Is a Picture Worth a Thousand Words?
An Evaluation of Information Awareness Displays

Christopher Plue
Todd Miller
John Stasko
Peripheral/Ambient Displays

Dangling String

Water Lamp and Pinwheels

Informative Artwork

Digital Family Portrait

Information Percolator

Kandinsky System
Evaluation Challenges

- Combination of utility, aesthetics, and long-term use
- Recent work in evaluation techniques include:
  - Mankoff et al.'s Heuristic Evaluation Criteria for Ambient Displays CHI 03
  - McCrickard et al.'s Notification System Categorization Framework TOCHI 03
The InfoCanvas

Highly personalized peripheral display placed in user’s environment
The InfoCanvas

Highly personalized peripheral display placed in user’s environment
The InfoCanvas

- Objects on InfoCanvas represent data
  - Example: Height of bird in sky represents stock value
- Users specify mappings between objects in scene and information presented
- Explicitly supports displaying multiple pieces of information simultaneously
- Personalization is important
  - Choose theme to fit mood, personality, etc.
User Study

- Focus on several displays’ effectiveness at conveying info in a short period of time
  - InfoCanvas
  - Web Portal type display
  - Text-based display
- **Not** to evaluate peripheral displays in general
Information Nuggets

time of day

weather forecast

temperature forecast

traffic conditions

stock update

airfare prices

website updates

new emails

baseball score update

news headline

Miller & Stasko, AVI 2002
Text-Based Display

News
Iraq's Armed Forces Dissolved, U.S. Says
BAGHDAD, Iraq – The military that failed to protect Saddam Hussein's regime took its final fall Friday, as the American occupation force ordered the dismantling of the Iraqi army and the

Personal Finance
Dow Jones 8117.23 +64.0 +.99%
S & P 500 777.2 -3.30 -.15%
NASDAQ 1210.11 +1.23 +.28%

Today's Forecast
Temperature: 53
Conditions: Cloudy

Traffic Conditions
Average Speed: 62 MPH

Travel
Airfare from ATL to LAX
Lowest Price: $220

Communication
Photo Website: Unchanged
New Email Messages: 4

Sports
Atlanta Braves: 2
Pittsburgh Pirates: 1

Date & Time
Tuesday, September 8
3:34 AM
Web Portal Display

- Design choice of more graphics and images than on a typical Web portal
Slider Data Elements

Kite::Airfare Price

A News Headline
Image Swappers

Bathing Suit Color:: Traffic Conditions

0 - 25 miles per hour
“Growers”

0 Emails
Drink Glass::Email Count
“Growers”

10 Emails
Drink Glass::Email Count
“Growers”

A News Headline

20 Emails
Drink Glass::Email Count
“Growers”

>20 Emails
Drink Glass::Email Count
“Growers”

A News Headline

Baseball Score

Stock Update

Email Count
Lingerie Store Robbed--Thief Gives Cops The Slip

Plane Banner::News Headline

Text
Information Awareness Displays

Highly Graphical

Highly Textual
Study Details

• 49 participants
• Mostly male (11 female)
• Ranging in age between 18 and 61
• 27 grad students, 17 undergrads, 5 other
• Financially compensated
Experimentation

- Individually tested
- Seated directly in front of display
- Within-subjects design w/ counterbalancing

- Introductory Tour
- Preparation Task
- Practice Task
- Actual Trials
Experimentation

- Individually tested
- Seated directly in front of display
- Within-subjects design w/ counterbalancing

Duration:
- InfoCanvas: ~3.5 minutes
- Web Portal: ~1.5 minutes
- Text-based: ~1.5 minutes

Pilot testing alleviated concerns that participants wouldn’t be able to learn the mappings used on the InfoCanvas
Experimentation

- Individually tested
- Seated directly in front of display
- Within-subjects design w/ counterbalancing

**Introductory Tour**

**Preparation Task**

**Practice Task**

**Actual Trials**

Shown an example display and completed a sample recall questionnaire (coming up)

No time limit enforced

Allow for additional questions
Experimentation

- Individually tested
- Seated directly in front of display
- Within-subjects design w/ counterbalancing

<table>
<thead>
<tr>
<th>Introductory Tour</th>
<th>Recall questionnaire face down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation Task</td>
<td>Info display shown for 8 seconds</td>
</tr>
<tr>
<td>Practice Task</td>
<td>Prompt to turn over and answer recall questionnaire</td>
</tr>
<tr>
<td>Actual Trials</td>
<td></td>
</tr>
</tbody>
</table>
Experimentation

- Individually tested
- Seated directly in front of display
- Within-subjects design w/ counterbalancing

- Introductory Tour
- Preparation Task
- Practice Task
- Actual Trials

3 information display exposures & recall pairs using different data sets/displays

Specific emphasis made not to guess
Recall Questions

- Varied question topic order across trials
- Incorporated confidence scale
  low / medium / high

What is the current time of day?
- 4:32 AM
- 7:40 AM
- 3:20 PM
- 7:55 PM

What is the current news headline?
- Pair pleads not guilty to embezzlement
- Pair pleads guilty to obstruction charges
- Jury hung on money launderer
- Couple found not guilty on conspiracy charge

What is the lowest airfare price from Atlanta to Los Angeles?
- $330
- $292
- $160
- $99

How many new emails were present?
- 22
- 16
- 1
- 0
Recall Questions

• Questions were designed to elicit comprehension and recall of information in the same manner that it was encoded.

What is the status of the Dow Jones?
+ 89 points
+ 42 points
- 2 points
- 75 points

What is the status of the Dow Jones?
Up over 50 points
Up 0 - 50 points
Down 0 - 50 points
Down over 50 points

“Exact-Value”

“Categorical”
### Results

<table>
<thead>
<tr>
<th></th>
<th>1st Trial</th>
<th>2nd Trial</th>
<th>3rd Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.14 (1.59)</td>
<td>5.12 (1.33)</td>
<td>5.02 (1.57)</td>
</tr>
<tr>
<td></td>
<td>5.67 (1.61)</td>
<td>5.65 (1.54)</td>
<td>5.29 (1.89)</td>
</tr>
<tr>
<td></td>
<td>6.27 (1.80)</td>
<td>6.22 (1.79)</td>
<td>6.31 (1.76)</td>
</tr>
</tbody>
</table>

*Recall score out of 10 questions*

**Statistical Significance for:**

- InfoCanvas over Web Portal: (F(1,48) = 14.65, MSE = 2.66, p < .0005)
- Web Portal over Text-Based: (F(1,48) = 8.17, MSE = 1.76, p < .007)
- InfoCanvas over Text-Based: (F(1,48) = 40.1, MSE = 2.51, p < .0001)
Results: Another Take

- Weighted Scores: Taking into account confidence levels

<table>
<thead>
<tr>
<th>Confidence</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
</tr>
<tr>
<td>No Answer</td>
<td>0</td>
</tr>
</tbody>
</table>
# Weighted Results

<table>
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<tr>
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<th>1st Trial</th>
<th>2nd Trial</th>
<th>3rd Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall score out of 10 questions</td>
<td>11.47 (4.92)</td>
<td>11.78 (4.81)</td>
<td>10.57 (5.02)</td>
</tr>
<tr>
<td></td>
<td>12.88 (5.09)</td>
<td>12.35 (5.84)</td>
<td>11.27 (6.40)</td>
</tr>
<tr>
<td></td>
<td>13.88 (5.96)</td>
<td>14.02 (5.89)</td>
<td>13.82 (6.63)</td>
</tr>
</tbody>
</table>

**Statistical Significance for:**

- InfoCanvas over Web Portal: $(F(1,48) = 7.29, \text{MSE} = 30.56, p < .0095)$
- InfoCanvas over Text-Based: $(F(1,48) = 22.21, \text{MSE} = 22.93, p < .001)$
Item by Item

- Airfare
- Baseball Score
- Forecasted Temp
- New Email
- News Headline
- Stock Updates
- Time of Day
- Traffic Conditions
- Weather Forecast
- Web Site Update

Bars represent different percentages for Text, Web, and InfoCanvas.
Item by Item

- Airfare
- Baseball Score
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Legend:
- Text
- Web
- InfoCanvas
Summary

- Participants able to recall significantly more information with the InfoCanvas
- 7 of the 10 data items averaged best recall rate with InfoCanvas
- Suggests benefits for comprehension
Analysis

• Results shouldn’t be too surprising
  • Leverage high bandwidth perceptual system
  • Graphics conducive to recall tasks (Umanath and Scamell, CACM ’88)

• Concrete confirmation of intuition
Tree→Website Update?

- Would data→object mappings limit recall?
- Authors, not participants, designed mappings
  - “I struggled with the visual mappings”
- InfoCanvas still performed well
Tree Website Update?

- Would data → object mappings limit recall?
- Authors, not participants, designed mappings
  - “I struggled with the visual mappings”
- InfoCanvas still performed well

InfoCanvas is designed to be a highly personalized display consistently in a user’s environment!
### Subjective Results

<table>
<thead>
<tr>
<th>Facilitator Type</th>
<th>Text</th>
<th>Web</th>
<th>InfoCanvas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best Recall Facilitator</td>
<td>4%</td>
<td>33%</td>
<td>63%</td>
</tr>
<tr>
<td>Worst Recall Facilitator</td>
<td>84%</td>
<td>10%</td>
<td>6%</td>
</tr>
<tr>
<td>Most Preferred</td>
<td>4%</td>
<td>71%</td>
<td>25%</td>
</tr>
<tr>
<td>Least Preferred</td>
<td>71%</td>
<td>4%</td>
<td>25%</td>
</tr>
</tbody>
</table>
Interesting

- Participants generally expressed preference for the Web Portal over InfoCanvas.
- Participants felt that the InfoCanvas best facilitated the recall of information:
  - Felt that Web Portal was “more professional looking”
  - Web Portal displayed information in a “logical and precise manner”
Yet Others...

- ...captured the essence of InfoCanvas
  - “I think I could choose to ignore it while I was working. I think once I got used to what all the icons meant and what the scales were, I could easily look at it to see the information I was interested in.”
  - “[InfoCanvas] is the quickest and easiest to see at a glance the information you want.”
  - “[I am] able to keep working and not get distracted by details; [InfoCanvas] is faster to see and interpret from a distance.”
Ongoing Work
Ongoing Work

- Explore performance in a more peripheral nature
- Long-term general study
- End-user InfoCanvas creation tool
Acknowledgments

• InfoCanvas Development Team:
  Zach Pousman, Shannon Bauman, Osman Ullah, Julie Hoffman
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  Microsoft Research

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• NDSEG Graduate Research Fellowship
Visit the InfoCanvas Web Site at:
http://www.cc.gatech.edu/gvu/ii/infoart/
Potential Followup

- Compare with other highly graphical systems, such as Sideshow / Scope.