Alternative Tools for Tangible Interaction: A Usability Evaluation

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Outline

• Motivation: usability of TUIs
• Task design
• Cognitive support; tool design
• Experimental hypotheses and design
• Experimental results
• Conclusion
• Future work
Motivation: usability of TUIs

Tangible User Interface vs. alternative tools
Video

CHI 2000
Task design

Positioning task that needs cognition & interaction
Cognitive support

We wanted to examine the cognitive support offered by the TUI

Hence, we sought alternative tools
a) for the same task
b) giving different cognitive support
c) reflecting different real world aspects

The TUI and the alternative tools would then be evaluated in terms of their cognitive support
Tool design

A set of decision support techniques guided the design of alternative tools (Zachary, 1986).

- Focus on problem representation
- Design tools that can be easily learned
- Design tools for different strategies
- Design tools facilitating rational decision-making
„Supportive“ alternative tool: Physical
"Demanding" alternative tool: Cardboard
Hypotheses

H1: Cardboard gives less cognitive support than PhysicalBlocks.
H2: Cardboard gives less cognitive support than BUILD-IT.
H3: BUILD-IT gives less cognitive support than PhysicalBlocks.
Operationalization of cognitive support

**C1**: Lower trial time

**C2**: More blocks tested per trial (epistemic action reduces cognitive load, Kirsh & Maglio, 1994)

**C3**: Learning effect in trial time (first vs. last)

**C4**: Learning effect in blocks tested (first vs. last)

**C5**: Higher user satisfaction with task-tool combination used (perceived clarity of task formulation, task difficulty, and tool suitability)
Experimental design

- Between-subject scheme, eliminating between-tool learning
- Ten participants for each tool, altogether thirty
- 12 task variations, two for aided use, ten for “counting” unaided use
- Counting unaided task were were permuted
- Stop criterium: Five correct tasks, last three ones in a closed sequence
Results C1 and C2: trial time [s], # blocks (partly significant)
Results C3 and C4: Learning effects (not significant)

- **TUI/BUILD-IT**
  - Trial time
  - #Blocks/trial

- **Cardboard**
  - Trial time
  - #Blocks/trial

- **Physical**
  - Trial time
  - #Blocks/trial
## Results C5: Subjective preferences

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<th>clarity</th>
<th>difficulty</th>
<th>suitability</th>
<th>total</th>
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<td>TUI/BUILD-IT</td>
<td>1.4</td>
<td>0.5</td>
<td>0.9</td>
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<tr>
<td>Cardboard</td>
<td>1.3</td>
<td>0.3</td>
<td>1.4</td>
<td>1.0</td>
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<tr>
<td>Physical</td>
<td>1.7</td>
<td>1.2</td>
<td>1.1</td>
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**Significant results (Yes/No)**

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<th></th>
<th>C1</th>
<th>C2</th>
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<th>C4</th>
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<th>ΣCi, i=1-5</th>
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Conclusions - TUI

• TUI is efficient - coming close to the physical tool

• TUI supports exploratory action - also coming close to the physical tool

• However, TUI needs to be more user friendly; - accuracy in rotation not satisfactory - scarce need for side view in problem solving - coordination plan side view demands learning
Conclusions - alternative tools

- Cardboard:
  Training helped, spurred reflection
  Different strategies were observed.

- Physical:
  Task tool separation unclear
Future work

TUI research needs further real-world anchoring to offer convincing solutions to architects, city-planners, and designers. Hence, either focus on

- task design: Explore other kinds of positioning, search, or path-pursuit tasks (Balakrishnan and Kurtenback, 1999), or

- tool design: Introduce CAD alternative
Alternative tools: CAD system

One more alternative tools, being either CAD, modeller, or architecture tools:

- AutoCAD, or
- Inventor, or
- 3D Studio Max, or
- Maya

We chose 3D Studio Max
3D Studio Max – three views
3D Studio Max – interactive support
3D Studio Max – laser beam
Paper at:

www.fjeld.ch/pub/ISMAR2002b.pdf