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Improving Voting Systems

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"I hope my vote counted. I don't know. Hanging Megabyte?"

"If they took out something that wasn't working, why did they put in something that works even worse."

–Voters using new touch screen voting machines in primary elections in Florida (*The New York Times*, September 11, 2002)

The United States began using the Australian-type ballot in the late 1800s. This is a ballot produced at public expense on which all candidates are listed and voters mark their selection. It was considered an advance over voting by role call, write-in, or privately produced ballots listing only certain candidates, and it brought fairness to the election process.

Over the years, the technology used in the voting process has changed quite a bit, and today a wide range of technologies are employed, including paper ballots, punch cards, mechanical lever machines, and optical scanning devices. More recently, computer-based voting machines, called *direct recording electronic* (DRE) devices, have been introduced.

The U.S. national election of 2000 spotlighted potential problems voters might have in accurately indicating their selections on the various voting devices. The human factors issues associated with the butterfly ballot used in Florida's Palm Beach County captured international attention. In part as a response to these issues, the Help America Vote Act of 2002 (H.R.3295) was recently passed and will significantly change the voting technology used in many areas of the United States (see http://www.electionline.org/site/docs/pdf/hr3295.final.pdf). Among other things, it will provide funds to replace older technology with new technology: mainly optical scan and DRE technology.

DRE Voting Machine
(Photo courtesy of Sequoia Voting Systems)

However, voting system usability issues were again highlighted during primary elections in Florida when voting equipment employing advanced technology was used. Thus, as we enter an era in which voting technology will rapidly change, it will be important to address the human factors aspects of these devices in order to ensure that they are easy to use and as error free as possible. In this article, I describe some of the issues and the development of a new standard in which HFES is participating that, it is hoped, will help to ensure that technology-based voting systems operate as intended.

National Voting System Standards

In the early 1990s, the Federal Election Commission (FEC, http://www.fec.gov) published the first National Voting System Standards (VSS). Although the VSS is voluntary, it was adopted by the majority of states. In 1997, the FEC began the process of updating the VSS, and the update was published in May 2002 (http://www.fec.gov/pages/vss/vss.html). The purpose of the VSS is to ensure the reliability of certified election equipment used in local, state, and federal elections by enabling state and local election officials to assure the public of the integrity of computer-based election systems and by providing a common set of requirements across all voting technologies.

The commission has acknowledged that the standard does not fully address everything that is needed. Two areas identified are usability and accessibility. The VSS contains some information on usability and accessibility, but more complete guidance is needed.

HF/E Challenges

Although the overall goal of human factors is to design systems that are easy to use and that minimize human error, this is a real challenge given the diversity of users of voting systems.

The new DRE voting equipment is intended to make voting easier and more accessible, but a look at recent history provides a lesson in what can happen when the interfaces between voters and relatively simple voting systems are not well designed.

It is tempting to address existing problems by throwing technology at them. Some of the voting problems experienced in Florida were associated with punch card technology. Therefore, many people feel that if punch cards are replaced with computer-based systems, the problems will disappear. New technology has a halo effect – it's new, it's high-tech, and therefore it must be better. However, technology in and of itself does not enhance or detract from human performance. Old problems are often solved, but new problems may be created. This type of approach fails to recognize that overall system performance is a function of the integrated performance of all system components and that failure is often the result of the interaction of system elements.

But does it make sense to think of a voting system as a *system* in this sense of the word? I think it does. The voting system is the integration of all the elements that support the election and voting

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process. It consists of a complex interaction of hardware, software, and human resources that, together with policies and procedures, achieve the overall mission of conducting elections. In systems engineering terms, it is a loosely coupled distributed system, but it is a system nevertheless. For example, even with good voting machines, if ballots are poorly designed, if the equipment is improperly set up, or if the voters are not given adequate instructions and familiarization, the system will fail.

When one thinks of voting systems, the voter immediately comes to mind. However, other user groups are essential to reliable voting systems. Election officials must design ballots and test that the ballots correctly record votes prior to Election Day. On Election Day, poll workers – often volunteers – must set up the voting machines and verify voter registration. With DRE equipment, poll workers may give voters key cards or some other technology, which the voter uses to start the voting process and to access the correct ballot for local elections. When voting is completed, election officials must tally the votes. Somehow, votes from individual machines must be sent to centralized locations.

The success of any complex system is based on systems engineering and defense-in-depth design, including high design standards, redundancy of and diversity for key system elements, analysis of likely failures and design for recovery from them, and preparation of personnel for normal and abnormal conditions through training and procedures.

One of the human factors contributions to system design is to ensure that the system enables voters to give their complete attention to the task at hand: voting for the candidates and issues of their choice. To do this, the voting system interface should be almost transparent to the voter and should guide appropriate behavior. A poor design may confuse the voter or may cause the voter to shift attention away from voting to trying to understand the interface itself. At best, this is distracting and can lead to frustration. At worst, it can lead to errors.

At a minimum, designing effective and usable interfaces involves three activities. First, human-centered requirements should be identified for all user groups. These requirements reflect the ways users interact with a system to accomplish their tasks and vary depending on the voting technology. For example, the way a vote is cast is different for a paper ballot than for a computer-based voting system. The requirements for these tasks need to be carefully analyzed.

Second, human factors design guidelines should be used to help specify the characteristics and functions of the voting system interface and its supporting infrastructure. These guidelines have evolved from scientific research on human performance and from many years of application in the design of other types of systems. Their use can help to ensure that the final design of a voting system is consistent and compatible with the characteristics of the voting public.

Third, tests and evaluations should be conducted to ensure that the voting system has achieved human factors design goals. The results from these evaluations can be used to correct any design deficiencies before the systems are actually used for voting.

DRE voting will likely come to a polling place near you in the not-too-distant future. The national interest in improving the voting process and the new legislation that supports this objective will lead to novel approaches to voting. For example, it may not be long before people vote over the Internet. As these developments occur, it will be important to ensure that the needs of the users of voting systems are foremost in the minds of voting system developers. This will help ensure that the technology is properly implemented and that events like those that occurred in Florida are a distant memory. HFES has been given the opportunity to help make this vision a reality.

Addressing the Problems

In response to the need for better and more comprehensive standards for the new voting systems that are and will be emerging, the Institute of Electrical and Electronics Engineers (IEEE) initiated an effort in 2002 to develop a standard (IEEE P1583) that is complementary with the FEC VSS. (For information on the IEEE voting system standard, see http://grouper.ieee.org/groups/scc38/1583/.) The purpose of the project is to develop requirements and evaluation methods for election voting equipment. The standard will provide technical specifications for electronic, mechanical, and human factors that can be used by manufacturers of voting machines or by those purchasing such machines. The tests and criteria developed will ensure equipment usability, accessibility, accuracy, confidentiality, reliability, and security.

HFES is working with the IEEE on the standard (see http://standards.ieee.org/announcements/1583hfes.html) by establishing a task force that is responsible for developing the sections of the standard that address usability and accessibility. Those of us on the task force are now working on two main sections: one addressing voting system requirements and the other dealing with testing. Topics addressed in the draft requirements section include the following: General Principles, Overall Design and Layout of the Voting Location, Voter Identification and Authentication, Ballot and Information Presentation, Voter Input and Response, Navigation and Interaction with Ballots, Preventing and Minimizing Voter Errors, Help and System Failure, and Voter Familiarization and Training. The evaluation section will address verification against the requirements and usability testing.

The schedule for the standard is aggressive. Our work began over the summer, and we hope to have a completed standard by early 2003. This includes preparation of the draft, balloting and comment resolution, and final publication. Such a schedule is needed in order to support the voting device manufacturers and the states in procuring new equipment prior to the 2004 presidential election.

John O'Hara is a scientist at Brookhaven National Laboratory in New York. In addition to voting systems, he is interested in human performance and safety in complex systems. For more information about the HFES Voting System Task Force, please contact him at ohara@bnl.gov.