Process Is Technology: Coming to Terms with Systems-Level Problems and Human-Factors Failures with Voting

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ABSTRACT

The "technology" to be supervised in voting processes is the process itself. No one particular device can be a magic bullet to ensure secure voting. Process failures occur in every step of the voting process, including the technical steps voters take as they register, check in to polling sites, receive their ballots, solicit human technical assistance with voting hardware, and entrust their ballots to election staff. Process failures in these and other areas are currently a greater threat to accurately measuring voter intention than direct security breakdowns or vulnerabilities of voting devices themselves.

Author Keywords

voting, user interfaces, voting security, chain of custody, electronic voting systems

INTRODUCTION

The process of voting is itself a type of technology. If one could view the entire modern voting experience from a distance, the most common failures of voting occur in the interfaces between various devices and in the awkward interactions between humans and these devices. Electronic voting mechanisms may have gained popularity with the promise that they remove irregularities from election steps including ballot distribution, voter selection, and counting -- but many issues continue to plague voting. Process failures occur as voters register, check in to polling sites, receive their ballots, solicit human technical assistance with voting hardware, and entrust their ballots to election staff [1][2]. This paper will argue that these and other process failures are currently a greater threat to accurately measuring voter intention than direct security breakdowns and the vulnerabilities of voting devices themselves.

As has been well demonstrated (e.g. [1][3]), voting process control is essential for accuracy, security, and reliability. But process varies according to needs of each party involved. Voters, for instance, follow a flow chart in making voting selections that is different from poll workers' steps in administering them.

For voters, the steps in the voting process include the following:

- · registering
- · learning about the issues
- · getting to the polling place
- · demonstrating legitimacy
- · making selections
- · depositing votes.

For election officials, the process includes the following:

- · collecting registrations
- · creating a registration database
- · collecting race information
- · creating a ballot
- · collecting and deploying election technology and materials
- · collecting workers, training them, and deploying them
- · collecting results securely
- · counting the results and posting them.

Candidates, voting technology vendors, and watchdog organizations each have their own processes as well. These processes are variously under the supervision of local, state, and federal jurisdictions; contracted vendors; and activist and party poll watchers. When everything works right, the presence of multiple organizations provides oversight of each process. Because of the number of steps involved and the possibilities for hired poll workers to make mistakes, the control of these processes becomes imperative. The paper's intent is to illustrate that the "technology" to be supervised in voting processes is the process itself. If the anecdotes discussed here serve the paper well, the computer science research community's proposals in the field will have greater overall systems value in response to the

problems posed in this discussion. No one particular device can be a magic bullet -- unless that device somehow administrates all aspects of voting process with multiple interests overseeing each one.

PROCESS: VOTER CHECK IN

As we examine the steps in the contemporary voting process from the perspectives of the voter and poll worker, we find that the most troublesome first steps involve registration and check in. The check-in process at a polling site often includes steps to find a voter's name on a registration list in a poll book to assure that he or she belongs at that polling place. An additional step includes a check-off process to assure that the voter inserted a ballot in the ballot box after voting and did not walk out with a blank ballot, potentially committing fraud. Registration problems can occur with both paper and electronic poll books, and these problems often arise because of typographical errors in voters' names, voters erroneously registered to an old address, and erroneously removed names. In fact, registration issues at polling place check-in accounted for the largest number of lost votes in the 2000 election [4]. A smooth check-in process is critical to enabling people to vote; when process problems arise, lines grow longer and some voters give up and become disenfranchised.

Figure 1. A warehouse polling site entrance, with signage indicating "Vote Here". New Orleans, 2006.

The ponderous technology of printing a registration list, distributing it, looking up the voter, and then documenting that a voter has come to the polls and voted has been prone to error under our current system. As an example, in Chicago in March of 2002, we witnessed as a party poll watcher discovered that one precinct's paper poll books erroneously left out the names of voters living along several blocks of a street in the jurisdiction.[1] Poll workers had been sending these voters to other polling places, which in turn also lacked the names on the books. Such problems could be solved by electronic poll books, which can tie registration information between polling places, confirming for example that a voter is registered elsewhere and reflecting which voters have completed their ballots at the polls.

An improved voting process needs to address the question of how to find a name efficiently and how to prevent names from being either erroneously entered in or omitted from the poll books. Electronic poll books have been widely heralded [5] as an improvement over paper poll books because they can reveal the master registration list with correct polling places to any poll worker. They have not, however, been in service long enough for quantitative research to tell how well they've been administered. These new systems will need to be supervised and tested to ensure that they are not systematically disenfranchising people by erroneously removing names or changing addresses. Since voter lists are of public record, duplicate versions of electronic poll books online or on poll watchers' electronic devices could provide a mechanism to double-check voters' registration status.

Not only do registration systems need to produce information accurately, they need to do so in a way that can be easily accessed and read by poll workers with a variety of backgrounds. The user interface to both paper and electronic poll books can pose a barrier or benefit to accurate, efficient check-in. Historically, paper poll books have presented some challenges for poll workers to accurately find and cross off voters' names. Paper books also have security vulnerabilities, as noted during the closedown of a Boston election site in 2004.[2] Poll watchers saw two election officials reconciling the check-in and exit poll books with erasers and pencils, inviting the suggestion of fraud and potentially undermining confidence in the system. Electronic poll books can be an improvement in these areas, because they provide multiple ways to locate a voter's name and confirm his or her registration. These

[1] This passage draws from visits by the author to Cook County, Illinois, and Chicago, Illinois, during elections in both March and October of 2002.

[2] Witnessed by the author during a Caltech/MIT Voting Technology Project poll watching exercise November 2, 2004.

systems often provide a clearer audit trail for changes that occur in check-in and exit poll books.

Poll books that automatically produce smart cards for voters seem to solve the "mistaken voter" problem, but can present their own problems as well. These systems could potentially place the voter's identifying information on the electronic medium when the card is generated, which will certainly raise valid privacy concerns for some voters and potentially lower voter participation. Voting-machine certification should easily uncover an architectural subsystem for associating a database of names with ballots. Still, a better approach might be to have the voter select a smart card with a smart-card ballot that was clearly programmed before voters arrived. In this way, the registration rosters could demonstrate that the cards are not a mechanism for associating personal information with vote selection.

PROCESS: DISTRIBUTING ELECTION INFORMATION AND SIGNAGE

The distribution of official election information is part of the technology of putting on an election. Signage, for example, is a seemingly "low-tech" information distribution point with a grave impact on voter participation. Voting signage affects whether voters can find the polls and whether they can vote correctly. In a May 2006 Louisiana election observation session, we witnessed two official signs at two precincts that described different criteria for what constituted valid forms of identification to vote. (See Figure 1 for another image of this site's chaotic polling site setup). There have been reports alleging that polling places have also posted identification requirements that are not required by state law. In 2004, a representative from the National Congress of American Indians claimed to have witnessed signs stating "No ID, No Vote" in several South Dakota polling sites, where voters can participate by signed affidavit, according to state law [6]. Official polling-site signage is part of the technical setup for a voting system, and should be treated as a part of the secure system.

Despite the need for strict standards and practices in voting materials, signs and sample ballots are regularly posted in an ad hoc manner. We have seen signs and sample ballots posted along the front of a crowded, 30-inch desk or behind a table and poll worker. These locations make it nearly impossible for voters to easily see instructional materials. In 2002 in Chicago, for example, pre-voting information and signage were scarce and confusing, causing long voter lines. In adjacent Cook County, however, we witnessed dramatically better voter success using the same voting equipment because of improved signage. Instructional materials were distributed ahead of time to polling sites and coordinated such that the carefully designed instructional posters were easy for voters to easy to view in the polling places.

PROCESS: EQUIPMENT SETUP

Variations in equipment setup can cause even greater potential disasters than variation in signage and voter instructions. Most contemporary voting devices work correctly when set up properly. Some electronic means -- electronic poll books, direct-record electronic devices, and optical-scan readers -- have experienced some difficulties in polling sites because the equipment may be new and its setup may have no established or rationalized process. Getting these systems to operate as designed in the context of the particular polling site and in the context of the particular poll workers' training and past experience may engender the a great deal of researchers' future work in improving voting systems.

Some of the most notable problems we have seen in this country come from places where setup did not work. The morning of November 2, 2006, in Cambridge, MA, poll workers discovered that they did not possess the activation keys for the city's new Automark optical scan machines [7]. In cases where the Automark systems did operate, they produced ballots that were only partly complete and unusable. Instead, the polling places held the election by passing out paper ballots and hand-counting them. In the same Boston election, incorrect and inadequate optical-scan ballot delivery problems ended up causing a review of the entire operation. In a 2004 poll watching observation undertaken by the Voting Technology Project in Carteret County, NC, 4,530 people made selections that were not saved or counted because poll workers did not set up a Unilect voting machine correctly and instructed voters to ignore the message that its memory was full. The practice continued unchecked during the two-week early voting period there (also reported by [8]). Proper setup of voting machines is obviously integral to helping prevent process failures.

PROCESS: BALLOT ASSIGNMENT

A clear inconsistency and failure in the voting process appears when poll workers give voters the wrong ballot. This type of problem has occurred with all ballot types: paper, mechanical, and electronic. In the past, voters have been misdirected to vote on lever machines programmed for the party opposite from their own, forcing them to vote only for candidates from the other party. During an observation session by the Caltech/MIT Voting Technology Project in a 2002 congressional election in Chicago, poll workers were careful to give the voters punch cards for two different ballots used by the precinct, but they often sent voters to the wrong voting machines. The result was that half the ballots became invalid.[3] With electronic voting machines, we've seen poll workers accidentally create smart cards for provisional ballots, which disallowed voters from voting in

[3] Based on a visit by the author to Cook County, Illinois, and Chicago, Illinois in March of 2002.

local races in Reno, Nevada in September 2004 (See Figure 2, below).

Figure 2. Ballot programming machine in Reno, Nevada, September 2004.

Research needs to establish ways to prevent voters from being disenfranchised by being given the wrong ballot or directed to the wrong machine, and voters need to be assured that their votes will be properly recorded and counted.

PROCESS: POLL WORKER TRAINING

Human processes are one of the foremost technologies we depend on for running elections. Variations in the performance of the same tasks create inconsistencies and failures in the process. These variations include supervision of poll workers and of poll workers' unconventional interactions with polling machines. For instance, we watched several instances in which poll workers reached into ballot boxes to clear jams in scanners in Chicago in 2002. In September of 2004 in Nevada, we witnessed a poll worker open a voter-verified paper audit trail printer during elections and remove parts of the audit trail. Repeatedly and at different sites, we have witnessed solitary voting officials record beginning-of-day and end-of-day tallies without supervision. In New Orleans during the 2004 presidential election -- because of difficulties with voting equipment that had been used for 12 years -- a new polling site administrator failed to open some polling places until almost 9:30 a.m. -- after the morning rush.

In some cases, poll workers are called on to assist a voter in need of physical help or to oversee a voter's family member or other designed helper. Some voters find the polling procedures intimidating, and many bring family members to the polls as moral supporters or assistants. Occasionally, however, this crosses the line and becomes an influence on how to vote. In other cases, poll workers have assisted voters who do not have legal provisions for assistance. With levers, for example, poll workers should not be involved in pulling the mechanism to make a selection unless there is some documentation of the event by a third-party. However, we have witnessed poll workers assisting voters on optical-scan devices, direct-record electronic systems, and lever machines. If the voting process allows anyone other than the voter to have private access to the vote without legal provisions for doing so, the honesty and integrity of the process can be questioned.

How poll workers interact with the voting machines can have dire consequences to the integrity of the voting process. We have seen poll workers try to force the protective sleeves that fit around optical-scan ballots through optical scan machines, and one voter[4] reported that he was unable to introduce his ballot into a scanner because it had an aluminum protector in place. In all likelihood, these incidents are innocent errors, but they increased the chance that the voter would not personally submit their ballots to the optical-scan reader, necessitating additional handing of the ballot before it is read and opening up the election process to voter doubt. We have noted many instances in which folded optical-scan ballots have been scanned into ballot boxes, so that the container fills too quickly and has to be opened repeatedly during election day – a problem with both supervision and interaction. At a Reno, Nevada site, we witnessed poll workers asking voters to use pencils to make selections on DRE touch screens, making the selections difficult and potentially damaging the touch screen. On another poll watching expedition, we witnessed as poll workers neglected a breach of security, allowing a voter to turn on a direct-record electronic (DRE) voting machine himself and attempt to vote before the beginning-of-day zero count tape had been written down (See Figure 3). The event signaled a failure in voting-site security, and would have jeopardized the validity of the beginning-of-day count had a poll worker not stopped the voter.

If people are to do the repetitive, detailed steps of running elections, voting researchers and election officials must test, debug, and demonstrate the processes as we do for computer programs. We must learn to set standards for set-up procedures that are demonstrated to work for any person certified to perform them. Furthermore, no procedure should be administered by a single person without being witnessed and verified by at least one other certified person, a second set of eyes with no motive to conspire to affect the procedure. Research needs to establish ways to prevent

[4] An experience reported to the Caltech/MIT Voting Technology Project by Cambridge, MA-resident Charles M. Vest.

voters from being disenfranchised by being given the wrong ballot or directed to the wrong machine, and voters need to be assured that their votes will be properly recorded and counted.

Figure 3. Voter in Reno, Nevada attempts to vote before beginning-of-day tallies captured.

PROCESS: CHAIN OF CUSTODY

The steps in collecting a ballot are important, but equally so is the honest transfer of ballots to be counted and archived for certification. Counting is of course central to the election process, and we know that hand counts and even optical scan counts don't come out the same each time. Election officials are often not careful about the electronic security of the systems that count votes. We have witnessed counting rooms with doors open to public areas in Reno, Nevada in September 2004. We also saw poll workers carrying spare memory devices in a Reno counting room in which the equipment featured extra memory device ports.

Breaches in the chain of custody happen in many polling situations. Rooms containing voting machines are often inadequately secured before voting day. We witnessed polling equipment protected only by low cubicle walls during a 2002 election office visit to Arlington, VA. In New Orleans in 2006, we saw voting machines piled high in a cafeteria (See Figure 4). Untrained poll workers often take over election tasks such as transporting ballots. In our polling observations in 2002, we noted people coming and going in counting rooms in Broward County, Florida without documentation, sometimes even carrying pencils, pens, and markers in their shirt pockets. These locations should have strict policies against carrying marking instruments into counting rooms.

Across many polling places, ballot boxes are not sealed during the day of election. By necessity, ballots will be in the hands of people outside the voters' control. However, when a single person transports voting materials in an unlocked container, how can we ensure the integrity of the voting materials? In Brookline, Massachusetts in November 2006, we witnessed poll workers repeatedly handling materials without supervision -- a poll worker regularly took piled-up ballots from the optical scan machine into a back room to rearrange them. Since the poll worker took a few hundred ballots to a private room for 20 minutes, no one can attest that those ballots were the same after they were returned to the voting area. Our poll watching sessions also noted unsupervised transportation of absentee ballots in Boston and Brookline during the same 2006 election, in which one poll worker came to the precinct to bring completed absentee ballots without supervision. Reevaluating these processes is crucial to maintaining fair voting.

Certification is a hallowed practice that many election officials say ferrets out sloppy end-of-the-evening mistakes. The certification process can even change the outcome in some elections. During a recount in the 2004 Washington State election for the governor's office, extra ballots were found, swinging the results of the election several times until a rival candidate finally won the post after a state supreme court vote [9]. Such mistakes in handling voting materials erode trust in the voting system; they need to be analyzed and eliminated to help ensure transparency and accuracy.

Figure 4. Open storage for voting equipment in New Orleans, July 2006.

DISCUSSION

Many election observers believe we need better voting technology -- i.e. better and more secure physical voting devices. Better hardware wouldn't hurt, but millions of votes are lost today because of the voting process. All improvements in voting security and reliability will require upgrades in the election process. Process problems occur because voting systems do not interact well with each other and because poorly designed processes for voters to interact with voting equipment make voting difficult. The solutions to process problems can be found in better training, enforced best-practices standards, redundancy in human systems and data systems, a better standard for the chain of custody, and a clear audit trail of steps in the election process.

Many of these process failures occur because of human error, but they are almost always in the context of the poll workers trying to do the right thing and making do with available resources. We can reduce and eliminate mistakes with better training, practice, and supervision. We depend on poll-workers to make correct use of equipment to collect voter ballots. Errors in the counting room and on precinct counting screens can be eliminated by a standard that requires that two election workers log in simultaneously and that everyone who uses administrative software identify themselves in the process of logging in. This provides an evidence trail, which can describe how any action occurred and who initiated it.

Election officials in the US are not required to demonstrate their competence, but qualification methods may be necessary to make sure poll workers understand the correct setup of voting equipment and their use. And as we move toward improving credentials for election workers, we should focus on how to create ones based on performance, not training. Training should not be considered complete until election workers have demonstrated that they can perform tasks correctly in a realistic scenario. In short, process mistakes occur across all technologies and are a large problem in collecting votes. We must consider this a

crucial part of the technology if we expect to get accurate election results.

Studies in so-called "lean manufacturing" approaches have greatly improved manufacturing processes in many companies. Now these techniques are being proposed to improve voting [1]. Lean manufacturing techniques rely an outside analysis to design a process to anticipate and avoid problems. Research into such approaches have been put into practice in cockpit operations with critical incident analysis (e.g., [10]), and in anesthesiology, when studying morbidity rates for anesthetic-related causes [11]. This paper is a call for applying the best systems approaches to improving voting process. Modeling problems and analyzing demonstrated failures are central to solving systems problems. At the outset we promote voting as a technology of process. Voting might rely on excellent technologies in various aspects of collecting votes, but these technologies are useless until we include end-to-end systems design as the central evaluation metric for accuracy, security, and integrity of voting.

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