Human-Computer Interaction
- how to acquire design knowledge -

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What is Human-Computer Interaction about?

Goal:
Actual Performance => Desired Performance
Interface Design or Interaction Design?
HCI Research Line: basic cycle

Design relevant knowledge

[empirical] validation

analysis

synthesis

Interactive systems
NUI: The First Round

Tangible interaction

Expert Interview

Digital Desk
The Digital Desk
from Pierre Wellner in 1991

The DigitalDesk is built around an ordinary physical desk and can be used as such, but it has extra capabilities. A video camera is mounted above the desk, pointing down at the work surface. This camera's output is fed through a system that can detect where the user is pointing (using an LED-tipped pen) and it can recognise the documents that are placed on it. The more advanced version also has a computer-driven projector mounted above the desk enabling electronic objects to be projected onto real paper documents -- removing the burden of having to switch attention between screen and paper and allowing additional user-interaction techniques. [invented and built by Pierre Wellner, Xerox EuroPARC]

Video clip
What is a design principle?

- **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!
  - “Interlacing the display and manipulation space” (Djajadiningrat, 1998)
Natural User Interfaces (NUI): design constrains

1. design requirement
   No technical equipment inside the body space of the user!

2. design requirement
   Perception space and action space must coincide!
NUI: The Second Round

Design principle

Field experiment

Digital Playing Desk

overhead projector
video camera
virtual player
virtual chips
real chip
NEW button
Tic-Tac-Toe with four interaction styles
Digital Playing Desk (DPD)
User Studies with the DPD

Video clip
Empirical Results: Playing time per game

Cell Line Chart for "playing time"
Grouping Variable(s): Interface type
Error Bars: ± 1 Standard Deviation(s)
Empirical Results: winning chance per dialog technique

Cell Line Chart for "winning chance"
Grouping Variable(s): Interface type
Error Bars: ± 1 Standard Deviation(s)

- CI: P<.001
- MI: P<.007
- TI: P<.001
- DPD: P<.007

User win

Remis

Computer win

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NUI: The Third Round

Prop Design

User study

Build-It systems
The Build-It System
Bichsel, Fjeld & Rauterberg 1997

Video clip
The Build-It tangible props

18th Century: tool production
NUI interaction props: user study

Props design factors:
form, size, material and metaphor:

• An experiment was carried out to explore different design strategies.

• Tasks were based on initial planning of an interior architecture.

• Focus of the experiment was subjective opinion (n=12) about the bricks.

• The bricks were ranked by user performance before (first number) and after (second number) task solving activity.
NUI: The Fourth Round

Navigation Design

Experiment

Build-It systems
The Build-It System
Fjeld, Bichsel & Rauterberg 2001

Video clip
Navigation Design: experimental results

Dependent variable: Trial completion time (tct)

<table>
<thead>
<tr>
<th>Experimental condition</th>
<th>Plan view</th>
<th>Side view</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SH:Ground Catcher</td>
<td>VH:Frame Catcher</td>
</tr>
<tr>
<td>1st</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3rd</td>
<td></td>
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<tr>
<td>4th</td>
<td></td>
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</tbody>
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**Plan view method:**
No significant effect.

**Side view method:**
Scene Handling (SH: tct=150 s) gave better performance than View Handling (VH: tct=183 s).

**Other effects:**
Trial (learning effect) and task had a significant effect.
NUI: The Fifth Round

3D interaction

Experiment

VIP system
VIP: tangible interaction props

Aliakseyeu, Martens, Subramaniam & Rauterberg 2002

Video clip
Further Developments

• Empirical validation
• Additional interaction techniques, e.g. speech input
• full 3D interaction possibilities
• video conferencing functionality for distributed cooperation
GUI versus NUI interaction models

Ullmer & Ishii, 2000

INPUT / OUTPUT

control

graspable representation

Non graspable representation

model

physical
digital

control

view

model

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Design Metaphors

Tool

Channel

Substitute

long time ago 2000 history
Trend in Interface Design

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Design trends

mechatronic style
active forms
(smart memory alloys)

connected forms
(ambient intelligence)

given forms
(ubiquitous computing)

mechanical style
dedicated form
(e.g. typewriter, etc)

electronic style
channel forms
(e.g. PC, TV, Radio, etc)
Thank you for your attention

More at
http://www.ipo.tue.nl/homepages/mrauterb/