Design Principles

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2005
Information types

- **Physical**
  - Static: descriptive relationships, spatial
  - Dynamic: discrete action, continuous action, events, procedural
    - Causal: states, descriptive relationships, values

- **Conceptual**
  - Static: descriptive relationships, values
  - Dynamic: discrete action, continuous action, procedural
    - Causal: states, descriptive relationships, values

**Media selection and combination**

<table>
<thead>
<tr>
<th>Information type</th>
<th>Preferred media selection</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Realistic still or moving image</td>
<td>Photo of a person</td>
</tr>
<tr>
<td>Conceptual</td>
<td>Text or speech, designed image</td>
<td>Explain sales policy</td>
</tr>
<tr>
<td>Descriptive</td>
<td>Text, speech, realistic image</td>
<td>Chemical properties</td>
</tr>
<tr>
<td>Spatial</td>
<td>Realistic/designated image</td>
<td>Diagram of a building</td>
</tr>
<tr>
<td>Value</td>
<td>Text/tables/numeric list(s)</td>
<td>Pressure reading</td>
</tr>
<tr>
<td>Relationship</td>
<td>Designed images, graphs, charts</td>
<td>Histogram of rainfall/month</td>
</tr>
<tr>
<td>Procedural</td>
<td>Image series, text</td>
<td>Evacuation instructions</td>
</tr>
<tr>
<td>Discrete action</td>
<td>Still image</td>
<td>Make coffee</td>
</tr>
<tr>
<td>Continuous action</td>
<td>Moving image</td>
<td>Movements while skiing</td>
</tr>
<tr>
<td>Events</td>
<td>Sound, speech</td>
<td>Fire alarm</td>
</tr>
<tr>
<td>States</td>
<td>Still images, text</td>
<td>Photo of weather conditions</td>
</tr>
<tr>
<td>Causal</td>
<td>Still &amp; moving image, text, speech</td>
<td>Video of rainstorm causing flash flood</td>
</tr>
</tbody>
</table>
Examples for media design

<table>
<thead>
<tr>
<th>representational</th>
<th>abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>• concrete</td>
<td>speed -&gt; speedometer, e.g.</td>
</tr>
<tr>
<td>visual</td>
<td>symbol, e.g.</td>
</tr>
<tr>
<td>• signified</td>
<td>danger -&gt; alarm flasher, e.g.</td>
</tr>
<tr>
<td></td>
<td>blue light of a police car</td>
</tr>
<tr>
<td>auditory</td>
<td>speech, e.g.</td>
</tr>
<tr>
<td>• verbal</td>
<td>“Stop the machine!”</td>
</tr>
<tr>
<td></td>
<td>speech, e.g.</td>
</tr>
<tr>
<td></td>
<td>“Attention, please!”</td>
</tr>
<tr>
<td>• spatial</td>
<td>onomatopoeia and mimic, e.g.</td>
</tr>
<tr>
<td></td>
<td>event generated sound pattern</td>
</tr>
<tr>
<td></td>
<td>tone, e.g.</td>
</tr>
<tr>
<td></td>
<td>beep-beep-beep…</td>
</tr>
</tbody>
</table>


The Concept of Perceptual Attractors

• To guide the users attention on the interface, each visual attractor (=any separate perceivable structure) is of crucial importance, so use them carefully in your design to avoid not intended distractions.

• Consequence: you will end up with a slim design!
A design concept for visual attractors

Historical Trends for Icon Design

- Four different levels of abstraction can be found over the last 80 years.
- Actual icons get more abstract compared to the past.
An Icon Set for Different Sports

Exercise:
try to find out the
different kind of sport
represented by each
icon.

An Icon Set for a Way-finding System
The Meaning of Icons

- The numbers in the table mean the percentage of all collected answers; each intended answer is underlined.


<table>
<thead>
<tr>
<th>Answered to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flag-transport</td>
</tr>
<tr>
<td>![Flag-transport Icon]</td>
</tr>
<tr>
<td>62.5</td>
</tr>
<tr>
<td>10.4</td>
</tr>
<tr>
<td>0.0</td>
</tr>
<tr>
<td>2.1</td>
</tr>
<tr>
<td>0.0</td>
</tr>
<tr>
<td>8.3</td>
</tr>
</tbody>
</table>

The Icon Set for Marshalling Signals

- [redrawn from Henry Dreyfuss, Symbol Sourcebook (New York, 1972), p. 152]

Redesign of Icons (1)

- **Design Principle:**
  - avoid excessive detail in icon design.


Redesign of Icons (2)

- **Design Principles:**
  - design the icons to communicate object relations and attributes whenever possible;
  - accompany icons with names.

Design of Road-Signs (1)

- Based on the concept of Natural Mapping (see the book of Donald Norman, The psychology of every day things) the road-sign is realized.
- The exception is the order of the city names on top of the sign: first the most nearby city, and then the more far away locations.

Design of Road-Signs (2)

- The sign above is following the concept of natural mapping.
- The sign below is mis-designed, because the whole shape is indicating a turn to the left.
Dynamic in a static picture (1)

- The right picture is more dynamic than the left caused by the oversized ball

Dynamic in a static picture (2)

- The right picture is more dynamic than the left caused by the tilted frame
Dynamic in a static picture (3)

- Breaking through the frame increases the perception of dynamics

Dynamic in a static picture (4)
The Power of the Center

- [see the book of Rudolf Arnheim, 1982, The power of the center—a study of composition in the visual arts, University of California Press]
- Results of an eye recording experiments: the area in the center (see the figure) covers 13% of the total screen area, but captures 26% of 220,000 fixation points of users looking at different screens of these size.
- Results of a mock-up study: the central hot spot area (one of four hot spots = 25%; see next slide) captures 38% of all touch downs of different users.

Implicit Design for a Multimedia Information System
Explicit versus Implicit Design

- This design concept for a specific screen of the hypercard stack “Inigo Gets Out” is based on explicit design: only two buttons are used for navigation (--> forward, <-- backward).

Implicit Design: screen from “Inigo Gets Out”

- This screen is based on implicit design and has a second-person perspective: to get the cat to run to the right, you click on the cat itself. The actual image from “Inigo Gets Out” has been overlaid with data (the click markers) from a field study of the use of the system in a Copenhagen kindergarten.

Explicit Screen Design

Implicit Screen Design
Corrective Design

To motivate users to switch from explicit to implicit an additional explicit instruction is necessary:
“Tippen Sie auf eines der EC-Symbole”

• One major problem of a mixed style (explicit plus implicit) is that nearly all users are not able to switch from the buttons (explicit) to the picture with touch sensitive areas (implicit).
• To overcome this problem an extra explicit instruction is necessary: “Wählen Sie die gewünschte Region durch Berühren”
First golden rule

All things on earth have the tendency to fall down!

Second golden rule

- **horizon**
  - the horizon is always lighter than the ground

- **ground**
  - the ground is always darker than the horizon
Third golden rule

- **The Top**
  - All good, strong and important things are at the top (e.g., God in heaven, the king, the boss, etc.).

- **The Bottom**
  - All small, weak and unimportant things are at the bottom line.

Fourth golden rule

- **Perception Space**
  - The physical space where the user’s attention is.

- **Action Space**
  - The physical space where the user acts in.

- **Design Principle**:
  - perception space and action space must coincide!
Fifth golden rule

Affordances are perceived and actual properties of an object that suggests how the object should be used in line with user’s expectations.

Affordances originate from a variety of object properties:

- **Material**: opacity, transparency, firmness, reflectivity
- **Shape**: roundness, holes, handles
- **Size**: hand-sized, person-sized, miniaturized
- **Texture**: roughness, smoothness, contours (i.e. "organic"), softness
- **Color**: brightness, dullness, glossiness

The Concept of Natural Mappings

- **Definition** [see Norman, D., 1988, p. 75ff]:
  - A design solution based on a natural mappings reduces the need for additional explanatory information in memory!
  - Natural mappings guarantee a minimum number of cognitive transformation steps.
  - If a design depends upon labels, it may be faulty. Labels are important and often necessary, but the appropriate use of natural mappings can minimize the need for them. Wherever labels seem necessary, consider another design!
Design of Light Switch Panels (1)

• Problem:
  – no direct mapping between switches and corresponding lamps
Design of Door Handles

Natural Mapping (1)
Natural Mapping (2)

Design of Stove Controls (1)
Design of Stove Controls (2)

Interactive Directness: the desktop example

Head-up Displays in Cars

- More information and less distraction
  - Information on the state of the road, on the speed of the vehicle in front (supplied by the intelligent cruise control), on obstacles lying around the next bend in the road identified by the remote detection system, or direction arrows sent by the driver guidance system... drivers will be receiving more and more information from "intelligent" vehicle systems.
  - Although the information is intended to enhance safe driving, there is a danger that an abundance of information may produce the opposite effect if driver glance-away time has to increase in order to apprehend the data.
Electronic Performance Support System

- Food processing plant worker with a first-generation prototype wearable computer.
- Possible applications include support for quality control data collection or assistance with environmental auditing.
- This system gives its users the information they need to perform a task as they actually perform the task.

Airline Applications

- This remarkable ultra-lightweight computer, worn as a belt, delivers maximum information to users with a minimum of work.
- Designed for individuals who demand mobility, this computer offers voice control and head-up display for complete, hands-free operation.
- Users can enter or retrieve information while going about their jobs, instead of constantly returning to the shop area to check a stationary computer, or stopping work to punch keys.
Two design principles for natural user interfaces

1. design principle

No technical equipment inside to body space of the user!

2. design principle

Perception space and action space must coincide!

The two different interaction areas

The Virtual Workbench

BUILD-IT: an integrative design tool

- design team with different domain knowledge
- unconstrained social interaction
- integration of **form** and **content**
- intuitive interaction style
Actual research goals...

- hand-written input
- speech input
- two-handed interaction

- new methods and concepts for **integrative design**

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**Design Metaphors**

**Tool**

**Channel**

**Substitute**

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Trends in User Interface Technology

Ubiquitous and Mobile computing

Ambient rooms and Cooperative buildings

Ubiquitous Computing

- Two issues are of crucial importance: **location** and **scale**
  - **Location**: ubiquitous computers must know where they are
  - **Inch-scale** machines: approximate active Post-It notes
  - **Foot-scale** machines: like a sheet of paper (or a book or a magazine)
  - **Yard-scale** machines: the equivalent of a blackboard or bulletin board
- Prototype tabs, pads and boards are just the beginning of ubiquitous computing
The PalmPilot

- The PalmPilot has a lot functionality.
- This device fits with its pocket size into one hand.
- There is a communication channel via IR to the PC.
- Small, and a reasonable price

Wearable Computer

- Providing hands-free operation
- Sharing the data in real-time with background
- Supporting user comfort
- Allowing audio interactions in a noisy environment

- Creating a simple user interface
- Keeping costs down
The DynaWall and two CommChairs

- The size of the DynaWall opens a new set of human-computer interactions.
- It is possible that information objects can be taken at one position and put somewhere else on the display or thrown from one side to the opposite side.
- Dialog boxes always appear in front of the current user(s).
- User interface components are always at hand, etc.

Home of the Future

- **Main characteristics:**
  - Home automation is defined as a process or system which provides the ability to enhance one's lifestyle, and make a home more comfortable, safe and efficient.
  - Home automation can link lighting, entertainment, security, telecommunications, heating and air conditioning into one centrally controlled system.
Office of the Future

- Main characteristics:
  - attentive
  - active
  - adaptive

Design challenges

wearable computing
- Penetration of the body space

intelligent environments
- Isolation in immersive virtual worlds
- Privacy in augmented worlds

Penetration of the social space
Trend in Interface Design

- Mechanical style
- Electronic style
- Mechatronic style
Literature for Visual Design


References for Guidelines

Articles and Books


Organizations

ACM Special Interest Group on Computer-Human Interaction (SIGCHI): The largest organization of UI practitioners.

German HCI Group: A specialist group of the German Computer Society.

Human Factors and Ergonomics Society.

Usability Professionals Association: See their consultant directory for contract resources.

Other Online Resources

Microsoft User Experience and UI Design Resources [http://msdn.microsoft.com/ui/]

Usenet [http://www.useit.com/]
ISO TC 159 SC4 Ergonomics of Human System Interaction

WG1 is responsible for ISO 7249 and ISO 9355 which deal with fundamentals of displays and controls rather than HCI.

WGs 2 to 5 are responsible for ISO 9241 (see later slide).

WG 5 is developing a standard dealing with the ergonomics requirements of multi-media interfaces ISO NP 14915 - see later slide.

WG 6 is concerned with how ISO 9241 can be used and with ISO 13407 Human-Centred Design of Interactive Systems.

WG8 is concerned with ISO 11064, (see Table h621-2) on the ergonomics design of control centres, which include process plant control centres, security control centres and other, frequently safety critical control centre applications.

Part 1 Principles for the design of control centres
Part 2 Principles of control suite arrangement
Part 3 Control room layout
Part 4 Workstation layout and dimensions
Part 5 Displays and controls
Part 6 Environmental requirements for control rooms
Part 7 Principles for the evaluation of control centres
Part 8 Ergonomics requirements for specific applications

ISO/IEC JTC1 SC18 WG9 User System Interfaces and Symbols

Joint Technical Committee (JTC1) deals with standards in the field of information technology.

Sub committee 18 (SC18) is responsible for standards for Document Processing and Related Communication.

Working Group 9 is developing standards in keyboard layout, symbols and user interfaces which have relevance beyond the strict domain of document processing.

It has sub-groups working on Keyboard Layout, User Interfaces and Symbols.

ISO/IEC 9995 is a multi-part standard dealing with keyboard layout which replaces a number of existing standards (see Table h621-3). It includes a keyboard layout for multiple Latin alphabet languages and a layout for letters used on a numeric keyboard. It should be noted that WG9 deals with the layout of keyboards, not with the key operation or other ergonomic features which are the responsibility of WG3 of TC 159 SC4.

Part 1 General principles governing keyboard layouts
Part 2 Alphanumeric Section
Part 3 Complementary layout of the alpha-numeric zone of the alpha-numeric section
Part 4 Numeric Section
Part 5 Editing Section
Part 6 Function Section
Part 7 Symbols used to represent functions
Part 8 Numeric zone of the numeric section, allocation of letters
**HCI Standards**

ISO methods 9241 (ISO 9000 series standards address quality)

Ergonomic requirements of VDT - both hardware and software in 17 parts:

- Introduction
- Guidance on task requirements
- Visual Display requirements
- keyboard requirements
- workstation layout and postural requirements
- environmental requirements
- display requirements with reflections
- requirements for displayed colours
- requirements for non-keyboard input devices
- Dialogue Principles
- Usability Specification
- Presentation of Information
- User Guidance and Help
- Menu Dialogues
- Command Dialogues
- Direct Manipulation Dialogues
- Form-filling Dialogues

**Task Design - ISO 9241-2**

The application of ergonomic principles ... is essentially the integration of task design with the design of software - where well designed tasks

- provide for the application of an appropriate variety of skills;
- ensure that the task performed are identifiable as whole units of work rather than fragments
- provide sufficient feedback on task performance in terms meaningful to the user

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**ISO 14915 Multimedia User Interface Design - Ergonomic Requirements for human-centred multimedia interfaces**

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design Principles and Framework</td>
<td>DIS</td>
</tr>
<tr>
<td>2</td>
<td>Multimedia Control and Navigation</td>
<td>CD</td>
</tr>
<tr>
<td>3</td>
<td>Media Selection and Media</td>
<td>DIS</td>
</tr>
<tr>
<td>4</td>
<td>Domain Specific Interfaces</td>
<td>W1</td>
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</tbody>
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