

Please note: This is a paper submitted to the committee in response to a call for input. It is not an official report of the Computer Science and Telecommunications Board, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, or National Research Council (collectively The National Academies). Opinions and statements included in this paper are solely those of the individual author(s), and are not necessarily adopted or endorsed or verified as accurate by The National Academies.

The Need For Usability of Electronic Voting Systems: Questions for Voters and Policy Makers

Association of Computing Machinery (ACM)
Special Interest Group on Computer-Human Interaction (SIGCHI),
U.S. Public Policy Committee

Harry Hochheiser, National Institute on Aging, harry@alum.mit.edu
Ben Bederson, University of Maryland, bederson@cs.umd.edu
Jeff Johnson, User Interface Wizards, jjohnson@uiwizards.com
Clare-Marie Karat, IBM T J Watson Research Center, ckarat@us.ibm.com
Jonathan Lazar, Towson University, JLazar@towson.edu

Introduction

Democratic elections are the bedrock of our country's political system. Voting systems must instill confidence in voters. To participate confidently in elections, voters must know that votes were recorded and counted accurately and that only legitimate voters were allowed to vote. Otherwise, voters are likely to become disillusioned with the voting process. Electronic voting systems compound this difficulty by reducing the transparency of the process. Whereas punch-card, optical scan, and mechanical voting systems produce physical artifacts that provide information about whether they are functioning correctly or incorrectly, the workings of electronic voting systems are much more opaque.

As the only component of the voting system that is visible to voters, the user interface

plays a key role in ensuring that voting proceeds smoothly and voters feel comfortable with the result. Voters and policy makers — particularly those officials responsibly for purchasing voting systems — should insist that user interfaces for electronic voting systems are carefully designed, evaluated, and field-tested to meet agreed-upon usability objectives prior to implementation and use in elections (Whiteside, Holtzblatt, and Bennett, 1998.).

The unique nature of the voting process makes this particularly necessary and difficult. Many user interface evaluations make assumptions that are not appropriate for voting systems. Users of office productivity software (for example) can be assumed to be generally literate, comfortable with computer use, comfortable with technology, and perhaps working in an environment where assistance from friends or colleagues is available. None of these assumptions apply to voting systems. Voters and poll workers will vary widely in their levels of literacy and comfort with technology. Help or clarification beyond that which is provided by the system may be unavailable, particularly when in the voting booth. Even the most dedicated voters seldom vote more than once per year, and may vote only once every four years or less.

As a result, user interfaces for voting systems must be more robust than many other user interfaces. They must be “walk up and use”, requiring minimal or no training for voters before they enter the voting booth and use the system. They must provide simple and clear instructions, offer graceful recovery from user errors, provide adequate and detailed feedback regarding the effects of user actions, and they must handle user and system

errors and mistakes. Furthermore, user interfaces for voting technology must meet all of these requirements for voters who vary widely in age, skills, physical abilities, education and cultural background, while guaranteeing confidentiality for all voters and accurate counting of all votes.

Results from a recent study of the usability of electronic voting systems demonstrated some of the difficulties with the current systems (Bederson, et al., 2003). The good news is that in a field study of voting systems similar to some of those used in the November 2004 elections, most participants had favorable impressions of the system, felt comfortable with the system, found it easy to read, were able to correct mistakes, and trusted that votes were counted correctly. As encouraging as these results may be, the authors of the study noted several issues that illustrate the challenges faced in designing and evaluating electronic voting systems. A study population that was relatively affluent (and therefore more likely to be technically savvy), older (60% of participants over 60 years of age), highly educated, and under-representative of minority groups limited the generalizability of these results. Despite the relative advantages of these subjects, 10% of them rated the system as “anywhere from difficult to somewhat challenging to use”.

This observation points to the crux of the challenge of designing user interfaces for voting systems. As the authors of the above study note, “While 90% satisfaction may be acceptable for some usability studies, we strongly feel that digital government initiatives in general and voting systems in particular must have higher standards.” (Bederson, et al. 2003). Moving from 90% satisfaction to 99% satisfaction and successful user

performance may involve significant challenges for system designers and developers.

Usability concerns in voting systems are not limited to the user interfaces presented to voters for casting ballots. Election staff and polling-place volunteers may not be technically experienced, and as a matter of best practice in elections procedures, cannot be required to complete anything more than minimal training prior to an election. Voting systems that have configuration, management, and startup procedures that are not designed to high usability standards might lead to the loss of votes long before polling places open.

Questions and Rationales

As a socio-technical system, voting must be considered to include all aspects of the process, from initial registration through the casting of the ballot and verification of its correctness. Evaluations that fail to consider the entire range of issues run the risk of overlooking potentially important problems. User interface questions regarding electronic voting can be divided into three broad classes including:

- Whether voters have information available to them about electronic voting machines prior to arriving at the polling place and while there;
- Whether voters are able to easily and confidently understand the voting machine, read the contents of the ballot, and cast their votes; and
- Whether voters trust the fairness and accuracy of the electronic voting systems.

These questions take a broad view of the term “electronic voting system.” Many of the

questions presented below take the form of simple yes/no criteria that might be used to assess the usability of a given voting system.

How can we be confident that eligible voters will have access to necessary information about how to use the electronic voting machines?

Voters who do not know how to use the voting system found in their polling place will find it very difficult to cast their votes. This is particularly true for systems that use technologies that are unfamiliar to many voters. Touch-screen voting systems, with their somewhat idiosyncratic calibration requirements, may be particularly troublesome in this regard.

Educational materials for voting systems are particularly challenging. Due to the infrequent nature of voting, voters may not remember how to use systems that they've used in previous years. The diversity of voting systems in use insures that some people will always be voting on unfamiliar equipment. The malleability of software and the constant upgrades of operating systems and graphical user interfaces may lead to constantly changing user interfaces, even at polling places that consistently use the same product from a single vendor.

While computer users often take advantage of interactive help while learning a new application, voting is likely to offer a different experience. In the unfamiliar confines of the voting booth with lines of other voters looming, voters may feel pressure to complete their votes as quickly as possible. In addition to increasing the likelihood of errors

(Wallace, Anderson, and Shneiderman, 1987), this pressure may make some voters unwilling to use help facilities. Ideally, all voters should know how to use the voting equipment before they arrive at the voting booth. However, voting systems should include help facilities for those cases where problems do arise.

Specific questions that might be asked to determine the quality of the voter education components of voting systems include:

- Are simple and clear task-based instructions for using the system provided to eligible voters both before voting and at the polling place?
- Are these instructions accessible to all potential voters?
- Are they clear and easy-to-understand with explanatory text and pictures of the user interface for the voting process?
- Have they been field-tested with adequate samples of a representative range of potential voters?
- Do the help systems provide clear assistance that will help voters gracefully recover if they encounter difficulties or confusion?
- Can voters interact with the machines before the election – either directly, or through appropriate on-line proxies?

Will all voters be able to easily and accurately cast their ballots using the electronic voting systems' user interfaces?

Voting systems must be held to an extremely high standard of usability. Controls, labels, and fonts must be clear, error correction must be straightforward, and input must be as simple as possible.

To meet these high standards, voting systems should be subjected to rigorous testing with users representing a wide range of potential voters, in terms of education, socio-economic background, technical experience, literacy, physical disabilities, etc.

Ideally, these evaluations would be conducted by a neutral third-party, and in accordance with usability standards that would be included alongside other standard requirements for voting systems.

Accurate usability tests cannot occur in a vacuum. Polling places are often noisy and crowded. Tests conducted in a relatively sterile usability lab might miss problems that would appear under more realistic conditions.

Specific questions about usability include:

- Are controls clearly-labeled? Are fonts readable?
- Is consistent language used throughout the interface?
- Can users easily change votes once selected?
- Are write-in votes easy to cast, with clearly labeled choices?
- Are controls laid out so as to minimize the likelihood of accidental completion of a ballot?

- Have user interfaces been designed for use by and tested by a wide range of users of varying levels of expertise, education, and literacy?
- Have user interfaces been designed for use by and tested by voters with various disabilities, including (but not limited to) poor vision/blindness, motor impairments, and cognitive difficulties?
- Has the testing been conducted in environments that approximate the stresses and distractions of real polling places?
- Has testing been conducted by qualified independent parties with no financial or political stake in the success of a given platform?

How can users confidently trust the fairness and accuracy of voting systems?

User interfaces can play a key role in building trust in a computer system (Millett, et al. 2001; Cranor and Garfinkel, 2005). Many of the questions described above in terms of the ease of casting votes apply equally well to building confidence in voting systems.

Voters who are confused by voting technologies, have difficulty making their choices, or otherwise have sub-optimal experiences, might be less likely to trust the voting system.

Ideally, voter trust in voting systems should be based on confident understanding of the correct and verifiable functioning of the equipment. One evaluation found that frequent computer users reported lower levels of trust in electronic voting systems than less frequent computer users (Bederson, et al., 2003). Trust derived from ignorance is potentially dangerous.

Voter-Verified Paper Trails (VVPTs) have been identified as important tools in guaranteeing the accuracy and fairness of vote counting (Grove, 2004; Jefferson, Rubin, Simons, and Wagner, 2004). The design of VVPT systems poses additional interface challenges: users must be able to verify their vote without sacrificing their anonymity. These challenges can be addressed if the requirements are included in the design of the electronic voting systems (National Research Council, 2003). As stated by Adams and Sasse (2001), “Most invasions of privacy are not intentional but due to designers inability to anticipate how this data could be used, by whom, and how this might affect users”. Deciding how to design privacy considerations in technology for the future includes philosophical, legal and practical dimensions – any or all of which can be considered as within the domain of the field of human-computer interaction (HCI) (Karat, Brodie, Karat and Feng, 2004).

Just as VVPTs provide auditability of individual votes, detailed, clear, and well-designed audit trails can help increase transparency regarding large-scale aspects of system operation. For example, the time-stamped logs identifying voters can be cross-referenced against voter-intake rolls in order to verify an accurate count of ballots. Logs of system restarts, user logins, and other configuration aspects can increase confidence that only authorized personnel have used these systems.

Specific questions include:

- Does the system provide a clear, usable, and anonymous voter-verified paper

trail?

- Are clear, detailed, and usable audit trails provided for configuration, installation, voter-count, and other functions?

Conclusions

The design of usable voting systems was identified as a problem before the widespread use of electronic voting systems (Roth, 1998). The interactions that voters, poll workers and officials, journalists, and other concerned parties have with these systems are all defined by the user interfaces to various system components. User interfaces that enable voters to easily and successfully cast their votes with appropriate feedback and provide these users with verifiable control over their votes are most likely to be used correctly and instill trust and confidence in users (Norman, 2001; Karat, Blom, Karat, 2004).

The usability of electronic voting systems is a core building block of an elections system that the citizens of the country can trust and use. As with other information technology systems, the public will judge the electronic voting systems by the user interfaces they interact with and the feedback the systems provide them rather than by system capabilities they are not aware of or cannot understand (Gould, 1988; Norman, 2001; Bias and Mayhew, 1994, 2005) Focusing on usability along with the complementary security, performance, audit and other functional requirements for these systems can provide our citizens with highly usable, secure, reliable, and verifiable electronic voting systems. Let's address this challenge now.

References

- Adams, A, and Sasse, M. (2001) Privacy in multimedia communications: protecting users, not just data. In Blandford, A. and Vanderdonkt, J. (Eds.), *People and Computers XV - Interaction without frontiers*. Joint Proceedings of HCI2001 and ICM2001, Lille, Sept. 2001. 49-64. Springer.
- Bederson, B. B., Lee, B., Sherman, R., Herrnson, P. S., and Niemi, R. G. (2003). Electronic voting system usability issues. CHI 2003, *ACM Conference on Human Factors in Computing Systems, CHI Letters*, 5(1), 145-152.
- Bias, R. and Mayhew, D. (1994) *Cost-Justifying Usability*. New Jersey: Academic Press
- Bias, R. and Mayhew, D. (2005) *Cost-Justifying Usability: An Update for the Internet Age*. San Francisco: Elsevier.
- Cranor, L., and Garfinkel, S. (2005) *Designing Secure Systems that People Can Use*. O'Reilly and Associates.
- Gould, J. (1988). How to design usable systems. In M. Helander(Ed.) *Handbook of Human Computer Interaction*. Amsterdam: Elsevier.
- Grove J. (2004) ACM Statement on voting systems. *Communications of the ACM*, 47(10), 69-70.
- Jefferson, D., Rubin, A., Simons, B. and Wagner, D. (2004) Analyzing internet voting security. *Communications of the ACM*, 47(10), 59-64.
- Karat, C. Blom, J., and Karat, J. (2004). *Designing Personalized User Experiences in eCommerce*. Amsterdam: Kluwer Academic Publishers.
- Karat, C., Brodie, C., Karat, J, and Feng, J. (2004). Privacy in information technology: Designing to enable privacy policy management in organizations. Paper submitted for publication.
- Millet, L., Friedman, B., and Felten E. (2001) Cookies and web browser design: towards realizing informed consent online. CHI 2001, *ACM Conference on Human Factors in Computing Systems*, 46-52.
- National Research Council (2003) *Who Goes There: Authentication Through the Lens of Privacy*. The National Academies Press, Washington DC.
- Norman, D. A. From ballots to cockpits, questions of design. *New York Times*, Jan 23, 2001.

Roth, S. K. (1998). Disenfranchised by design: voting systems and the election process. *Information Design Journal*, 9(1), 1-8.

Wallace, D., Anderson, N., Shneiderman, B. (1987) Time stress effects on two menu selection systems. *Proceedings of the 31st Annual Meeting - Human Factors Society*, (NY, NY) 727-731.

Whiteside, J. Bennett, J., and Holtzblatt, K. (1988) Usability engineering: Our experience and evolution. In M. Helander (Ed.) *Handbook of Human Computer Interaction*. Amsterdam: Elsevier.