User Modeling and Personalization
11: Human-Computer Interaction

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Outline I

Introduction

Computers and related devices have to be designed with an understanding that people with specific tasks in mind will want to use them in a way that is seamless with respect to their everyday work.

All designers are people, and - most probably - they are users as well. Isn't it therefore intuitive to design for the user?

It isn't intuitive or easy to design consistent, robust systems that will cope with all manners of users' 'carelessness'.

Why usability is important

Designing usable systems is not simply a matter of altruism towards the user, of even marketing.
National health and safety standards constrain employers to provide their workforce with usable computer systems:

- that are suitable for the task
- that are easy to use, and - where appropriate - adaptable to the user's knowledge and experience
- that provide feedback on performance
- that display information in a format and at a pace that is adapted to the user
- that conform to the 'principles of software ergonomics'

Aspects of usability

Usability is a quality attribute that assesses how easy user interfaces are to use. The word 'usability' also refers to methods for improving ease-of-use during the design process.

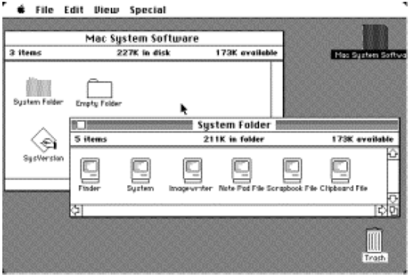
Usability is defined by 5 quality components:

- **Learnability**: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- **Efficiency**: Once users have learned the design, how quickly can they perform tasks?
- **Memorability**: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- **Errors**: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- **Satisfaction**: How pleasant is it to use the design?

A brief timeline of HCI interfaces

- 50s - Interface at the hardware level for engineers (switch panels)
- 60-70s - interface at the programming level (COBOL, FORTRAN)
- 70-90s - Interface at the terminal level - (command languages)
- 80s - Interface at the interaction dialogue level (GUIs, multimedia)
- 90s - Interface at the work setting (networked systems, groupware)
- 00s - Interface becomes pervasive (RF tags, Bluetooth technology, mobile devices,. . .)

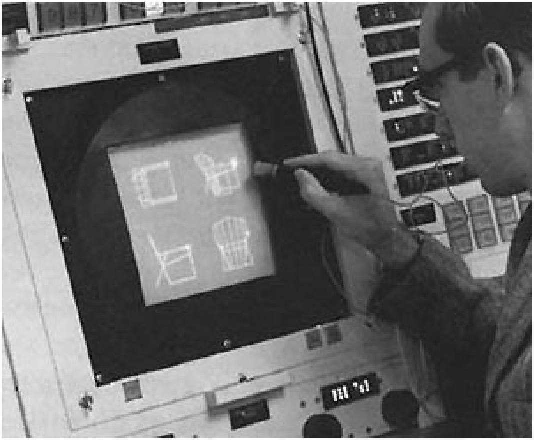
Apple Macintosh



1984 – commercially successful GUI

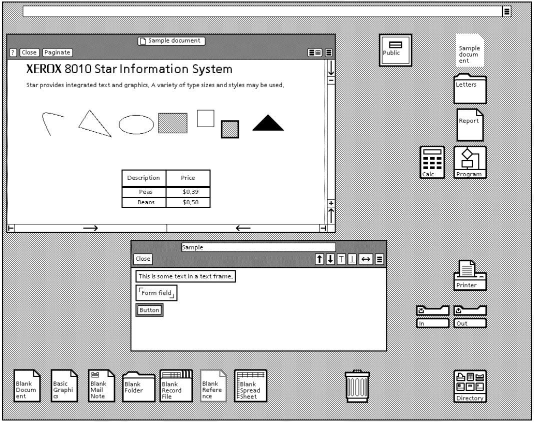
Origins of direct manipulation and graphical user interfaces

- Ivan Sutherland's Sketchpad, 1963, object manipulation with a light pen (grabbing, moving, resizing)
- Douglas C. Engelbart, 1968, Mouse, NLS
- XEROX ALTO (50 units at Universities in 1978)
- XEROX Star (1981)
- Apple Macintosh (1984)



Changing Interaction Paradigms

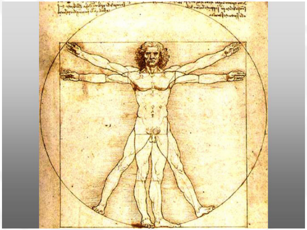
- Replacement of command-language
- Direct manipulation of the objects of interest
- Continuous visibility of objects and actions of interest
- Graphical metaphors (desktop, trash can)
- Windows, icons, menus and pointers
- Rapid, reversible, incremental actions


Sample document
Close
Paginate
XEROX 8010 Star Information System
Star provides integrated text and graphics. A variety of type sizes and styles may be used.
Description
Price
Peas
$0.39
Beans
$0.50
Public
Sample document
Letters
Report
Calc
Program
Sample
Close
This is some text in a text frame.
Form field
Button
Printer
In
Out
Blank Document
Basic Graphics
Blank Mail Note
Blank Folder
Blank Record File
Blank Reference
Blank Spread Sheet
Directory

Foundations of HCI

As a basis, we take the Model of the Human Processor. This is a very simple ‘model’ of a human interacting with a computer. The model describes the human as three sub-systems

- Perceptual system (acquire input from the real world)
- Cognitive system (connection between input and output)
- Motor system (manipulate the real world)



Perception: Gestalt principles of form perception

Gestalt psychology attempts to understand psychological phenomena by viewing them as organized and structured wholes rather than the sum of their constituent parts.

In the 30s and 40s, Gestalt psychology was applied to visual perception, most notably by Max Wertheimer, Wolfgang Köhler, and Kurt Koffka who founded the so-called gestalt approaches to form perception.

The investigations in this subject crystallized into 'the gestalt laws of perceptual organization'. Some of these laws, which are often cited in the HCI or interaction design community, are as follows.

Law of similarity

Elements will be grouped perceptually if they are similar to each other.

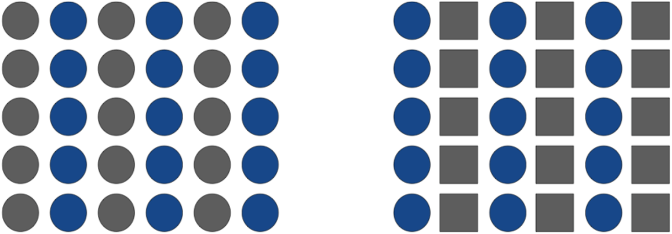


Abbildung 3.25: Gruppierung nach dem Gestaltgesetz der Ähnlichkeit

The objects are grouped by your cognition into vertical rows of similar objects. Similarity can result from shape, brightness, pattern, colour.

Figure: Which figure is more similar to the T ?

Most people vote for the leaning T.

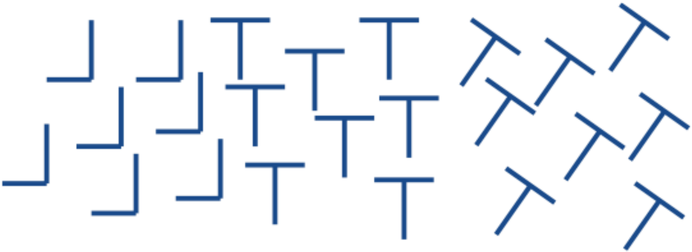


Figure: Which group is most similar to the T's?

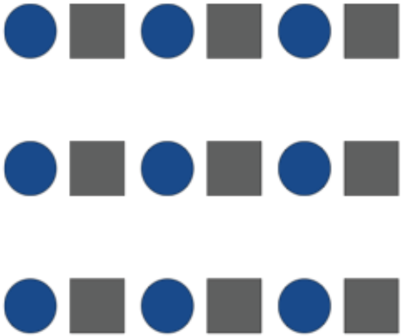
Most people vote for the turned L's

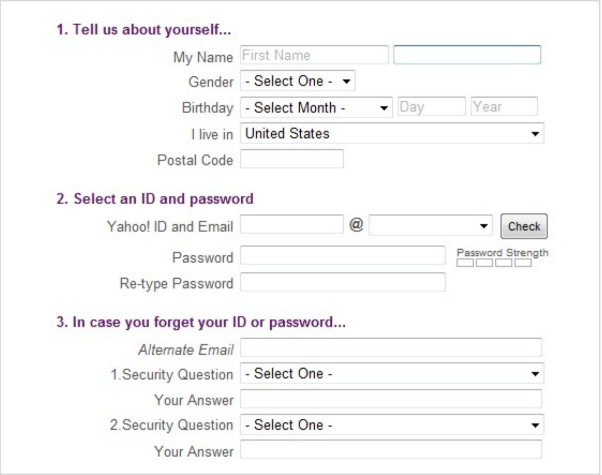
Figure: Use of similarity: blog posts have the same caption and image frame; the feeds in the left and right column follow a similar design.

Law of promixity

When we perceive a collection of objects, we will see objects close to each other as forming a group.

Abbildung 3.28: Objekte, die nahe beieinander liegen, werden gruppiert.





1. Tell us about yourself...

My Name: First Name
Gender: - Select One -
Birthday: - Select Month - | Day | Year
I live in: United States
Postal Code

2. Select an ID and password

Yahoo! ID and Email @ Check
Password — Password Strength
Re-type Password

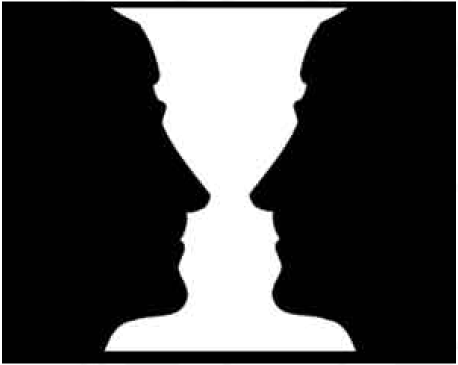
3. In case you forget your ID or password...

Alternate Email
1.Security Question: - Select One -
Your Answer
2.Security Question: - Select One -
Your Answer

Figure: Proximity in a Web form

Law of Prägnanz (figure-ground)

In perceiving a visual field, some objects take a prominent role (the figures) while others recede into the background (the ground). The visual field is thus divided into these two basic parts.



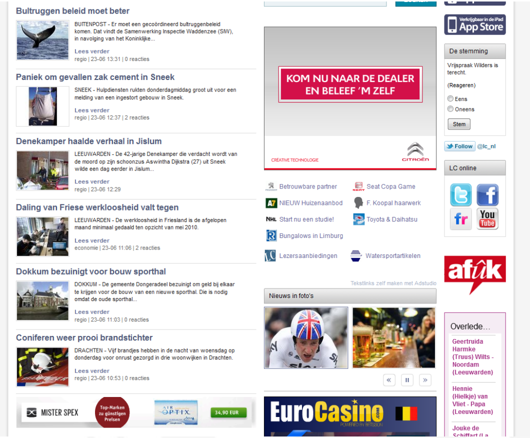


Figure: A local news site. The right side of the screen is filled with advertisements, which users learned to 'ban to the background'. The news pictures (right below) are likely to be seen as ads as well.

Law of symmetry

When we perceive objects, we tend to perceive them as symmetrical shapes that form around their center.

Most objects can be divided in two more or less symmetrical halves. When we see two unconnected elements that are symmetrical, we unconsciously integrate them into one coherent object (or percept).

The more alike objects are, they more they tend to be grouped.

`[   ][   ][   ]`

A typical textbook example consists of a configuration of a number of brackets.

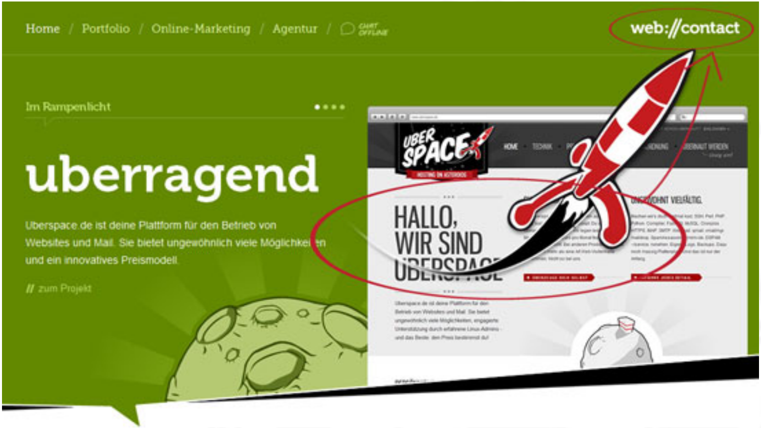
When perceiving the configuration, we see three pairs of symmetrical brackets as opposed to 6 individual brackets, or two pairs and two singles.

This happens despite what is suggested by some of the brackets immediate proximity to each other.

Law of Continuity

The mind continues visual, auditory and kinetic patterns.

Abbildung 3.31: Objekte, die sich auf einer Linie befinden, werden gruppiert.


Home / Portfolio / Online-Marketing / Agentur
web://contact
Im Rampenlicht
uberragend
Uberspace.de ist deine Plattform für den Betrieb von Websites und Mail. Sie bietet ungewöhnlich viele Möglichkeiten und ein innovatives Preismodell.
// zum Projekt
UBER SPACE
HALLO, WIR SIND UBERSPACE

Law of closure

We perceptually close up, or complete, objects that are not, in fact, complete.

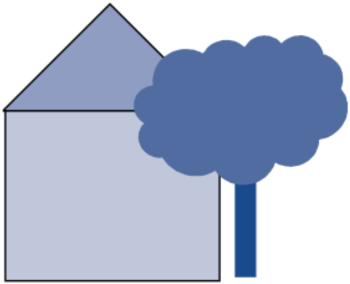


Abbildung 3.32: Ergänzung und Fortsetzung von verdeckten Objekten

The law of closure is also used in order 'to see' objects that are partially covered, like the house behind the tree.

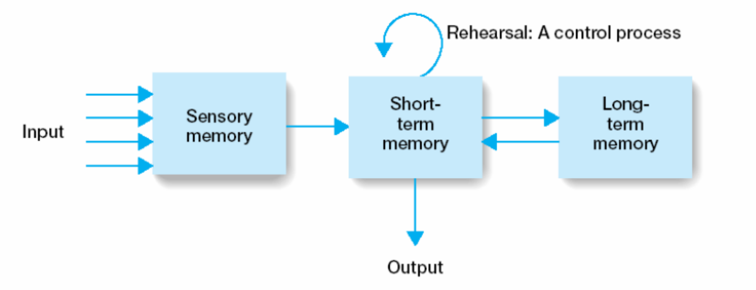
Optical illusions

Abbildung 3.33: Optische Täuschungen mittels Anwendung von Gestaltgesetzen

Familiarity

Figures that once have been recognized as a familiar, well-known form or figure, are from this time on an associated figure. It becomes then difficult to deconstruct the single parts.

Cognition: Human Memory



Sensory memory acts as a buffer for stimuli received through the senses (visual, aural, touch). These memories are constantly overwritten by new information coming in.

For example, in fireworks displays, moving sparklers leave a persistent image

Short-term memory acts as a ‘scratch pad’ for temporary recall of information. It is used to store information which is only required fleetingly. Short-term memory can be accessed rapidly and also decays rapidly.

Long-term memory is our mean resource for factual information, experiential knowledge, rules of behavior, ...

- *Episodic* memory represents our memory of events and experiences
- *semantic* memory is structured in some way to allow access to information, representation of relationships between pieces of information, and inference.

Memory involves encoding and recalling knowledge and acting appropriately

- We don't remember everything - memorizing involves filtering and processing
- Context is important in affecting our memory
- We recognize things much better than being able to recall things (which explains the rise of the GUI over command-based interfaces)
- We are better at remembering images than words (which is why we use of icons rather than names)

Misconceptions about memory

There are many misconceptions about human memory and the implications for interface design. Before we continue, try to memorize the following:

`2 7 5 9 2 8 1 2 9 1 6 3`

`39 333 23 89 481`

`39 1 pizza now`

`heh ousew asg reena ndb igt`

The problem with the classic "7 +/- 2"

- George Miller's theory of how much information people can remember
- People's immediate memory capacity is very limited
- .. In general, one can remember 5-9 chunks - and chunks can be letters, numbers, words, sentences, images, ...

Many designers have been led to believe that this is a useful finding for interaction design:

- Present only 7 options on a menu
- Display only 7 icons on a tool bar
- Have no more than 7 bullets in a list
- Place only 7 items on a pull down menu
- Place only 7 tabs on the top of a website page

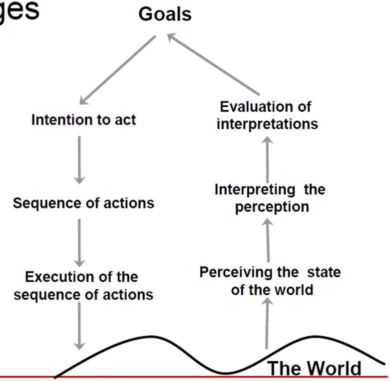
But this is wrong. Why?

- People can scan lists of bullets, tabs, menu items till they see the one they want
- They don't have to recall them from memory having only briefly heard or seen them

Action and Interaction

Seven Stages of Action

1. Forming a goal
2. Forming an intention
3. Specifying an action
4. Executing the action
5. Perceiving the system state
6. Interpreting the system state
7. Evaluating the outcome



Fitt's Law

is a function of the time it takes a user to hit a certain target (e.g. a button, a menu item, or an icon).

$$Movement - time = \alpha + \beta log_2(\frac{distance}{size + 1})$$

where α and β are empirically determined constants.
Since users will find it difficult to manipulate small objects, targets should generally be as large as possible and the distance to move as small as possible.

Device	r^a	Intercept, a (ms)	Slope, b (ms/bit>	IP (bits/s)^b
		*** Pointing ***		
Mouse	.990	−107	223	4.5
Tablet	.988	−55	204	4.9
Trackball	.981	75	300	3.3
		*** Dragging ***		
Mouse	.992	135	249	4.0
Tablet	.992	−27	276	3.6
Trackball	.923	−349	688	1.5

Regression Coefficients

[a] $n = 16$, $p < .001$

[b] IP (index of performance) = $1/b$

Figure: Approximation of Fitt's Law coefficients for different kinds of actions

Keystroke Level model

The keystroke level model provides numerical predictions of user performance for different kinds of tasks. The actual values are based on empirical studies to derive a standard set of approximate times for main operations.

Operator name	Description	Time (sec)
K	Pressing a single key or button	0.35 (avg)
	Skilled typist	0.22
	Average typist	0.28
	User unfamiliar with keyboard	1.20
	Pressing shift or control	0.08
P	Pointing with a mouse to a target	1.10
B	Clicking the mouse	0.20
H	Homing hands on the keyboard	0.40
D	Draw a line using a mouse	depends on length
M	Mentally prepare to do something	1.35
R(t)	System response time (count only if it causes user to wait)	t

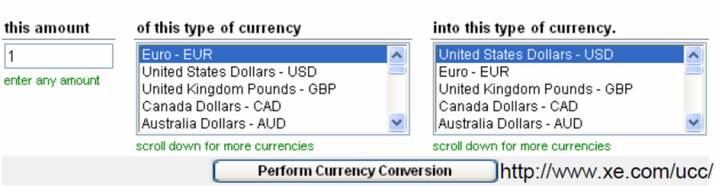


Figure: Calculate the time needed for converting 712 GBP into EUR. Your hand is already on the mouse.

- P[to input field]
- B[click]
- H[to keyboard]
- M[consider number]
- 4K[Backspace-7-1-2]
- H[to mouse]
- M[consider currency]
- P[to GBP]
- B[click]
- M[consider currency]
- P[to EUR]
- B[click]
- P[to convert]
- B[click]
- R[show page with result]

$$4P + 4B + 2H + 3M + 4K + R =$$
$$4.40 + 0.80 + 1.20 + 4.45 + 1.52 + 1.00 = 15.57 \text{ seconds}$$

Human Errors

"If an error is possible, someone will make it" (Norman)

Two fundamental categories:

Mistakes

- overgeneralization
- wrong conclusions
- wrong goal

Slips

- Result of 'automatic' behaviour
- Appropriate goal but performance/action is wrong

Slips

Slips include:

- *Capture errors* - two actions with common start point, the more familiar one captures the unusual (driving to work on Saturday instead of the supermarket)
- *Description errors* - performing an action that is close to the action that one wanted to perform (putting the cutlery in the bin instead of the sink)
- *Data driven errors* - using data that is visible in a particular moment instead of the data that is well-known (calling the room number you see instead of the phone number you know by heart)

- *Associate action errors* - you think of something and that influences your action. (e.g. saying come in after picking up the phone)
- *Mode errors* - you forget that you are in a mode that does not allow a certain action or where a action has a different effect

Figure: Alarm clocks are prone to mode errors. Due to limited display capacity, users often do not know which time they change - the actual time, the time of the first alarm or the time of the second alarm.

Confirmation is unlikely to prevent errors

- User: “remove the file ‘most-important-work.txt’”
- Computer: “are you sure that you want to remove the file ‘mostimportant-work.txt’?”
- User: “yes”
- Computer: “are you certain?”
- User: “yes of course”
- Computer: “the file ‘most-important-work.txt’ has been removed”
- User: “Oops”

Human errors may be a starting point to look for design problems.

- Assume that all possible errors will be made
- Minimize the chance to make errors (constraints)
- Minimize the effect that errors have (is difficult!)
- Include mechanism to detect errors
- Attempt to make actions reversible

The F-Shaped Pattern

This dominant reading pattern on the Web.

- Users first read the upper part of the content area.
- Next, users move down a bit and then read across the first paragraphs.
- Finally, users scan the content's left side in a vertical movement - this is where the navigation menu is (or used to be).

The need for personalization

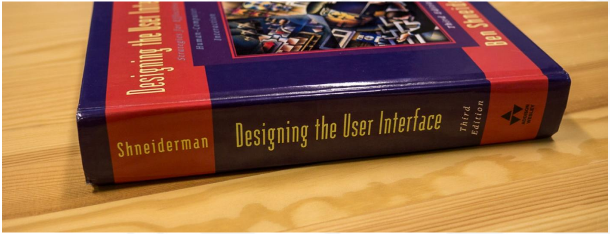
Adaptive systems follow the philosophy 'one design does not fit all'. In personalized systems, the following user characteristics are often taken into account:

- *Demographic information*: simple demographics can be used for a rough initial fine-tuning of the interface (e.g. localization)
- *User goals and user tasks*: used to satisfy user needs as effectively and efficiently as possible
- *User background knowledge*: which concepts is a user is already familiar with and which need additional explanation.

- *User interests*: used for determining the information, services or products that users are most likely to appreciate.
- *User skills and capabilities*: the user's familiarity with the system and practical knowledge on how to interact with the system.
- *User traits*: personality factors, cognitive factors and learning styles.
- *User mood*: happy, stressed, relaxed, tense, afraid, motivated, bored, engaged, frustrated, . . .

The Eight Golden Rules of interface design

As stated by Ben Shneiderman, Professor of the Human-Computer Interaction Lab of the University of Maryland.



1. Strive for consistency

- consistent sequences of actions in similar situations
- identical terminology in prompts, menus and help screens
- consistent color, layout, capitalization, fonts, ...
- exceptions should be comprehensible and limited in number

In the WWW it gets pretty hard:

- No real guidelines and no authority
- How are links represented?
- Where is the navigation?
- Styles and 'fashion' change quickly

2. Cater to universal usability

Recognize the needs of diverse users and design for both novices and experts; different age ranges and background knowledge; technological diversity.
Example: shortcuts on different levels

- Access to single commands, e.g. keyboard shortcuts (CTRL+S) or toolbar
- Customizing of commands and environments, e.g. printer presets (duplex, A4, color or greyscale)
- Reusing actions performed, e.g. history in command lines, macro functionality

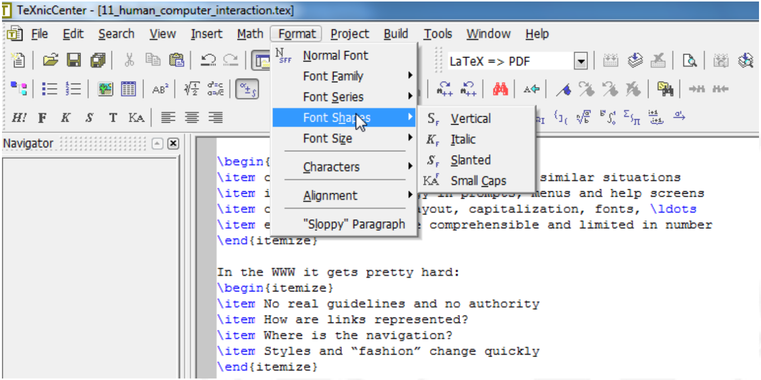
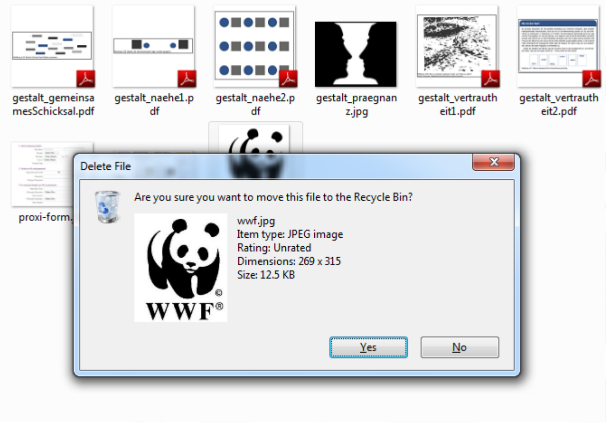


Figure: How universally usable is this TeX editor?

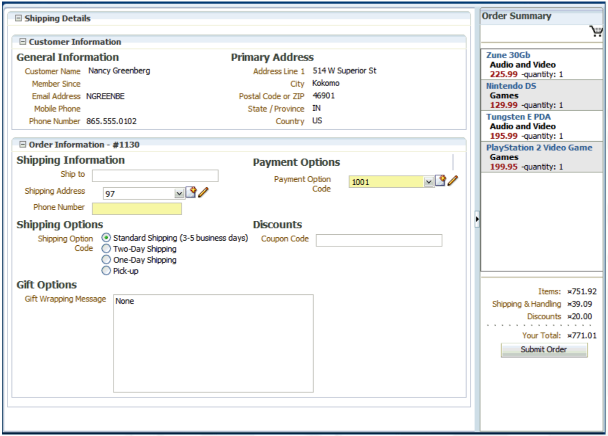
3. Offer informative feedback

- For every user action, there should be system feedback
- For frequent and minor actions, the response can be modest
- Visual presentation of the objects of interest provides a convenient environment for showing changes explicitly


gestalt_gemeinsamesSchicksal.pdf
gestalt_naehe1.pdf
gestalt_naehe2.pdf
gestalt_praegnanz.jpg
gestalt_vertrautheit1.pdf
gestalt_vertrautheit2.pdf
proxi-form.
Delete File
Are you sure you want to move this file to the Recycle Bin?
wwf.jpg
Item type: JPEG image
Rating: Unrated
Dimensions: 269 x 315
Size: 12.5 KB
WWF
Yes
No

4. Design dialogs to yield closure

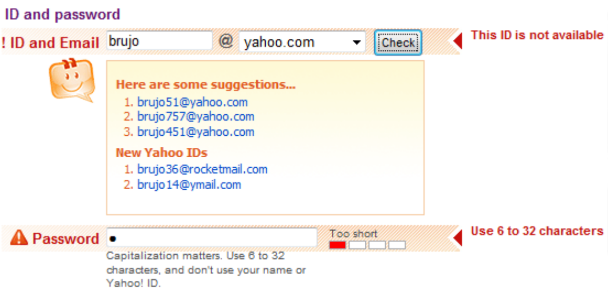
- Sequences of actions should be organized into groups with a beginning, middle and end
- Informative feedback at the completion of a group of actions informs users about the accomplishment of a task
- For example: e-commerce sites move users to the checkout, ending with a clear confirmation page that completes the transaction



Throughout the checkout process, the order summary is displayed on the right side. Customers can check anytime the total amount and whether all items are included.

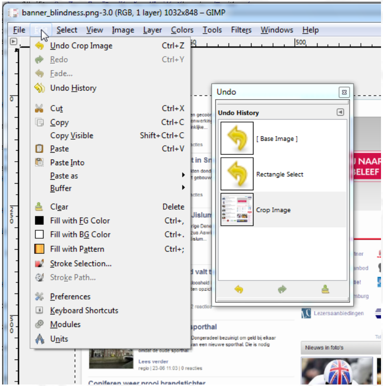
5. Prevent errors

- Design the system such that users cannot make serious errors (e.g. gray out inappropriate menu items)
- If a user makes an error, the interface should offer constructive and specific instructions for recovery



6. Permit easy reversal of actions

The units of reversibility may be a single action, a data-entry task, or a complete group of actions.



7. Support internal locus of control

Experienced users strongly desire to be in control of the interface. They do not want surprises or changes in familiar behavior.

This is an important lesson learned by the designers of Microsoft, who introduced personalized menus in Office 2003.

The problem with these menus was that they changed continuously and that users needed to read each single item (instead of picking item 5 or something).

After massive criticism, Microsoft disabled the personalized menus in the default settings.

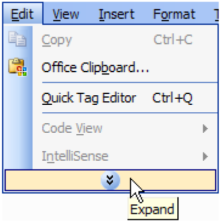
This means that, at least for the time being, menus and toolbars are still alive as a part of many important programs, such as Publisher, Project, Visio, and several others.

The good news for fans of usability worldwide is that an historical moment is upon us. As of Tuesday, we have officially flipped the switch to turn off Personalized Menus by default for all apps in all future builds of Office 12. *(New UI programs based on the Ribbon, of course, were designed without Personalized Menus from the beginning.)*

Don't know what Personalized Menus are? You can read all about them in Part 3 of the "Why The UI?" series, including my take about why they weren't a good idea.

The option isn't going away, so if you do love this feature for some reason, you can still manually turn it on in Office 12. But the default setting for "Always show full menus" will be set to on, reversing the default first introduced in Office 2000.

A small but significant victory for humankind.



Fare thee well, Personalized Menus, an experiment whose time has passed...

8. Reduce short-term memory load

Avoid interfaces in which users must remember information from one screen and then use that information on another screen.

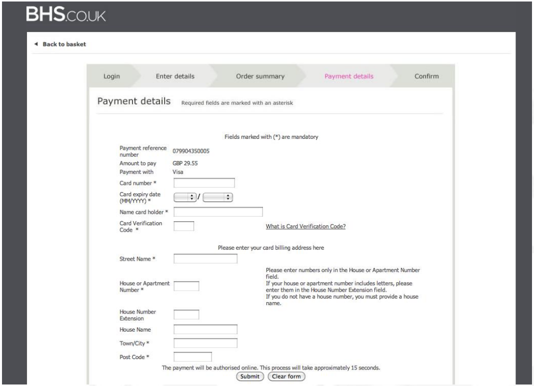


Figure: Now that I have to provide my credit card details, I want to verify that my order is correct. Unfortunately, it is not displayed on this particular screen. This annoyance is compensated by the 'promise' that I can review and confirm my order in the next screen.