A Study of Vote Verification Technologies for the Maryland State Board of Elections

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My name is Paul Herrnson and I am the director of the Center for American Politics and Citizenship at the University of Maryland. I have been studying the usability of voting systems and ballot styles for roughly four years. My research on voting is primarily funded by the National Science Foundation and the Carnegie Corporation of New York.

Today, I will discuss a report that will be released in a few days. Before I give you an overview of the report, I wish to acknowledge some colleagues who collaborated on this project: Benjamin Bederson, Director, Human-Computer Interaction Lab, University of Maryland; Richard Niemi, Professor, Department of Political Science, University of Rochester. Michael Hanmer, Assistant Professor, Department of Government, Georgetown University.

We were assisted by Professor Charles Hadley, Research Professor and Chair, Department of Political Science, University of New Orleans, and a small army of graduate and undergraduate assistants.

The Maryland State Board of Elections commissioned the University of Maryland's Center for American Politics and Citizenship, along with the Human-Computer Interaction Lab, to conduct a usability study of seven vote verification systems. Because three manufacturers did not provide us with access to their systems, were only able to test four. The four are pictured and described on the pages at the end of my written testimony.

- Diebold AccuVote-TSx with AccuView Printer Module—allows voters to read their votes on a printed sheet of paper

- VoteHere Sentinel—provides a piece of paper with a unique identification number that voters can later use to verify that their vote has been counted by dialing a toll-free telephone number or logging on to the internet

- Scytl Pnyx—voters review their votes on a separate computer monitor

- MIT audio system—voters hear their votes in a set of headphones

All of the systems but the Diebold AccuVote-TSx with the AccuView Printer Module were prototypes in various stages of development. The Diebold AccuVote-TS, which has no vote verification unit and is presently used in the State of Maryland, also was included in the study to provide a baseline for comparisons.

To meet the requirements of democratic elections, voting systems must enable voters to register their voting intentions accurately, record votes correctly, count votes accurately, prevent coercion or vote tampering, and instill confidence in voters. Usability research is concerned with the first two criteria and the last one.

Usability studies typically include assessments of "learnability," efficiency, "memorability," errors, accuracy, speed, and user satisfaction. Here, we focus on the public opinion component of usability: user satisfaction. Understanding how voters react to technologies—including ease of use, confidence that one's vote is

recorded accurately, and the need to request help when casting a vote—is crucial for an evaluation of the effectiveness of current electoral processes and new processes under consideration.

Usability research is particularly relevant for voting systems because voting is an infrequent, unspecialized practice in which virtually all U.S. citizens—no matter how well-educated, technically proficient, or physically able—are entitled to participate.

Usability concerns about voting systems are just as important as security concerns. A voting system can be absolutely perfect in terms of its ability to count votes and protect them from tampering, but such considerations decline in importance when citizens are not confident their votes were accurately recorded or have serious concerns about their experience at the polls. This situation is analogous to investing millions of dollars to protect a bank vault at the same time that customers have little confidence about what has been deposited into their individual accounts.

The problems associated with the 2000 presidential election in Florida concerned usability, not security. The major culprit was a voting interface that was not tested for its usability--the so-called “Butterfly Ballot.”

Many speculate about or ignore usability issues related to voting systems, we systematically study them. We used three approaches to study the usability of the four vote verification systems:

- Expert review by 9 human-computer interaction experts known for their knowledge of voting systems and computer interfaces.

- A field test involving more than 800 Maryland voters in a simulated election.

- Observations about system set-up and maintenance drawn from the simulated election.

Expert review

The goal of an expert review is to identify potential problem areas with a computer interface, such as a vote verification system. Reviewers did side by side comparisons of the vote verification systems (and the voting system with no verification unit) while going through normal voting procedures.

The major findings from the expert review are:

- There was a perceived trade-off between usability and security. In all cases, the verification system appeared to reduce the usability of the voting process compared to the Diebold AccuVote-TS, which had no verification unit.

- The Diebold AccuVote-TSx with the AccuView Printer Module (paper printout) was rated most favorably of all the vote verification systems. However, suggestions were made for improvement and questions were raised about the paper record's utility when used for a long ballot.

- Privacy concerns were raised about each of the four vote verification systems. Each provided less privacy than the voting system with no verification unit.

Field test

The field test was a simulated election that involved 815 Maryland voters who were asked to vote on five voting systems. It was designed to record the appraisals of a diverse group of voters in a realistic voting situation.

The major findings from the simulated election are:

- All of the systems were viewed favorably, including the Diebold AccuVote-TS with no verification unit.

- The Diebold with AccuView Printer (paper printout), the Diebold AccuVote-TS (with no verification), and the VoteHere Sentinel (cryptography) were rated the most favorably. The differences in their evaluations were too small to be statistically significant.The MIT (audio) and Scytl Pnyx (computer monitor) systems were rated less favorably.

- Participants received the least amount of help when using the Diebold AccuVote-TS system (no verification unit). The Diebold with AccuView Printer system came next. Voters received more help using the other three systems.

- Background characteristics concerned with the digital divide, which one might expect to affect voters' assessments of the systems, had little impact on voter satisfaction across systems.

The findings regarding the use of a paper printout, either as part of a touchscreen voting system or as part of a paper ballot/optical scan system are consistent with those of a larger study of 1,540 voters, including 624 from Maryland. That study tested the ES&S Model 100 (paper ballot/optical scan), the Avante Vote-Trakker (paper printout), and the Diebold AccuVote-TS (no paper printout).

That study showed that voters provided lower evaluations for paper-based systems than they provided for the AccuVote-TS with no verification unit. These voters also were less confident that their vote was accurately recorded on the two systems using paper than the AccuVote-TS.

The study also showed that significantly more voters needed help on the two systems that used paper than they did on the AccuVote-TS.

Finally, the study analyzed voter accuracy. That is, the ability of voters to cast their ballots as intended on the different voting systems. Here the findings are:

- Most of the differences in accuracy among the three systems are too small to be statistically significant.

- There are two exceptions

    - When voters changed their vote from one candidate to another, they voted significantly more accurately on the AccuVote-TS.

    - When voters cast a write-in vote, they made significantly more errors on the paper ballot/optical scan system (a 25% error rate).

The study can be found at the Center for American Politics and Citizenship's website (www.capc.umd.edu).

Usability Issues concerned with Election Administration

Our major findings concerned with the set-up, maintenance, and service support of the vote verification systems are:

- Adding any of the four verification systems greatly increased the complexity of administering an election.

- Integrating the vote verification systems to a voting system poses technical challenges.

- Other challenges involve the cooperation of a voting system manufacturer in integrating a vote verification system. We had to integrate the vote verification systems with a mock system designed to emulate the Diebold AccuVote-TS (provided courtesy of MIT's media lab) because we were unable to get to Diebold to participate in integrating its system with the vote verification systems.

- The paper spool in the Diebold AccuView Printer had to be changed frequently, and changing it was fairly complex.

- It was difficult and time consuming to set up the Scytl system.

- The Scytl, MIT, and Diebold AccuVote-TS with no verification unit became inoperative when used under normal voting conditions and were out of commission for short portions of the study.

- Diebold provided outstanding response to service calls. Scytl (based in Spain) provided poor service. We did not need to make service calls to MIT or VoteHere.

Final Comments

In summary, although a verification system with a paper trail or some other verification device may sound good in the abstract, it may cause serious problems in the real world of voters and elections.

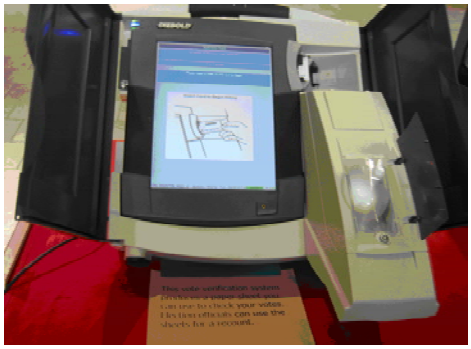
Our charge was to investigate how real voters interact with and respond to real vote verification systems or system prototypes provided by their manufacturers. The analysis of the human-computer interaction experts, the opinions of 815 Maryland voters who participated in a simulated election, and our experiences using these systems in the simulated election show that some vote verification systems are better than others, but none are significantly better in terms of usability than a voting system with no vote verification unit. These findings are supported by other usability studies.

The findings do not lend themselves to recommending any of the four vote verification systems we tested.

Thank you. I invite your questions.

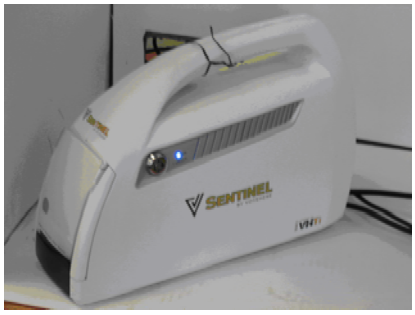
Diebold AccuVote-TSx with AccuView Printer Module

- Paper printout
- After-the-fact verification
- No independent verification unit
- Magnifying glass
- Privacy cover
- Two chances to review prior to casting ballot
- Ballots not randomly stored (privacy issues)
- Bar code can be scanned for recount



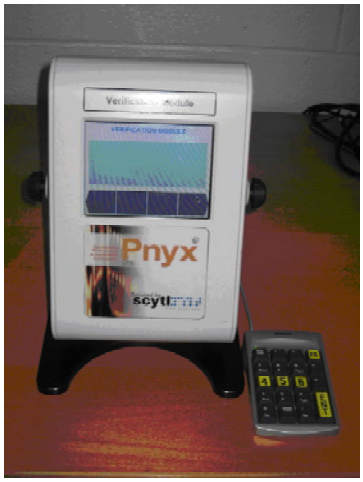
VoteHere Sentinel

- Cryptography
  - Very complicated
- After-the-fact verification
- Independent verification unit
- Paper printout
- Simple verification-all
  - Was ballot counted?
- Advanced verification-500
  - Were individual votes accurately cast?
- Ballots randomly stored
- Compare computerized vote totals to voting system



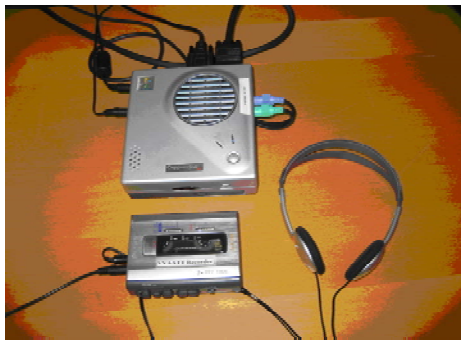
Scytl Pnyx

- Small computer monitor
- After-the-fact verification
- Independent verification unit
- Voters review elections race by race
- Can change ballot on system and cast vote
- Ballots randomly stored
- Compare computerized vote totals to totals on voting system



MIT Prototype

- Audio
- Recorder/headphones
- Analog tape
- Simultaneous verification
- Independent verification unit
- Ballots not randomly stored (privacy issue)
- Tape can be played for recount



Diebold AccuVote-TS

- No verification unit
- Used in Maryland & other states & localities
- Control system in field experiment