong
- Provide good error messages
  - Feedback give the user control and reduces waiting for a result and hence leads to less user frustration
- **Reversible actions**
  - Allow users to correct their own errors
- **Provide feedback**
  - The user need to know the state of the system

Maintain Consistency and Clarity

- Standard operations and representations
- Appropriate metaphors help building and maintaining a user's mental model
- Easier for users to learn, recognize and to foresee what is going to happen

Interaction Design goes beyond Desktop Computing

- The fundamental HCI principles also apply to the design of the following technologies, but new design challenges.
  - Ubiquitous Computing
  - Pervasive Systems
  - Tangible Interfaces
  - Ambient Intelligence
  - Context-aware Systems
  - Virtual Reality/Augmented Reality
- Increasing influence of these technologies on our daily lives has fueled a shift to user-centric design

Reference

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- http://www.w2vr.com/timeline/timeline.html
- http://theoligarch.com/microsoft_vs_apple_history.htm
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