Exploring the Design Space for Adaptive Graphical User Interfaces

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Scope

Graphical User Interfaces where the system automatically adapts the presentation of the functionality

The Split Interface
The Moving Interface
The Visual Popout Interface
Motivation

They optimize the UI for the individual! They disorient the user!
Prior Work

Greenberg and Witten [1985]
Trevellyan and Browne [1987]
Mitchell and Shneiderman [1989]
Sears and Shneiderman [1994]
McGrenere, Baecker and Booth [2002]
Findlater and McGrenere [2004]
Tsandilas and shraefel [2005]
Commercial Deployments
Our Goal

Uncover the factors and relationships that influence users’ satisfaction and actual performance when using adaptive UIs.
Road Map

- Introduce and motivate the problem
- Video
- Experiment 1: qualitative results
- Experiment 2: quantitative results
- Synthesis
- Conclusions
Mapping the Design Space for Adaptive User Interfaces: The Good, the Bad, and the Ugly
<table>
<thead>
<tr>
<th>Interface</th>
<th>Potential Benefit</th>
<th>Potential Disorientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Split Interface</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>The Moving Interface</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>The Visual Popout Interface</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Experiment 1

Goal: collect informative subjective data
Participants

- 26 volunteers (10 female)
- aged 25 to 55 (mean=46)
- moderate to high experience using computers (as indicated by a validated screener)
- intermediate to expert users of MS Office (as indicated by a validated screener)
- participants received software gratuity
Tasks

- Three classes of editing tasks:
  - Flow chart edits
  - Text edits
  - Combined text and graphical edits
Procedures

Start

Training

Flow Chart task

Quotes task

Poster task

Questionnaire

Done 4 conditions?

Final Questionnaire

End
Users ranked the **Split Interface** the highest (p<0.001)
General Satisfaction

![Bar chart showing satisfaction with different features: Ease of Use and Satisfaction. The chart compares Unchanging, Split, Moving, and Visual Popout features.](chart.png)
General Satisfaction

![Bar chart showing Ease of Use and Satisfaction satisfaction with Unchanging, Split, Moving, and Visual Popout categories.](image)
Usability

- Discoverability
- Sense of Control
- Predictability of adaptation

Types of adaptation:
- Unchanging
- Split
- Moving
- Visual Popout
Subjective Cost and Benefit

- **Subjective cost**
  - based on:
    - Mental demand
    - Physical Demand
    - Frustration
    - Confusion due to adaptation

- **Subjective benefit**
  - based on:
    - Performance
    - Efficiency due to adaptation
Subjective Cost and Benefit

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Diagram:

- Split Interface
- Moving Interface
- Non-adaptive baseline
- Visual Popout Interface
## User Comments

<table>
<thead>
<tr>
<th>Split Interface</th>
<th>Moving Interface</th>
<th>Visual Popout Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>- stability</td>
<td>- discoverability</td>
<td></td>
</tr>
<tr>
<td>- semantic</td>
<td></td>
<td>- anti-salience</td>
</tr>
<tr>
<td>grouping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- poor</td>
<td>- instability</td>
<td></td>
</tr>
<tr>
<td>discoverability</td>
<td></td>
<td></td>
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Road Map

- Introduce and motivate the problem
- Synthesis
- Video
- Experiment 1: qualitative results
- Experiment 2: quantitative results
- Conclusions
Experiment 2

Goals:

Collect accurate performance data

Investigate how the accuracy of the adaptive algorithm affects how adaptation is used
Participants

- 8 research colleagues (2 female)
- aged 25 to 58 (mean=36)
- high experience using computers
- expert users of MS Office
- participants received two meal vouchers as gratuity
Tasks

Please find and click this button → 

|And then click here → | Experim

Next Button
Procedures

• Introduction and a brief training on a non-adaptive version of the interface

• Each participant used each of the three interfaces (Unchanging, Split and Moving) at two different accuracy levels (30% and 70%)
Performance Vs. Adaptation Type

Completion time (seconds)
Performance Vs. Adaptation Type

- Participants were significantly faster using Split Interface than Non-adaptive baseline (p<0.003)
Performance Vs. Adaptation Type

- Participants were significantly faster using Split Interface than Non-adaptive baseline ($p<0.003$)
- Participants were marginally faster using Moving Interface than Non-adaptive baseline ($p<0.073$)
Both adaptive interfaces resulted in faster performance at the higher (70%) accuracy level than at the lower (30%) level (p<0.001)
Frequency of Use Vs. Accuracy

7% 93% 70% accuracy
19% 81% 30% accuracy
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## Putting It All Together

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<tr>
<th>Interaction Mechanics</th>
<th>Algorithm Behavior</th>
<th>Context</th>
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<tbody>
<tr>
<td>stability</td>
<td>frequency of adaptation</td>
<td>interaction frequency</td>
</tr>
<tr>
<td>locality</td>
<td>accuracy</td>
<td>task complexity</td>
</tr>
<tr>
<td></td>
<td>predictability</td>
<td></td>
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</tbody>
</table>
Stability

User satisfaction

Interaction Mechanics
- stability
- locality

Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability

Context
- interaction frequency
- task complexity

Split Interfaces

High stability

Moving Interface

MS Smart Menus

Low stability

Visual Popout
User comments indicate that, especially for manual tasks, high locality improves discoverability of adaptation.
Adaptation Frequency

Two studies of Split Menus:

↑ Sears and Shneiderman [1994]
  adaptation once per user/session

↓ Findlater and McGrenere [2004]
  adaptation once per interaction
• Participants performed faster at higher accuracy levels
  (also in [Tsandilas and Schraefel CHI’05])

• Participants were more likely to take advantage of adaptation at higher accuracy levels
Predictability

A study in progress!
Interaction Frequency

Two studies of adaptive deep hierarchical menus:

↑ Greenberg and Witten [1985]
30 interactions per trial

↓ Trevellyan and Browne [1987]
100 interactions per trial:
-- first 30 positive
-- last 30 neutral or negative
# Task Complexity

## Experiment 1

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## Experiment 2

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### Columns
- **Interaction Mechanics**
  - stability
  - locality
- **Algorithm Behavior**
  - frequency of adaptation
  - accuracy
  - predictability
- **Context**
  - interaction frequency
  - task complexity
Conclusions

Split Interface vs. Moving Interface: Visual Popout
Conclusions

Split Interface | Moving Interface | Visual Popout

Preferred | [Experiment 1] | Disliked
Conclusions

Split Interface: Preferred
Moving Interface: Faster
Visual Popout: Disliked

[Experiment 2]
Conclusions

Interaction Mechanics
- stability
- locality

Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability

Context
- interaction frequency
- task complexity
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