The Technology of Access: Allowing People of Age to Vote for Themselves

By Ted Selker

With the changing cognitive abilities of an aging person, we immediately face the issue of that person's independence, and questions arise of whether he or she has the ability or the legal right to take part in some civic activities, including voting. The question of voting among elderly populations does have a legal dimension; in their paper, "Voting by Residents of Nursing Homes and Assisted Living Facilities: State Law Accommodation,," Amy Smith and Charles Sabatino discuss how different states in the US evaluate what assistive services should be provided to residents of nursing homes.[1] Eight states hand the power to vote to caregivers for voters living in certain care facilities, and many states also prohibit voters under guardianship to vote. And yet guardianship does not necessarily preclude people from voting; in an August, 2001 case in Maine, the ban was overturned as a principle.[2]

This paper, however, will not discuss the legal implications of voting for people of age. We will start with the premise that technology's goal is to create access. In this context, *access* should be contrasted with *assistance*. Technology should facilitate any voter legally permitted to do so without help from another person. To the extent that we can remove the barriers to allow people to vote independently -- so that their intentions can be recorded, recognized, and understood -- we have reduced the need and complications involved in having another person in the voting booth or penning an absentee ballot for the voter.

Universal access is an important goal of technology. This chapter examines several evolving electronic voting technologies and their impact on persons with cognitive and physical disabilities. In the research described, we will show how many of the accessibility opportunities for people of age could actually improve the performance of the voting population as a whole. The number of people who make mistakes throughout the population varies dramatically. However, it appears that in many examples, one in every 30 voter selections on a typical ballot is actually for an adjacent selection.[34]

card to tell if a person had residual votes, allowing the voter to override the warning message, add selections on the same ballot, or "spoil" the ballot to get a new one. We witnessed voters becoming confused and frustrated by this process. In fact, it was unclear if these machines' notification of residual votes prompted them to go back to make selections they wanted or if they simply added anxiety and an impediment to the voter's feeling of success in their voting experience. The machines' procedure was confusing enough that election officials had posted specially identified poll workers near the devices to explain what the liquid crystal displays and printouts meant. And yet the process was still difficult for people to understand. In many cases, voters knew that they hadn't voted, but did not know what to do about it. Fewer than 10 of the more than 200 voters I observed took this opportunity for a second chance to fill out the ballot. Perceptual or short-term memory problems add difficulty to understanding delayed and complex feedback.

Polling technologies can be so intimidating that a person of age will often bring a friend or family member to assist them. And yet the presence of another person in the voting booth leads the question who decided on the ballot selections. As an example, we witnessed a woman in the 2002 Chicago election who appeared to be having a conflict with her daughter. We could clearly hear a flurry inside of the polling booth.

The daughter said, "We like this person."

To which the mother protested, "Well, I thought I was going to . ."

"No, no, we vote this way, this is how we feel about this."

It's possible that mother and daughter had discussed the election earlier, and the elder had said, "Please remind me that I feel this way about this topic." But by listening to the exchange, it wasn't clear that the voter was making the decisions. Whenever there is assisted voting, coercion is a concern. The disabilities community consistently feels uncomfortable about assistance, and many advocates call for the possibility of successful independent access.

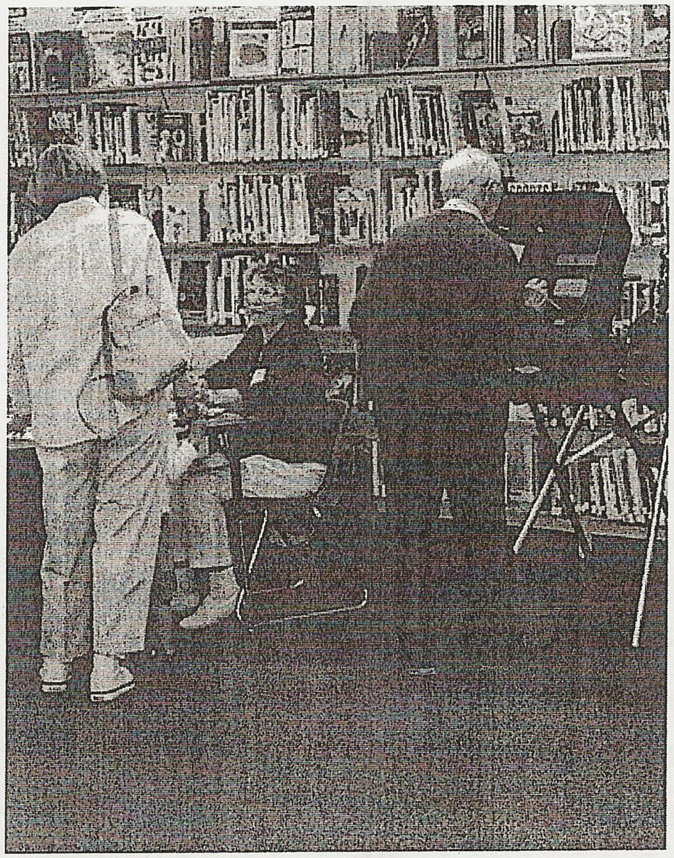

Figure 1: Voter, at left, using a pencil to make onscreen selections.

In some cases, new voting technologies experience growing pains, especially in areas of training in which poll workers are expected to set them up and maintain them. In 2006 in polling places all over Boston, no one was able to use the Automark ballot marking system machines for disabled people because of an incorrect setup.[9] A less worrisome example comes from Reno Nevada in 2004 where voters were given pencils to make selections on a touch screen designed for fingers. I watched an elderly gentleman who spent a long time voting. This voter chose to use the sharp end of the pencil to poke the liquid crystal display surfaces. He took a long time to vote, partially because he needed to make multiple jabs to the screen to make a selection. Because of a poor polling place setup that limited privacy, I was able to witness his difficulty from across the room. Because it took him so long to vote, I asked him how it went when he finally departed. In a cheery tone, he answered: "Oh, it wasn't so bad. Next time it'll be a snap." And yet I knew better. This person had been very frustrated, making his difficulties apparent in his body language at the time. His patience was strained, and I am sure that the stress had an impact on his concentration. I hope that he voted the way he wanted to. However, his example frail to the point of being coerced, either by a person assisting them, or a complex procedural action, such as an overly long ballot and a requirement to fill out the entire thing. This voter might be able to vote correctly on their own with assistive aids. However, there are several hindrances at the polling site, including election workers not understanding them, workers confusing them with attention or inattention, workers and other voters coercing them either explicitly, or by assisting them in such as way that influences their vote. 3.) The person who is confused or may be experiencing severe cognitive disabilities. This voter might be able to make decisions with memory aids and redundant markers on a ballot. He or she might be able to succeed with audio or text redundancy and other cognitive and perceptual aids. Unfortunately, the voter's cognitive frailties mean that the introduction of complicated instructions can reduce the ability to independently understand how to make selections. An untrained, unsophisticated human assistant can lead to this voter's becoming disturbed emotionally as well as confused intellectually. Their disabilities might make them much more susceptible to coercion.

Problems with Traditional Voting Approaches

Technology has been making voting more accurate for a long time. One historical origin for voting can be traced to Greece, with the use of *ostraca*, or chips of ceramic put into a vessel and counted. Of course, other kinds of voting -- such as a black ball used to signify that one person did not like another -- have been used from very early times. Certainly, marks on pieces of ceramic are as old as voting. More typical for our time are paper ballots, in which a ballot is either marked on by a voter, or assigned to a voter. An example of an assigned ballot can be found in the current Basque area in Spain, for example, where each party prints a ballot and the voter chooses the ballot of their party to insert into the voting machine. The benefit to voters is that their job is to select a group of candidates, and then insert their selections into the voting box without having to mark an intention explicitly. The drawback is that there have been times in the US when partisan agents of one party would put a ballot into a voting machine, named as though it were from the other party. So, coercion can occur with these pre-marked ballots as well.

In the 1890s, problems with ballot stuffing, bad counting, bad ballots, and coercion of other sorts led US citizens to want to get rid of ballots. Lever machines were invented and gained punch cards, do not contain actual ballot information. Instead, the card slides into a carrier ballot voting machine with a template, allowing the voter to push the chads out of the ballot to form rectangular holes. It aligned these holes with a separate card to the side which identified each race and its candidates. This type of punch card has engendered the worst residual voting rate of any of today's voting systems. This is likely due to difficult-to-interpret ballots, alignment problems, poor prescoring, separation of ballot and information, and paper handling and counting problems. This type of card is not allowed where funds from the Help America Vote Act of 2002 are dispersed.

Systems in which the ballot itself does not contain information about the specific races and candidates are confusing, especially to the person with cognitive or physical disabilities. This problem can arise today in punch cards -- still used by approximately 3 percent of voters in the United States[12] -- and punch card substitutes such as the marked card, Inkavote, currently used in LA. The separation of a ballot from an election template means that the card has to be inserted correctly and completely into the correct voting machine. And once it is taken out, it is possible to have the ballot attributed to a different template, registering incorrect votes. In Chicago in March 2002, for example, we watched was poll workers accidentally issued the wrong template to voters 60 percent of the time.[13] This occurred because election officials themselves did not understand the importance of making the correct voting card selections. In that case, more than half of voters were not able to vote correctly for a senatorial election in a split precinct. To avoid this, a voter would have to understand issues that even poll workers had not been clear on, ensuring that the ballot card on their voting machine was correct and appropriate to their district.

In optical-scan systems -- the leading means of voting, used by approximately 41 percent of US voters[14] -- election officials can also hand out incorrect ballots, though this problem more noticeable than with unlabeled punch cards. Optical-scan systems can pose other difficulties for voters with physical or cognitive challenges. The layout of these ballots can often use small, difficult-to-see graphics. In some cases, an optical-scan format will require a voter to complete the image of an arrow on the card. Circling it, checking it off, or drawing an x through any optical scan ballot does not make a selection. These types of marks typically invalidate the selections in many jurisdictions, and are frequently invalidated when scanned by voting

Internet voting is currently not used in the US, but in 2000, it was tested in Phoenix for the primaries, with favorable results.[16] At that time, the major security issues were considered to be "denial-of-service" -- or the possibility that miscreants would overwhelm an Internet server with false communications. Today, the deepening problem of viruses on many computers have overshadowed these concerns, with the discussion of voting technology centered on dangers of hacking and software security breaches.[17] Non-government Internet voting is currently practiced in the US by companies such as eGovernment, which runs corporate and shareholder elections for various private clients. In these examples, the term "Internet voting" entails making selections on a Web site or other interface on a networked computer, then having selections counted electronically on a server or on the voter's client computer. A different sort of Internet voting was tried in 2002 with the Serve Project -- the Department of Defense's effort to get ballots to overseas voters. In the test, voters living abroad were asked to go to a specific test terminal, log in with two different passwords, and pull up the ballot for their home voting precinct in the US. The voter would print out the ballot image and fill it out in pencil. An image of the ballot page would be then transmitted either by fax, mail, or Internet back to the voter's precinct. Election officials would then count the ballot by hand or by optical scan just as they do with other absentee ballots. The demonstration was not completed, but this simplified form of Internet voting may be superior to networked transmission of voter selections in terms of security risk. In any case, both types of Internet voting could provide clues to those designing election technologies for the elderly. In many cases, the ability to get to the polling place is the only hindrance to voter turnout from these populations.

As we discuss the use of computers for people with dementia and other cognitive disabilities, we must ask: does memory loss and dementia make the use of computer interfaces worse or better? In one surprising study done in Boston, a group of caregivers and Alzheimer's victims were given a two-hour demonstration of how to use the Internet. A year later, over 70 percent were still using the Internet, demonstrating the value of this new access to them.[18] To create an interactive experience for Alzheimer's victims themselves, an MIT research project developed a Web site called The Living Center.[19] It wasn't an Internet voting system, but an activity center to study the possibility that people with Alzheimer's could successfully navigate online. Researchers identified cognitively simple and difficult tasks and attempted to create an

DRE Accessibility for those with Cognitive Disabilities

Direct record electronic voting machines, currently the second most widespread means of voting in the US, have the potential to greatly improve voting for those with physical and cognitive disabilities. But currently, fully electronic devices carry some of the same impediments as their analog and optical-scan peers. Two of these trouble spots arise from full-faced ballots and designs that aggravate problems for those with reading difficulties. Full-faced ballots are ones in which all selections for all races are crammed onto a single ballot, whether electronic or mechanical. In our tests with several different voting systems,[20] it appeared that all the full-faced ballots tended to be under-voted. We looked at ballots on paper overlays, button-driven interfaces used on voting machines such as Election System & Software's iVotronic V2000, and a prototype device with a large liquid crystal display showing ballot names and races at the same time. The result was that voters tended to miss more selections on full-faced formats than they did on direct record electronic voting machines that went page-by-page. It is possible that interface improvements might allow the enlargement of the viewable area to aid voter orientation, but this has not yet been researched.

We also discovered that error rates encountered in full-faced ballots were gravely exacerbated by voter reading ability. In our experiments in New York, we tested voters and poll workers for reading disabilities.[21] (For our purposes, we defined a "disability" as a reading level well below the expected level for the tested cognitive ability of the person.) This is typically found in 15 percent of Americans, and is attributable in many cases to dyslexia. In the context of voting, we found a large difference in error rates between voters with reading disabilities and those without. The error rates on DRE machines were extensive. Even when the page layout visually prompts users to move from one selection to the next, voters would under-vote, either by not selecting anything on that page, or by selecting fewer selections than they should in some other way.

One good method for discovering problems in interface design is to compare similar ballot presentations from one county to the next. In Charlotte County, Florida, voters in the 2006 Jennings Congressional 13th District either under- or over-voted a relatively small 1 to 2 percent

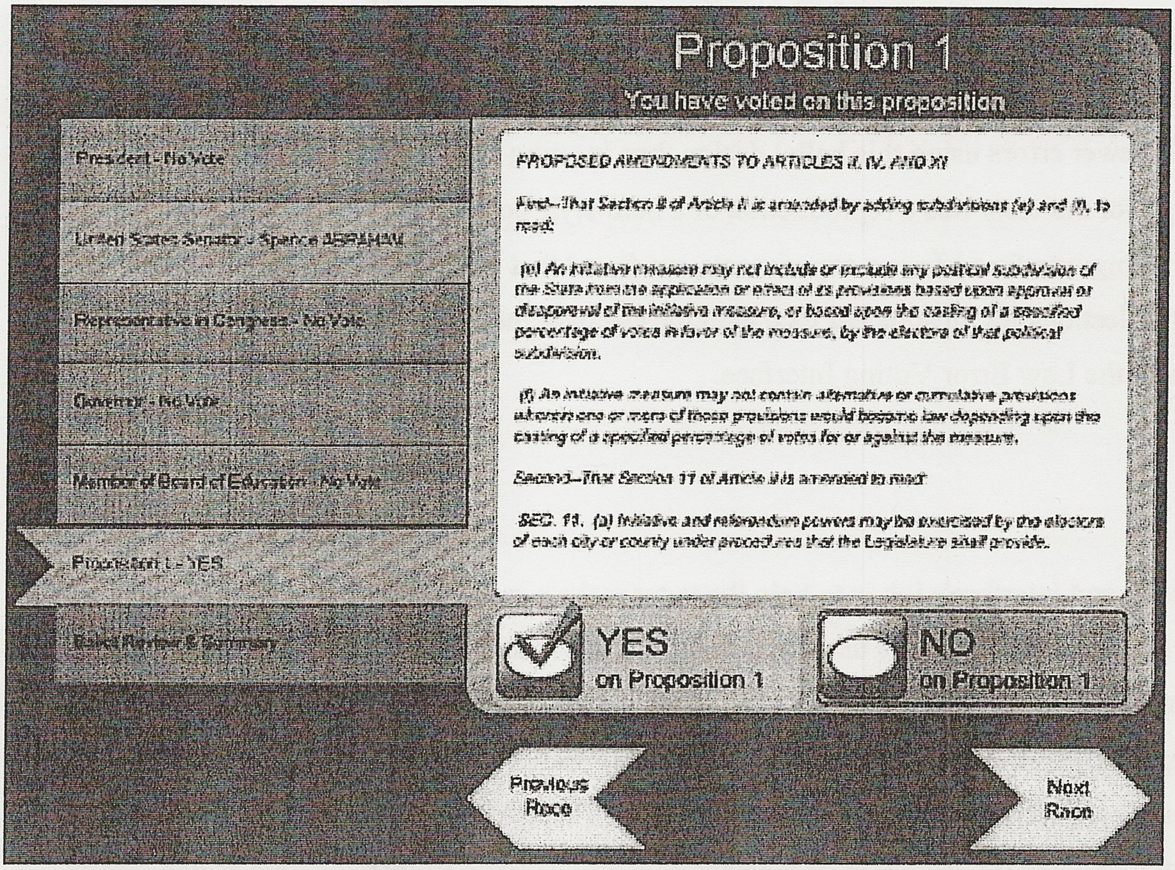

Figure 2: The LEVI voting interface.

LEVI has demonstrated that redundant information in the tabs can reduce the rate of overlooking mistakes in selections even for able-bodied voters. We have worked with tab styles that would allow us to show full text for each of the races, albeit in a form that's greatly reduced in size. The races closest in sequence to where the person is currently working are rendered in highest resolution, while the races earlier or later on the ballot are shrunk down so that they only show the name of the race and whether it has been completed. Using this so-called fish eye approach, a person can select a race by its tab to find out more information about it even before they select its full-page selection pane. By moving down through the ballot, the interface is constantly reminding voters of the nature of races and their completion status.

Many times, with traditional voting systems, a lack of good labeling on the ballot can disorient voters. In a 2006 race in the Boston area, for example, only the candidate's last name appeared on the optical-scan ballots in one race.[25] Voters who were concrete thinkers might have expected the down the page, can prompt a voter to continue the task sequentially and to lock on to the selection accompanying its text description.

DRE machines obviate some of the problems of earlier election mechanisms, such as inserting a punch card into the wrong template to begin voting. But DRE machines are also vulnerable to assign the wrong electronic ballots to voters. In some site configurations, poll workers use a device called a ballot creation module when checking in voters at the polling place. Voting officials assign voters an electronic ballot, often on a smart card. An incorrect digital ballot will limit voters from entering choices for certain elections or even certain parties. In the photograph to the right, you see voters in Nevada sitting frustrated because a worker had inadvertently given them a provisional-voting ballot smart card for a Sequoia DRE voting system. Once voters put it into the voting machine, they were unable to vote for anything but federal elections. In this instance in Nevada, the accident occurred when a voting official did not realize that provisional numbers for the ballots were different from the local precinct numbers.

[image] A ballot module programmer may have accidentally create provisional ballots.

From our field observations, we know that voting site problems frustrate all voters. But for elderly voters, the problems of human error, ambiguities, and technical glitches can compound difficulties.

Alternatives in Verifying Votes

Beyond simply making a selection, there is an increasingly controversial step in the voting process. It involves helping voters double check their own selections on ballots. The Help America Vote Act mandates that a voter have a second chance to verify their vote and change it. This can be accomplished though an electronic review pane on a DRE. For a cognitively energetic/active voter, the panes simply require you to remember and check your selections against those you thought you made. Typically, voters make mistakes in their selections about 1 in 30 times. Sometimes, they are able to find and fix these selections with a review pane. Recently, election officials have introduced an additional method for verification called the

the most errors when audio ballots called out selections as they were made, promoting voters to remedy errors as they occurred. We believe that an audio audit trail worked best because it provided redundant information in a different modality, reinforcing the task via two different cognitive inputs. Voters found the audio "interruption" frustrating, but they did heed it to improve their votes. There are further refinements we would like to make on this experiment. Our methods improved performance despite the presence of an artificial computer voice and a delay caused by prototype software. As we test the audio verification system with natural speech and no delay, we believe we will observe even greater levels of error identification.

We have made subsequent experiments to combine some of our discrete findings. By adding audio verification to the Low Error Voting Interface in our experiments,[32] for example, we found that adjacency errors on ballots decreased an additional third. What's exciting to us about this is that none of our test subjects in those experiments included anyone with special needs. We plan to conduct further research to demonstrate that these effects would be much greater for populations with specific difficulties with perceptual and cognitive tasks.

Environmental and Industrial Design Barriers to Voting

Improving voter access will involve changes to electronic interfaces, but there are also environmental factors at the polling site that can add to distraction. Environmental issues fall into technology concerns when they concern ballot design, lighting on certain electronic interfaces, and issues as simple and critical as electric power needs for machines.

technologies, it is crucial that teaching aids are delivered in a systematic way, whether they are delivered through voting machine instructions, videos, or paper handouts. In Chicago, election officials made available a well-produced videotape to teach people how to use the new scanning paper trail system in the Election Systems & Software PBC 2100.[34] During our observation on election day, however, no one watched these videos. In some precincts, video monitors sat behind the registrar. In others, they were off to the side or by themselves. The video images were never placed where a line would form, where voters could watch while waiting for a free voting booth. Best practices should be put together for allowing people to learn how to vote, and bring instructional materials into the polling place. Another important training aid is a demonstration voting machine for visitors to practice on before they enter a voting station. Sample ballots and machines have long been recognized as best practices, and yet they are often missing from sites or ineffectively presented. To the extent training materials are available, how do we make people aware of them? If the sample ballot is pasted behind the registrar's desk, how would anyone see it?

[image]

An increasingly important environmental factor at polling sites is overall design and architecture. Voting has always been conducted in a variety of conditions, from dark high-school gymnasiums to spotless post offices. But with the introduction of new DRE machines and the modernizing of equipment, design plays an increasingly important factor in issues of ergonomics, visibility, and privacy. Sites with electronic systems may now have a clean, paper-free appearance, but what's often forgotten is that many voters, especially those with cognitive challenges, bring election materials with them for their personal reference. The majority of new voting booth designs and electronic voting stations do not provide a simple space to put down a piece of paper. Privacy is also an issue with the new devices. Most electronic voting stations dispense with the traditional voting-booth curtain that can be pulled to ensure privacy. The anxiousness of people with short-term memory problems and cognitive and physical disabilities can be very real around this issue, and can distract them from the task at hand.

instructions and making selections either with audio responses or manual actions. Rhode Island uses an innovative tactile ballot; An audio tape reads instructions telling a voter what a mark in a specific hole is for.[36] Such a system might be more complex than using a familiar keypad. We have even found that using mouse buttons to make selections is simplifying for people compared with keypads.[37] Telephone audio response systems allow people to vote from anywhere and have been tested several places. DREs typically include audio voting as an option which we have also found to be useful as a redundant feedback to reduce errors and create a verifiable record of selections. These audio-response systems are exciting for people with sight problems, but, to date, they have extended the amount of time it takes to vote compared with other voting approaches. In order to give voters every chance to succeed with accessibility technology, these technologies must be as expedient and simple as other technologies. We are currently conducting research to reduce the amount of time it takes to vote with audio interfaces.[38] Instead of using a beep between selections, the interface utters a quickly spoken word, which helps the user perform the task with redundant information. We have found words such as "forward," "reverse," "selected," and "unselected," can effectively orient the user as well as provide a prompt for the voter to act. Other techniques to improve audio voting are being tested as well. Our experiments showed that a computer mouse was a superior interface for navigating through an audio interface.[39] We imagine a day when a person doesn't have to listen to repeated selections to remember where they are on a ballot.

With hearing-impaired people, we have experimented with visible prompts or vibration as feedback, and especially for redundant verification that the vote is being selected. In a proposed experiment, test subjects would distinguish between vibrations on their hand from the voting machine audio. Voters would potentially feel the difference between their selections such as such out *schwarzenegger* versus *schwartz*: the first name is longer, with more syllables. Alternately, an audio verification system might employ a speech-to-text interpretation for hearing-impaired people, so they could verify that their selections were made through a separate interface. Some modern voting systems give paralyzed voters access by letting them use sip-and-puff or mouth-stick selecting methods.

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