Vorlesung Mensch-Maschine-Interaktion

Albrecht Schmidt
Embedded Interaction Research Group
LFE Medieninformatik
Ludwig-Maximilians-Universität München
http://www.hcilab.org/albrecht/

Chapter 5 Designing Interactive Systems

Interactive Systems What can be described?

- System functionality with regard to interaction
- Overall interaction concepts (metaphors, styles)
- Layout of key screens, sketches
- Layout of user interface elements (e.g. buttons, icons)
- Navigation and interaction details
- Interactive behavior of a system
- Platform requirements
- Functional assertions (e.g. login will take on average 7 seconds, average time per case is 2 minutes)
- User groups
- …

Interactive Systems How to describe them?

- Informal
  - System descriptions in plain text
  - Scenarios and use cases
  - Sketches and designs
  - Task-action-mappings
- Semi-formal
  - Task-action-grammar
  - Abstract UI description languages
  - UMLi
- Implementation languages
  - XML based languages (e.g. XUL)
  - Can be used to generate a concrete UI for the target platform
- …more next term

References

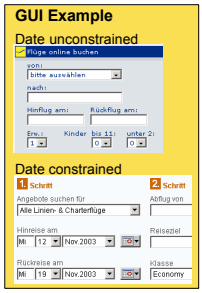
- B. Shneiderman. Designing the User Interface: Strategies for Effective Human-Computer Interaction , Third Edition. 1997. ISBN: 0201694972
- Robertson (Microsoft), Data Mountain , UIST'98,, http://www.microsoft.com/usability/UEPostings/p153-robertson.pdf
- Mander et al.(Apple), „Pile" metaphor, CHI'92, http://www1.cs.columbia.edu/graphics/courses/csw4170/resources/p627-mander.pdf
- Task-action-mapping http://www.psy.gla.ac.uk/~steve/HCI/cscln/trail1/Lecture8.html

Chapter 6 Implementing Interactive Systems

(selected topics)

Constraints

- Physical constraints
  - basic physical limitations
- Semantic constraints
  - Assumption that create something meaningful
- Cultural constraints
  - Borders provided by cultural conventions
- Logical constraints
  - Restrictions due to reasoning
- Applying constraints is a design decision!

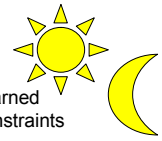


Constraints & Redundancy

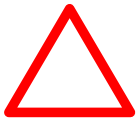
- Redundancy is safe!
- Constraints can only work at their own level
- But: things can go wrong elsewhere

Cultural Constraints

- Universal or culturally specific
- Arbitrary conventions that have been learned
- Users' expectations build on cultural constraints



:-)
:-(
;-)
:D
:o
8-)
:`-(



Foreign Cultures: Example

Physical Constraints & Affordances Examples

- USB Memory Stick vs. DVD vs. money
  - If there is more than one option (physically) cater these cases

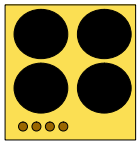
- Dials vs. Buttons vs. Sliders
  - Dials are turned
  - Buttons are pressed
  - Sliders are pushed

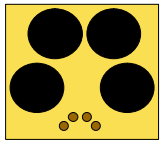
Chapter 6
Implementing Interactive Systems
(selected topics)

- 6.1 Constraints
- **6.2 Mapping**
- 6.3 Guidelines

Mapping

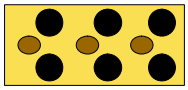
- Relationship between controls and action
- Mappings should be
  - Understandable (e.g. moving the mouse up move the slider up)
  - Consistent
  - Recognizable or at least quickly learnable and easy to recall
  - Natural, meaning to be consistent with knowledge the user already has
- Example: cooker
  (for these issues see also Gestalt theory)





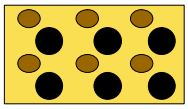
Mapping & Human Error

- Labels are correct
- However full context is needed
- Built-in source for potential frustration
- Missing context



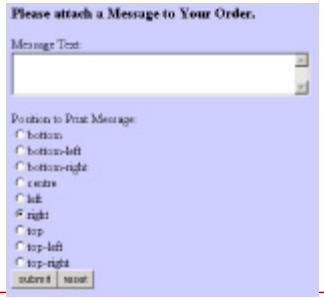
Mapping & Human Error

- Labels are correct
- However full context is needed
- Built-in source for potential frustration
- Missing context



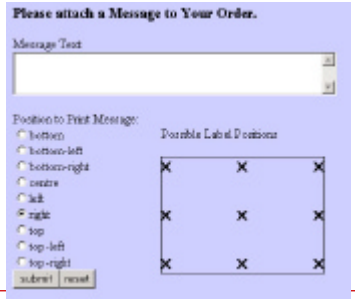
Mapping – Examples (1)

- Relationship between controls and action



Mapping – Examples (2)

- Relationship between controls and action

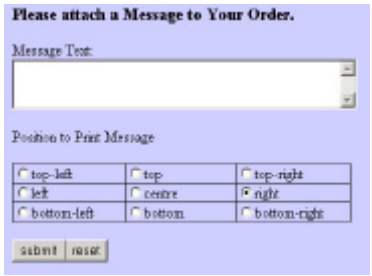


Mapping – Examples (3)

- Relationship between controls and action

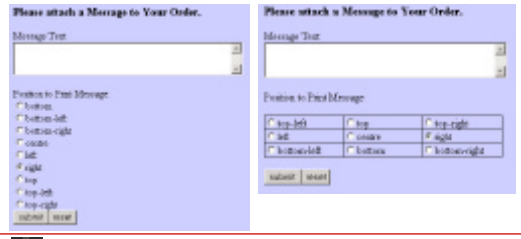
Mapping – Examples (4)

- Relationship between controls and action

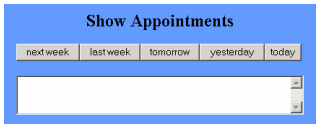


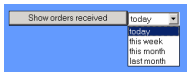
Mapping – Examples (6)

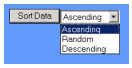
- Relationship between controls and action

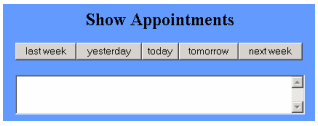


Mapping – Examples (5)









- "natural" mappings can be found in many areas
- It is not always obvious what the "natural" mapping is
- Correlation with cultural constraints

Chapter 6 Implementing Interactive Systems

(selected topics)

- 6.1 Constraints
- 6.2 Mapping
- **6.3 Guidelines**

Hix and Hartson's guidelines

1. User centered design
2. Know the user
3. Involve the user
4. Prevent user errors
5. Optimize user operation
6. Keep control with the user
7. Help the user to get started
8. Give a task-based mental model
9. Be consistent
10. Keep it simple
11. Design for memory limitations
12. Use recognition rather recall
13. Use cognitive directness
14. Draw on real world analogies

Hix and Hartson guidelines (2)

15. Use informative feedback
16. Give status indicators
17. Use user-centred wording
18. Use non-threatening wording
19. Use specific constructive advice
20. Make the system take the blame
21. Do not anthropomorphise

- Use modes cautiously
- Make user action reversible
- Get attention judiciously
- Maintain display inertia
- Organize screen to manage complexity
- Accommodate individual difference

(Hix and Hartson, Developing User Interfaces, Wiley, 1993)

GNOME Guideline

- 1. Usability Principles
  - Design for People
  - Don't Limit Your User Base
  - Accessibility
  - Internationalization and Localization
  - Create a Match Between Your Application and the Real World
  - Make Your Application Consistent
  - Keep the User Informed
  - Keep It Simple and Pretty
  - Put the User in Control
  - Forgive the User
  - Provide Direct Manipulation
- 2. Desktop Integration
  - Placing Entries in the Applications Menu
  - Menu Item Names
  - …
- 3. Windows
  - Titles
  - …
  - Layout
  - Common Dialogs
- 4. Menus
  - The Menubar
  - Types of Menu
  - Drop-down Menus
  - …
  - Help
- 5. Toolbars
  - Appearance and Content
  - …
- 6. Controls
  - …
  - Sliders
  - Buttons
  - Check Boxes
  - …

Drag and Drop Semantics

Your application must determine whether to move or copy a dragged item after it is dropped on a destination. The appropriate behavior depends on the context of the drag-and-drop operation, as described in this section.

Move Versus Copy

If the source and destination are in the same container (for example, a window or a volume), a drag-and-drop operation is interpreted as a move (that is, cut and paste). Dragging an item from one container to another initiates a copy (copy and paste). The user can perform a copy operation within the same container by pressing the Option key while dragging. When performing a copy operation, indicate a copy operation to the user by using the copy cursor. (See "Standard Cursors" (page 67).)

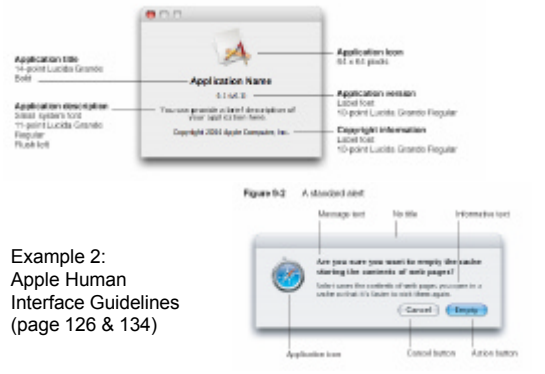
Example 1:
Apple Human Interface Guidelines
(page 42)

Table 3-1 Common drag-and-drop operations and results

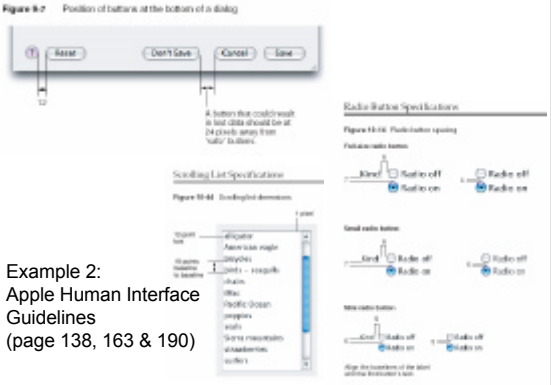
Dragged item	Destination	Result
Data in a document	The same document	Move
Data in a document	Another document	Copy
Data in a document	The Finder	Copy (creates a clipping)
Finder icon	An open document window	Copy
Finder icon	The same volume	Move
Finder icon	Another volume	Copy

Icon Genres and Families

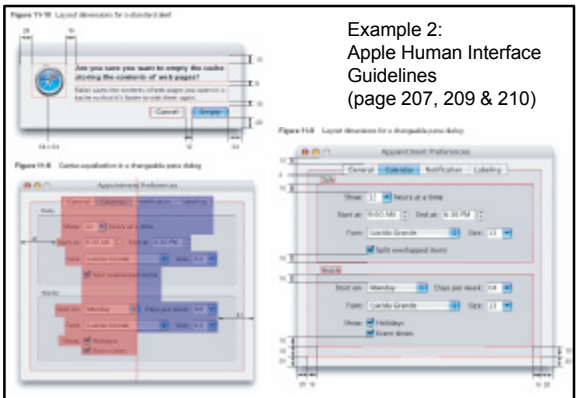
Example 2:
Apple Human Interface Guidelines
(page 55)



Example 2:
Apple Human Interface Guidelines
(page 126 & 134)



Example 2:
Apple Human Interface Guidelines
(page 138, 163 & 190)



Example 2:
Apple Human Interface Guidelines
(page 207, 209 & 210)

Specific Guidelines for Operating Systems, Window Managers, and the WWW Some Examples:

- Introduction to the Apple Human Interface Guidelines
  http://developer.apple.com/documentation/UserExperience/Conceptual/OSXHIGuidelines/index.html
- KDE User Interface Guidelines
  http://developer.kde.org/documentation/design/ui/
  http://developer.kde.org/documentation/standards/kde/style/basics/
- Palm OS® User Interface Guidelines
  http://www.palmos.com/dev/support/docs/ui/UIGuide_Front.html
- MSDN - User Interface Design and Development
  http://msdn.microsoft.com
- GNOME Human Interface Guidelines (1.1 - DRAFT)
  http://developer.gnome.org/projects/gup/hig/draft_hig_new/
- Web Guidelines???
  http://www.webstyleguide.com/ … and many others!

References

- D. A. Norman. The Design of Everyday Things. Basic Books 2002. ISBN: 0465067107
- B. Shneiderman. Designing the User Interface: Strategies for Effective Human-Computer Interaction , Third Edition. 1997. ISBN: 0201694972
- A. Cooper. About Face 2.0: Chapter 1 - Goal-Directed Design
  http://media.wiley.com/product_data/excerpt/13/07645264/0764526413.pdf

References

- B. Shneiderman. Designing the User Interface: Strategies for Effective Human-Computer Interaction , Third Edition. 1997. ISBN: 0201694972
- L. Miguel Encarnação. Concept and realization of intelligent user support in interactive graphics applications. http://www.crcg.edu/company/staff/mencarna/publs/diss/node11.html
- Hiroshi Ishii and Brygg Ullmer. Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms
  http://tangible.media.mit.edu/courses/ti02/ishii-chi97-tangbits.pdf
- H.-W. Gellersen, A. Schmidt. Look who's visiting: supporting visitor awareness in the web.
  http://www.comp.lancs.ac.uk/~albrecht/pubs/pdf/gellersen_ijhcs_2001.pdf
- Alan Dix, Janet Finlay, Gregory Abowd and Russell Beale. (1998) Human Computer, Interaction (second edition), Prentice Hall, ISBN 0132398648 (new Edition announced for October 2003)
- D. A. Norman. The Design of Everyday Things. Basic Books 2002. ISBN: 0465067107
- GNOME Human Interface Guidelines (1.0) by The GNOME Usability Project
  http://developer.gnome.org/projects/gup/hig/1.0/hig-1.0.pdf

Chapter 7 Evaluation

(selected topics)

- **7.1 User studies**
- 7.2 Heuristic Evaluation

What to evaluate?

- The usability of a system!
- … it depends on the stage of a project
  - Ideas and concepts
  - Designs
  - Prototypes
  - Implementations
  - Products in use
- … it also depends on the goals
- Approaches
  - Formative evaluation – throughout the design, helps to shape a product
  - Summative evaluation – quality assurance of the finished product.

Why Studies and Experiments?

- To measure more precisely the usability or other features
- Applicable mainly to
  - Functional prototypes
  - Testing an implementation
  - Quality monitoring of software products
- To compare solutions, e.g.
  - Users are quicker using version A than using version B
  - Users make 10% less errors when using version X than when using version Y
- To provide quantitative figures, e.g.
  - 90% of the users can complete the transaction using version Y in less than 3 minutes
  - On average users will be able to by a ticket using version A in less than 30 seconds

Designing the experiment

- Basic Scientific Method
  1. Form Hypothesis
  2. Collect data
  3. Analyze
  4. Accept/reject hypothesis
- Issues for user studies
  - System to test
  - Participants
  - Hypothesis
  - Variables
  - Experimental Methods
  - Statistical approach

Does computer science fit this traditional science approach?

Is it really possible to prove usability?

Procedure for user studies

- Set goals
- Design the experiment
- Schedule users
- For each user (typical example):
  - Inform the user and sign the consent form
  - Do a survey on demographics and questions of interest to the experiment
  - Give the participant instructions on the task – do not reveal the hypotheses
  - (optional) Make a training run - depends on the study
  - Perform the actual run and measure variables
  - (optional) do a survey on subjective measure
  - Be available for questions of participants or for their (informal) feedback
- Analyze the results

Participants (Subjects)

- How many participants do we need?
  - Depending on the project and the goals
  - Depending on the set-up
    - measuring the login-in time of remote users vs.
    - Doing a full video observation for a 1 hour task
  - Be pragmatic
  - Minimal size of about 10 participants
- Participants should be representative for the user group
  - Age, background, skills, experience, …
  - In most cases the other people on the team are NOT representative!
- How to recruit participants
  - Customer data base
  - Market research services
  - Volunteers (online, newspapers, etc) – this is risky because the people who will respond are often not representative

Selection of Participants

- Services offered that allow to get participants fitting a specific description
- Methods widely used in market research
- Example: Online Panel
  - For online questionnaires
  - Pool of users
  - Customer can specify the users that should take part
- How do companies get their subjects?
  - Incentive (money, prices, …)
  - Big set of questions when registering potential users, show examples from ComCult Online Panel

Variables

- Variables are manipulated and measured
  - Independent variables are manipulated
  - Dependent variables are measured
- The conditions of the experiment are set by independent variables
  - E.g. number of items in a list, text size, font, color
  - The number of different values used is called *level*
  - The number of experimental conditions is the product of the levels
  - E.g. font can be times or arial (2 levels), background can be blue, green, or white (3 levels). This results in 6 experimental conditions (times on blue, times, on green, …, arial on white)
- The dependent variables are the values that can be measured
  - Objective values: e.g. time to complete a task, number of errors, etc.
  - Subjective values: ease of use, preferred option
  - They should only be dependent on changes of the independent variables

Hypotheses

- Prediction of the result of an experiment
- Stating how a change in the independent variables will effect the measured dependent variables
- With the experiment it can be shown that the hypotheses is correct
- Usual approach
  - Stating a null-hypotheses (this predicts that there is not effect of the change in the independent variable on the measured variable)
  - Carrying out the experiment and using statistical measures to disprove the null-hypotheses
  - When a statistical test shows a significant difference it is probable that the effect is not random

Designing the experiment

- The experiment should be set up to be reproducible!
- Main factors
  - Participants
  - Independent variables
  - Hypotheses stated
- Approach
  - state the hypotheses – what do you want to proof
  - find the variables? Which are varied? which are measured?
  - Find participants – representative for the experiment
  - Fix the method to use (between-groups / within groups)

Experimental Method

- Within groups
  - Each user performs under all the different conditions
  - Important to randomize the order of the conditions for each participant
  - Problems
    - Learning may influence results
  - Advantages
    - The effect of differences between individuals are lessened
    - Fewer participants required
- Between groups (randomize)
  - One condition is selected for each participant
  - Each user performs only under one condition (avoids learning)
  - Careful selection of groups is essential
  - Drawback
    - Differences between individuals in different groups can play an important role (leads to large groups)
    - More user required
    - Usually harder to show significance

Statistical Tests

- See statistics text book (e.g. form psychology or medical tests)
- Software packages offer functions
- Test selected depends on
  - Distribution of the measured variables
  - The type of variables (continuous or discrete)
  - Experimental Method
- Example: Student's t-test
  - On the difference of means
  - Assumes a normal distribution
  - Functions available in spreadsheet software and statistics packages
- Example ANOVA
  - Analysis of Variance
- "significant difference"
  - Simplified: the probability that effect observed is random is less the 0.05

T-Test example in Excel

- TTEST(…)
- Parameters
  - Data row 1
  - Data row 2
  - Ends (1 or 2)
  - Type (paired, same variance, different variance)

User	Time M1	Time M2		
100	37	31		
101	44	38		
102	42	43		
103	56	37		
104	99	50		
105	33	30		
106	45	50		
107	49	36		
108	70	71		
109	63	56		
110	54	51		
111	61	46		
average	54,4167	44,9167		
t test (paired)			0,042	TTEST(B7:B18;C7:C18;2;1)
t test (un-paired)			0,137	TTEST(B7:B18;C7:C18;2;2)

Further Issues

- Consent form – get written consent from participants
  - Templates available
  - May be checked with the legal department / review board
- Let participants know what they are doing
  - What is the participant expected to do
  - Procedure
  - How long will it take, breaks
  - What is the study for in general – but do NOT tell about the specific purpose or your hypotheses
- Make sure they know
  - Quality of a UI / software is tested
  - They are NOT tested
- Ethical Issues

Participants Consent (Example)

Participants Consent Form

Study _____ **Institution** _____

Name: _____ Date of Birth: _____
Email: _____
Phone: _____

I have been informed on the procedure and purpose of the study and my questions have been answer to my satisfaction.
I have volunteered to take part in this study and agree that during the study information is recorded (audio and video as well as my interaction with the system). This information may only be used for research and teaching purpose. I understand that my participation in this study is confidential. All personal information and individual results will not be released to third parties without my written consent.

I understand that I can withdraw from participation in the study at any time.

Date: _____ Signature: _____

Example: Study on Text Input

- Is text input by keyboard really better than using T9 on a phone?
- Compare text input speed and errors made
  - Qwertz-keyboard on a notebook computer
  - T9 on a mobile phone
- Concentrate on test input only, ignore:
  - Time to setup / boot / initialize the device
  - Time to get into the application

Example: Study on Text Input (2)

- Participants
  - How many?
  - Skills
    - Computer user?
    - Phone/T9 users?
- Independent variables
  - Input method
  - Text to input
- Dependent variables
  - Time to input a text
  - Number of errors made

Example: Study on Text Input (3)

- Independent variables
  - Input method,
    - 2 levels: Keyboard and T9
  - Text to input
    - 1 level: text with about 10 words
- Experimental conditions
  - 2 conditions – T9 and Key
  - User 1,3,5,7,9 perform T9 than Key
  - User 2,4,6,8,10 perform Key than T9
  - Different texts in first and second run?
  - Particular phone model?
  - Completion time is measure (e.g. stop watch or application)
  - Number of error/corrections is observed

Example: Study on Text Input (4)

- Hypotheses
  - H-1: Input by keyboard is quicker than T9
  - H-2: fewer errors are made using keyboard input compared to T9
- Null-Hypotheses
  - Assumes no effect
  - H0-1: there is no difference in the input speed between keyboard and T9
  - H0-2: there is no difference in the number of errors made using a keyboard input compared to T9
- Experimental Method
  - Within groups
  - Randomized order of conditions

Example: Study on Text Input (5)

- Collect Data

User	Order	Time Cond1	Time Cond2	# Err Cond1	# Err Cond2
01	c1>c2	…	…	…	…
02	c2>c1	…	…	…	…
03	c1>c2	…	…	…	…

- Perform a statistical analysis
- … exercise on Friday.

Example: Study on Text Input (6)

- Fairness
  - Same conditions and procedure (e.g. light condition, interruptions, noise)
  - Specify procedure for exceptions (e.g. someone does not complete the test)
  - No bias
- Participants Consent
- Further Issues?
  - Ethical issues
  - Privacy