Human-Computer Interaction

an overview
“Design, v.: What you regret not doing later on.”

/usr/games/fortune
How about the interaction(s) between user(s) & software and/or things?
Human

a person who tries to accomplish a goal
Computer

runs applications (software)
Computer

runs applications (software)

locally versus remotely
1st game developed on PDP (1961-1962) – www.masswerk.at/spacewar/
Interaction

“dialogue” between humans and computers/things
interaction

/ɪntərˈækʃ(ə)n/

noun
noun: interaction; plural noun: interactions

reciprocal action or influence.
"ongoing interaction between the two languages"

- PHYSICS
  a particular way in which matter, fields, and atomic and subatomic particles affect one another, e.g. through gravitation or electromagnetism.

Translate interaction to

Romanian

noun

1. interacțiune
2. acțiune reciprocă
3. influență reciprocă
The interaction between user(s) and application(s) is achieved via an interface – user interface
The interaction between user(s) and application(s) is achieved via an interface – *user interface*

**API** (Application Programming Interface) 

*versus* 

**UI** (User Interface)
Types of user interfaces:

conventional (classical) UI – e.g., desktop
Graficon (Douglas Engelbart, 1963)
Types of user interfaces:

**conventional (classical) UI** – *e.g.*, desktop

WIMP (Window Icon Menu Pointer) paradigm
interaction via keyboard & mouse + additional devices
graphical representations (bitmap vs. vectors)
support provided by the OS kernel vs. a window system
multi-tasking
Bryce (Kai Krause, 1997)
Types of user interfaces:

Web interface
WorldWideWeb system (Tim Berners-Lee, ~1990)
www.slideshare.net/busaco/25-de-ani-de-web
Types of user interfaces:

**Web interface**

browser (specific interface, Web forms, bookmarks,...)  
hypertext/hypermedia – access to remote resources  
RIA (Rich Internet Applications)  
(a)synchronous interaction  
open standards  
availability – world-wide audience
Moqups is a nifty HTML5 App used to create wireframes, mockups or UI concepts, prototypes depending on how you like to call them. We've tried to make things simple and fairly intuitive so you can unleash your creativity without any obstacles. If you don't listen to the green question-mark-man, your hair will turn green.

This is a bit tricky to master until you get a hold of it

Double click to explode

Select and click again to close the browser

Stencils are objects that mimic various user interface elements. Some have editable content and other have configurable properties like color, shape, icon, states etc.

Editable stencils can be spiced up with **bold**, *italic*, links and more, using the standard Markdown syntax.

**Quick tips:**

- Press F1 or # for keyboard shortcuts
Types of user interfaces:

mobile user interface
Types of user interfaces:

**mobile user interface**

limited resources/features:
- display resolution, memory, I/O, power, etc.,
- one task vs. multi-tasking, off-line vs. on-line,
- context awareness services,
- different business models ▶ *app stores*
challenge:
interaction design in the context of multi-device UI
› responsive design
Types of user interfaces:

natural UI
Types of user interfaces:

**natural UI**

- new interaction paradigms + new expectations,
- haptic, gesture, locomotion, auditory & voice, tangible UI,
- augmented and virtual reality,
- physical computing, ambient intelligence (AmI),
- emotion & persuasion,...
Blind Beethoven - Music application for visually impaired

In a parallel universe, Ludwig van Beethoven (famous composer and pianist) is born in an era where ubiquitous computing is highly developed. Over time, he lost his sight, but he can still compose and play the piano and also recognize several musical scores. However, he will enjoy to use a device to help him to compose music, including to manage different versions of a certain musical work, and/or navigate on the Web (e.g., for example, to share his musical preferences with Franz Schubert or Goethe on Last.fm).

Course: Human-Computer Interaction
Taught by: PhD. Sabin C. Buraga
Teaching assistant: Stefan Negru
Students:
- Marina Cufliuc
- Cristian-Alexandru Dragusaru
- Andreea Alexandra Iuga
- Petronela Stan
Website: blindbeethovenhcl.wordpress.com
PowerArm - Arduino and Android Game

Develop a 3D puzzle game (labyrinth type) which provides an enhanced interactive experience for the player, using two physical devices (one custom built & a mobile phone) to augment the user interaction with the game. These devices will be used to control the game character actions. The custom physical device will interpret hand/finger gesture and will serve as a way to control the playable character and/or quickly switch between

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- Sergiu Recean

FII Project Exhibition: profs.info.uaic.ro/~stefan.negru/studentprojects/
Types of user interfaces:

invisible UI

directions of research – context: Internet of Things (IoT)
wearable devices
connected car ("smart" automotive)
connected home ("smart" appliances)

see also uxdesignweekly.com/archived-issues/
User – desktop, Web, mobile,... – interface

part of a program/application
– on desktop, Web, mobile/wearable devices,... – which permits users to expose their intentions (goals) with respect to the actual software and to interpret the results of certain actions performed by machine(s)
User – desktop, Web, mobile,... – interface

perceived by the user not only as a visual part of a certain software application
User – desktop, Web, mobile,... – interface

from the point of view of an user, it represents the entire system

the application *per se*
UI quality attributes
(Jakob Nielsen, 2012)

utility

provides the features users need
UI quality attributes
(Jakob Nielsen, 2012)

usability

how easy & pleasant the features are to be used
UI quality attributes
(Jakob Nielsen, 2012)

useful

usability + utility
Everyone who uses a (software) tool is driven by a **motivation**
finding an entity (thing): information, object, people, etc.
(self)learning and/or instruction
performing a process – e.g., a (business) transaction
social interactions – in a real and/or virtual environment
creating an artifact: (micro)blog note, picture, article, source-code,
entertainment – individual vs. community
UX – User Experience

Defining the perception of a product/service from the point of view of person(s) who use it and the apparent pleasure/satisfaction
UX – User Experience

“Every product that is used by someone has a user experience: newspapers, ketchup bottles, reclining armchairs, cardigan sweaters.”

James Jesse Garrett, 2003
UX – User Experience

Cannot design a user experience, only design for a user experience
UX – User Experience

experience = expectation → user is satisfied
UX – User Experience

$\text{experience} > \text{expectation} \quad \Rightarrow \quad \text{user is delighted}$
UX – User Experience

experience < expectation → user is dissatisfied
other examples: www.webpagesthatstuck.com • www.baddesigns.com
UX and interaction between users and mobile devices
Main categories of interactions
(in the mobile/wearable device context)

Application Centric
Activity Centric
Timeline Centric
Context (Location) Centric
Process/Task Centric
Emotion Centric
People/Identity Centric

johnnyholland.org/2010/05/archetypes-and-their-use-in-mobile-ux/
IA – Information Architecture

Necessity of organizing the desired information
IA – Information Architecture

The solutions of presenting the content regard the IA – Information Architecture
Programming in 2039: How Persistent Memory Will Change Databases
8 Feb 2019 1:34pm, by Kyle Davis

Q&A: How LinkedIn Uses Data Science To Reveal the Way Forward
8 Feb 2019 10:45am, by Joab Jackson

Dendogram
A tree diagram frequently used to illustrate the arrangement of the clusters produced by hierarchical clustering. Gaston Sanchez

Triangulations
Computational geometry that maximizes the minimum angle of all the angles of the triangles in the triangulation. Mathworks

Donut Chart
Similar to a pie chart, the arc length of section is proportional and when combined represents the total amount. Visual.ly

Dot Clusters
Each dot in the circular cluster represents a unit of measurement used to indicate which entity has the largest cluster. TD Architects

2-D Table
Arrangement of data into rows and columns with the condition that the coordinates of each row and column produce a unique value. Science Direct

Dial Chart
A circular chart that shows an amount, typically in %, in relation to the whole. Designify.me

Fan Genealogy Chart
Organized and split by gender and inheritance, each identified person is connected by their corresponding maternal and paternal lines. Genealogy.com
IA – Information Architecture

We can adopt different techniques regarding data visualization

details in other lecture
4.35 3.17 3.06 1.37 0.19 0.11 0.03 0.05 0.20 1.22 2.86 3.09
5.35 4.03 3.77 2.51 1.84 1.59 0.85 1.22 1.94 3.25 5.65 6.00
1.53 1.36 2.69 3.64 3.32 3.78 3.66 4.22 3.82 2.41 2.92 2.47
3.17 3.02 3.59 3.90 3.80 3.65 3.80 3.41 3.30 2.88 3.65 3.42
2.01 2.08 2.39 2.85 6.21 9.33 5.70 7.58 7.63 5.64 2.66 1.83

from raw data to knowledge
### Average Rainfall (inches/month)

<table>
<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
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<td>1.37</td>
<td>0.19</td>
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<tr>
<td>Seattle</td>
<td>5.35</td>
<td>4.03</td>
<td>3.77</td>
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<td>1.59</td>
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<td>3.25</td>
<td>5.65</td>
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<tr>
<td>New York</td>
<td>3.17</td>
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<td>3.90</td>
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<td>3.65</td>
<td>3.80</td>
<td>3.41</td>
<td>3.30</td>
<td>2.88</td>
<td>3.65</td>
<td>4.42</td>
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<tr>
<td>Miami</td>
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<td>2.08</td>
<td>2.39</td>
<td>2.85</td>
<td>6.21</td>
<td>9.33</td>
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<td>2.66</td>
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</tr>
</tbody>
</table>

from raw data to knowledge
from raw data to knowledge
IA – Information Architecture

We can adopt different techniques regarding data visualization, visual design, visual representation, and infographics.
HCI: process

understand

evaluate

study

build

design
The most important aspects regarding the UI design?
interaction design

“Designing interactive products to support the way people communicate and interact in their everyday and working lives.”

Sharp, Rogers & Preece, 2007
related domains (Dan Saffer, 2006)
interaction design: issues

“Digital products are rude.”

Alan Cooper et al., 2014
interaction design: issues

The user is responsible for the application’s – in fact, developer’s – mistakes.

stupidity?

more examples at hallofshame.gp.co.at
interaction design: issues

Users must think as computers...they do not want to learn the “Boolean” language.
Usually, applications do not help people
Why digital products are so “nasty”? 
interaction design

Ignoring reality aka the target public (the common user)

we tend exclusively to develop software for the “elite”
...when the UI is designed by software developers
interaction design

Conflicts of interests:

developers

versus

business
interaction design

The lack of a coherent process regarding the developing of the common software
interaction design

The lack of a coherent process regarding the developing of the common software too many amateurs?
interaction design

The lack of a coherent process regarding the developing of the common software

typical example: Web development
The evolution of the software development process
Alan Cooper et al., 2014
interaction design

The complexity of software applications is greater than the one of the tangible products
“If your UI even vaguely resembles an airplane cockpit, you’re doing it wrong.” – John Gruber
interaction design

The process of interaction design is an inter-disciplinary one (Rogers, 2007)
interaction design

Academic Disciplines
Ergonomics
Psychology/Cognitive Science
Informatics
Engineering
Computer Science/Software Engineering
Social Sciences (e.g. Sociology, Anthropology)

Human Factors (HF)
Human-Computer Interaction (HCI)

Cognitive Engineering
Cognitive Ergonomics

Design Practices
Graphic Design
Product Design
Artist-Design
Industrial Design
Film Industry
Information Systems
Computer-Supported Cooperative Work (CSCW)

Interdisciplinary Fields

research regarding interaction design
(Yvonne Rogers, 2007)
interaction design: questions

What we want to create (develop)?
interaction design: questions

How about the premises?
interaction design: questions

What are the final goals?
interaction design: questions

We’ll really obtain what we hope?
If yes, how?
interaction design: questions

How about the intrinsic difficulties?
interaction design: questions

Can we (re)use an existing solution?
interaction design

The design process must be performed with respect to the user requirements/goals

user-centered interface design
interaction design

“Users (clients) typically speak to you in terms of desired features and solutions, not of needs and problems.”

Jenifer Tidwell, 2006
interaction design: questions (II)

How the software will be used?
interaction design: questions (II)

Who will use the developed application?
interaction design: questions (II)

How often software will be used?
How long the user will interact to the application?
interaction design: questions (II)

How about the easiness of using a given application?
interaction design: questions (II)

Software will be portable?
interaction design: questions (II)

How about the internationalization, localization, accessibility, credibility, ...?
interaction design

Important aspect: understanding the problem to be solved
interaction design

Important aspect: understanding the problem to be solved in order to create the desired design (application)
interaction design

Aspects:

UI type(s): desktop, Web, mobile, TV screen, ...
user expected behavior
functionalities
user categories: children, teens, special users, etc.

see next lecture
interaction design

- users
- content
- context
the interaction with a specific application is often driven by **context:** user goal(s) & attitude (e.g., emotional state), available time, location, (social/cultural) environment,...

T. Urff, *Deliver UX that converts on Web, Mobile and Apps* (2015)
Making a phone call using a classical phone unit (or booth) versus via a mobile device: an old and/or last generation phone versus using a VoIP software – e.g., FaceTime, Skype
interaction design

We must consider:

(the categories of) involved users
performed activities
the context of using a specific device
the environment
interaction design

The need of a conceptual model describes how the system is perceived by its users
interaction design

The need of a conceptual model

software (implementation) model

user (mental) model

environment model
interaction design

The need of a conceptual model

“A high level description of how a system is organized and it functions.”

Johnson & Henderson, 2002
interaction design

Important issue:

user model \textit{versus} program model

Alan Cooper \textit{et al.}, 2014
The spreadsheet conceptual model
analogy with real paper tables used by accountants
easy to understand
simple & intuitive interaction
real-time computing of formulas
facilities for further extensions – e.g., URLs as cell values

VisiCalc (1979)
first spreadsheet computer program (“visible calculator”)
for personal computers
danbricklin.com/visicalc.htm
How about the interface usability?
usability

**Usability** refers to the “proper” way the users can exploit the functionality of a given system

Jakob Nielsen

usability

*Learnability*

how easily a person can learn to use a system (its interface)
# The Dropbox Tour

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<td>Surprise Yourself</td>
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usability

Efficiency

after user learnt the interface, how can (s)he optimally use it?
Memorability
it is easy for the users to remember the interaction with the system?
memorability versus security

“many authentication systems require users to memorize secrets that they should recall whenever they want to be authenticated by a system” (R. Kainda et al.) – www.cs.ox.ac.uk/files/2859/ares_main.pdf
usability

Errors

the number of potential errors must be minimal
the user mistakes must be easily detected/corrected
No CD/DVD writer found.
K3b did not find an optical writing device in your system. Thus, you will not be able to burn CDs or DVDs. However, you can still use other K3b features like audio track extraction or audio transcoding or ISO9660 image creation.

☐ Do not show again
usability

Satisfaction

the user likes to use the software/product/service?
child who does not master this stage feels inferior, as if he or she were incapable of reaching positive solutions and unable to achieve what peers are accomplishing.

IDENTITY VERSUS ROLE CONFUSION

LISTEN TO THE AUDIO:
system acceptability

social acceptability

usefulness

utility

easy to learn

efficient to use

easy to remember

usability

few errors

subjectively pleasant

practical acceptability

cost

compatibility

reliability

etc.

Jakob Nielsen
“The applications that are easy to use are designed to be familiar.”
Jenifer Tidwell
“Attractive things work better.” – Donald Norman
First, do no harm (primum non nocere)

sad fact:
“badly designed products serve their creator (or sponsor) first and the users second”

First, do no harm (*primum non nocere*)

easyple #1

*Therac-25 radiation therapy machine (1985—1987)*

6 patients killed by substantial overdoses of radiation

“*The machine stopped 5 seconds into the treatment with an error. The technician seeing that No Dose had been administered (according to the computer) hit the P key thus proceeding with the dose. This was done a total of 5 times giving the patient 13000—17000 rads (a regular treatment is ~200 rads).”*

Troy Gallagher
First, do no harm (primum non nocere)

example #2
Air Inter Flight 148 – Airbus A320 (1992)
87 passengers died + 9 injured

two modes for descent:
flight path angle (FPA)
$-3.3 \equiv$ a descent angle of 3.3 degrees
vertical speed (VS)
$-3,300$ ft/min abbreviated to $-33$

the pilot forgot to push the mode selector knob before typing in “$-33$”

Shariat & Saucier, 2017
First, do no harm (*primum non nocere*)

example #3
Ferry Crash in New York City (January 2013)
instead of slowing down, the ferry accelerated
▶ 79 injured people

Shariat & Saucier, 2017
First, do no harm (*primum non nocere*)

example #4

Hawaii false missile alert (January 2018)

DON’T put the ejection seat button near less consequential stuff.”
remember

Keep the Simple Simple

“No matter how complex the overall system, there is no excuse for not keeping simple tasks simple.”

Jef Raskin
Keep the Simple Simple
...the most engaging interface of a game?
remember

A user-interface is considered to be good if the application is behaving conform to the expectations of its users.
A. Cooper et al., *About Face* (4\textsuperscript{th} Edition), Addison-Wesley, 2014


A. Sears, J. Jacko (Eds.), *The Human-Computer Interaction Handbook* (2\textsuperscript{nd} Edition), Taylor & Francis Group, 2008

J. Tidwell, *Designing Interfaces*, O’Reilly, 2005

*The Encyclopedia of Human-Computer Interaction*

[www.interaction-design.org/books/hci.html](http://www.interaction-design.org/books/hci.html)

*HCI Bibliography*

[hcibib.org](http://hcibib.org)
interaction, agent, IA, cognetics, markup, art, visual design, KISS, control, user testing, idiom, latency, mode, icon, GUI, Fitt’s Law, event, human factors, infographics, RAD, metaphor, accessibility, privacy, skin, affordance, prompt, menu, pointer, risk, augmented reality, UX, animation, web, game, graceful degradation, query, tag, prototyping, ID, evaluation, task, design patterns, gesture, tabs, color, ergonomics, feedback, CLI, script, look & feel, AI, navigation, role, multimodal, audio, RAD, typography, window, voice, mouse, demographics, help, l1on, shortcut, direct manipulation, efficiency, paradigm, usability, CADUI, experiment, VR, eye candy, 3D, effect, WYSIWYG, semiotics, i18n, RIA, style, tooltip, iterative, keyboard, pervasive, learnability, hypertext, anticipation, handheld, memory, social, natural language, methodology, ubiquitous computing, persona, dialogue, user, screen, wireframe, PUI, zoom, psychology, recommender system, brand, flow, storyboard, architecture, model, responsiveness, satisfaction, touch, undo, metrics, video, semantic
next lecture: human factor