

**“The sooner you start to
code, the longer the program
will take.”**



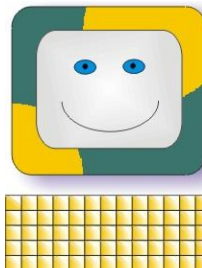
Roy Carlson

www.interaction-design.org

Usability of Interactive Systems

dr Kristina Lapin

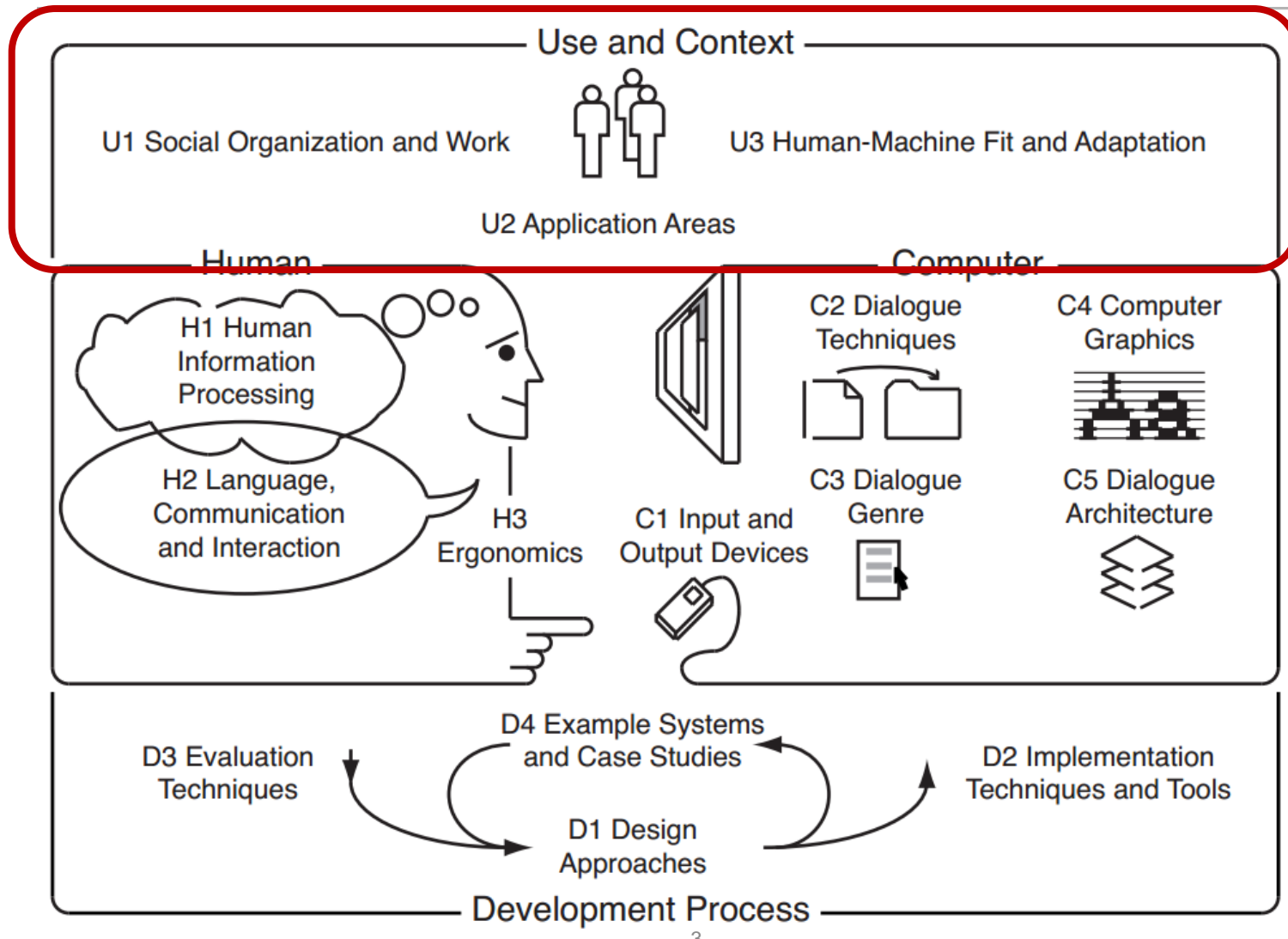
Human Computer Interaction



Outline

- Introduction
- The skills of interactive systems designed
- Definition of usability
- Usability objectives and measures

ACM model of HCI



People and technologies

Interactive system

- combination of **hardware** and/or **software** and/or **services** and/or **people** that users interact with in order to achieve specific goals
 - Note 1 to entry: This includes, where appropriate, packaging, user documentation, on-line and human help, support and training. [SOURCE: ISO 9241-11: 2018, 3.1.5]
- the technology that covers components, devices, products and software systems that are primarily concerned with processing information.
- deals with the transmission, display, storage or transformation of information that people can perceive.
- devices and systems that respond dynamically to people's actions.

Successful designers

- Go beyond vague notions of “user friendliness”, “intuitive”, and “natural” doing more than simply making checklists of subjective guidelines
- Have a thorough understanding of the diverse community of users and the tasks that must be accomplished
- Study evidence-based guidelines and pursue the research literature when necessary
- [US Web Design Standards](#)

The User Experience (UX)

- 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, beliefs, preferences, perceptions, physical and psychological responses, behaviors and accomplishments
 - that occur **before**, **during** and **after** use.
 - UX is
 - a consequence of brand image, presentation, functionality, system performance, interactive behavior and assistive capabilities of the interactive system,
 - the user's internal and physical state resulting from prior experiences, attitudes, skills and personality, and the context of use.
- Usability, when interpreted from the perspective of the users' personal goals, can include
 - the kind of perceptual and emotional aspects typically associated with user experience.
- **Usability criteria can be used to assess aspects of user experience.**

Definition of usability

ISO 9241-11:2018 Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts

Usability is the extent to which a system, product or service can be used by **specified users** to achieve **specified goals** with **effectiveness, efficiency and satisfaction** in a **specified context of use**.

Note 1 to entry: The “specified” users, goals and context of use refer to the particular combination of users, goals and context of use for which usability is being considered.

Context of use (ISO 9241-11:2018)

- Context of use is combination of **users, goals and tasks, resources, and environment.**
- Note 1 to entry: The “environment” in a context of use includes the technical, physical, social, cultural and organizational environments.
- The context of use is a major source of information for establishing requirements and an essential input to the design process’ (ISO/IEC 25010:2010 p.11)

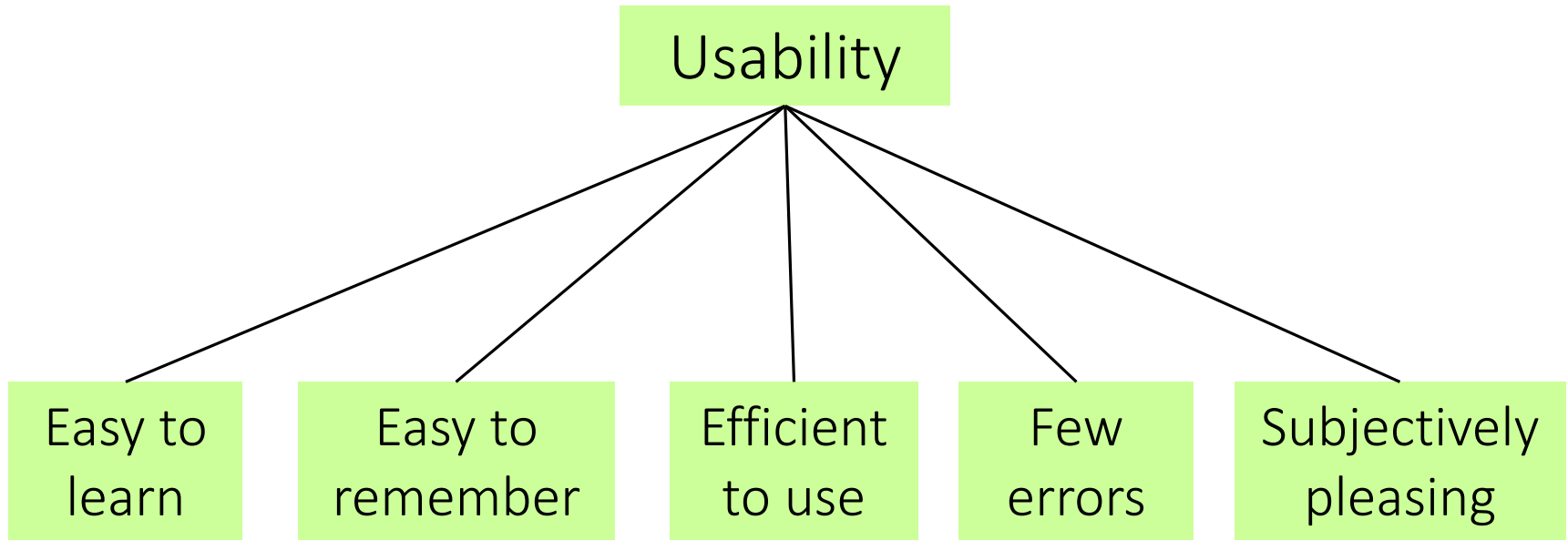
Usability Goals and Measures according to ISO 9241

- **Goal: effectiveness**
 - Accuracy and completeness with which users achieve specified goals
 - Interaction is effective if appropriate functions and information is provided.
- **Measure: how many users successfully finished the task?**
 - 95% of users will be able to identify insurance options on Healthcare.gov
 - 90% of users will be able to find the Usability Guidelines database

Usability Goals and Measures according to ISO 9241

- Goal: **efficiency**
 - How much efforts is required to achieve the user goal?
 - How much time does an experienced user spend performing task?
- Example of measure
 - 90% users will be able to identify insurance options on Healthcare.gov in no more than 1 min.

Usability goals according to Nielsen



(Nielsen, 2010)

Usability goals and measures according to Nielsen (2010)

- Learnability
 - Time to become minimally proficient
 - Measures:
 - How many users are able to complete certain task
 - successfully?
 - In a certain, minimal amount of time?
 - How much practice time is needed to get defined proficiency level
 - Example: user will be able to edit a page of corrections in 15 minutes after 1 hour during first time usage.

(Nielsen, 2010)

Usability goals and measures according to Nielsen (2010)

- Memorability
 - How many casual users that are away from the system are able to complete certain task in a certain time?
- Few and non-catastrophic errors
 - Number of errors
- Subjective satisfaction
 - Asking users for subjective preferences
 - by filling a short questionnaire
 - In a few cases can be psychophysiological measures
 - heart rate, skin conductivity, blood pressure ...

Comparison of usability goals

Nielsen's principles

1. Learnability
2. Efficiency of use
3. Memorability
4. Few and non-catastrophic errors
5. Satisfaction

ISO 9241

- A. Effectiveness
- B. Efficiency
- C. Subjective satisfaction

Further Usability Goals and Measures

- Ensure reliability
 - Actions must function as specified
 - Database data displayed must reflect the actual database
 - Appease the user's sense of mistrust
 - The system should be available as often as possible
 - The system must not introduce errors
 - Ensure the user's privacy and data security by protecting against unwarranted access, destruction of data, and malicious tampering

Further Usability Goals

- Standardization
 - Use pre-existing industry standards where they exist to aid learning and avoid errors (e.g. the W3C and ISO standards)
- Integration
 - The product should be able to run across different software tools and packages (e.g. Unix)
- Consistency
 - Compatibility across different product versions
 - Compatibility with related paper and other non-computer based systems
 - Use common action sequences, terms, units, colors, etc. within the program
- Portability
 - Allow for the user to convert data across multiple software and hardware environments

Essential usability goals with example of measure

- Time to learn
 - How long does it take for typical members of the community to learn relevant task?
- Speed of performance
 - How long does it take to perform relevant benchmarks?
- Rate of errors by users
 - How many and what kinds of errors are made during benchmark tasks?
- Retention over time
 - Frequency of use and ease of learning help make for better user retention
- Subjective satisfaction
 - Allow for user feedback via interviews, free-form comments and satisfaction scales

Trade-offs in UX design

- Trade-offs in design options frequently occur
 - Changes to the interface in a new version may create consistency problems with the previous version, but the changes may improve the interface in other ways or introduce new needed functionality
- Design alternatives are evaluated by designers and users via mockups or high-fidelity prototypes
 - The basic tradeoff is getting feedback early and perhaps less expensively in the development process versus having a more authentic interface evaluated

Expectations in specific application domains

Many interfaces are poorly designed and this is true across domains:

- **Life-critical systems**

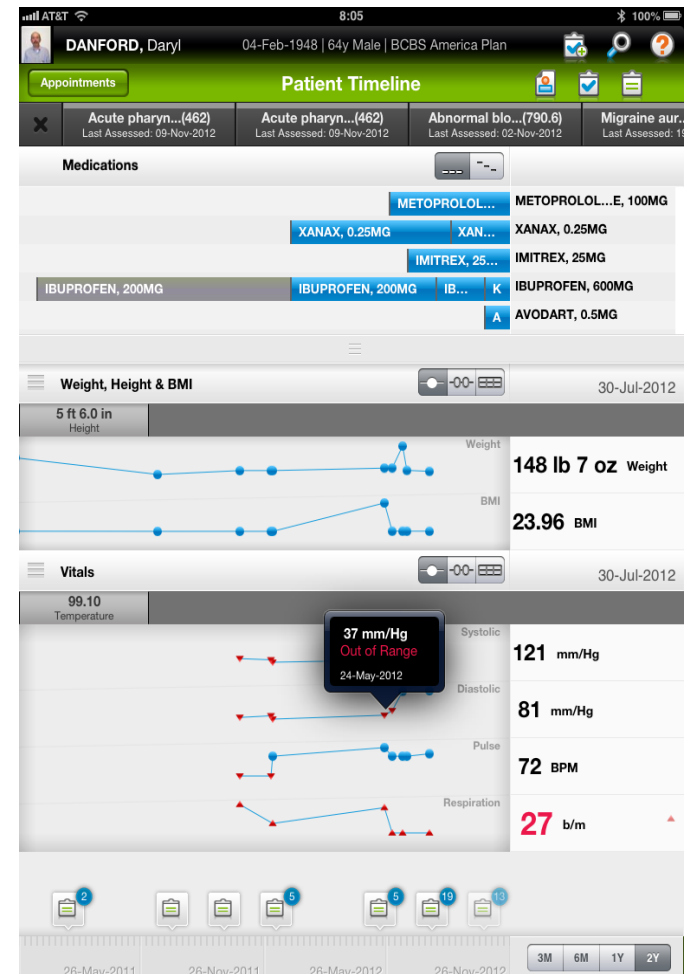
- Air traffic control, nuclear reactors, power utilities, police and fire dispatch systems, medical equipment

- **Typical user expectations**

- High costs, reliability, and effectiveness
- Lengthy training periods are acceptable despite the financial cost to provide error-free performance and avoid the low-frequency but high-cost errors
- Subject satisfaction is less an issue due to well motivated users

Expectations in specific application domains

Example life-critical application:
The Wand timeline view of a patient record in Allscript's ambulatory Electronic Health Record iPad application



Expectations in specific application domains

Industrial and commercial applications

- Banking, insurance, order entry, inventory management, reservation, billing, and point-of-sales systems
- Typical User Expectations
 - Ease of learning is important to reduce training costs
 - Speed and error rates are relative to cost
 - Speed of performance is important because of the number of transactions
 - Subjective satisfaction is fairly important to limit operator burnout

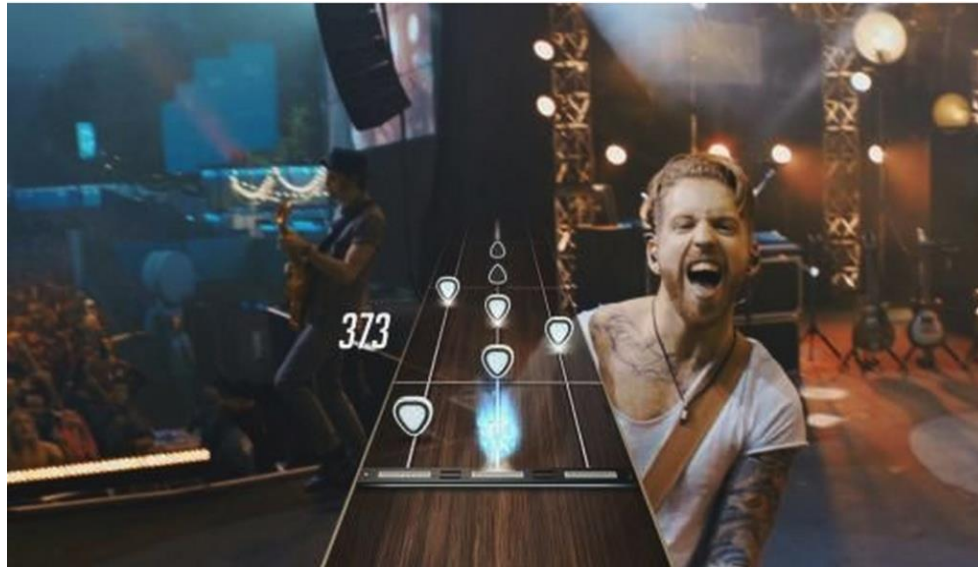
Expectations in specific application domains

- **Office, home, and entertainment applications**
 - Word processing, electronic mail, computer conferencing, and video game systems, educational packages, search engines, mobile device, etc.
 - Typical User Expectations
 - Ease of learning, low error rates, and subjective satisfaction are paramount due to use is often discretionary and competition fierce
 - Infrequent use of some applications means interfaces must be intuitive and easy to use online help is important
 - Choosing functionality is difficult because the population has a wide range of both novice and expert users
 - Competition cause the need for low cost
 - New games and gaming devices!

Expectations in specific application domains

Example: Guitar Hero, a highly successful music playing game in which users learn to play popular songs and earn points for how well they keep up

- The Guitar Hero web site shows potential users how to use the provided special small guitar and also hosts a community for discussions and runs contests



Expectations in specific application domains

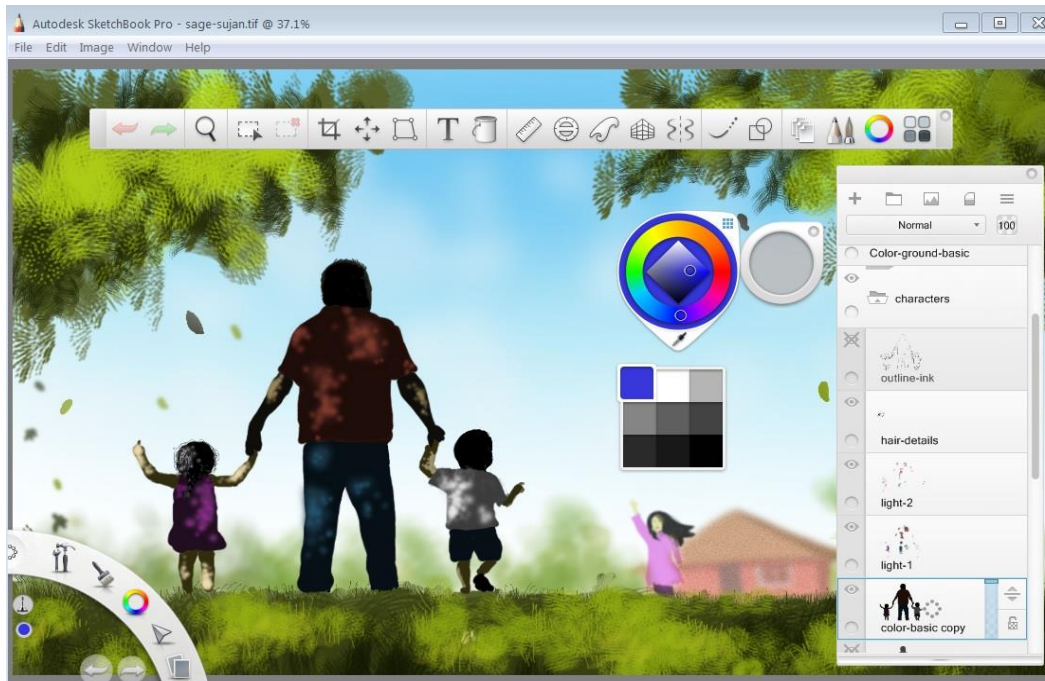
Exploratory, creative, and cooperative systems

- Web browsing, search engines, artist toolkits, architectural design, software development, music composition, and scientific modeling systems
- Typical User Expectations
 - Collaborative work support
 - With these applications, the computer **should be transparent** so that the user can be absorbed in their task domain
 - Benchmarks are hard to describe for exploratory tasks and device users

Expectations in specific application domains

Sketchbook™ design tool for digital artists from Autodesk™

- A large number of tools and options are available through a rich set of menus and tool palettes (<http://www.sketchbook.com>)

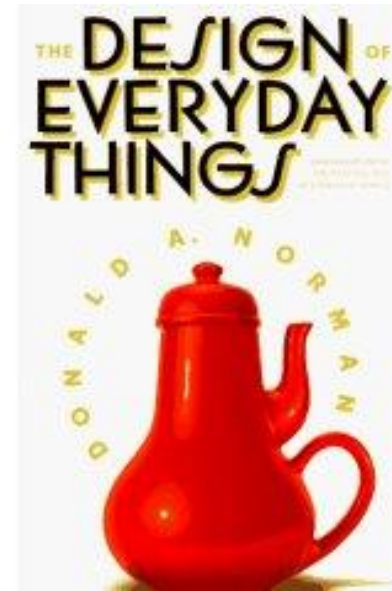


Expectations in specific application domains

- **Socio-technical systems**
 - Complex systems that involve many people over long time periods
 - Voting, health support, identity verification, crime reporting
- Typical User Expectations
 - Trust, privacy, responsibility, and security are issues
 - Verifiable sources and status feedback are important
 - Ease of learning for novices and feedback to build trust
 - Administrators need tools to detect unusual patterns of usage

Norman's usability design principles

- Visibility
- Constraints
- Mapping
- Consistency
- Feedback
- Affordance



Norman, Donald A. (2002). *The Design of Everyday Things*. New York: Basic Books.

Visibility



- This is a control panel for an elevator
- How does it work?
- Push a button for the floor you want?
- Nothing happens. Push any other button? Still nothing. What do you need to do?

It is not visible as to what to do!

From:
www.baddesigns.com

Visibility



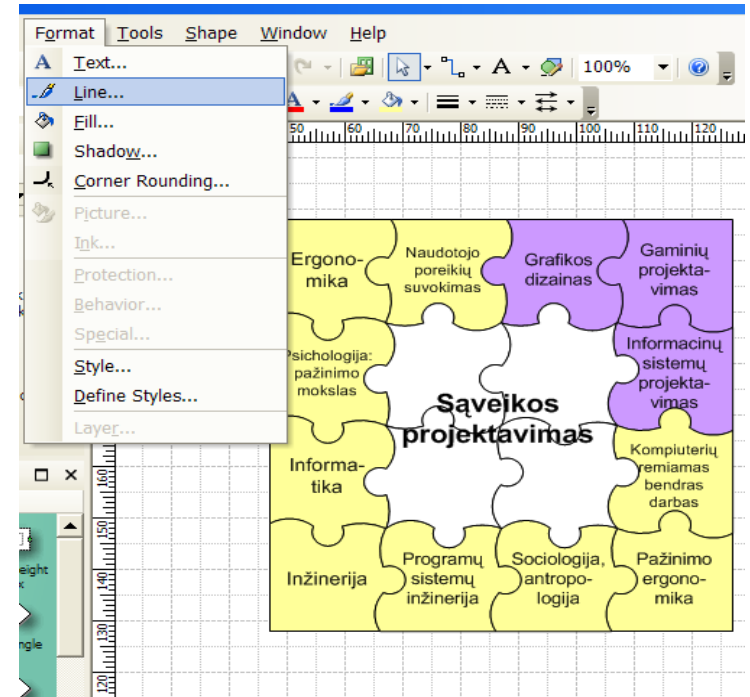
...you need to insert your room card in the slot by the buttons to get the elevator to work!

How would you make this action more visible?

- make the card reader more obvious
 - provide an auditory message that says what to do (which language?)
 - provide a big label next to the card reader that flashes when someone enters
-
- Make relevant parts visible
 - Make what has to be done obvious

Constraints

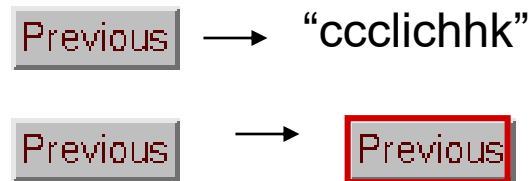
- Restricting the possible actions that can be performed
- Helps prevent user from selecting incorrect options
- Physical objects can be designed to constrain things
 - e.g. only one way you can insert a key into a lock



Feedback

Sending information back to the user about what has been done

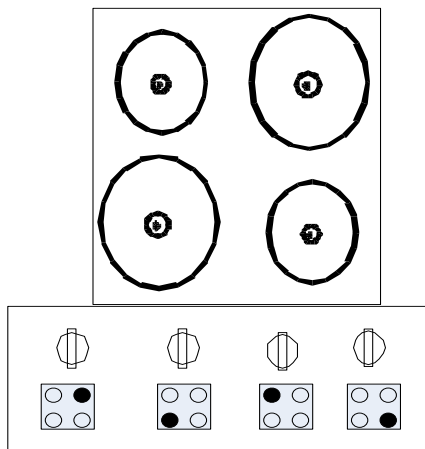
- Includes sound, highlighting, animation and combinations of these
 - e.g. when screen button clicked on provides sound or red highlight feedback:



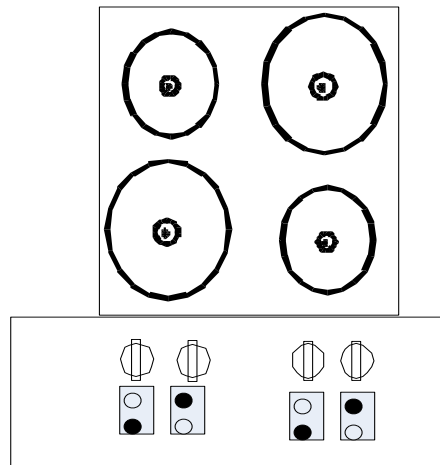
Mapping

A clear relationship between controls and the effect they have.
Which is the best here?

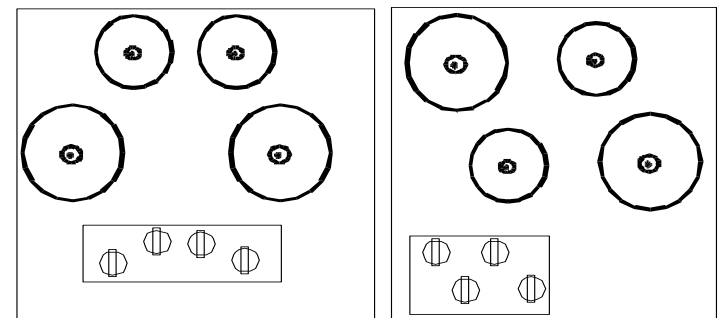
(a)



(b)



(c)



Mapping: logical or ambiguous?



- Where do you plug the mouse?
- Where do you plug the keyboard?
- Top or bottom connector?
- Do the colour coded icons help?

From: www.baddesigns.com

How to design them more logically?



(i) A provides direct adjacent mapping between icon and connector

(ii) B provides colour coding to associate the connectors with the labels

From: www.baddesigns.com

Consistency

- Design interfaces to have similar operations and use similar elements for similar tasks
- For example:
 - always use `ctrl` key + first initial of the command for an operation – `ctrl+C`, `ctrl+S`, `ctrl+O`
- Main benefit is consistent interfaces are easier to learn and use

When consistency breaks down?

- What happens if there is more than one command starting with the same letter?
 - e.g. save, spelling, select, style
- Have to find other initials or combinations of keys, thereby breaking the consistency rule
 - e.g. ctrl+S, ctrl+Sp, ctrl+shift+L
- Increases learning burden on user, making them more prone to errors

Internal and external consistency

- Internal consistency refers to designing operations to behave the same within an application
 - Difficult to achieve with complex interfaces
- External consistency refers to designing operations, interfaces, etc., to be the same across applications and devices
 - Very rarely the case, based on different designer's preference

Keypad numbers layout

- A case of external inconsistency

(a) phones, remote controls

1	2	3
4	5	6
7	8	9
	0	

(b) calculators, computer keypads

7	8	9
4	5	6
1	2	3
0		

Affordance: to give a clue

- An attribute of an object that allows people to know how to use it
 - e.g. a mouse button invites pushing, a door handle affords pulling
- Norman (1988) used the term to discuss the design of everyday objects
- Since has been much popularised in interaction design to discuss how to design interface objects
 - e.g. scrollbars to afford moving up and down, icons to afford clicking on

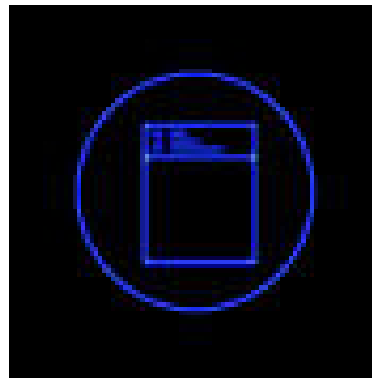
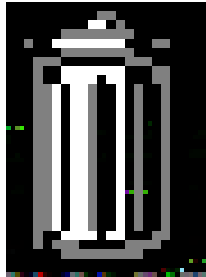
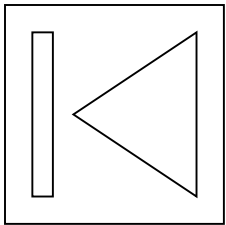
Examples of physical affordances

How do the following physical objects afford?
Are they obvious?



Virtual affordances

How do the following screen objects afford?
What if you were a novice user?
Would you know what to do with them?



Virtual affordances

Use your EasyChair account to sign in.

User name:

Password:

If you have no EasyChair account, [sign up for an account](#)

Forgot your password? [click here](#)

Problems to sign in? [click here](#)

is for the selected device:

Balance: left right

Output volume: ☐ Mute

☒ Show volume in menu bar

Swisscom 11:03

Abbrechen Heute Sichern

Wählen Sie das Ausführungsdatum:

14.	September	2011
15.	Oktober	2012
16.	November	2013
17.	Dezember	2014
18.	Januar	2015

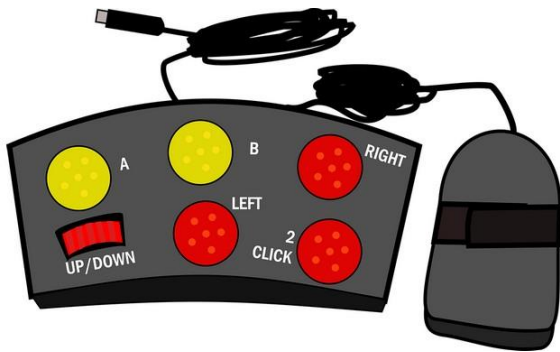
Achtung: Das Datum ist ein Samstag!

Affordance on the web page: what can you click [on this page](#)?

Accessibility

Accessibility: usability for all

- Legislation
 - UK Disability Discrimination Act
 - [W3C declarations and guidelines](#)



Accessibility

- Concerns removing the barriers that would otherwise exclude some people from using the system at all.
- Excluding reasons:
 - Physically: Inappropriate siting of equipment
 - Conceptually: Cannot understand complicated instructions
 - Economically: Cannot afford essential technology
 - Culturally: Inappropriate metaphors
 - **Socially:** Equipment is unavailable at an appropriate time and place
 - If people are not members of a particular social group and cannot understand particular messages

User needs for accessibility

- **Visual:** Long-sightedness, blindness, color blindness, etc.
- **Motor/Mobility:**
 - problems with the use of the *hands* and *arms*
 - which are very likely to cause problems with web accessibility,
 - other muscular or skeletal conditions
- **Auditory:**
 - affect the hearing and come in varying degrees of severity, including total deafness.
- **Epilepsy and other seizures:**
 - light, motion, flickering, etc. on screen, can trigger various attacks, such as photosensitive epilepsy.
- **Learning:**
 - not all disabilities are physical,
 - for example, learning and cognitive disabilities

Web Content Accessibility Principles

Principle 1: Perceivable

Information and user interface components must be presentable to users in ways they can perceive.

Principle 2: Operable

User interface components and navigation must be operable

Principle 3: Understandable

Information and the operation of user interface must be understandable.

Principle 4: Robust

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

Assistive technologies

Make your computer easier to use

Quick access to common tools

You can use the tools in this section to help you get started.

Windows can read and scan this list automatically. Press the SPACEBAR to select the highlighted tool.

☒ Always read this section aloud

☐ Always scan this section



Start Magnifier



Start Narrator



Start On-Screen Keyboard



Set up High Contrast



Not sure where to start? [Get recommendations to make your computer easier to use](#)

Explore all settings

When you select these settings, they will automatically start each time you log on.



[Use the computer without a display](#)

Optimize for blindness



[Make the computer easier to see](#)

Optimize visual display



[Use the computer without a mouse or keyboard](#)

Set up alternative input devices



[Make the mouse easier to use](#)

Adjust settings for the mouse or other pointing devices



[Make the keyboard easier to use](#)

Adjust settings for the keyboard

User needs analysis

User needs analysis

1. Define business intentions:
 - What is the motivation for building the application or Web site to be a viable investment?
2. Analyze context of use:
 - users, activities and contexts
 - how do they solve their problems now?
3. Identify user needs:
 - What do your users want and need?
4. Set the usability objectives:
 - To what extent does the site need to satisfy both the user and the business goals?
 - How do we measure success?

Personal and business goals

Personal goals

- Do not look stupid
- Not make mistakes
- Get adequate amount of work done
- Have fun
- Do not need to remember how to use rarely used application

Business goals

- Increase profit
- Increase market share
- Defeat competition
- Hire more people
- Go public

Business goals – usability - UI

Business goal	Usability goal	User interface solutions
Grow the business by getting more new users to adopt the offered service	Improve the learnability	<ul style="list-style-type: none">• Progressive tooltips• Wizards to get people started
Reduce support costs	Reduce and prevent errors	<ul style="list-style-type: none">• Formatting information for text fields• Error message enhancements• Diagnostic features
Inspire loyalty among existing users	Reduce navigational requirements	<ul style="list-style-type: none">• Shortcuts to frequency used content or features

Tom Brinck, Darren Gergle, and Scott D. Wood. User needs analysis. In *User Experience Re-Mastered*. Morgan Kaufman, 2010, Chapter 2.

User need statement: a definition

A **user need statement** is an actionable problem statement used to summarize

- who a particular user is,
 - the user's need, and
 - why the need is important to that user.
- It defines what you want to solve before you move on to generating potential solutions, in order to
 - 1) condense your perspective on the problem, and
 - 2) provide a metric for success to be used throughout the design thinking process.

User need is

- ... a prerequisite identified as necessary for the user, or the set of users, to achieve an **intended outcome**, implied or stated **within a specific context of use** (BS ISO/IEE 25064:2013)
 - Sometimes, when Scott takes the train home, there is no room for his bike and he has to wait for the next one. Scott needs a way to plan what train to take based on how much room is available in the bike car;
 - A presenter needs to know how much time is left, in order to complete the presentation in time during a presentation with a fixed time limit.
 - An account manager needs to know the number of invoices received and their amounts, in order to complete the daily accounting log as part of monitoring the cash flow.

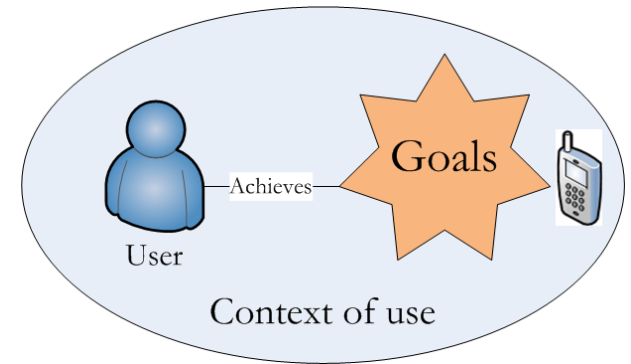
User need statement: examples

- An employee (**user**)
needs to know how to obtain an access code (**need**) in order to
log onto their work application (**intended outcome**)
using the company computer system (**context of use**).
- A presenter (**user**)
needs to have an alarm clock (**need**)
in order to complete the presentation in time (**intended outcome**)
using the presentation software in meeting room (**context of use**).

What is wrong in these needs statements?

- The current process of navigating through multiple screens and several clicks to view the schedule is time-consuming and inefficient. Dr. Smith requires a solution that significantly minimizes the number of clicks required to access her appointment schedule on the healthcare information system.
- Andrew needs a booking process that is quick and efficient with few data entry fields, the booking process should have as few entry fields as possible.

Usability objectives



- Target values of specific criteria and measures that quantify usability
- The target values can be selected to beat the competition or derived analysing current user activities

ISO 9241

Mayhew, 1999

Examples of usability objectives

Usability Goal	Examples of Specific Objectives
Learning time/ task time	Users will be able to use this site the first time without any training First-time users will be able to find their topic of interest within two minutes of visiting the site; expert users (five or more visits) will be able to find a topic within 30 seconds
Number of errors	Users will not visit more than three incorrect pages (on average) in completing a task Users will make no fatal errors at least 99 percent of the time (such as entering an incorrect credit card or shipping address)
Subjective impressions	On a scale of 1 (really appealing) to 7 (really unappealing), users will rate the site at least a 2.5
Accomplished tasks	At least 75 percent of users who add an item to a shopping cart will complete a purchase At least 95 percent of users who complete their credit card information will complete a purchase
Revisits	At least 50 percent of registered users will return to the site at least once per month

Social Impact Analysis

Describe the new system and its benefits

- Convey the high level goals of the new system
- Identify the stakeholders
- Identify specific benefits

Social Impact Analysis (continued)

Address concerns and potential barriers

- Anticipate changes in job functions and potential layoffs
- Address security and privacy issues
- Discuss accountability and responsibility for system misuse and failure
- Avoid potential biases
- Weigh individual rights vs. societal benefits
- Assess trade-offs between centralization and decentralization
- Preserve democratic principles
- Ensure diverse access
- Promote simplicity and preserve what works

Social Impact Analysis (concluded)

Outline the development process

- Present and estimated project schedule
- Propose process for making decisions
- Discuss expectations of how stakeholders will be involved
- Recognize needs for more staff, training, and hardware
- Propose plan for backups of data and equipment
- Outline plan for migrating to the new system

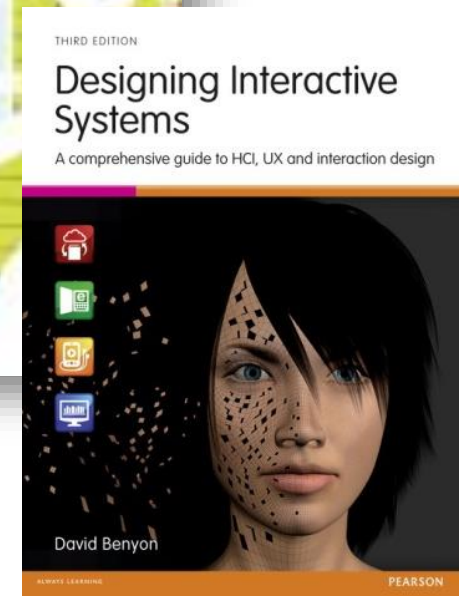
Summary

- Access to interactive systems for all people is an important right.
- Usability is concerned with balancing the PACT elements (the next lecture) in a domain.
- Acceptability is concerned with ensuring that designs are appropriate to contexts of use.
- User needs analysis aims at specification of user needs and usability objectives.
- Social impact analysis describes the new system and its benefits, addresses concerns and potential barriers and outlines the development process

MIF library

David Benyon, Phil Turner,
Susan Turner

Designing Interactive
Systems: People, Activities,
Contexts, Technologies,
Addison Wesley,
2005, 2010, 2014

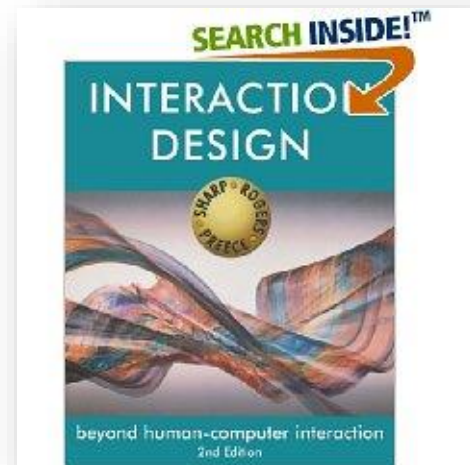


MIF library

- Helen Sharp, Yvonne Rogers, Jenny Preece

Interaction Design: Beyond Human-Computer Interaction

John Wiley & Sons, 2002 (20 egz.)
2007, 2011, 2014, 2019.



MIF library

- Donald A. Norman. **The Design of Everyday Things**. Basic Books; Reprint edition (September 17, 2002), 272 pages
 - Puikus ŽKS įvadas



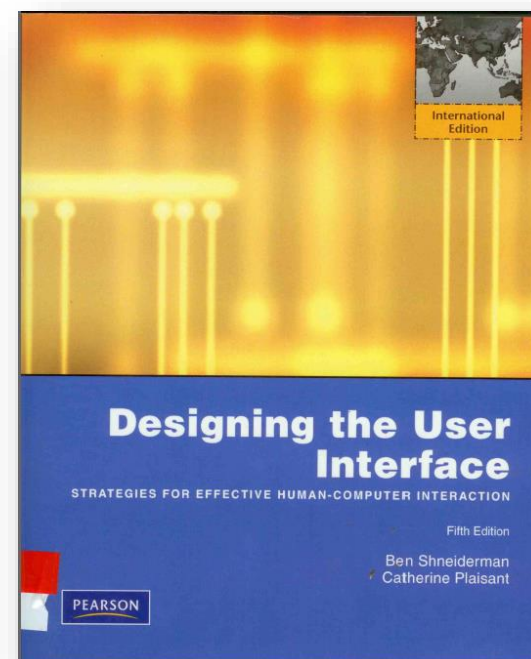
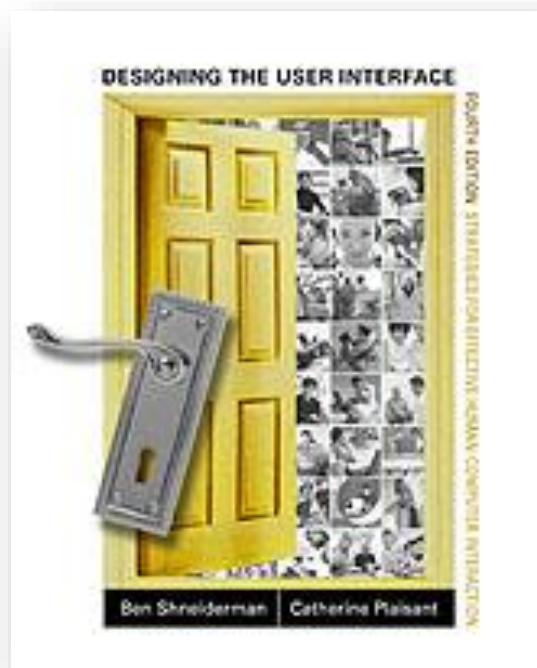
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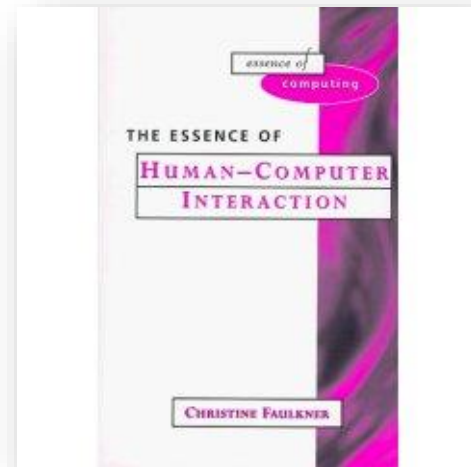
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MIF library

- Faulkner, Ch. **The Essence of Human-Computer Interaction**, Pearson Prentice Hall, 1996.



UX resources

- [Nielsen Norman Group](#)
- [Interaction Design Foundation](#)
- [AskTog: Interaction Design Solutions for the Real World](#)
- [Usability.gov](#)
- [User focus articles](#)
- [User Experience Professionals Association](#)
- [AIQA, the professional association for design](#)
- [ACM Special Interest Group CHI](#)
- ...



References

- David Benyon. Designing Interactive Systems: A comprehensive guide to HCI and interaction design, Addison Wesley, 2005, 2010, 2014.
 - 1 chapter: Designing interactive systems: a fusion of skills
- Jennifer Preece, Yvonne Rogers, Helen Sharp (2002, 2007, 2011). Interaction design: beyond human – computer interaction. John Wiley & Sons www.id-book.com
 - 1 chapter: What is Interaction Design?