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
Scope

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

The Split Interface
Scope

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

The Moving Interface
Scope

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

The Visual Popout Interface
Scope

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

They disorient the user!
Motivation

They optimize the UI for the individual!

They disorient the user!
Prior Work
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
Commercial Deployments
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>Potential Benefit</th>
<th>Potential Disorientation</th>
</tr>
</thead>
</table>


The Split Interface

Adaptive toolbar -->

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Potential Disorientation</th>
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<tbody>
<tr>
<td>Medium</td>
<td>Low</td>
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The Split Interface

Adaptive toolbar -->

<table>
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The Moving Interface

<table>
<thead>
<tr>
<th>Potential Benefit</th>
<th>Potential Disorientation</th>
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<tbody>
<tr>
<td>High</td>
<td>Medium</td>
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<tr>
<td>The Split Interface</td>
<td>Potential Benefit</td>
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<tr>
<td>---------------------</td>
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<tr>
<td>Adaptive toolbar</td>
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</table>

<table>
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<table>
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<tr>
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<td>Low</td>
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</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
Procedures

Start

Training
Procedures

- Start
  - Training
    - Flow Chart task
      - Quotes task
        - Poster task
          - Questionnaire
Procedures

Start

Training

Flow Chart task

Quotes task

Poster task

Questionnaire

Done 4 conditions?

Change Interface
Procedures

Start

Training

Flow Chart task

Quotes task

Poster task

Questionnaire

Change Interface

Done 4 conditions?

Final Questionnaire

End
Results: Ranking

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

[Diagram showing bar chart with categories 'Ease of Use' and 'Satisfaction', comparing Unchanging, Split, Moving, and Visual Popout]
General Satisfacation

Ease of Use

Satisfaction

Unchanging  Split  Moving  Visual Popout
General Satisfaction

![Graph showing general satisfaction levels for different conditions.](image)
General Satisfaction

![Bar Chart]

- Ease of Use
- Satisfaction

Legend:
- Blue: Unchanging
- Red: Split
- Yellow: Moving
- Green: Visual Popout
Usability

Discoverability Sense of Control Predictability of adaptation

Unchanging Split Moving Visual Popout
Usability

Discoverability  Sense of Control  Predictability 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 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 showing:
- Subjective benefit
- Subjective cost
- Non-adaptive baseline
- Visual Popout Interface
- Split Interface
- Moving Interface
## User Comments

<table>
<thead>
<tr>
<th>Split Interface</th>
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Road Map

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

Please find and click this button →

And then click here →
Please find and click this button →

| And then click here → |

| De | X |
| Experim | Next Button |
Tasks

Please find and click this button ➔

And then click here ➔
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

<table>
<thead>
<tr>
<th>Completion time (seconds)</th>
<th>None</th>
<th>Split</th>
<th>Moving</th>
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<td>95</td>
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<td>70</td>
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</tbody>
</table>
Performance Vs. Adaptation Type

Completion time (seconds)

- None
- Split
- Moving

Completion times:
- None: 70 seconds
- Split: 80 seconds
- Moving: 90 seconds
Performance Vs. Adaptation Type

- Participants were significantly faster using Split Interface than Non-adaptive baseline (p<0.003)
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 ($p<0.073$)
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

Please find and click this button →

And then click here →
Frequency of Use Vs. Accuracy

Please find and click this button →

And then click here →
Frequency of Use Vs. Accuracy

Please find and click this button →
And then click here →
Frequency of Use Vs. Accuracy

19%  81%  30% accuracy

Please find and click this button and then click here.
Frequency of Use Vs. Accuracy

7%  93%  70% accuracy
19%  81%  30% accuracy
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Exploring the Design Space for Adaptive Graphical User Interfaces
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Putting It All Together
Putting It All Together

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<th>Interaction Mechanics</th>
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<tr>
<td>stability</td>
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<tr>
<td>locality</td>
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## Putting It All Together

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## Putting It All Together

### Interaction Mechanics
- stability
- locality

### Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability

### Context
- interaction frequency
- task complexity
Stability

User satisfaction

Interaction Mechanics
- stability
- locality

Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability

Context
- interaction frequency
- task complexity

Split Interfaces

Moving Interface

High stability

Low stability

High stability

Low stability

User satisfaction
Stability

User satisfaction

Split Interfaces

Moving Interface

MS SmartMenus

Low stability

High stability

Interaction Mechanics
- stability
- locality

Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability

Context
- interaction frequency
- task complexity
Stability

User satisfaction

Split Interfaces

Moving Interface

Visual Popout

MS Smart Menus

Low stability

High stability

Interaction Mechanics
- stability
- locality

Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability

Context
- interaction frequency
- task complexity

Interaction Mechanics

Algorithm Behavior

Context

Split Interfaces

Moving Interface

Visual Popout

MS Smart Menus

Low stability

High stability
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]

↓ Findlater and McGrenere [2004]
Adaptation Frequency

Two studies of Split Menus:

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

↓ Findlater and McGrenere [2004]
   adaptation once per interaction
# Accuracy

<table>
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Accuracy

- Participants performed faster at higher accuracy levels

(also in [Tsandilas and Schraefel CHI’05])
Accuracy

- 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
Accuracy

- 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

- More disorienting interfaces affected more by reduced accuracy
  [Tsandilas and Schraefel CHI’05]
Predictability

A study in progress!
Two studies of adaptive deep hierarchical menus:

↑ Greenberg and Witten [1985]

↓ Trevellyan and Browne [1987]
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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### Context
- interaction frequency
- task complexity

### Interaction Mechanics
- stability
- locality

### Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability
# Task Complexity

## Experiment 1

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Conclusions
Conclusions

- Split Interface
- Moving Interface
- Visual Popout
Conclusions

Split Interface

Moving Interface

Visual Popout

Preferred

[Experiment 1]

Disliked
Conclusions

Split Interface  Moving Interface  Visual Popout

Preferred  Faster  [Experiment 2]  Disliked
## Conclusions

### Interaction Mechanics
- stability
- locality

### Algorithm Behavior
- frequency of adaptation
- accuracy
- predictability

### Context
- interaction frequency
- task complexity
Acknowledgments

- Andrea Bunt, Leah Findlater and Joanna McGrenere at UBC
- Members of the VIBE Group at MSR
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