Human-Computer Interaction

Practice Webpage Navigation

Use VoiceOver now to use VO and the arrow keys, the Rotor, and the direction keys. When you’re done, continue.

Let’s learn about lemurs

Lemurs are small primates known as “prosimians.” They range from very small to about 15 lbs. Facts

What do lemurs look like?
What do lemurs eat?
How do lemurs communicate?
How many types of lemurs are there?
Did the early lemurs live in Africa?
What happened to the early lemurs?
Provide feedback

HCI engineering

Dr. Sabin Corneliu Buraga – profs.info.uaic.ro/~busaco/
“If you are not embarrassed by the first version of your product, you’ve launched too late.”

Reid Hoffman
How we can evaluate the usability (quality) of interactive systems?
UI quality

Presentation of information

multiplicity of devices & representations
UI quality

Presentation of information

input/output reusability

use output produced by one action as input for another
UI quality

Task planning

multiplicity of user roles

regular user versus administrator
UI quality

Task planning

multiplicity of execution paths

menu *versus* toolbox *versus* shortcuts
UI quality

Task planning

non-preemptiveness

degree of freedom for users to decide what’s next
UI quality

Task planning

reachability

options to navigate in the system
(e.g., undo, redo, breadcrumb patterns)
UI quality

Task planning

observability *versus* browsability
UI quality

Adaption of interaction

reconfigurability

system ability to support user personalization
UI quality

Adaption of interaction

reconfigurability

system ability to support user personalization

configuration *versus* personalization

affects system’s function & performance

relevant to a certain user
UI quality

Adaption of interaction

adaptivity

system ability to support automated adaptation
UI quality

Adaption of interaction

migrability

system ability to transfer responsibility from one user to another, among users, among users and systems/platforms
UI quality

Adaption of interaction

plasticity

system ability to adapt to the context of use while preserving predefined usability properties
UI quality

Standards – initial specifications

ISO/IEC 9126-3 (2003) – internal measures
UI quality

Quality in use is the user’s view of the quality of the software product when it is used in a specific environment and a specific context of use.

UI quality

External quality is the totality of characteristics of the software product from an external view.

UI quality

External quality is the totality of characteristics of the software product from an external view measured and evaluated in the testing phase within a simulated environment, by using external metrics.
UI quality

Internal quality is the totality of attributes of a product that determine its ability to satisfy stated and implied needs when used under specified conditions.

UI quality

**Internal quality** is the totality of attributes of a product that determine its ability to satisfy stated and implied needs when used under specified conditions.

remains unchanged until the system redesign.
UI quality

Standards – actual specifications

Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE)

replaces ISO/IEC 9126
UI quality

DesignOps

focusing on processes and measures that support designers in creating consistent, quality designs

www.nngroup.com/articles/design-operations-101/

study also Dave Malouf et al. (Eds.), DesignOps Handbook
www.designbetter.co/designops-handbook
1. How we work **TOGETHER**

**ORGANIZE**
- Organizational structure
- Team composition
- Role definition

**COLLABORATE**
- Rituals and meetings
- Environment
- Communities of practice

**HUMANIZE**
- Hiring and onboarding
- Career development
- People Operations

2. How we get work **DONE**

**STANDARDIZE**
- Guiding principles
- Design process
- Consistent toolsets

**HARMONIZE**
- Design systems
- Research hubs
- Asset management

**PRIORITIZE**
- Balancing workflow
- Estimation
- Allocation

3. How our work creates **IMPACT**

**MEASURE**
- Design standards
- Design metrics
- Defining good and done

**SOCIALIZE**
- Success stories
- Reward and recognition
- Value definition

**ENABLE**
- Skills training
- Playbooks
- Education
Usability evaluation

Criteria
Scapin & Bastien, 1997; Vanderdonckt, 1995

compatibility
consistency
work load
adaptation
dialog control
guidance
error management
Usability evaluation

Important aspects

*a priori* and/or *a posteriori*

design *versus* testing (evaluation)
Usability evaluation

Example:

the lack of explanatory messages in the case of Web links

Click [here](#) to go to the UAIC main page.
Click [here](#) to visit our HCI Website.
Click [here](#) for details about this event.

“click here” anti-pattern
Usability evaluation

Example:

adoption of different placement strategies for content and navigational methods
“Optimal” placement of links for the main page of a Website (Shaikh & Lenz, 2006)
“Optimal” placement of links for the subsidiary pages (Shaikh & Lenz, 2006)
“Optimal” placement of the internal search tools (Shaikh & Lenz, 2006)
“Optimal” placement of the advertisements (Shaikh & Lenz, 2006)
Usability evaluation

Eye tracking

30—60 minute interviews, in which users are asked to complete real-life tasks online, while the eye tracking monitor captures their eye movements.


[www.nngroup.com/reports/how-to-conduct-eyetracking-studies/](www.nngroup.com/reports/how-to-conduct-eyetracking-studies/)
What areas of the page draw users’ attention?

www.evocinsights.com
Do users notice and use key navigation elements?
Do users notice key marketing elements and do they recall them?
Are users successful in completing a particular task?
Which pages, ads, videos, or images do users prefer?

www.evocinsights.com
What do users expect to find but overlook on the site?

www.evocinsights.com
Usability evaluation

Eye tracking

several open-source software solutions:

EyeWriter – eyewriter.org/developer/
Gaze Tracking – sourceforge.net/projects/gazetrackinglib/
OGAMA (OpenGazeAndMouseAnalyzer) – www.ogama.net
PyGaze – www.pygaze.org
Usability evaluation

PUI – Plastic User Interfaces

adaptation to the context of use while satisfying predefined usability properties of interest
D. Thevenin, J. Coutaz & G. Calvary, 2004
Usability evaluation

PUI – Plastic User Interfaces

levels of adaptation:
  lexical
  sintactic
  semantic
performed tasks
concerning the user goals
Accessibility

successful access to information and IT applications by people having special needs

visual, hearing, motor, cognitive, seizure disorders
Accessibility

realities:
20% of US population have a certain type of disability
10% of persons are having severe problems

4% of world-wide humans have major sight problems
discussion

general usability
affects all users

variables
inconveniences for some
barriers for others

physical barriers
affects only disabled people
Touch

one arm

arm injury

new parent
See blind cataracts distracted driver
Speak non-verbal laryngitis heavy accent
Cognitive issues
larger context: mental health
Cognitive issues
larger context: mental health

examples:
**inattention** caused by bipolar disorder (~2.8% of adults)
**major depression** (~6.7% of adults)
**anxiety** (~19% of adults)

B. Gregory, *Designing for Cognitive Differences*, 2018
alistapart.com/article/designing-for-cognitive-differences/
Accessibility

offering alternative means in order to facilitate the completion of users’ tasks for people having temporary (on short/long term) or permanent problems
Accessibility

principles:
perceivable

information and UI components must be presentable to users in ways they can perceive
Accessibility

principles:
perceivable

information and UI components must be presentable to users in ways they can perceive

Text Alternatives
Alternatives for Time-Based Media
Adaptable Content
Distinguishable
Accessibility

principles:
operable

UI components and navigation must be operable
Accessibility

principles:
operable

UI components and navigation must be operable

Keyboard Accessible
Enough Time
Seizures
Navigable
Accessibility

principles: understandable

information and the operation of UI must be understandable
Accessibility

principles:
understandable

information and the operation of UI must be understandable

Readable
Predictable
Input Assistance
Accessibility

principles:
robust

content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies
Accessibility

principles:
robust

content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies

Compatible
Accessibility

general strategies:

textual descriptions of multimedia content (images, audio, animations, video, 3D)
Accessibility

general strategies:

a proper (logical) organization of the content and navigational paths
Accessibility

general strategies:
support for keyboard-only interaction
Accessibility

general strategies:

using standardized formats
Accessibility

guidelines and tools – concerning Web applications:

www.w3.org/WAI/
www.webaim.org
thisiswcag.com

bitsofco.de/the-accessibility-cheatsheet/
Internationalization (I18N) and localization (L10N)
Internationalization (I18N) and localization (L10N)

**language**
linguistic preferences of the users

**locale**
cultural preferences concerning number and date formatting, currency, etc.
Internationalization (I18N) and localization (L10N)

“If the user can’t read the description of the preference, he/she doesn’t even have a chance to make a choice.”

Achim Ruopp, 2007
Internationalization (I18N) and localization (L10N)

it is desirable to use complete phrases in order to give a better translation
Internationalization (I18N) and localization (L10N)

Web guidelines + resources:

www.w3.org/International/

www.globalbydesign.com
avoid absolute width
(texts in other languages could have different lengths)

avoid pictures
(use translatable text)
Usability evaluation (Rogers, 2007)

analytical evaluation
controlled experiment
field study
formative evaluation
heuristic evaluation
predictive evaluation
summative evaluation
usability laboratory
usability studies
user testing
Multiple existing heuristics introduced by Jakob Nielsen (1994)

www.nngroup.com/articles/ten-usability-heuristics/
Multiple existing heuristics proposed by Bruce Tognazzini (revised in 2014)

<table>
<thead>
<tr>
<th>Aesthetics</th>
<th>Discoverability</th>
<th>Metaphors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anticipation</td>
<td>Efficiency of the User</td>
<td>Protect Users’ Work</td>
</tr>
<tr>
<td>Autonomy</td>
<td>Explorable Interfaces</td>
<td>Readability</td>
</tr>
<tr>
<td>Color</td>
<td>Fitts’ Law</td>
<td>Simplicity</td>
</tr>
<tr>
<td>Consistency</td>
<td>Human-Interface Objects</td>
<td>State: Track it</td>
</tr>
<tr>
<td>Defaults</td>
<td>Latency Reduction</td>
<td>Visible Interfaces</td>
</tr>
<tr>
<td></td>
<td>Learnability</td>
<td></td>
</tr>
</tbody>
</table>

[asktog.com/atc/principles-of-interaction-design/]
Multiple existing heuristics
corext: mobile computing (E. Bertini et al., 2006)

1. Visibility of system status & device findability
2. Match between system and the real world
3. Consistency and mapping
4. Good ergonomics & minimalist design
5. Ease of input, screen readability and glancability
6. Flexibility, efficiency of use and personalization
7. Aesthetic, privacy and social conventions
8. Realistic error management
Usability evaluation (Rogers, 2007)

The evaluator could not substitute the real users

an UI has usability problems
only if its final common users have these problems

code inspection vs. code testing
User testing

UI quality evaluation could be performed by users.
User testing

Aspects of interest (J. Dumas & J. Fox, 2008)

the focus is on usability
User testing

Aspects of interest (J. Dumas & J. Fox, 2008)

the participants are (potential) end users
User testing

Aspects of interest (J. Dumas & J. Fox, 2008)

there is a real product/service to be evaluated
User testing

Aspects of interest (J. Dumas & J. Fox, 2008)

the participants perform tasks, usually while thinking aloud
User testing

Aspects of interest (J. Dumas & J. Fox, 2008) the data are recorded and further analyzed
a usability test plan HTML5 template
profs.info.uaic.ro/~stefan.negru/usability/
User testing

Considered metrics

effectiveness, efficiency & satisfaction
User testing

Considered metrics

effectiveness, efficiency & satisfaction

+ fun, challenge & stimulation
User testing: planning (*Adaptive Path*)

- **t – 2 weeks**: Determine test audience, start recruiting immediately
- **t – 2 weeks**: Determine feature set to be tested
- **t – 1 week**: Write first version of guide, discuss with team, check on recruiting
- **t – 3 days**: Write second version of guide, recruiting should be completed
- **t – 2 days**: Complete guide, schedule practice test, set up and check equipment
- **t – 1 day**: Do practice test in the morning, adjust guide/tasks as appropriate
- **t**: Test (usually 1-2 days, depending on scheduling)
- **t + 1 day**: Discuss with observers, collect copies of all notes
- **t + 3 days**: Watch all video recordings, take notes
- **t + 1 week**: Combine notes, write analysis
- **t + 1 week**: Present to team, discuss and note directions for further research
User testing

Methods:

formative evaluation

field study

controlled experiment
User testing

Formative evaluation

finding problems for next iteration of the design project
User testing

Formative evaluation

prototype/implementation is evaluated within a controlled environment (lab), with focus on specific tasks
User testing

Formative evaluation

users, facilitators, observers offer qualitative data (usability issues)
User testing

Field study

tries to find problems with respect to a given context
User testing

Field study

evaluates the (preliminary) UI in a concrete context, with focus on real tasks
User testing

Field study

evaluates the (preliminary) UI in a concrete context, with focus on real tasks

offers qualitative annotations
User testing

Controlled experiment

to test a hypothesis

e.g., youngsters prefer conversational user interfaces
User testing

Controlled experiment
could be used to evaluate a preliminary UI, in lab rigorous conditions, with focus on specific tasks

has one or more conditions (independent variables) and measures (dependent variables)
User testing

Controlled experiment

gives quantitative information:
time of reaction, error rate, user satisfaction,...

exp-platform.com/Documents/GuideControlledExperiments.pdf
User testing

Advices + aspects of interest (Lukas Mathis, 2011)

do not influence the tester
User testing

Advices + aspects of interest (Lukas Mathis, 2011)

- do not influence the tester
- avoid stressful situations
User testing

Advices + aspects of interest (Lukas Mathis, 2011)

- do not influence the tester
- avoid stressful situations
- consider the ethics of conducting tests
  (e.g., respect, confidentiality, consent, be aware of cultural & social differences)
User testing

A/B testing

comparing 2 versions of an UI element or an entire Web page in a time interval to see which performs better
User testing

A/B testing

comparing 2 versions of an UI element or an entire Web page in a time interval to see which performs better

performance criterion = conversion rate (from visitors to goal achievers)

› CRO – Conversion Rate Optimization
User testing

www.alistapart.com/articles/a-primer-on-a-b-testing/

study also elem.com/~btilly/effective-ab-testing/
User testing

A/B testing

multivariate testing – different versions of individual parts of the design are tested at the same time
a multivariate test (Julian Gaviria, 2017)

**Variant A**
Single Offer with Intro Message

**Variant B**
Top 3 Converting eBooks

**Variant C**
Single Offer w/ Intro Msg + Top 2 eBooks

Website Converted at **8.59%** with 108 leads generated out of 1,258 visitors (**+22.3% Improvement**).

Website Converted at **8.14%** with 109 leads generated out of 1,339 visitors (**+16.0% Improvement**).

Website Converted at **10.12%** with 127 leads generated out of 1,255 visitors (**+44.2% Improvement**).
User testing

A/B testing tools – examples:

A/B Tasty – www.abtasty.com
Google Optimize – marketingplatform.google.com/about/optimize/
LeadFormy – leadformly.com
VWO – vwo.com
Vanity (Experiment Driven Development framework for Rails) – vanity.labnotes.org
<table>
<thead>
<tr>
<th>Website</th>
<th>Increase %</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Majestic Wine</td>
<td>201%</td>
<td>Redesigning category webpage increases leads generated. Majestic Wines revamped their category page design to increase online enquiries for their Wedding services by 201%.</td>
</tr>
<tr>
<td>Server Density</td>
<td>144%</td>
<td>A/B testing between different pricing structures increases revenue by 114%. Server Density A/B tested between per unit and packaged pricing plans. The winning plan reduced free signups but increased the Average Order Value (AOV), and consequently revenue by 114%.</td>
</tr>
<tr>
<td>Taylor Gifts</td>
<td>111%</td>
<td>Redesign of ecommerce product page increases conversions. Conversion Optimization Agency Trinity Insight used Visual Website Optimizer to test a better version of the ecommerce product page. This led to a 111% increase in conversions.</td>
</tr>
</tbody>
</table>
User testing

Pilot study

a trial run of an experimental procedure, not expected to produce valid research data
User testing

Remote testing

by using a screen-sharing software

for details, read N. Bolt, “Quick and Dirty Remote User Testing”, A List Apart, 2010: 
alistapart.com/article/quick-and-dirty-remote-user-testing
User testing

Remote testing

the tester’s environment cannot be typically controlled

also, the tester might get distracted during the test
Predictive evaluation

Having a correct model of the interaction between users and computers, we can predict the usability of a system, without the need of designing and/or testing a concrete UI.
Predictive evaluation

User testing could only relieve certain problems, but can not explaining them
Predictive evaluation

Classical models:

probabilistic – *e.g.*, Bayes networks

GOMS (Goals, Operators, Methods, Selection rules)

CMP-GOMS (Cognitive-Motor-Perceptual)
task graph used by CMP-GOMS model

the critical path is the path of tasks having the longest time of execution
Predictive evaluation

Direction of research: objectives beyond productivity

- hedonomics

peterhancock.ucf.edu/hedonomics-the-power-of-positive-and-pleasurable-ergonomics/
Usability evaluation

For further information, study:

[www.interaction-design.org/encyclopedia/usability_evaluation.html](http://www.interaction-design.org/encyclopedia/usability_evaluation.html)

How about designing interactivity by using model-driven approaches?
Reality

Major differences between software engineering and the effective UI development
Reality

Target-applications & domains of interest

personal productivity, business, entertainment, etc.
Reality

Notations and engineering tools

(formal) methods for software development
Multiple interaction paradigms

textual, graphical, multimedia, natural, 3D,...
Evolution of the interactive apps: context of use = (U, P, E)

Jean Vanderdonckt, 2006
Model-based UI design

Model(s) facilitate(s) an abstract view of the interaction

separation of concerns, ability of correlation

parsability, editability

if possible, human readability
Model-based UI design

Models

explicitly capture knowledge about UI and interactive applications with appropriate abstractions
Model-based UI design

Method

structures the definition and use of underlying models in a stage-wise approach

example: agile usability (Scott Ambler, 2008)
www.agilemodeling.com/essays/agileUsability.htm
Model-based UI design

Supporting tools

support the use of the method by providing tools for models and their related operations

ideally, one model should be supported by at least one tool
Models used in the processes of UI design (P. Forbrig et al., 2004)
Using notations to model tasks to be performed by users (L. Marucci et al., 2004)
designing the abstract UI of a computer game
user task modelling via a specific tool
(S. Tofan, A. Pradais, S. Buraga, 2009)
Process Reference Framework for the development of plastic user interfaces
Model-based UI design

CADUI – Computer-Aided Design of User Interface

(formal) descriptions of interactive systems,
in terms of existing meta-models,
used to design and deploy multiple user interfaces
Model-based UI design

(Meta)languages for describing UI

MARIA
(Model-based lAnguage foR Interactive Applications)

UIML – User-Interface Modeling Language

UsiXML – USer Interface eXtensible Markup Language

chess.eecs.berkeley.edu/pubs/940/dreams-18-09-2012.pdf
Model-based UI design

(Meta)languages for describing UI

- FXML (JavaFX)
- Glade XML
- JSX (React.js)
- XAML – eXtensible Application Markup Language
- XUL – eXtensible User-interface Language
Model-based UI design

(Meta)languages for describing VUI
(Voice-based UI)

VoiceXML
CCXML – Call Control eXtensible Markup Language

+ 

PLS – Pronunciation Lexicon Specification
SSML – Speech Synthesis Markup Language
Statechart uses finite-state machine (FSM) formalism, based on Harel statecharts (David Harrel, 1987). Abstract description of the behavior of a system (in our case, UI).
Statechart represents a state machine that allows any state to include more machines – subordinate state machines, called substates –, in a hierarchical manner.
case study

Statechart

- State Off:
  - Entry/turn light on
  - Exit/turn light off

- State A:
  - Flick

- State B:
  - After 2 s

- State On:
  - Flick
  - Entry/turn light on
  - Exit/turn light off

(statecharts.github.io)
Statechart

expressed by various modeling languages such as State Chart XML (SCXML):
State Machine Notation for Control Abstraction

W3C Recommendation, 2015
www.w3.org/TR/scxml/
Statechart

SCXML open-source implementations:

- Apache Commons SCXML (Java)
- LXSC (Lua) – [github.com/Phrogz/LXSC](https://github.com/Phrogz/LXSC)
- scxmlcc (C++) – [scxmlcc.org](http://scxmlcc.org)
- SCION (JavaScript) – [scion.scxml.io](http://scion.scxml.io)
- XState (JavaScript, TypeScript) – [xstate.js.org/docs/](http://xstate.js.org/docs/)
case study

example: specifying the interaction to a microwave oven

a tutorial (Zhornyak, 2021): github.com/alexzhornyak/SCXML-tutorial
model-based tools for designing conversational UIs

cui.tools
All Applications

Invisible UI

No more programming: only models

Embedded systems
Command & control systems, games
3D Applications

Web, desktop, mobile apps

Information systems
Business applications
Automated, batch systems

Physical models
World models
Scene model
Task model, context model, UML...

Entity-relationship model
Attribute model
State-transition diagrams
Screen definitions
Nothing

Embodied UIs
Tangible UIs
Mixed Reality User Interfaces
Virtual Reality User Interfaces
Multi-platform User Interfaces
Graphical User Interfaces
Character UIs
No Interaction Technique

Target Applications, Domains
Notations & Engineering Tools
User Interface Interaction Techniques

Palanque, 2002 & Vanderdonckt, 2006
"Conclusion"

HCI engineering
UI quality
testing
models
next episode: data visualization