Usability of Electronic Voting Systems: Results from a Laboratory Study

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- Vendors:
  - Hart InterCivic, ES&S, NEDAP, Avante

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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

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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

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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

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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

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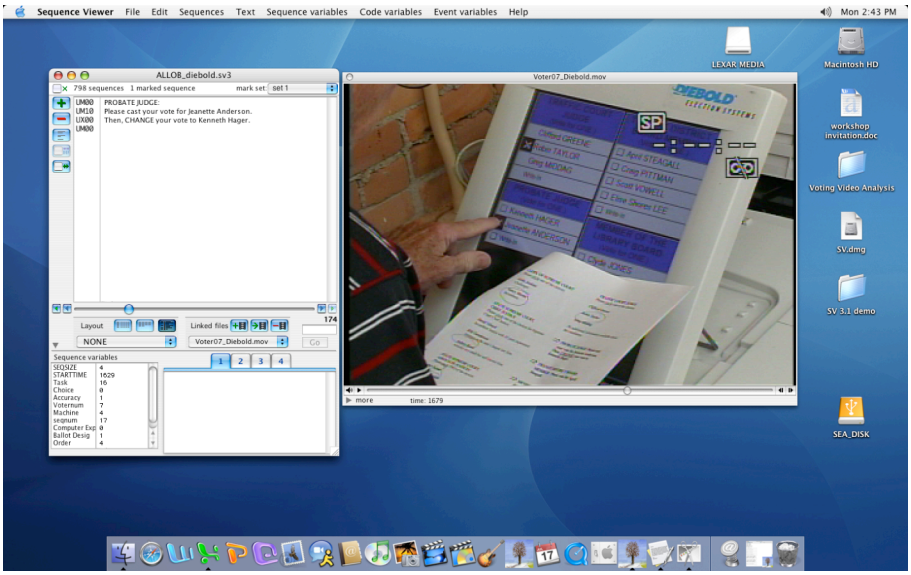
Coding the Video



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

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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"*

	Satisfaction	
Effort	Ease	Comfort
Duration	-0.40	-0.37
Number of Actions	-0.33	-0.33

$p < .001$ for all correlations

*Agreement scale (1 = strongly disagree, 7 = strongly agree)

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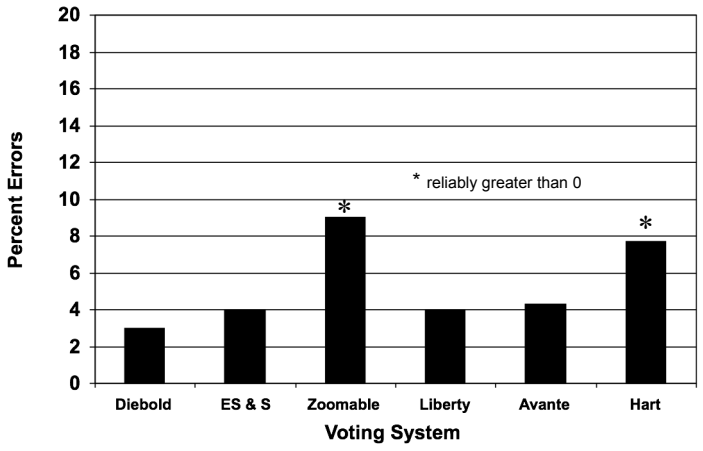
Errors (Inaccuracy)



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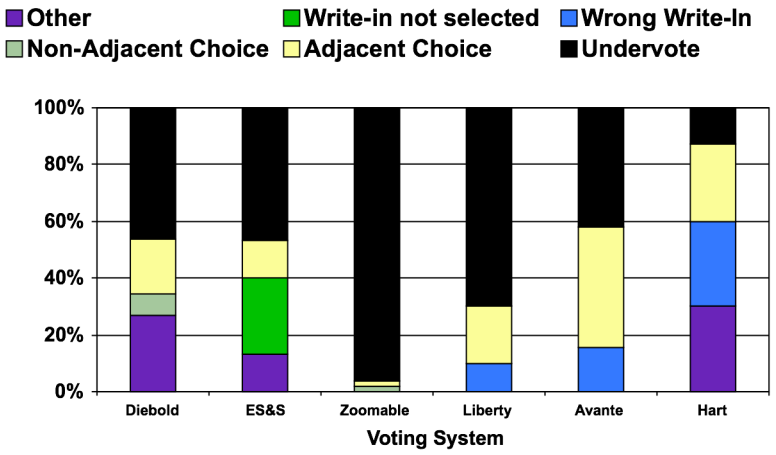
What kind of errors did voters make?



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Results: Errors and Satisfaction

- As voters make more errors they are less satisfied
  - Easy to use (ρ = -0.23, p < .001)
  - Comfortable using (ρ = -0.18, p < .005)
- Suggests that errors are associated with frustration, not simple inaccuracy

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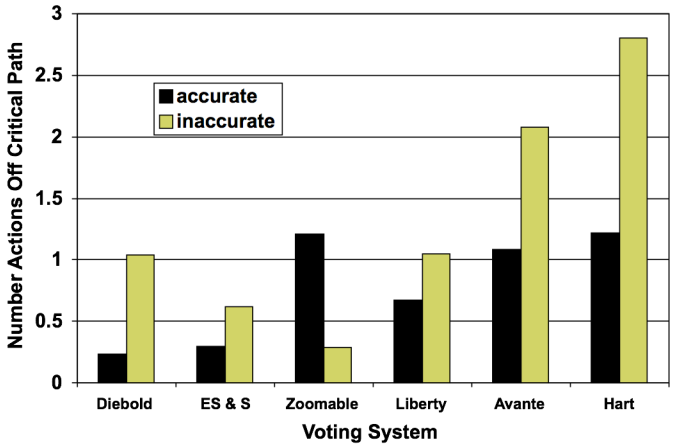
Critical Path and Accuracy



- Effect is stronger for voters with low computer experience

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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

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Changing a Vote

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

System	Errors
Diebold	.04
ESS	.22
Avante	.18
Zoomable	.10
Liberty	.02
Hart	.07

Vote-change video examples: Diebold, Avante

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Writing-in a vote

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

System	Errors
Diebold	.16
ESS	.12
Zoomable	.19
Liberty	.27
Avante	.17
Hart	.34

Write-in video examples: Avante, Hart, Zoomable

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Reviewing Ballot

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

System	Duration (min's)
Diebold	.59
ESS	.56
Zoomable	.67
Liberty	.75
Avante	1.66
Hart	1.16

- Ballot Review example (Diebold, Hart)

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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

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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

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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

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Thank you!

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