Usability of Electronic Voting Systems: Results from a Laboratory Study

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- **Vendors:**
  - Hart InterCivic, ES&S, NEDAP, Avante
Take Home Points

- People have problems using these voting systems
  - Reduce Satisfaction
  - Increase Errors

- The particular interface (navigation and selection) matters

- Some tasks especially problematic
  - Irrespective of the system
  - E.g. changing votes, writing-in votes

Usability has real consequences

CLEVELAND --- A 61-year-old man was arrested after an alleged poll rage incident, NewsChannel5 reported.

Voter smashes touch-screen machine in Allentown
Current Study: Participants

- 42 participants visited lab in Ann Arbor, MI in Summer, 2004
  - 31 with limited computer experience
    - “less than two times a week” or less
  - 29 older than 50 years of age
  - Each paid $50 for up to 2 hours

Current Study: Procedure

1. Voters (users) indicate intentions by circling choices in booklet
   a. In a few cases, voters instructed how to vote
2. Voters vote for their choices on each of 6 systems
   a. Interactions video-recorded
   b. After using each system complete satisfaction questionnaire
3. Voters complete questionnaire about overall experience, opinions, demographics
Coding the Video

Results: Satisfaction and Effort

- **Satisfaction** ("easy to use" and "comfort") depends on the user interface
  - Diebold rated highest and Hart lowest

- **Effort** (number of actions and duration) depends on user interface
  - Diebold requires relatively few actions and the least time, Hart requires most actions and most time
Satisfaction and Effort

- The more effort required to vote, the less satisfied voters are with the experience
  - Effort: Number of Actions, Duration
  - Satisfaction: “easy to vote” and “comfortable voting”*

<table>
<thead>
<tr>
<th>Effort</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ease</td>
</tr>
<tr>
<td>Duration</td>
<td>-0.40</td>
</tr>
<tr>
<td>Number of Actions</td>
<td>-0.33</td>
</tr>
</tbody>
</table>

\[ \rho < .001 \text{ for all correlations} \]

*Agreement scale (1 = strongly disagree, 7 = strongly agree)
What kind of errors did voters make?

Results: Errors and Satisfaction

- As voters make more errors they are less satisfied
  - Easy to use ($\rho = -0.23, p < .001$)
  - Comfortable using ($\rho = -0.18, p < .005$)

- Suggests that errors are associated with frustration, not simple inaccuracy
Critical Path and Accuracy

- Effect is stronger for voters with low computer experience

Video Examples:

- Some tasks lead to low levels of performance no matter how implemented in different interfaces
  - Changing a vote
  - Writing-in a vote

- What happens if voters do not take advantage of features that might help?
  - Reviewing ballot

- Verifying paper audit trail
Changing a Vote

- For Probate Judge, voters instructed to first choose Jeanette Anderson and then change to Kenneth Hager

<table>
<thead>
<tr>
<th>System</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diebold</td>
<td>.04</td>
</tr>
<tr>
<td>ESS</td>
<td>.22</td>
</tr>
<tr>
<td>Avante</td>
<td>.18</td>
</tr>
<tr>
<td>Zoomable</td>
<td>.10</td>
</tr>
<tr>
<td>Liberty</td>
<td>.02</td>
</tr>
<tr>
<td>Hart</td>
<td>.07</td>
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Vote-change video examples: Diebold, Avante

Writing-in a vote

- For write-in task, voters given name of candidate to enter

<table>
<thead>
<tr>
<th>System</th>
<th>Errors</th>
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<tbody>
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<td>.16</td>
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<tr>
<td>ESS</td>
<td>.12</td>
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<tr>
<td>Zoomable</td>
<td>.19</td>
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<tr>
<td>Liberty</td>
<td>.27</td>
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<tr>
<td>Avante</td>
<td>.17</td>
</tr>
<tr>
<td>Hart</td>
<td>.34</td>
</tr>
</tbody>
</table>

Write-in video examples: Avante, Hart, Zoomable
Reviewing Ballot

- Voters review ballot with different levels of care on different systems

<table>
<thead>
<tr>
<th>System</th>
<th>Duration (min's)</th>
</tr>
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<tbody>
<tr>
<td>Diebold</td>
<td>.59</td>
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<tr>
<td>ESS</td>
<td>.56</td>
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<tr>
<td>Zoomable</td>
<td>.67</td>
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<tr>
<td>Liberty</td>
<td>.75</td>
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<tr>
<td>Avante</td>
<td>1.66</td>
</tr>
<tr>
<td>Hart</td>
<td>1.16</td>
</tr>
</tbody>
</table>

- Ballot Review example ([Diebold, Hart](#))

Paper Trail

- “Voter verified paper audit trail” makes recounts possible despite vanishing character of e-voting
- But critical that voters verify
- Usability of Avante printed receipt interferes with voter verification
  - System times out, automatically depositing (unverified receipt) for 38% (16/42) voters
  - 24% (10/42) voters deposited (verified) receipt without looking at it
  - Only 26% (11/42) follow ideal sequence of looking at receipt then depositing
- Video example of paper record verification
Conclusions

- In a situation designed to maximize usability problems, the systems fared reasonably well
  - Error rates relatively low

- But did exhibit serious usability problems and, for some systems, errors were disturbingly frequent
  - Particularly for complex voting tasks
  - For different reasons for different interfaces

- When people have trouble they have serious trouble
  - Long inefficient sequences of actions
  - Lower levels of satisfaction

- An unsatisfying experience could well translate to lower turnout and lower confidence in process

Implications

- Many design problems can be identified with usability engineering techniques
  - But industry and election officials need to make a priority

- Unparalleled design challenge:
  - Systems should be usable by all citizens all the time, even if used once every few years
Thank you!