VOTING

WHAT HAS CHANGED, WHAT HASN'T, & WHAT NEEDS IMPROVEMENT

CALTECH VTP MIT
VOTING TECHNOLOGY PROJECT

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WHO WE ARE

The Caltech/MIT Voting Technology Project was begun in the aftermath of the 2000 presidential election. Now nearing our 12th anniversary, we continue to provide scientific analysis regarding voting technology and election administration. The principal authors of this report:

R. Michael Alvarez
Professor of Political Science, Caltech
Co-Director, Caltech/MIT Voting Technology Project

Stephen Ansolabehere
Professor of Government, Harvard University

Thad E. Hall
Associate Professor, University of Utah
Research Fellow, Institute of Public and International Affairs, University of Utah

Jonathan N. Katz
Kay Sugahara Professor of Social Sciences and Statistics, Caltech
Chair of the Division of Humanities and Social Science, Caltech

Ronald L. Rivest
Andrew and Erna Viterbi Professor of Electoral Engineering and Computer Science, MIT

Charles Stewart III
Kenan Sahin Distinguished Professor of Political Science, MIT
Co-Director, Caltech/MIT Voting Technology Project

Other current and past VTP participants contributed important ideas to this report, including Jehoshua Bruck (Caltech), Stephen C. Graves (MIT), and Ted Selker (Carnegie Mellon Silicon Valley). Erik Antonsson (Caltech) provided extensive, detailed, and helpful comments that helped improve the final draft of the report.

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EXECUTIVE SUMMARY

In this report, we examine how voting technologies and election administration in the United States have changed—or have not changed—since the controversial 2000 presidential election. We present our research and analyses of the past 12 years, as well as the perspectives of a number of individuals prominent in the election administration, voting technology, and election advocacy communities.

Based on our research reported here, we provide the following recommendations for how we might improve the administration and technology of elections in the United States.

VOTING TECHNOLOGY

» Legislation mandating effective election auditing, which at a minimum would require post-election auditing of all voting technologies used in an election.

» Continued strong support for voting systems security research, emphasizing auditing and the verifiability of election outcomes.

» A movement toward mandating statistically meaningful post-election audits, rather than setting security standards for election equipment, as the primary way to safeguard the integrity of the vote.

» A new business model led by states and localities, with harmonized standards and requirements.

VOTER REGISTRATION

» The streamlining of the provisional balloting process in many states and the creation of common best-practices and voluntary standards across states.

» The development of voter verification systems in which states bear the cost of stringent voter ID regimes, in those states that desire to increase ID requirements for in-person voting.

» Continued standardization of voter registration databases, so they can be polled across states.

POLLING PLACES AND POLLWORKERS

» Continued improvement of pollworker training and more reliance on network technologies to facilitate pollworker training.

» Development of applications deployed on mobile devices that bring more information to poll workers, and transmit real-time data about Election Day workloads back to the central voting office and the public at large.

» Increased functionality of electronic pollbooks and their wider adoption.

» Development of applications that gauge how long voters are waiting in line to vote, so that wait times can be better managed and reported to the public.

ABSENTEE AND EARLY VOTING

» Discourage the continued rise of no-excuse absentee balloting and resist pressures to expand all-mail elections. Similarly, discourage the use of Internet voting until the time when auditability can be ensured and the substantial risks entailed by voting over the Internet can be sufficiently mitigated.

» Require that states publish election returns in such a way that allows the calculation of the residual vote rate by voting mode.

» Continued research into new methods to get usable ballots to military and overseas civilian voters securely, accurately, and rapidly, and to ensure their secure return in time to be counted.

INFRASTRUCTURE AND SCIENCE OF ELECTIONS

» Continued development of the science of elections.

» Continued, and expanded, support for the research functions of the Election Assistance Commission.

» Development of an Electoral Extension Service, headquartered in each state's land-grant colleges, to disseminate new ideas about managing elections in the United States.

PART I
LOOKING BACK

INTRODUCTION

The 2000 presidential election in the United States was one of the closest and most controversial elections in American history. The outcome of the controversial election, between Republican George W. Bush and Democrat Al Gore, Jr. was unclear on election night. It was only after a protracted recounting of ballots from Florida, and litigation that ended up in the U.S. Supreme Court (*Bush v. Gore*), that Bush was declared the victor with 271 electoral votes to Gore's 266.

Nationally, the final vote tally demonstrates how close this election was. Out of the 105 million votes cast in the presidential election, Gore outpolled Bush by only 500,000 votes, or a margin of just under 0.5% of the ballots cast for the two major parties.[1] Although the election was close in Florida—where the media attention was focused during that state's recount and legal contest—it was also close in a number of other states, especially Iowa, New Hampshire, New Mexico and Oregon.

The photo finish to the 2000 presidential race gave the world a crash course into how elections are conducted in the United States. In particular, the media scrutinized how ballots were counted and recounted. It also introduced the world to the panoply of voting systems used by voters in Florida: paper ballots that were counted by hand, systems where voters marked their choices on paper ballots that could then be scanned by machines, punch-card voting systems, and lever voting machines. Florida proved a microcosm of the United States, as the systems used in the Sunshine State were also used across the nation. (The only difference was that in some states outside of Florida, voters cast their ballots on certain types of electronic voting machines.)

Florida inspired particular focus on pre-scored punch-card voting systems (often called "Votomatic" punch-card systems). Those who watched the Florida ballot recount on television learned a new term, "chad," that harkened back to the earliest days of the computer revolution. Chads are the small paper rectangles created when a voter has punched out a certain position on his or her ballot. However, when the chad does not get punched out completely from the punch-card, it creates different species of chads that go by names such as "pregnant," "dimpled," "hanging," and "flapping."

Those watching these scenes from Florida were left asking, "Why do Americans vote this way, and isn't there a better way to vote?" We asked those questions as well, and the desire to improve the technology of voting led to the formation of our nearly 12-year research effort.

THE CALTECH/MIT VOTING TECHNOLOGY PROJECT

In the days following the 2000 election, the presidents of the California Institute of Technology and the Massachusetts Institute of Technology helped to mobilize an interdisciplinary, bicoastal team of scholars and students to produce new voting technologies, "to prevent the recurrence of the problems that threatened the 2000 presidential election." This collaborative research effort was formally announced December 15, 2000, and was made possible by a generous initial grant from the Carnegie Corporation of New York.

[1] "Statistics of the Presidential and Congressional Election of November 7, 2000", Clerk of the House of Representatives, http://clerk/house.gov/member_info/electionInfo/2000election.pdf. Unless otherwise noted, the election statistics reported for the 2000 presidential election in this chapter are taken from this source.

Ten faculty members from both institutions formed the original team, along with nearly 50 graduate and undergraduate students based at Caltech and MIT. These scholars spanned an impressive array of academic disciplines—representing computer science, economics, engineering, management, and political science—research domains that had rarely collaborated in the past. This unique team quickly set to work, analyzing the problems seen in the 2000 presidential election, consulting the limited research literature on election administration and voting technology, and reaching out to beleaguered election officials and technologists in the private sector to learn as much as it could, as quickly as possible, about how elections are run and how technology could address the problems that arose in the 2000 election.

> Our original mandate was to do the sorts of things that faculty from Caltech and MIT are known for—studying technology and developing innovative solutions to technological problems.

As reflected in the name that our project developed ("Voting *Technology* Project"), our original mandate was to do the sorts of things that faculty from Caltech and MIT are known for—studying technology and developing innovative solutions to technological problems—with an intention of understanding the problems seen with voting technologies in Florida and other states. However, as we rapidly learned from our research, election administration in the United States is complex and highly decentralized. Our research quickly expanded beyond a narrow focus on voting machines to include voter registration, polling places, absentee voting, election finance, and the overall administrative structure of elections. Everywhere we looked, we found important ways that new technologies might mitigate or resolve the most pressing issues in the larger domain of election administration.

We faced a number of hurdles when we began our work, in the immediate aftermath of the 2000 presidential election. There was very little previous research on voting technologies that we could draw upon to guide and frame our own work. We also found that the basic data needed to evaluate the performance of voting systems in the United States were difficult to obtain. Even basic information, such as the type of voting systems used in many parts of the country, how many registered voters voted in recent elections, and how many ballots were tabulated in those same elections, often was either not available to the public or did not even exist.

Working closely with election officials and representatives from the voting technology industry throughout the nation and around the world, we learned a great deal about the voting technologies used in the 2000 presidential election and gathered some preliminary information to assess their performance. This research led us to develop an innovative yardstick to study the basic performance of voting technologies, which we termed the "residual vote rate." (The residual vote rate is simply the number of over- and under-votes in a particular race, expressed as a percentage of the number of people who turned out to vote.) Using the residual vote rate, we could answer the central question posed by the 2000 presidential election: how accurate and reliable were these different voting systems?

We used the residual vote measure in our first major research study, "Residual Votes Attributable to Technology: An Assessment of the Reliability of Existing Voting Equipment."[2] This study, released in its final form in March 2001, was controversial in a number of ways. On one hand, it provided nationwide empirical evidence to support what many had observed anecdotally in the Florida recount—punch-card voting systems, especially the pre-scored punch-cards, seemed to be inaccurate and unreliable. In fact, punch-cards had higher average residual vote rates than any other voting system used in the United States in presidential elections from 1988 to 2000.

[2] This study is available at http://www.vote.caltech.edu/sites/default/files/vtp_wp2.pdf. It was subsequently published by Ansolabehere and Stewart (2005).

But, surprisingly, this study also found that the electronic voting systems then in use had high residual vote rates—about the same as the punch-card voting systems. Although we speculated about why this was the case, the evidence was clear. This led us to question the efficacy of the electronic voting equipment then being used in the United States and to suggest ways to improve it.

> Between 4 million and 6 million votes were lost in the 2000 presidential election.

This report established that some voting technologies being used at the dawn of the 21st century were more prone than others to lose a voter's vote. The natural next question to ask was whether the number of lost votes due to inadequate voting technologies was "large" or "small." Like the old vaudeville joke, the answer to this question was "compared to what?" Putting voting machine failures into the right context required us to understand the scope of other problems that might interfere with voters successfully casting a ballot. We cast our empirical net beyond election returns and used data available from the U.S. Census Bureau to compare the number of votes lost due to inadequate voting machines with the number lost due to other shortcomings in the electoral process. In this research, we estimated that between 4 million and 6 million votes were lost in the 2000 presidential election:

- 1.5 million to 2 million because of voting equipment and ballot problems.
- 1.5 million to 3 million due to problems with voter registration.
- At least 1 million due to problems in polling places.

At the time, we were not able to estimate the number of votes that might have been lost in the absentee voting process, so the number of lost votes may have been considerably greater in the 2000 presidential election than we originally estimated.

These estimates of lost votes were central to the analysis in our 2001 report, *Voting: What Is, What Could Be*. By quantifying votes lost due to deficient voting machines, messy voter files, and inadequate polling place practices, we then were able to recommend voting machine upgrades, computerized voter files, and provisional ballots. In addition, we went beyond the numbers to ask why America did not have world-class voting technology that matched our commitment to popular democracy. We concluded our 2001 report by arguing that the monolithic voting systems deployed across the country hindered innovation, drove up costs, and led to an inevitable mismatch between the complications of voting and the ability of modern computer technologies to help manage that complexity. Our report made some preliminary suggestions regarding the design of high-integrity voting systems, a topic of continuing relevance and research today.

THE HELP AMERICA VOTE ACT

Our 2001 report received considerable attention when it was released, as did a similar report from the National Commission on Federal Election Reform (which was chaired by former Presidents Carter and Ford, commonly called the Carter-Ford Commission). The research of the VTP played an important role in informing the work of the Carter-Ford Commission. The VTP also played an important role in helping to shape the debate over election reform in the aftermath of the 2000 election. Several VTP members testified before House and Senate committees that were investigating election reform. The VTP also provided extensive information to the committee staffs as they worked to craft a federal response to the 2000 election problems.

The eventual federal election reform legislation, called The Help America Vote Act (HAVA), was passed by Congress into law in 2002. HAVA contained many provisions for reforming federal elections, with many of these provisions rooted in the problems that the VTP's report, and others, had identified. The primary elements of HAVA:

- A process (along with federal funding) for the replacement of punch-card and lever voting systems.
- The development of a federal Election Assistance Commission (EAC).
- A requirement that states develop statewide computerized voter registration systems and new procedures for registering voters.
- A requirement that all states adopt provisional-balloting procedures.
- A requirement that states adopt new voter education procedures, informing voters of their voting rights.
- Changes to the procedures used to develop voluntary voting systems standards.

But implementation of HAVA was not easy. The federal funds for voting system replacement were not immediately available, and states had to develop plans for how they would reform their election administration and spend HAVA funds. The EAC itself took time to form and get into action, and many of the other provisions of HAVA took further time to implement. The full history of HAVA is a tale worthy of a study in its own right, not something that we can take up here.

ELECTION ADMINISTRATION AND REFORM POST-HAVA

Policymakers, election officials, scholars, and advocates all had high hopes in the immediate aftermath of HAVA that this sweeping federal legislation would resolve most, if not all, of the problems seen in the 2000 presidential elections. States began to replace their punch-card and lever machines with new voting equipment and moved to implement new statewide computerized voter registration systems. States that did not have provisional balloting developed those procedures. In many states, convenience voting became the rage, either through a widespread use of voting by mail or in-person early-voting options. Poll worker training and evaluation programs were established in many states and counties, and resources were made available for their redesign and improvement. Voter education programs were initiated; many started with HAVA funding. It was a high-water mark for innovations in election administration.

Unfortunately, the aura of HAVA quickly faded. The 2004 presidential election brought another closely contested federal election. The parties, the press, activists, and the public were primed to anticipate a wide variety of problems with election administration, particularly those associated with voting machines. However, by now, the most salient concerns with voting systems were no longer related to reliability of vote counting. Instead, attention shifted to the security of voting technologies themselves.

The reasons behind this shift in attention are many, and have been covered in other studies (Alvarez and Hall 2004, 2008). However, the focus on voting system security during this period produced a significant change in the types of voting technologies used by American voters. In many states and counties, electronic voting systems that did not have a "voter-verifiable paper audit trail" (VVPAT) were abandoned and replaced either by electronic voting systems with VVPAT or by optical scan voting systems.

This concern with security, and the desire to prevent electoral fraud, brought another entirely different issue into the debate about elections in the United States—whether voters should be required to produce government-issued photo identification when they sought to cast their ballots. This debate surfaced in a few states by 2008 and has now grown into a large movement. The debate over voter identification and associated claims of election fraud may become one of the most important issues of the 2012 presidential election. It is interesting to note that these twin issues of election fraud and voter identification were not major points of discussion in the aftermath of the 2000 election and in the writing of HAVA.

WHERE WE STAND TODAY— AND WHY WE ARE WRITING THIS REPORT

When we released our 2001 report, we did not think that our recommendations would solve all the problems with the American electoral process. However, we believed that our recommendations would put the nation on a path toward significant improvement in the quality of our elections. As we examine changes to the election landscape that have occurred over the past dozen years, we can identify a number of ways in which elections have been improved in America. We can point with pride to the ways that the VTP helped to facilitate many of these improvements, particularly improvements to voting machines and voter registration systems. Unfortunately, the nation has not always had the patience to sustain and fully implement reforms, and election reform is no exception. Today, new challenges in elections have arisen that, if not addressed, could result in an eventual constitutional crisis just as critical as that following the 2000 presidential election.

As we write this study during the summer of 2012, we are focused on the areas of voting technology and election administration that we have studied extensively since 2000, in particular those areas where we identified significant numbers of lost votes in the 2000 presidential election. Of course, each election year is different, and each election has its own particular problems. At this time, we cannot determine exactly where things might go wrong in the 2012 presidential election (if things go wrong at all). We simply offer this report containing our insights, as scientists and technologists, to explain where we perceive that progress has been made toward strengthening our election administration procedures and developing better voting technologies—and to identify those areas where we still see weaknesses that need attention in coming years.

To this end, our report has four primary parts. The first part is what you are now reading, a short summary of the last decade from our perspective.

The second part, "What Has Changed, What Hasn't," turns to the four primary areas we identified in our 2001 report: voting technologies and ballots, voter registration and authentication, polling places and pollworkers, and absentee and early voting. In these four chapters, we provide more detailed discussion about the changes since our 2001 report, and of areas where more reform is necessary.

In a third part, "The Future," we discuss the need for a stronger infrastructure for election administration, the need to further develop the science of elections, and our recommendations for reform.

Finally, we present a part titled "Perspectives." We invited a number of prominent election officials, researchers, election reform advocates, and representatives from the voting systems industry to write short essays about what they see as pressing problems and potential solutions. These essays represent their perspectives, not ours. We believe it is critical that all points of view are reflected about the state of election administration and voting technology, even points of view with which we may not agree.

We hope to make clear in this report that the reform journey the nation embarked upon a decade ago is less than halfway complete. There is strong, objective evidence that the old challenges to election administration remain and that new ones have arisen. Despite the salutary changes to election administration that have transpired over the last 12 years, American election administration continues to need more attention, research, reform, and resources.

PART TWO
WHAT HAS CHANGED, WHAT HASN'T

VOTING EQUIPMENT AND BALLOTS

Voting machine failures stood front and center in the recount of the 2000 presidential election vote in Florida. The election dispute between George Bush and Al Gore exposed problems in the absentee and registration systems, in the management of polling places, and even in the definition of a vote in Florida's law. However, a single image captured the heart of the election controversy: Judge Robert Rosenberg of Broward County Canvassing Board inspecting punch-card ballots with a magnifying glass to determine whether the card indicated a vote for Bush, a vote for Gore, or one of the many ambiguous hanging, dangling, or pregnant chads. The technology for recording and tabulating votes had failed, plain and simple, and the determination of the Presidential election hung in the balance. In an age of ever-greater computing innovations and power, America was still using 1960s computer technology—punch-cards—to vote. Surely, there was a better, more reliable way.

That was the starting point of the collaboration between Caltech and MIT: to find a better way to cast and count votes. As it turned out, that was not a hard problem. One could certainly build a better machine than the punch-card systems used in many Florida counties in 2000, and indeed, many companies already had developed technologies such as optical-scan paper ballots and electronic machines with touch-screen interfaces. The biggest problem was that improved voting systems just were not being used widely.

A visit to the proceedings of the Florida Governor's Task Force on Election Reform in January 2001 revealed why. Confusion reigned as a dozen voting machine vendors attempted to persuade the commission to adopt their machines. For their part, the task force members lacked information about the performance of the various technologies in actual elections, and they had no background in matters such as computer security or technology standards. The task force also faced strong opposition to any statewide actions from the state's 67 county election officials, each a constitutionally elected officer in Florida. We shared what we had learned to that point about the reliability of voting equipment—namely, that optical-scan and electronic equipment produced fewer uncounted votes on average than punch-cards. But, it was evident that the problems facing state and county election officials went deeper than the need for a new type of voting machine.

The voting machine challenge has four components. First, equipment must be reliable. Second, voting machines need to be secure. Third, there must be standards for performance in order to assist governments in making appropriate decisions. Fourth, and perhaps most important, there needs to be a sustainable business model for the voting machine industry.

In an age of ever-greater computing innovations and power, America was still using 1960s computer technology—punch-cards—to vote.

WHAT HAS HAPPENED SINCE 2000

County and state governments in 2001 needed an immediate solution to the voting equipment vulnerabilities exposed in Florida. It was evident to us at the time that the choices available for adoption before the 2002 (or even 2004) elections consisted of machines already on the market. By the time technology firms could develop, certify, license and manufacture new equipment, the 2002 election would be over. It was also evident that there was a lack of credible and objective information about the performance of different types of equipment in operation.

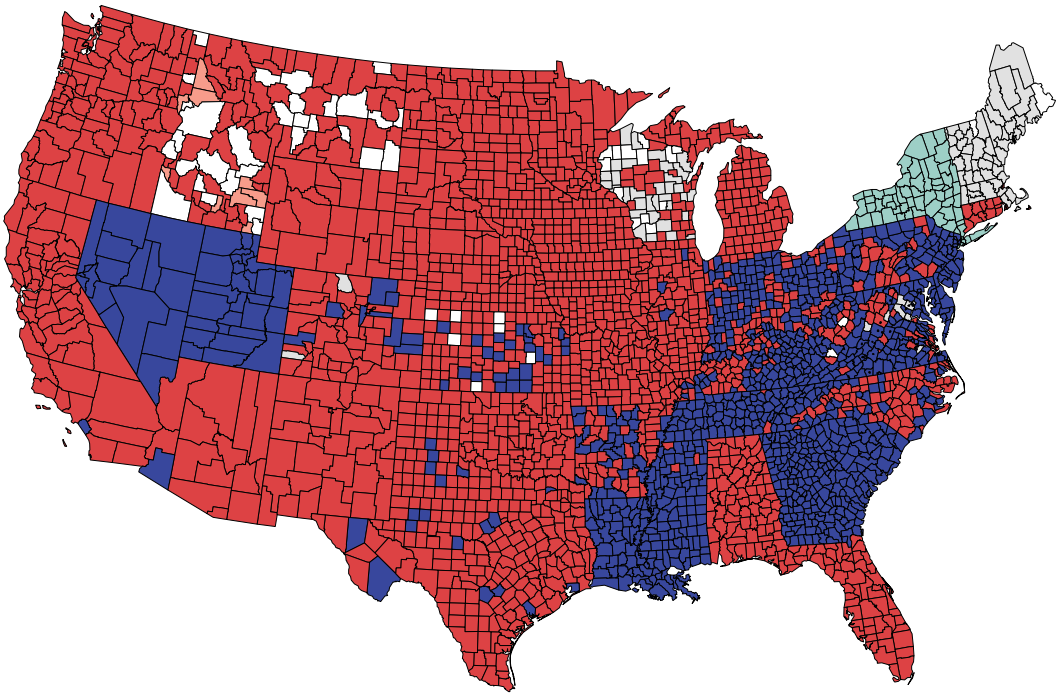
In January 2001, we conducted a nationwide assessment on the performance of available voting technology in past elections. That assessment led to several simple conclusions and straightforward recommendations. County and state governments then using punch-card or lever machine voting equipment should decommission that equipment and adopt either optically scanned paper ballots, preferably counted at the precincts, or direct recording electronic voting equipment (DREs, similar to automated teller machines). While these technologies may present other problems, they had a track record of improved reliability in recording and tabulating votes.

The recommendation to replace underperforming or antiquated machines was central to our 2001 report, *Voting: What Is, What Could Be*. It was adopted by Carter-Ford Commission, and it became one of the core provisions of HAVA. In 2000, counties used a wide mix of technologies, including hand-counted paper ballots (in 1% of counties), lever machines, punch-cards, optically scanned paper ballots, and electronic voting machines. By 2006, with the exception of New York State, all punch-card and lever voting machines in the United States had been replaced with optical scan or electronic voting equipment. Today, approximately three out of every five counties use optical-scan technology and two out of five use electronic equipment, and a very small number continues to use hand counted paper.

As important as our recommendation was for near-term technology improvement, our methodology for assessing voting technology performance and reliability was even more so. In 2000, there was no means for measuring the reliability of equipment for recording and tabulating votes during *actual* elections. The Florida recount guided our thinking. The key problem revealed with punch-card technologies was the large number of ballots on which the voter had attempted to express a preference, but where the voter's preference could not be discerned. That is, some voters went to the polls, received a ballot, marked the ballot, and submitted it. Some skipped voting for president intentionally; and some skipped the office unintentionally, but some attempted to cast a vote but failed.

Figure 1

VOTING EQUIPMENT USED BY COUNTIES IN 2008



Source: Election Data Services.

The difference between the number of ballots cast in an election and the number of votes cast for any office could be used to measure technology performance. The discrepancy between the number of ballots cast and the number of votes counted for any office we termed the *residual votes* for that office. Whatever the reason for the blanked or spoiled ballots, their frequency ought not be correlated with the type of technology used. The correlation between some voting technologies and higher numbers of blanked or spoiled ballots showed the extent to which those technologies offered lower reliability in facilitating voting and counting votes.

The residual vote rate for president in 2000 was approximately 2% of all ballots cast nationwide. We estimated that simply replacing older technologies with newer technologies would cut that rate in half (Ansolabehere and Stewart 2005). Our subsequent analyses documented that the improvement to the performance of voting equipment following the full implementation of the HAVA requirements matched our expectations. The residual vote rate reached 1% in 2006 and 2008 (Stewart 2009).

Technology upgrades bought short-term improvements. But other problems of performance and usability remained, in particular, for certain communities of voters, such as those with low literacy or who are blind. The VTP's 2001 report also called for long-term innovation in methods for recording votes; subsequent research led to the development of audio voting and other technologies (Selker 2006). Some technology firms have implemented these ideas; but sustained innovation, we think, calls for an entirely different framework for improving voting technology.

Our 2001 report *Voting: What Is, What Could Be* supported the separation of the development of the user interface from the development of the other components of the system, especially the vote tabulator. Such a separation would allow for continued improvement in the user interface to make voting easier and more universally accessible without forcing equipment vendors and governments to start from scratch in developing the voting system's security, gaining certification, and vending wholly new equipment. That approach, dubbed FROGS, would also accommodate many different methods for voting, but it has not been embraced by the U.S. industry.[3] The FROGS framework remains an alternative approach to voting technology development that would allow for continued improvement.

The increased use of absentee voting and early voting has created new technology needs and problems, as discussed elsewhere in this report. It is worth noting that a few states, such as Montana, allow submission of absentee ballots for military personnel over the Internet via email, but security concerns motivate many states to use the Internet to allow voters to download a blank ballot that is then printed and returned by postal mail.

SECURITY ISSUES AND TECHNOLOGY INNOVATIONS

The 2000 United States presidential election put a spotlight on the fragility and vulnerability of voting technology. It became clear that providing robust, accurate, and secure voting systems remained an important open technical problem. In response, Congress passed the HAVA Act of 2002, presuming that the states could solve this problem with a combination of increased funding and the guidance of the newly created Election Assistance Commission (EAC) and its advisory committee, the Technical Guidelines Development Committee (TGDC).

How secure and reliable voting systems should be designed and configured was, and still is, only partially understood.

Spending money on a problem works best for well-understood problems, such as building roads or fixing bridges. How secure and reliable voting systems should be designed and configured was, and still is, only partially understood. To spend funds wisely on new voting systems requires patience, and significant research and development. Congress gave funds to the states immediately, so the states bought large numbers of voting systems that were then available, before new standards were developed and adopted; it's a good example of the maxim denoting precipitous action, "Ready, fire, aim"!

[3] The ES&S Automark is a notable exception; it uses auditable paper ballots. The Brazilian voting equipment vendor Diebold-ProComp has similarly implemented such a system.

SIGNS OF TROUBLE— SECURITY REVELATIONS SINCE 2000

We begin with a brief overview of two representative threads illustrating the problems with voting systems purchased during the first decade of the 21st century: the saga of Diebold, and the investigations by the state of California. These are only representative threads; details can be found in books by Alvarez and Hall (2008) and Jones and Simons (2012).

Diebold investigations. The Diebold saga is instructive, showing how the existing process of developing, certifying, and purchasing voting systems failed to provide systems meeting even minimal criteria for security.

Diebold is an old and well-respected company, known for producing safes, bank vaults, and—more recently—ATMs. In 2002, it entered the business of voting systems with the purchase of Global Election Systems. While this looked like a good direction for Diebold's growth, subsequent events showed that Diebold failed to follow through by ensuring that the voting systems sold under its name were well-engineered. In the end, Diebold sold off its voting systems division to ES&S in 2009. (ES&S was required the next year by the U.S. Department of Justice to divest this purchase, which it did by selling it to Dominion Voting Systems).

Part of the problem was that the Diebold systems were "DREs"—voting systems using "direct recording by electronics." These systems had no paper records; *all* information was processed and stored electronically. Such designs were typical of the times. But all-electronic "Black-box" voting means a voter has no way of verifying that the voting system is recording his or her votes correctly—the machine could be displaying one candidate's name on the screen while mistakenly or maliciously storing another candidate's name on the official electronic record as the voter's choice.

In 2003 Bev Harris, a well-known voting-integrity activist, author of the book "Black Box Voting" (Harris, 2004) and founder of BlackBoxVoting.org, announced that she had obtained software for Diebold voting machines from a non-secure Diebold website. A number of teams examined the Diebold voting system software, including Science Applications International Corp. (SAIC), which was commissioned by the state of Maryland in 2003 to do so. SAIC issued a report (SAIC, 2003) that found that, although no overtly malicious code was found, the system was so poorly engineered that it exhibited a "high risk of compromise." A study of the software discovered egregious security lapses, such as the fact every Diebold voting system used the same "secret" encryption key, effectively making the encryption useless (Kohno et al. 2004).

A flood of other studies followed.[4] All were withering in their denunciation of the systems' security; some—such as studies by Hursti and by Felten—showed how the machines could be controlled by malicious parties and infected by viruses.

In the context of the revelations about Diebold voting systems, and given the weak federal certification program for voting systems, individual states began to respond by sponsoring more rigorous examination of their existing voting systems.

California was a leader. In 2007, California Secretary of State Debra Bowen established the Top-to-Bottom Review (TTBR) of all electronic voting systems; high-caliber teams of experts were contracted to perform a thorough (but brisk) review. In July 2007, Bowen decertified all the DRE systems, with conditional recertification if the companies provided improved security features and if the counties followed certain post-election auditing procedures to ensure that the machines were returning the correct results. Her decisions favored systems based on the optical scan of paper ballots, as they are "more transparent, and significantly easier to audit."[5]

[4] Among these studies were those by Compuware (2003), RABA (2004), Professor Ed Felten and his Princeton students (Feldman et al., 2007), Harri Hursti (2006), the 2007 studies by the state of California in its Top-To-Bottom Review (California Secretary of State Debra Bowen 2007) and the state of Ohio in its EVEREST report (Ohio Secretary of State, 2007).

[5] https://josephhall.org/nqb2/index.php/casosttbrstmt

TECHNICAL PROPOSALS FOR SECURITY IMPROVEMENTS

Since 2000, there has been an extensive study of voting. From a security perspective, three themes stand out: the need for software independence, the necessity of evaluating end-to-end voting systems, and requirements for post-election auditing. All three relate to increasing the verifiability of election outcomes.

Software independence. The notion of "software independence" (Rivest and Wack , 2006, and Rivest 2008) captures the intuition that election outcomes should not be critically dependent on software-based voting systems. More precisely, a voting system is said to be "software independent" if a (undetected) change or error in its software cannot cause an undetectable change or error in an election outcome.

This notion was proposed for adoption as part of the federal voting system certification standards (the 2005 Voluntary Voting System Guidelines). The notion does not exclude the use of software, but recognizes the extraordinary difficulty of producing correct software, by requiring that election outcomes produced by software-based voting systems be checkable by other means; the simplest software-independent approach is to complement such systems with voter-verifiable paper ballots.

End-to-end voting systems. An "end-to-end" (E2E) voting system provides verifiability from the starting point (the choices in the voter's mind) to the final tally. Votes should be verifiably (by the voter) cast as intended, verifiably (again by the voter) recorded as cast, and verifiably (by anyone) tallied as recorded. Overall, this provides a level of verification of the election outcome that exceeds what is available in voting systems in current widespread use.

There have been numerous proposals for E2E voting systems; we mention only two here. They typically involve the use of cryptography and also a website where voters can check that their (encrypted) votes are correctly logged. Checking that encrypting ballots is properly performed and checking that the tally of the encrypted ballots is correct are typically non-trivial but doable.

The "Prêt à Voter" system (Chaum et al. 2005) is an E2E voting system using a two-part paper ballot, with one part containing the candidate names (in scrambled order), and the other part containing the voter's choices and some encoding of the name permutation. The voter casts only the second part, and discards the first part. See Peter Ryan's "Perspectives'' piece in this report for further details.

The "Scantegrity'' system (Carback et al. 2010) uses an innovative invisible-ink method on what appear to be ordinary optical-scan paper ballots. However, when the voter marks a bubble (using a special pen) a secret "confirmation code'' is revealed. The voter can look up these codes on a website later to confirm that his ballot was properly recorded. The Scantegrity system has been successfully used in two binding governmental elections, in Takoma Park, Maryland.

Election Auditing. Election audits are an effective approach to verifying the correctness of election outcomes (e.g., Alvarez, Atkeson, and Hall 2012). Some such audits assume that the paper ballots being counted have not been tampered with, but more holistic audits involve auditing the election process end to end, to ensure that all ballots can be accounted for throughout the election process. Such systems function largely through effective standard operating procedures (Alvarez and Hall 2008), which help to ensure that mistakes are not made in the handling of ballots (either electronic or paper). Such comprehensive audits resemble, in certain respects, E2E systems, which make no assumptions about ballot authenticity and provide for detection of tampering via the website.

A post-election audit verifies the correctness of the reported election outcome by hand-counting a sufficiently large random sample of the cast paper ballots. (Here "correctness'' refers to the agreement of the announced election outcome with the outcome that a full hand-count would provide; the audit checks the correctness of the machine-counting of the paper ballots.) The sample may either sample precincts or single ballots; the latter can be noticeably more efficient. A statewide election for a large state may be audited by examining just a few hundred ballots, for a typical margin of victory. If the margin of victory is small, or if the originally reported outcome was incorrect, the audit may escalate, auditing more and more ballots, until a sufficient level of statistical confidence is established. For a typical large election, only a tiny fraction of the ballots need to be examined.

Since 2000, the technology for post-election audits has improved greatly. Professor Philip Stark (U.C. Berkeley) has pioneered many of the new techniques; his website[6] includes many key papers. One new method is the "risk-limiting audit," which guarantees with high probability that if the originally reported outcome was incorrect, the audit will not terminate until all the ballots have been examined. The audit has a bounded probability (the "risk-limit") of confirming an incorrect outcome. Other post-election audit methods, such as the "Bayes audit" (Rivest and Shen 2012), have somewhat similar properties.

At least half of the states will be conducting post-election audits (Verified Voting, 2012). Some are running pilot risk-limiting audits; California has run more than 20 such pilots under its program initiated with the 2010 Assembly Bill 2023 (California Secretary of State 2011-2012).

Election auditing can be a powerful tool for assuring the integrity of election outcomes. Audits can be quite inexpensive to run, and can decrease the need for costly certification of voting systems.

INNOVATIONS AND CHANGE

Over the past decade, we have seen the following trends in voting system security:

» A strong movement away from all-electronic voting systems, toward voting systems based on paper ballots.

» Increased interest in post-election auditing.

» Strong interest from computer security experts and cryptographers in the problems of voting system security.

» Some jurisdictions (such as Travis County, Texas) taking the design of voting systems into their own hands, in consultation with expert advisory boards.

On the other hand, the following are troubling negative trends:

» Apparent increased interest in vote-by-mail and Internet voting. (In general, remote voting has much increased risk of vote-selling and voter coercion.)

» The proposed National Popular Vote (NPV) may have negative security implications, since the opportunity to perform proper post-election audits appears to be considerably diminished.

» Increased interest in more complex voting systems (e.g., ranked-choice voting systems such as instant-runoff-voting) that pose some serious challenges for auditing. (However, these challenges may be manageable; it is hard to tell at this time.)

» The federal certification system seems largely dysfunctional at present (discussed below).

» The voting system industry is over-centralized, has little transparency, and invests insufficiently in research and development.

[6] http://statistics.berkeley.edu/~stark/Vote/index.htm

HAS SECURITY IMPROVED?

Has the security of voting systems improved since 2000? It is difficult to answer this question because we do not have systematic data that can be used to examine this question over time. Studies of legal prosecutions by the federal government do not suggest that fraud is rampant (Bailey 2008), although case selection and the lack of systematic study does lead us to the old maxim "Absence of evidence is not the same as evidence of absence."

Researchers have developed over the past decade an array of statistical methodologies for attempting to identify election fraud using statistical methods or natural experiments that arise from election administration (Alvarez et al. 2008; Hill 2006). Mebane illustrates the detection of election fraud by irregularities in the patterns of digits of reported tallies.[7] Hyde's (2007) path-breaking work, for example, examines the incidence of irregularities in counts and their correlation with the placement of U.N. election observers in various new democracies. There are also important studies of individual countries (on Russia and the Ukraine, Myagkov et al. [2009]; on Venezuela see Levin et al. [2009]).

The increased interest in election auditing and in verifiability of election outcomes bodes well for improved security throughout the next decade. There is, however, a clear need for systematic assessment of election fraud. We see the following questions as essential as the area of secure voting systems moves forward.

» To what extent has fraud occurred in previous elections?

» Are voting systems returning the correct election outcome?

» Are voting systems providing good evidence for the correctness of the election outcomes they are reporting? Is the outcome verifiable?

RECOMMENDATIONS

We have developed the following recommendations for improved security of voting systems:

» Legislation is needed mandating effective election auditing, which at a minimum would require post-election auditing of all voting technologies used in an election.

» Continued strong support for voting systems security research is critical, emphasizing auditing and the verifiability of election outcomes.

» Continued work is needed examining the role of human factors and standard operating procedures in making elections more secure, including more effective chain-of-custody rules and clarity on security procedures to be used throughout the electoral process.

» Mandated use of public standards (such as EML) is required for representation of data by and between voting systems.[8]

» Mandated ownership of all election data by the electoral jurisdiction is necessary. Vendors must not own the election data.

» Encouragement for continued research into election forensics methods is required, as well as the collection and distribution of data necessary for their application in the immediate aftermath of contested elections.

[7] http://www-personal.umich.edu/~wmebane/

[8] http://en.wikipedia.org/wiki/Election_Markup_Language

STANDARDS DEVELOPMENT

Although the National Commission on Federal Election Reform's Task Force on the Constitutional Law and Federal Election Law noted that Congress does have the constitutional power to regulate federal elections, it has not historically done so. Instead, the federal government has historically deferred to the states the regulation of elections, and this "states rights" posture means that effective federal regulation of the voting system industry is not direct, but indirect, through pressure and payments made by the federal government to the states. Effective federal regulation only works with the voluntary cooperation of the states. However, with the passage of the Help America Vote Act (HAVA) of 2002, some advances were made concerning the adoption of voluntary voting system standards.

This section briefly reviews the pre-2002 standards landscape, examines the effect of HAVA 2002 on regulation and voting systems standards, and, finally, makes some recommendations for improvements.

EARLY STANDARDS (PRE-2002)

Prior to 2002, the only federal standards for voting systems were those adopted in 1990 by the Federal Elections Commission. The standards were created after the publication of several major reports about issues related to voting technology (Saltman 1975; Saltman 1988) by Roy Saltman of the National Bureau of Standards (now NIST, the National Institute of Standards and Technology) and after some activity at the state level in this area (Federal Elections Commission 1990). These standards were voluntary, and no corresponding testing process existed until 1994, when the National Association of State Election Directors (NASED) created one. At that point, some states began to require conformance to these (voluntary) federal standards; by 2001 a majority of the states had done so.

While the adoption of these voluntary standards was a significant first step, there were major gaps, weaknesses, and problematic aspects. For example, the voting system vendors directly paid Independent Testing Authorities (ITAs) for the required testing, an arrangement with a clear potential for conflicts of interest. The handling of the security of voting systems was very narrow and limited; for example, there was an exemption of Commercial Off-The-Shelf components (COTS components) from examination, even if these components were integral to the system. Neither voters, nor pollworkers, were included in the testing. NASED adopted a revised set of standards in 2002, just before the passage of HAVA, but these standards had similar weaknesses.

HAVA 2002, THE EAC, AND THE TGDC

The Help America Vote Act of 2002 provided substantial funding—more than $3 billion—to the states to improve their voting systems, with primary goals of replacing outdated punch-card and lever machines. The Act also set up a process for developing improved voting system standards.

HAVA established the Election Assistance Commission (EAC) to oversee and administer these improvements, as well as a Technical Guidelines Development Committee (TGDC) to develop the next round(s) of the Voluntary Voting System Guidelines, to replace the NASED 2002 standard.

The technical work of developing standards was to be performed by the Technical Guidelines Development Committee (TGDC), comprising 15 members from designated areas. The National Institute of Standards and Technology (NIST) provided strong technical and editorial support to the TGDC.

NIST held a meeting in December 2003, titled "Building Trust and Confidence in Voting Systems" to allow many stakeholders to express their views on what ought to go into a new standard. The most contentious issue was that of paper versus electronic ballots. One critical debate that the TGDC had to navigate was one between those who strongly support electronic systems because they allow individuals with disabilities the opportunity to cast ballots without assistance and those who are concerned about the auditability and security of electronic voting technologies.

The TGDC started work in 2004, and by December 2005 had its first set of Voluntary Voting System Guidelines approved; these guidelines went into effect December 2007. These initial guidelines were a modest rewrite of the NASED 2002 standards. The TGDC continued its work, and in August 2007 provided a substantial rewrite of the proposed Voluntary Voting System Guidelines. A notable feature of this rewrite was the requirement for "software independence"—the requirement that a software error could not cause an undetectable error in an election outcome. This requirement effectively means that the operations of software-based voting systems need to be auditable. The TGDC determined that this requirement is met by the use of paper ballots, as paper ballots can always be recounted by hand if desired, thus providing the necessary detectability of software errors.

The EAC has not approved the VVSG 2007 proposed guidelines, in part due to opposition to the requirement for software independence. Some opposition to the entire standards process has been bubbling up within NASS (the National Association of Secretaries of State), including a motion in favor of eliminating the EAC altogether.

WHAT ARE FEDERAL STANDARDS GOOD FOR?

Voting system standards are useful for examining the basic functionality, usability, reliability, and elementary security aspects of voting machines.

However, there are several conflicts that have become apparent in recent years regarding voting systems standards in the U.S.:

- Federal standards versus state standards for voting systems.
- A requirement for auditability, (say via paper ballots) versus allowing unauditable but potentially more flexible and user-friendly DREs.
- Requirements for voting systems for voters with disabilities versus general voting system requirements.
- The expense of having voting systems certified, versus the need for innovation.
- A desire for high integrity in voting systems, versus the fact that testing and certification cannot ensure secure voting systems. Note that security is a negative quality. You can test that a voting machine weighs at most 80 pounds, but you cannot test that a voting machine is "secure."

In a recent paper, Stark and Wagner (2012) argue that a better approach is to audit election *outcomes* (via post-election audits) than it is to try to ensure accurate election outcomes via testing and certification of election *equipment*.

It is worth noting that certification of voting equipment doesn't protect one from bad ballot design or misprogramming of ballot scanners. Even the best-tested equipment can be misused to yield invalid election outcomes; post-election audits are capable of detecting and correcting such problems.

Have federal standards helped improve voting systems in the U.S.? The answer isn't clear. While they may have helped ensure that voting systems meet some basic requirements, the difficulty, cost, and time involved in having voting systems certified have certainly also made life difficult for new voting system vendors and election officials.

RECOMMENDATIONS

We propose the following recommendations regarding standards for voting systems:

» De-emphasize standards for security, aside from requirements for voter privacy and for auditability of election outcomes. While testing for minimal security properties is fine, expecting ITAs to do a thorough security review is unrealistic and not likely to be effective. Instead, statistically meaningful post-election auditing should be mandated. ("Audit the election outcome, not the election equipment" (Stark and Wagner 2012)).

» States should harmonize their voting system requirements; right now the market is highly fragmented, in part because different states have different requirements. Harmonization would help reduce costs, especially if accompanied by increased information sharing on best practices and common problems.

VOTER INTENT

Largely unstudied since 2000 are standards relating to assessing voter intent.

When we look back at the 2000 election in Florida, it is important to remember that Judge Robert Rosenberg of the Broward County Canvassing Board was not just dealing with the results of an antiquated voting technology when he looked through the magnifying glass at the punch-card in this famous photo. He was also attempting to determine what those ballots said about the intent of the voters who marked them. A subject for concern with the return to paper ballots in many states is the ability of election officials to ensure a clear understanding of the intent of the voter.

The issue of voter intent has come to the fore in two recent elections in Minnesota. In both 2008 and 2010, the closeness of the election resulted in some ballots being scrutinized to determine if the votes were for one candidate or the other. In 2008, this process took eight months—a time frame that would not have been possible in a presidential election, when electors have to be chosen approximately seven weeks after the election.

If a state does not have clear standards for what constitutes a vote on a paper ballot—for example, stating that underlining or circling a name is the same as marking the oval next to the candidate that can be read by an optical scanner but that writing in the name of a candidate on the write-in line after also filling in the oval is an overvote—then problems like Florida can happen again even with new voting technologies.

States should review their standards for voter intent, and insure that they remain clear, unambiguous, and up-to-date as voting technologies continue to evolve. Standard-setting organizations should develop best practices for voter-intent standards, with the assistance of election officials and the research community.

BUSINESS MODEL ISSUES

In 2001, the VTP concluded that the greatest challenge in the future of voting equipment was not the performance of particular machines or the security of the system, but the business model of the industry.

Voting technology is computing and information technology. It involves capturing people's preferences, and aggregating that information into a certifiable vote tally. The United States leads the world in computing and information technology. Yet none of the great American computing and information firms develops or sells voting equipment. IBM, Dell, Apple, Hewlett-Packard have all steered clear of this industry, as have firms that contract information services to other government functions, such as Unisys and TRW. The firms in this industry are highly specialized, providing voting equipment nd little else. The industry totals only about $300 million in revenue annually.

The voting equipment industry in 2000 was built on an equipment vendor model. Individual firms would develop a particular technology, the specification of which was protected by trade secrets. Technology was not generally licensed to other firms as intellectual property. The firms would then submit their equipment for testing and certification. Once a machine was approved for use in a state, vendors would then attempt to sell their equipment to individual counties, usually in response to a county's Request for Proposals. Some firms provided service contracts through their local vendors. Some counties had staff on hand to perform service and maintenance, especially for lever machines and punch-card equipment.

Much of the effort and investment of the voting machine industry were devoted to its sales force. With more than 5,000 county and municipal election offices, the industry was focused on their needs and maintaining relationships with users and potential adopters of the equipment that a given firm vended. In 2000, there were many small firms in the industry, but four midsize firms had most of the market.

The challenges to sustaining a healthy and innovative voting machine industry were four-fold. First, selling stand-alone equipment made the market very thin. Most counties treated voting equipment as durable goods that would last after many years. Second, there were no economies of scale, creating little incentive for entrants. The practice of vending to counties fragmented the market. Third, the counties bore the entire cost to the system. Counties have the fewest resources, but state, federal, and special districts account for nearly all the elections on the ballot. Tensions between the states and counties made for little or no cost -sharing. Fourth, there was no vertical integration. Voting equipment was divorced from the rest of the system, such as registration and software services.

In our 2001 report, we recommended several changes in this market, both from the firm's side and from the government's side. Changes on the government's side were perhaps easiest to effect:

» An immediate infusion of federal funds to pay for the immediate upgrade in equipment.

» Contracting on a larger scale—states or clusters of states, rather than counties.

» Cost-sharing, perhaps on a per election basis.

» Leasing equipment rather than making durable-goods purchases. This seemed particularly important, given the rapid obsolescence of computers.

» New contracting models, along the lines of that adopted in Brazil.

Changes in the industry were more difficult to specify or to implement. We envisioned a radically different technology platform that could allow for certification and transparency in the security side of the equipment and that would allow for rapid and separate development of the user interface. We also saw that there should be integration of voting equipment with other sorts of election systems, such as registration and election management software. Because registration and election management represent much larger markets (in terms of revenue) we saw those as the potential drivers of a more profitable and healthier voting technology industry.

What has changed since 2000? In many respects, there have been profound changes in the voting equipment business, but in some very important respects, very little about this business has changed. Perhaps the most important change has been the increased involvement of state governments in contracting. Since 2000 we have seen the emergence of true economies of scale in this industry, as many states have adopted statewide contracting. Some neighboring states have even taken the next step of making multi-state contracting arrangements. No states, however, have gone as far as the national government of Brazil and committed the resources to regular upgrades of equipment that meets the state's own technology specifications (rather than the voting industry's own standards and specification). We see this as an eventual step in the natural progression of this business.

An equally important change in this industry was the infusion of federal funds under HAVA for adoption of new equipment or innovations in other technologies. Most states used these funds to get rid of underperforming technologies. Some states have shepherded these funds to devote to long-term development of registration software and future equipment purchases. The HAVA money created a bridge for many counties and states between older technologies, especially punch-cards and lever machines, which were increasingly impossible to maintain and use, and new technologies. The problem (as discussed below) will be the next transition, as the HAVA funds were a one-time commitment, rather than an ongoing cost-sharing arrangement.

These are significant changes in the government contracting side of the voting machine business, but the basic business remains unchanged. The industry is still based on developing, certifying, and selling stand-alone machines. Ten years after the passage of HAVA, the industry remains the same size (in terms of total revenue) as it was in 2000. After the commitment of the HAVA funds, total revenues of all voting equipment firms sank back to $300 million annually. There has been relatively little effort to integrate the voter registration software and services business with the voting equipment business.

The structure of the industry has changed somewhat, but not necessarily in ways that will produce technological innovations. One firm, Election Systems & Software (ES&S), now controls a large share of the market. In 2009, ES&S had arranged to purchase Premier (the new name for what had been Diebold Election Systems). The Department of Justice filed an antitrust suit. ES&S controlled 47% of all installed machines in 2008 and had $149.4 million in revenues. Premier, the second largest firm in the industry at the time, accounted for 23% of all installed machines and $88.3 million in revenue. Combined, ES&S and Premier would have more than 70% of the installed equipment and industry revenues. The agreement reached with ES&S allows further consolidation of the vendors in this market.

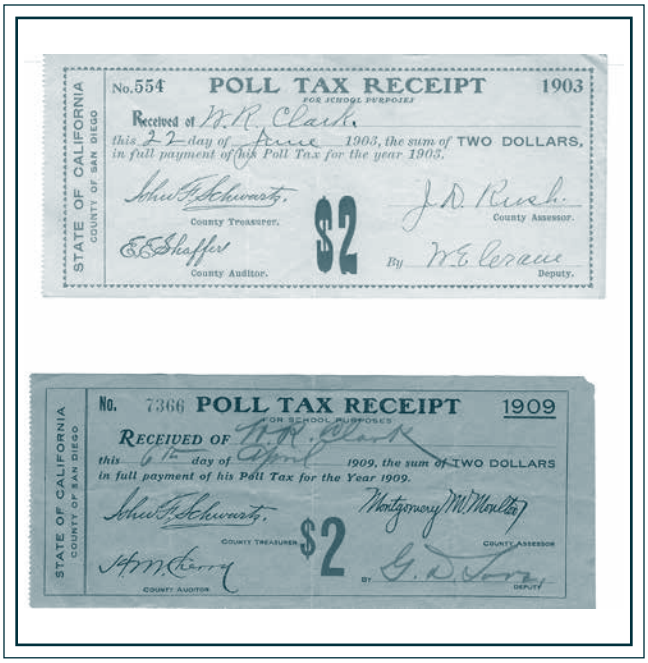
The story we told earlier of Diebold is emblematic of the industry's problems. Diebold is, by far, the largest firm to have entered the U.S. voting equipment business over the past decade. The low revenue, high cost, and bad publicity of the American voting equipment market did not make this a lucrative business for Diebold. It shed its U.S. voting equipment division within six years of acquisition.[9] The nature of contracting offers the economy of scale needed to make voting machine production viable on a large scale and to attract large companies, which either avoid the U.S. market altogether or are driven out after brief flirtations.

[9] Diebold remains interested and active in the voting equipment industry, but not in the U. S. Diebold purchased ProComp of Brazil in 1999, and is the primary vendor of voting technology to the entire nation of Brazil.

LOOKING FORWARD

What developments and issues do we expect to be prominent in the coming decade?

- Increased levels of experimentation with, and adoption of, post-election auditing; strong support for auditable voting systems via federal standards; and possible adjustment of election calendars to better accommodate post-election audits.
- Increased leadership and authority of state-level administration of elections relative to federal and local administration. That will result in increased state-level centralization of information, and more states adopting statewide voting systems.
- Vendors and jurisdictions will continue to propose a variety of ways to cast votes over the Internet, despite the reality of the security challenges. However, the Internet will be increasingly used to transmit blank ballots to remote voters, who can print them out, indicate their choices on the printed ballots, and return them via postal mail.[10]
- Computerization of election administration will continue to proceed, with increased attention on the security of voting registration systems.



[10] Simons, Barbara, and Douglas W. Jones. Internet Voting in the U.S. Communications of the ACM 56, 10 (Oct. 2012), 68-77.

VOTER REGISTRATION AND AUTHENTICATION

It's common for people to ask, "Why do we have voter registration?"

In the context of our earlier research, this is an excellent question. In our 2001 study, we found that of the estimated 4 million to 6 million votes that might have been lost in the 2000 presidential election, between 1.5 and 3 million may have been lost due to problems Americans had with their voter registration. So why have a voter registration system if it leads to so many lost votes?

When we talked with election officials about voter registration, we found that voter registration serves as the foundation upon which most of the election administration process in the United States now operates. Knowing how many registered voters are in particular geographic areas is important for the development of basic administrative geographies, such as legislative districting and the determination of voting precincts.

Voter registration (and the information that is associated with voter registration in so-called "voter history" databases) is used to allocate voting machines to polling places to and determine where early-voting centers should be located, and it determines the exact style of ballot that each and every voter receives. In many places, voter registration information is used by local and state election officials for the distribution of voter education materials; it is also used to authenticate the voter, thus insuring that only eligible individuals receive a ballot. Thus, a well-functioning voter registration system confirms eligibility, and helps prevent certain forms of election fraud (for example, voter impersonation and voting by non-citizens).

So we have voter registration to strengthen the integrity of our elections, and to provide election officials with mission-critical data they need to conduct efficient elections in our complicated system.

While the rationale for voter registration has not changed since we wrote our 2001 report, throughout the nation many changes have been made in how people register to vote, how that registration information is processed and used, and how it is used to authenticate individual voters. In 2001, we recommended the following near term reforms:

» Develop a system for allowing voters to check their registrations.

» Develop better databases.

» Make the county's or state's registration database accessible at each polling place.

» Provide polling places with the list of dropped voters and the reasons they were dropped.

» Use provisional ballots aggressively when there are registration problems.

We also developed the following longer-term recommendations:

» Computerize voter registration information and processes at both local and state levels.

» Develop statewide qualified-voter files

» Fix gaps in the more open registration system created by National Voter Registration Act (NVRA).

The good news is that HAVA prompted states and local jurisdictions to implement many of these changes. HAVA itself mandated that states implement statewide, computerized voter registration databases, and that all states develop provisional-balloting systems. Many counties and states have gone further, and have deployed innovative means for voters to verify their voter registration status prior to an election; many have used new technologies to push voter registration data to polling places and early-voting sites where it can be used actively during elections.

The transition toward statewide, centralized, computerized voter registration databases has led to developments that were not necessarily predictable in 2001. Statewide computerized voter registration files are allowing an unprecedented degree of openness and transparency with the voter registration system. States can now audit their entire voter registration databases—and researchers associated with the VTP have shown that such auditing procedures, if implemented well, can produce more accurate and usable voter registration files.[11]

These statewide computerized databases have allowed states to pool their voter registration information, and studies have shown that this pooling helps identify duplicate records across state lines and improves the accuracy and integrity of state voter registration databases.[12] States are even developing multi-state regional compacts for matching and analyzing databases.[13] As states move to standardize their voter registration databases, such data-sharing will become easier and more efficient.[14]

An important innovative trend in the area of voter registration has been the deployment of online voter registration systems in a handful of states. Early movers in this area were Arizona and Washington, and their experiences have been studied by the Pew Center on the States.[15] In both states, online registration is allowed for eligible citizens who already have a state drivers license or other state identification; those earlier credentials allow eligible citizens in these states to register to vote, or to change/update their registration status. Systems like these have been found to be more accurate, usable, economical, and faster than older paper-based registration systems, and perhaps more cost-effective. Other states such as California are moving in this direction.

However, while these changes have been made to voter registration systems throughout the nation, the question remains as to whether they have led to demonstrable improvements. In our 2001 report, we developed a metric that we termed "lost votes" to help quantify how many votes were lost in the 2000 presidential election, and where those losses occurred—in the process of registration, in managing polling places, or in casting ballots. In that analysis, we concluded that between 1.5 million and 3 million votes were lost due to problems related to voter registration.

We re-estimated those numbers using updated data from 2000. In the 2008 presidential election, these estimates show that the range of votes lost due to registration problem was between 910,000 and 3 million. Overall, lost votes due to registration problems have fallen over the past decade, but not by much—and the drop-off has not been nearly as great as that experienced because of improvements in voting technologies.

Millions of votes are still being lost due to registration problems. In a democracy that prides itself on the principle of "one person, one vote," losing this many votes due to procedural problems remains unacceptable.

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[11] See Stephen Ansolabehere and Eitan Hersh, "The Quality of Voter Registration Records: A State-by-State Analysis," July 14, 2010. (http://www.eitanhersh.com/uploads/7/9/7/5/7975685/reg_quality_report_8-5-10.pdf).

[12] R. Michael Alvarez, Jeff Jonas, William E. Winkler and Rebecca N. Wright, "Interstate Voter Registration Database Matching: The Oregon-Washington 2008 Pilot Project," 2009, (http://static.usenix.org/events/evtwote09/tech/full_papers/alvarez.pdf).

[13] Committee on State Voter Registration Databases, National Research Council, "Improving State Voter Registration Databases: National Research Council, The National Academies Press, 2010, (http://www.nap.edu/openbook.php?record_id=12788).

[14] R. Michael Alvarez and Thad E Hall, "The Next Big Election Challenge: Developing Electronic Data Transaction Standards for Election Administration," IBM Center for the Business of Government, 2005, (http://hou23bogs01.clearlake.ibm.com/sites/default/files/ElectronicData.pdf).

[15] http://www.pewstates.org/research/reports/online-voter-registration-85899378469

PROVISIONAL BALLOTING

What happens when a voter shows up at the polls but his or her name is not in the voter registry?

Oftentimes in the past—particularly, before HAVA—in many states, such a voter would be turned away from the polls and not be allowed to vote. In our 2001 report, we wrote: "We estimate that aggressive use of provisional ballots could itself cut the rate of lost votes associated with registration problems in half. Currently two-thirds of the states do not use provisional-ballots, and many locales that provide for them do not use them aggressively" (p. 30). The VTP, like many others involved in studying the problems of elections following the 2000 presidential election, argued that states should be required to provide provisional-ballots to voters not on the rolls so as to cut the number of votes lost due to registration problems.

HAVA did require that states provide provisional ballots to voters not on the rolls, so all states now have a provisional balloting process. But HAVA did not mandate the procedures that would be used to verify the potential voter's eligibility, nor did it mandate whether a voter who casts a provisional ballot from the incorrect voting precinct should have that ballot counted to the extent possible.

States have complied with HAVA's provisional ballot provisions, and provisional ballots have been widely used in recent elections. According to data collected by the EAC, at least 2.1 million provisional ballots were submitted in 2008; nearly 1.1 million were submitted in 2010.[16]

Of these provisional ballots submitted, 62% (2008) and 66% (2010) were included in the final election tabulation completely. In other words, about two-thirds of the provisional ballots were submitted by voters whose eligibility was verified after the election and who were in the correct polling place so that they were eligible to vote on all of the elections and measures on the ballot submitted. These represent 1.3 million (2008) and 700,000 (2010) lost votes that were recovered because of the provisional-ballot process.

VOTER AUTHENTICATION

Ensuring the strictest security for our entire electoral process is paramount. In our 2001 report, we felt so strongly about security and fraud prevention that we wrote a whole chapter on the subject of ballot security. That chapter began with a statement that is as true today as it was then, so true that it is worth restating:

"Security is as important as reliability in guaranteeing the integrity of the voting process and public confidence in the system."

Although security remains equally important today, the types of threats that are of primary concern have changed greatly in the past decade. In 2001, the main security concerns were voting machine tampering and ballot-box stuffing. Subsequent to our report, real and demonstrated security vulnerabilities were analyzed by experts throughout the world.[17] Concerns about the security of voting machines, especially electronic voting systems, became widespread.

In more recent years, attention has shifted away from concerns about voting machines themselves and toward a debate about voter fraud, in particular voter impersonation and voting by those who are ineligible. To address these new concerns, 10 states have passed laws requiring that all voters who cast a ballot in person show some form of government-issued photo identification, typically a driver's license, passport or student ID card.[18] These laws have sparked a number of lawsuits, including the important *Crawford v. Marion County Board of Elections* case, in which the U.S. Supreme Court upheld Indiana's voter identification law in 2008.

[16] These data are incomplete, as a number of states and territories did not report any provisional-balloting information to the EAC in 2008 and 2010. Thus, the actual number of provisional ballots submitted—and their resolution—is likely different from what we report here.

[17] See Chapters 5 and 6, Alvarez and Hall (2008).

[18] Gaskings and Iyer (2012).

Since these voter identification laws have many critics, it is necessary to acknowledge the four most common arguments against them. First, there simply is not a strong record demonstrating the prevalence of voter impersonation fraud or voting by ineligible individuals—the types of fraud that strong voter-identification requirements might mitigate.[19] Second, because these identification requirements are imposed at the polling sites, pollworkers must use their discretion in determining whether a photo matches the voter, which could lead to unequal application of these laws. Third, despite the best efforts of states to provide photo identification to those without it, many potential voters, especially minority voters, still do not possess the correct government-issued identification.[20] Fourth, these identification requirements are not imposed on those who vote by mail, which is one of the fastest-growing forms of convenience voting throughout the nation.

For these reasons and many others, voter identification laws have been controversial. They have spawned a number of recent lawsuits, and they are fueling a growing polarization regarding election administration.

While we believe strongly that elections should be as secure as reasonably possible, we also believe that the burden for preventing voter fraud should be placed mainly on the state, not voters. Therefore, we should seek ways to make voting more secure without making it more difficult for a voter to cast a ballot.

As scientists interested in how technologies can be applied to the electoral process, our puzzle is how we can develop a voter-authentication system that can be simultaneously easy for voters to navigate and highly secure. How can we ensure that the individual who enters the polling place and requests a ballot is in fact that individual and do so in a way that imposes little or no cost on the voter?

Such a system is easily within reach and it could be implemented in some states by 2014 and most others by 2016.

We begin by noting three facts about existing voter registration systems in most states:

- States are required by HAVA to have computerized statewide voter registration databases.
- Existing technology allows the easy use of these voter registration databases in polling places, in the form of what are commonly called electronic pollbooks.
- In many states, the voter registration database is integrated with the state Department of Motor Vehicles (DMV) or other office that issues photo identifications.

We envision a system of voter identification that uses these electronic pollbooks to maintain a database of photos of registered voters. Using each state's DMV photos, states would link each voter's electronic voter registration file to a photo in the state's DMV system or other identification database. Instead of asking a voter to present government-issued photo identification at the polling place, a voter's identity could easily and quickly be confirmed by a pollworker who has access to an electronic pollbook that contains both the voter's registration information and the current photographic identification that is on file with the state.

[19] Minnite (2010).

[20] Barreto, Nuño, and Sanchez (2009).

But, what about a voter who did not already have photographic ID on file with the state? The obvious solution is for the state to take a photo of the voter *at the polling place*, after the voter has executed an affidavit of identity, and for the photo to be added to the state's voter registration database, for use in future elections.

Certainly, there are questions that should be addressed about such a system, concerning cost, complexity, and privacy. However, all laws that increase the stringency of voter ID requirements are costly, complex, and challenge privacy. In our view, everyday, cheap technologies—digital cameras—could form the basis for a relatively inexpensive and system of voter identification that would address both security and access concerns.

While we agree that it is important to verify the identity of all in-person voters, we also believe that the states wish to implement such systems should bear the costs associated with strict forms of voter identification. Additionally, we hope that work will be done to verify the identity of those who vote by mail, to increase the security of that means of voting.

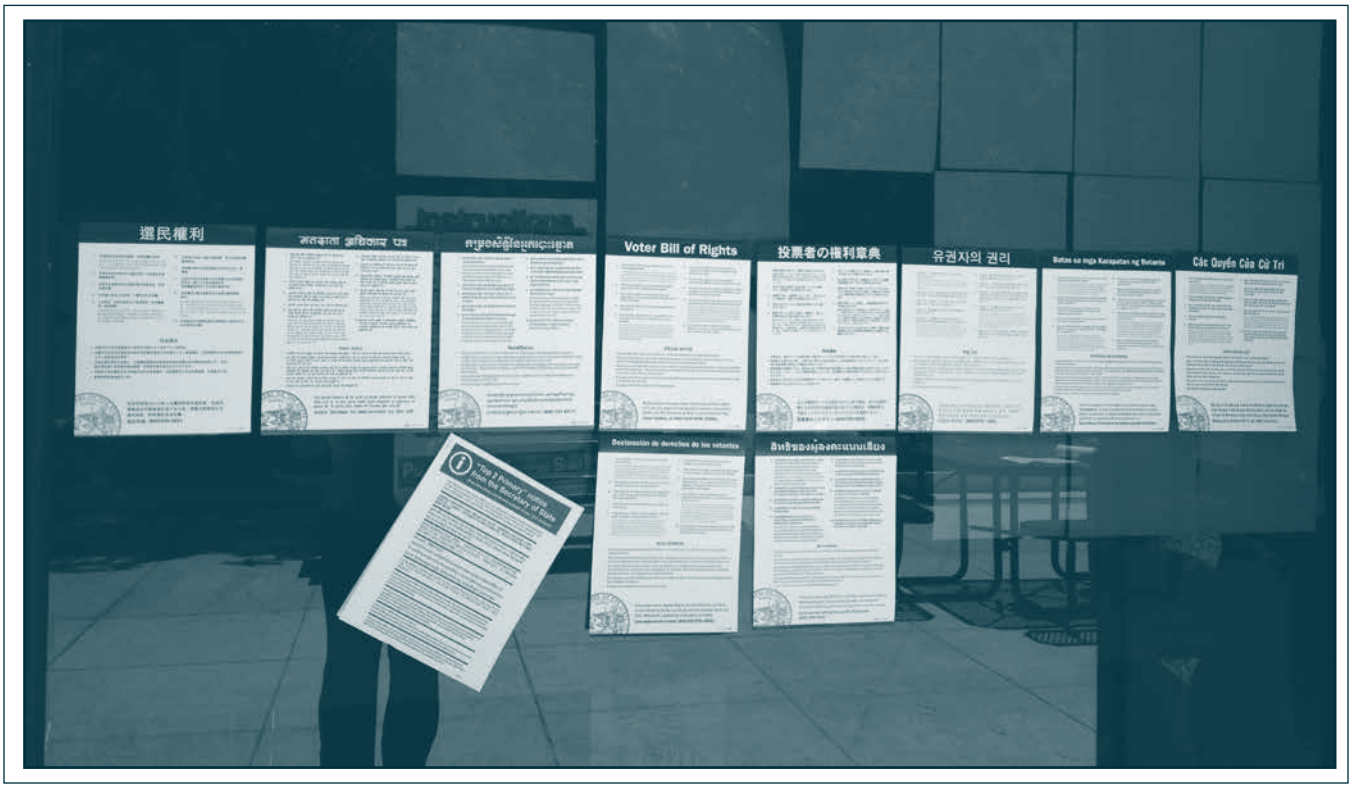
THE PATH FORWARD

In terms of recommendations, we offer the following:

» The provisional balloting process needs to be streamlined in many states, and best practices or voluntary standards could help.

» If states wish to move toward requiring stronger forms of authentication for in-person voting, the burden of identifying voters should fall upon the state and not the voter. We have outlined above a system that could be used for such a process, and we believe that further research into similar approaches is necessary.

» States should continue to standardize their voter registration databases so they can be pooled with databases from other states, and should investigate policies and technologies to insure that voter registration information is secure and private.



POLLING PLACES AND POLL WORKERS

Despite the fact that the percentage of voters who cast ballots on Election Day continues to decline, 60% of voters still used traditional polling places in the 2008 presidential election; that percentage is likely to be about the same, if just a bit lower, in 2012. Thus, maintaining well-functioning polling places remains a critical element of election administration in the U.S.

The number of polling places scattered around the country and the number of workers who staff them are staggering. There were roughly 110,000 physical locations at which voters cast ballots on Election Day in 2008 and 2010. These polling places were staffed by at least 878,000 poll workers in 2008, and 770,000 poll workers in 2010 (EAVS 2008, 2010).[21]

The polling place is the "pop-up" retail store of voting. Even if a polling place has been used for voting for decades, it is almost always an intruder in a building that has another permanent function. For instance, in 2008, 68% of Election Day votes were cast in schools (32%), churches (21%) and community centers (15%). Less than 10% of ballots were cast in a government building such as a courthouse or town hall (SPAE 2008).[22] Those who are new to the study of American election administration are often surprised to learn that we also vote in garages, restaurants, and businesses —pretty much any location that can be used for a polling place has been used as a polling place in the U.S.

The staffing of polling places is also dominated by seasonal employees—mostly temporary workers who may have staffed polling places for years, but who are still amateurs in the field of election administration, working long hours for nominal wages.[23] Getting workers to staff polling places is a headache for many election administrators. In 2008, more than 40% of local jurisdictions reported difficulty in finding enough people to staff Election Day (EAVS 2008).[24]

FINDING THE POLLING PLACE

The issue of polling place operations can be divided into three parts: finding the polling place, waiting in line to vote, and receiving the services that poll workers provide.

Almost all voters report that it is very easy to find their polling places on Election Day—91% of voting respondents gave precisely this response ("very easy") when asked how hard it was to find their polling places in the 2008 election. Yet some find it easier than others. Registered voters who have recently moved to their current residences, first-time voters, and younger voters are much more likely to report difficulties finding their polling places than longtime residents, longtime voters, and older voters. Young people and new residents are also much more likely to report that they failed to vote because they did not know where to go to vote.

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[21] All statistics in this chapter concerning the number of polling places, precincts, and poll workers are taken from the EAC's Election Administration and Voting Survey (EAVS), unless otherwise indicated. The numbers cited here are significantly greater than the ones we presented in our 2001 report. Despite limitations to the EAC's data gathering efforts, we consider these new numbers a closer reflection to reality than the statistics we were able to gather a decade ago. The estimates of the number of poll workers in the past two federal elections presented here are nonetheless a lower bound, because not all local jurisdictions reported to the EAC the number of poll workers they used on Election Day. In both 2008 and 2010, 18% of local election jurisdictions failed to report the number of poll workers. (These percentages are weighted by the number of registered voters in each jurisdiction.) If we account for the missing data in the simplest way possible, by just extrapolating out from the data we do have, the estimated number of poll workers in 2008 is almost 1.1 million, falling to well over 900,000 in 2010. (It is likely that the difference between 2008 and 2010 is due to the need to respond to larger numbers of voters in the presidential election year of 2008.)

[22] In this chapter, survey research pertaining to the experience of voters on Election Day was taken from the 2008 Survey of the Performance of American Elections (SPAE 2008), unless indicated otherwise.

[23] Despite the fact that poll workers are poorly paid, on aggregate, poll worker pay is a significant cost of running elections. If all 1 million poll workers worked for 12 hours in 2008 for minimum wage, the nationwide bill for poll worker services would be roughly $100 million, or just a little less than a dollar a voter.

[24] Despite the urban legend that the typical poll worker is older than 70 years old, data from the 2010 EAVS demonstrates otherwise. However, that data suggests the median age of poll workers is closer to 60, and that roughly a quarter of poll workers are over 70. Therefore, while the urban legend is an exaggeration, it contains a kernel of truth about the poll worker population.

Developments in online technologies over the past decade have made finding polling places easier than before. For instance, the Voting Information Project has created a Google Gadget that allows voters simply to type in their address and see where they vote. This gadget can be imbedded in other websites, which allows voters to receive the needed information from a number of different online resources. Software developers have begun creating cellphone apps that allow voters not only to find their polling place on a map, but also to find out all the candidates on a voter's ballot.

Almost every secretary of states' websites now has a search tool to help voters find out where to vote. If a voter types the phrase "where do I vote?" into a search engine, a voter is taken to several websites that help steer him or her to the right answer almost instantly. Thus, one can hope that even more voters will find it easier to find their polling places in 2012 and beyond.

Finding out where to vote is one area in which simple, off-the-shelf technologies are helping voters in ways that could only be imagined a decade ago. We also believe that these technologies should be used in polling places, so that poll workers can provide voters with clear and accurate information about where a voter's true poll site is located; that way voters can have an opportunity to quickly and easily find their true polling places so that they can vote in all of the elections they are eligible for.

WAITING TO VOTE

Once a voter gets to the polling place, she or he then has to wait in line, to be authenticated and given a ballot. Polling places are like any queue—things can be going smoothly, and suddenly turn sour, if just one person has a problem.

Pictures of long lines at polling places are the stock-in-trade of Election Day journalism throughout the country. Such pictures are, in a way, misleading. Very few people stand in long lines to vote. We estimate that in the 2008 presidential election 72% of all Election Day voters waited 10 minutes or less to vote—almost half of voters report walking right in and voting without any wait at all. Thus, for a typical voter, long lines are not an issue.

Still, for a significant minority of voters, the wait is quite long. Despite the fact that only 9% of voters stand in line a half-hour or longer to vote, the *total* amount of time spent by this small group accounts for almost *half* the cumulative hours spent by all Americans waiting to vote.[25] Thus, while a relatively small fraction of voters actually stand in line a very long time, they bear a significant cost by waiting.

Furthermore, waiting in line to vote isn't uniformly distributed across the nation, or across demographic groups. For instance, voters in the six New England states waited an average of seven minutes to vote in 2008; voters in the eight Great Lake states running from Wisconsin to New York reported an average wait time of 13 minutes; and voters in the 11 states of the former Confederacy waited an average of 22 minutes.

[25] By our calculations, using responses to the 2008 SPAE, Americans on Election Day spent a combined total of 2200 person-years standing in line to vote. If we confine ourselves simply to the 9% who waited a half-hour or more, their total waiting time is estimated to be 960 person-years, which is 44% of all waiting time. Incidentally, if we were to put a price tag on all this Election Day waiting time, by paying voters waiting in line the average hourly wage in the U.S., the cost of waiting to vote (even before we figure in in-person early voting) would be $347 million in 2008.

Voters who used electronic machines waited longer than users of paper ballots in 2008. African Americans waited longer than whites. Residents of urban areas waited longer than residents of rural and suburban areas. Yet none of these demographic factors accounts for the vast differences in wait times *across states*. This suggests that it is the administrative practices embodied in state laws and regulations that are responsible for long lines where they exist.

Long lines not only cost some voters time and money, but the spectacle of long lines of voters also creates suspicions that election officials are trying to starve some voters of the resources necessary to conduct elections fairly. Research conducted over the past decade also reveals that long lines have a strong influence on how individual voters rate their confidence in the electoral process (Claassen, et al., 2008). Therefore, finding ways to shorten lines at the polls is not only a matter of good economics and administrative practice, but it is also an important task for ensuring that voters regard elections as being fairly decided.

Until the day comes when everyone who votes in person can get a ballot instantly, better information could be delivered via the Internet to voters about how long they can expect to vote. It is now possible to build simple applications, to be loaded onto cell phones and tablet computers, which could report the length of lines at every polling place throughout the country in real time. In a world where the availability of washing machines is reported online (see laundryview.com), the capabilities exist to report waiting times to vote online, as well.

RECEIVING SERVICE AT THE POLLING PLACE

Finally, a critical aspect of polling place operations that is often overlooked is the service provided by poll workers to voters. Poll workers are responsible for four major sets of tasks: authenticating voters when they check in, getting the voter the correct ballot, making sure the voting equipment is working properly, and assisting voters with questions and problems they might have.

Authenticating voters—making sure they are who they claim to be—and making sure they get the right ballots are becoming increasingly important, as state legislatures pass more stringent voter-identification laws. These laws place the decision about whether the ID presented by a voter is sufficient in the hands of hundreds of thousands of poll workers. In our 2008 Survey of the Performance of American Elections, we discovered that it was common for voters to be asked to produce identification, a request that was at odds with state law. That finding has been confirmed by more micro-level research that has involved studying poll workers up-close in places such as New Mexico and Boston (Atkeson et al. 2010; Cobb, Greiner, and Quinn 2012). And, in general, African Americans and Hispanics report being asked to show a photo ID in order to vote more often than whites.

Advances in voting technology have presumably made the task of accurately authenticating voters easier. A decade ago, a few localities were beginning to use laptop computers loaded with the county's voter registration list as a way to help facilitate the authentication process. By 2010, electronic poll books—devices that give access to an entire county's (or even the entire state's) voter registration records to poll workers—were being used by localities that encompass about 25% of all voters. We believe it a reasonable goal to have all precincts equipped with electronic poll books by the end of the current decade.

The combination of several precincts into a single polling place is a development that is making the task of getting the right ballot to voters more challenging. Earlier, we noted that in the 2008 general election, there were around 110,000 polling places in the U.S. At the same time, there were more than 150,000 *precincts* in the country. In other words, there were about 1-½ precincts for every polling place. This means that for many Americans, when they have gotten to their polling place they haven't "arrived". They still have to be sent to the right table in order to vote.

Within the past two years, two cases have demonstrated that election outcomes can be thrown into doubt because of confusions arising when multiple precincts are slated to vote in the same location. One was a race for juvenile-court judge in Hamilton County (Cincinnati), Ohio, in 2010, in which provisional ballots were given to voters in the wrong precinct due to poll worker error, in an election where the margin came down to 23 votes.[26] The other was a primary in Topeka, Kansas, in which the election judge gave the wrong ballots to as many as 87 voters in a polling place that was shared by two precincts, and in the process threw into question the outcome of the primary for a state legislative district in which the margin separating the top two candidates was 41 votes.[27]

Confusion is bound to occur when precincts share the same polling place. Despite the risks, fiscal and facilities pressures are driving more localities to rely more and more on precinct co-location. Simple technological solutions could be developed to help minimize the risk that a voter will be given the wrong ballot in such cases. One such solution could be a bar code placed on voter registration cards mailed to voters ahead of an election. If a matching code were placed on the ballots for that voter, corresponding to the voter's correct "ballot style," and then the two codes matched via a simple hand scanner, poll workers could be alerted to the types of errors that beset the voters in Hamilton County and Topeka.

ASSESSING THE MAGNITUDE OF POLLING PLACE PROBLEMS

The number of registered voters who said they failed to vote due to polling place problems, as reflected in answers to the Census Bureau's Voting and Registration Supplement of the Current Population Survey, fell somewhat in actual numbers over the past decade. In 2000, that number was 489,000 voters, which fell to 483,000 in 2004 and 407,000 in 2008. As a percentage of turnout in these years, the fraction of those failing to vote due to polling place problems dropped from 0.46% in 2008 to 0.40% in 2004, to 0.31% in 2008.

While the number of lost votes due to polling place operations has slowly declined over the past decade, some voters who complete a ballot nonetheless experience difficulties with polling place operations—difficulties that undermine voters' confidence in the election process. The accompanying sidebar seeks to quantify some of these problems.[28] These figures place the numbers of potentially "dissatisfied customers" of Election Day voting in the millions.

Thus, despite the fact that lost votes due to polling place problems have slowly diminished over the past decade, they have not dropped nearly as fast as lost votes due to problems with voting machines. And, non-trivial numbers of voters still encounter polling places that render poor service.

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[26] Part of the dispute in the case arose because the county board of elections wanted to exclude these provisional ballots from the count, despite the fact that they had included provisional ballots that had been just as erroneously issued to voters in the wrong precinct at the central voting office, during the early-voting period. The Federal Sixth Circuit Court of Appeals eventually ruled that the ballots should be counted. On this case, *Hunter v. Hamilton County Board of Elections*, see http://moritzlaw.osu.edu/electionlaw/litigation/Hunter.php.

[27] http://www2.ljworld.com/news/2012/aug/13/officials-review-ballot-mistake-topeka-polling-pla/

[28] The enumeration of polling place problems was determined by taking the fraction of respondents to the 2008 SPAE who reported having that problem and multiplying that percentage by the estimated number of Election Day voters: 91.8 million.

Table 1

ESTIMATE OF THE NUMBER OF ELECTION DAY PROBLEMS FACED BY VOTERS IN 2008

Problem	Millions of Election Day voters affected
Poll worker performance rated "fair" or "poor"	4.4
Waited in line to vote longer than 30 minutes	4.3
Equipment problem	1.8
Experienced a voter registration problem	1.8
Polling place not well run	1.5
Felt intimidated at the polls	1.0

Source: Survey of the Performance of American Elections, November 2008.

CONTINUAL IMPROVEMENT IN POLLING PLACES

As we did a decade ago, we continue to emphasize the importance of regular training of polling workers, and the need to recruit poll workers who are both cool under pressure and comfortable with new technologies.

The Internet has made some aspect of poll worker training easier than it was a decade ago. Written materials can be more easily updated and disseminated. Remote training is easier, through the use of simple technologies that allow trainers to hold "webinars" with election workers throughout a state.

Because of the growing ubiquity of mobile computing, we encourage the development of mobile devices that bring more information to poll workers, and that help to transmit information about the status of polling places back to the central election office, and eventually to the public at large. Electronic poll books that are connected to mobile networks would generally provide greater functionality than the paper lists that most polling places continue to use. Simple mobile applications that would help to track how long voters were waiting in line and how many voters had already come through a voting place would benefit both the public and election officials.

ABSENTEE AND EARLY VOTING

Perhaps the most significant transformation in how American vote to occur since 2000 is *when* and *where* we vote, rather than the machines we use. Since the ill-starred 2000 presidential election, the percentage of Americans voting by mail or at early voting centers have doubled, from nearly 14 percent in 2000 to more than 28 percent in 2008.[29] Stated another way, the total number of people who no longer vote the old fashioned way on Election Day, opting instead to vote at home or at an official location before Halloween, has grown by 22 million voters since the turn of this century.

When we wrote about voting in the United States a dozen years ago, absentee and early voting were an emerging topic, fraught with possibilities and perils. Non-precinct voting promised greater convenience to existing voters (which is why it is now called "convenience voting") and an opportunity for election officials to even-out the workload that used to bear down entirely on Election Day. Other purported benefits included giving voters the opportunity to make more informed decisions, and allowing election officials to centralize the administration of elections. Champions of convenience voting argue that lowering the costs of voting would increase participation.

In the midst of positive hopes such as these, we noted potential pitfalls that led us to be cautious about the rise of convenience voting, especially when it was bought with the relaxation of absentee-ballot regulations. A decade later, our concerns have only grown. For reasons we make clear below, states would be wise to roll back no-excuse absentee balloting—except for individuals with disabilities and UOCAVA voters—while expanding opportunities for in-person early voting. Before making that argument, however, we review how state laws, regulatory practices, and voter behavior have changed in the dozen years since the *Bush v. Gore* election.

TRENDS IN ABSENTEE AND EARLY VOTING SINCE 2000

Today, Americans are twice as likely to vote prior to Election Day, than they were in 2004. Not only can they vote via traditional absentee balloting, but two states (Oregon and Washington) now conduct all their elections by mail, and numerous states allow voters to cast ballots in-person before Election Day, at special early-voting centers or the county courthouse. This last form of voting is called in-person early voting, or just early voting, for short.

The accompanying graph charts the nationwide rise in both aspects of non-precinct voting, voting by mail and voting early (and in person). Voting by mail has risen inexorably since 2000, from just under 10% of all voters in 2000 to 17% in the midterm election of 2010. In-person early voting has also risen, but in a less fluid line than absentee and mail voting. In 2000, voting early (in person) accounted for a mere 3% of ballots cast. This rose to nearly 13% in the presidential election of 2008, before falling to 8% in the most recent midterm election.

The rise of the two main strands of convenience voting have followed different trajectories, both in terms of how the law has developed, and in terms of how these voting modes have been used by political campaigns. The growth of voting by mail has been aided by the addition of Washington state to the all-VBM stable late in the past decade, the creation of "permanent absentee-voter-lists" in states such as California and Colorado, and the erosion of "for cause" absentee-ballot laws. In addition, some local officials in states with stringent absentee voting laws have been quite willing to interpret these statutes more liberally, creating *de facto* early voting in pockets of the states with the most conservative approaches to election administration.

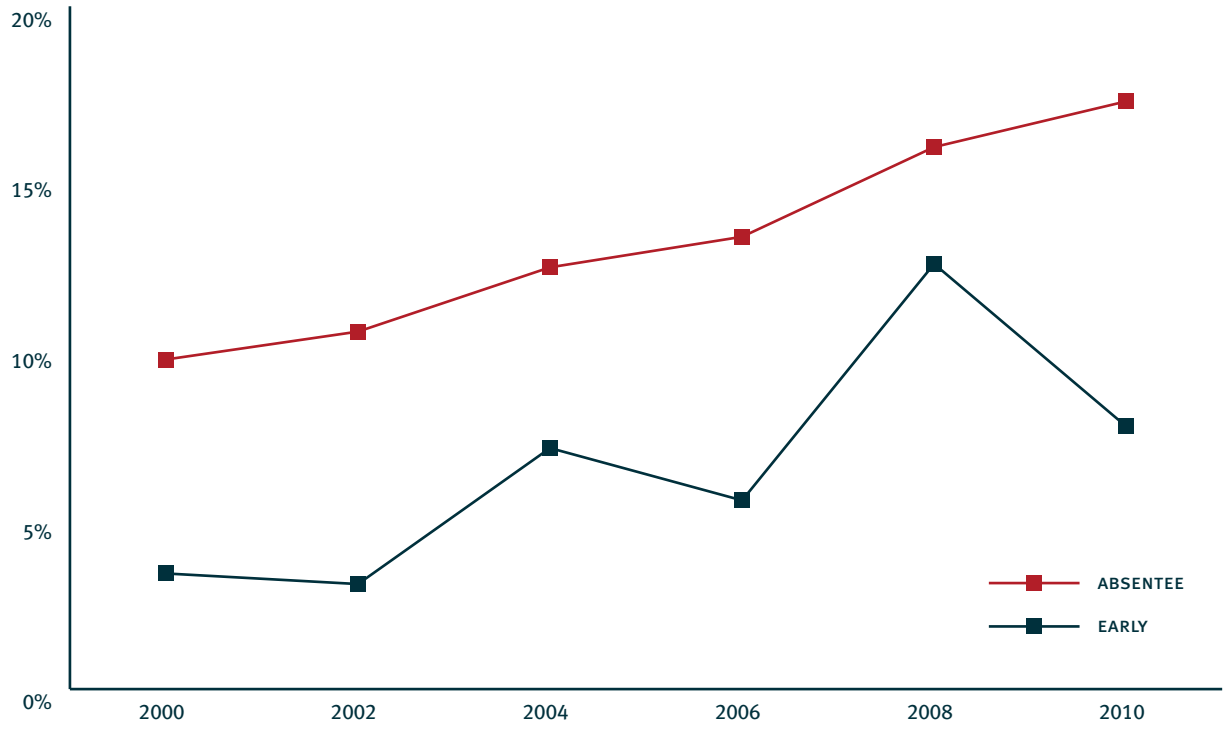
[29] Census Bureau, Current Population Survey, Voting and Registration Supplement.

The growth of in-person early voting has also been aided by a gradual accretion of states with explicit early-voting statutes, including some that establish satellite early-voting centers that are separate from county or city clerks' offices. According to the Election Assistance Commission's 2010 statutory overview, 36 states (plus the District of Columbia) now report they offer some form of early voting. This is in contrast with the state of affairs when we wrote our 2001 report, when only 11 states offered early voting. The sawtooth pattern in the growth rate of in-person early voting is almost entirely due to massive efforts to mobilize African American voters in Southern states in the last two presidential elections.

Growth in non-precinct voting has not been randomly distributed throughout the country. As demonstrated by the accompanying map, which reports the percentage of ballots cast in non-precinct settings in 2008, convenience voting is close to becoming the norm in much of the Western and Southeastern U.S. In the 2008 election, nine states—Oregon, Washington, Colorado, Nevada, Texas, New Mexico, Tennessee, North Carolina, and Georgia—saw more than half of voters cast ballots before Election Day, and in another three—Florida, Arizona, and California—between 40% and 50% voters cast their ballots early.

Figure 3

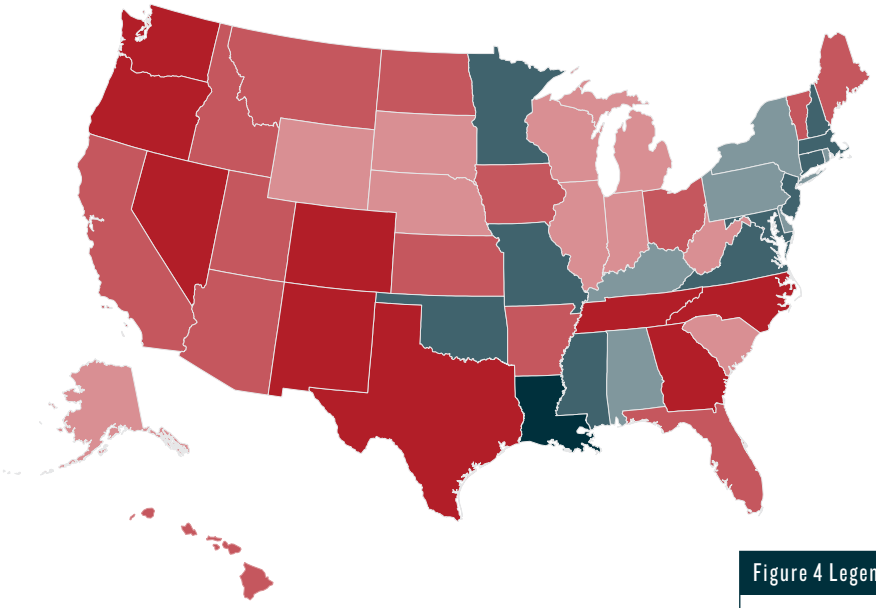
THE GROWTH OF NON-PRECINCT VOTING, 2000–2008



Source: U.S. Census Bureau, Current Population Study, Voting and Registration Supplement, various years.

Figure 4

NON-PRECINCT VOTING IN 2008



Source: U.S. Census Bureau, Current Population Study, Voting and Registration Supplement, various years.

It remains to be seen whether the growth of non-precinct voting will continue into the 2012 election and beyond. Six states reduced the period of early voting in 2011, including the battleground states of Ohio and Florida. On the other hand, a number of states with high levels of early in-person voting, such as Arizona and Utah, have recently passed laws to encourage further precinct consolidation and the use of vote centers for early voting. No state has significantly scaled back the availability of "no excuse" absentee voting in recent years. As we write this report, there are indications that courts might change some of the rules and procedures regarding non-precinct voting in the weeks leading up to the 2012 presidential election.

An unknown effect of the future use of absentee voting arises as a possible unintended consequence of heightened voter ID requirements. Since 2000, more than a dozen states have significantly raised their identification requirements for voting. However, these requirements generally apply only to in-person voting, leaving the much looser set of identification requirements for voting absentee unchanged. It is possible that, as more of these laws become fully implemented in the 2012 presidential election, we will see an increase of voting by mail by individuals who had previously voted in person.

Also lurking over the horizon is the future of the U.S. Postal Service, which is the conveyor of virtually all domestic mail-in ballots. News reports in Oregon and California have documented challenges that election officials have begun wrestling with, due to the closing of mail processing facilities. These closings will certainly delay the distribution and return of mail-in ballots in the upcoming 2012 election. Also, the possible end of Saturday mail delivery will have significant effects on the last-minute return of ballots in time for counting on a Tuesday Election Day. It is already the case that the most frequent reason for absentee ballots being rejected is that they are received after the deadline. The end of Saturday delivery and the closure of mail processing facilities will only serve to increase these numbers.

Voting by overseas residents, particularly members of the military stationed abroad, raises further issues. Overseas absentee ballots played a small role in the 2000 recount in Florida, as one of the minor controversies there was whether to count service members' absentee ballots that arrived after the deadline. However, a variety of factors, ranging from the widespread popular support of the military to interest-group activity, caused interest in these voters—termed UOCAVA voters, after the Uniformed and Overseas Citizens Absentee Voting Act of 1986—to grow over the past decade. Congress also dramatically expanded UOCAVA by passing the MOVE (Military and Overseas Voters Empowerment) Act in 2009. The MOVE Act was aimed at reducing the barriers faced by overseas voters to comply with state absentee-ballot laws, which often were constructed in a way as to make it nearly impossible for ballots to be mailed out to overseas voters and returned in time to be counted.

Assessing the effectiveness of the UOCAVA and MOVE acts has been difficult, in large part because the affected voters do not always identify as falling under provisions of the laws; they often look no different than other people attempting to vote absentee.

From a technology perspective, one of the most important aspects of the MOVE Act is that, by mandating all states deliver voter registration applications, absentee ballot applications, blank absentee ballots, and Federal Write-in Ballots online, states are being pushed a step closer to fully electronic elections. Indeed, some states adapted to the requirements of UOCAVA and MOVE by allowing for the electronic transmittal of *completed* ballots, by email or fax.

More resources must be devoted to studying the hurdles that UOCAVA voters must overcome in order to register to vote, and to the development of procedures and technologies that will address these barriers to fast, reliable and secure registration and voting for UOCAVA citizens.

While we believe that overseas citizens, military personnel and their dependents need the sorts of assistance exercising their right to vote that the MOVE Act promises, we also believe that caution is in order. Research and development efforts are needed so that reliable, accessible, and secure electronic voting technologies can be deployed successfully for UOCAVA voters. More resources must be devoted to studying the hurdles that UOCAVA voters must overcome in order to register to vote, and to the development of procedures and technologies that will address these barriers to fast, reliable and secure registration and voting for UOCAVA citizens.

RECONSIDERING THE ADVANTAGES AND DISADVANTAGES OF NON-PRECINCT VOTING

In 2001, we identified three major benefits of non-precinct voting and five potential dangers. What has the past decade taught us about the advantages and disadvantages of these emerging techniques?

The gains from non-precinct voting that were—and continue to be—propounded were convenience, accessibility, and cost. As a matter of logic, giving voters more ways to vote, *so long as the traditional in-precinct form of voting is not taken away*, should increase convenience (at least among the current set of voters). However, this caveat is critical. Some states have added early voting and liberalized absentee voting without reducing the ability of voters who wish to vote the old-fashioned way to do so. However, the expansion of vote-by-mail and in-person early voting has, at other times, been accompanying by a reduction in access to the polls on Election Day. When this has happened, the results have not always been positive.

> All-mail voting has expanded participation by increasing turnout in elections that have traditionally been low-turnout affairs.

For instance, a recent study—that took advantage of a feature of California election law sets up a "natural experiment" in which some voters are essentially randomly assigned to vote by mail one election but not the next—found the voters assigned to vote by mail were 13% less likely to vote, than voters who were allowed to vote in person on Election Day.[30]

When it comes to expanded in-person early voting, the net benefits seem more promising. First, consolidated vote centers allow election officials to consolidate their expertise and resources. Not only can they rely on less short-term staff than is necessary for traditional precincts, but they can also use their full-time professional staff to handle most of the business that occurs in the vote centers. Second, there is some evidence that voters interact more positively with the election officials they encounter in early-vote centers than in precincts, and that the interactions are less burdened by racial and class distrust.[31] Third, early vote centers are frequently in easier locations for most voters to access, even when they have to travel greater distances to get to them. That is because vote centers are often in places with ample parking, and situated in the places that local residents pass by on their way to school or work each day.[32]

There is little evidence that the rise of convenience voting has led to an expansion of the electorate in general, though there are specific ways in which more non-precinct voting may have increased participation on the margin. (There is emerging evidence, however, that well-placed early-voting centers may help attract some voters.) The most important way that all-mail voting has expanded participation is by increasing turnout in elections that have traditionally been low-turnout affairs, such as local bond and annexation referenda. (In 2001, we could identify 16 states that allowed some form of all-mail balloting, usually for municipal elections. Today, that number has grown to 20.[33]) But for high-turnout elections with state and national consequences, non-precinct methods have become another avenue for political campaigns to lock down their core supporters. More research is needed to determine whether voting by mail has benefits for voters with disabilities.

[30] Bergman and Yates (2011)

[31] Hall and Stewart (2012)

[32] Stein and Vonnahme (2008)

[33] http://www.ncsl.org/legislatures-elections/elections/absentee-and-early-voting.aspx

Fiscal data associated with election administration remains elusive, so we do not know whether non-precinct voting is a money-saver. The most comprehensive recent study on the issue concerned *prospective* savings in Colorado, should it shift entirely to voting-by-mail. Researchers Peggy Cuciti and Allan Wallis concluded that had the 2010 general election been conducted entirely by mail, Colorado counties would have reduced their costs by 19%. This is consistent with our own econometric analysis of actual spending patterns over the past decade in North Dakota.[34] In that state, a county that only uses absentee ballots saves 18% in election-related costs, over counties in which absentee ballots were rare. Major savings in both Colorado and North Dakota come from a decrease in part-time personnel costs, which more than offset increases in printing and postage costs.

The five concerns we raised about the rise of absentee voting were (1) coercion, (2) fraud and security, (3) accuracy, (4) speed, and (5) the loss of the public ceremony of voting. The first two concerns, while different in concept, are rooted in the observation that voting by mail is fundamentally not a secret ballot. Concerns continue to be expressed that voting methods that rely on the mails provide opportunities for people who would like to coerce vulnerable individuals—family members, employees, and institutionalized populations—to inappropriately influence how they vote. Anecdotal evidence arises from time-to-time about such coercion in nursing-home populations, though, to be fair, no evidence exists to verify whether this is a widespread problem. Fraud and security are related to the physical protection of the ballot, and the ease with which absentee ballots can be intercepted or bought and sold. It remains the case that having tens of millions of ballots being transmitted and marked without strict chain-of-custody procedures creates risks that simply do not exist with any form of in-person voting, whether on Election Day or in early-voting settings.

The third issue is accuracy, or the degree to which mail-in ballots are prone to more errors, and higher residual vote rates, than in-person ballots. One clear improvement over the past decade has come with the phase-out of punch-card ballots, since pre-scored punch-cards were especially prone to error and high residual vote rates when used within the absentee-voting context. Overall, data about the residual vote rates of absentee voting, compared to in-person voting, have been limited. The available evidence suggests that absentee voting is more prone than in-person voting to producing residual votes. For instance, members of the VTP team used two decades of data from California to compare in-person and absentee residual vote rates. This study found that the residual vote rate for absentee voters has been 2.2 percentage points higher in presidential races, 3.3 points higher in gubernatorial races, 4.9 points higher in U.S. Senate elections, and 3.0 points higher on ballot propositions than for in-person voters.[35] That study concluded that all the accuracy gains California had made by improving voting machines for in-precinct voting over the past two decades had been balanced out by an increase in the residual vote rate due to the rise of mail-in balloting.

Speed is another factor we identified a decade ago as counting against the use of all-mail elections. The slowness of handling mail-in ballots is not because it typically takes longer to count them—most absentee ballots are counted by scanners. Rather, the formalities associated with absentee ballots make them ripe for a challenge, especially in close races—lessons learned painfully twice in recent years in the state of Minnesota, which endured months-long disputes in the aftermaths of the 2008 and 2010 general elections. In each case, but particularly in the 2008 Senate race eventually won by the Democrat, Al Franken, the large number of absentee ballots in the state, coupled with inconsistent handling of ballots across counties, drew out the vote count.

[34] Stewart and Westgaard (2011).

[35] Alvarez, Beckett, and Stewart (2011).

The loss of public ceremony associated with voting when more voters use the mail-in route is an intangible feature of voting that is difficult to address scientifically. However, one piece of hard evidence has been produced over the past decade that informs this value-laden concern. Immediately following the 2008 election, the VTP team, funded by the Pew Charitable Trusts, conducted the first national survey that focused on election administration, called the Survey of the Performance of American Elections (SPAE). One of the questions asked in that survey was "How confident are you that your ballot was counted as cast?" Among those who voted by mail, 57% answered "very confident," compared with 74% of those who voted Election Day. Voters from Oregon and Washington, the two states with virtually universal vote-by-mail, were the least confident voters across the nation that their votes were counted as cast. What is surprising is that even among in-person Election Day voters, those living in states with higher-than-average absentee ballot usage were significantly less confident that their ballots were counted as cast than Election Day voters living in states that do not use absentee ballots so much. Thus, recent controversies such as the 2008 Minnesota senatorial recount and the 2000 Washington gubernatorial recount (where mail-in ballots played a central role) may have soured voters against the method, even though they are using the method at higher and higher rates.

Finally, in our 2001 report, we were unable to estimate how many votes were lost due to absentee voting, because the data were lacking, and absentee voting was still relatively uncommon. However, since that time, absentee voting has grown, and data sources have gotten better. In addition to the SPAE, cited above, the Election Assistance Commission has begun collecting data about the work flow associated with absentee ballots. Combining all that data, the best estimates we can produce suggest that not only are a larger *percentage* of votes lost through voting-by-mail, but the absolute *number* of votes lost by mail may approach the absolute number lost through in-precinct voting, despite that fact that the ratio of votes cast on Election Day to votes cast absentee is still 4-to-1 in favor of Election Day ballots.

In research reported by one of our team members last year, up to 3.9 million absentee ballots were requested but not received by voters in the 2008 presidential election; 2.9 million ballots that were transmitted to voters requesting them were not returned for counting; and 800,000 returned absentee ballots were rejected for counting.[36] Thus, 35.5 million requests for absentee ballots led to 27.9 million mail-in ballots being counted. This suggests that 7.6 million absentee ballots—21% of all requests—leaked out of the system before counting even began. We can add to this the reasonable assumption that the counted ballots contained an additional 200,000 residual votes, compared to what would have occurred had these ballots been cast in person.

Even if these estimates are off by a factor of 10, it is clear that mail-in balloting faces administrative questions before we can be confident that it is as reliable as the in-person voting methods.

[36] Charles Stewart III, "Losing Votes by Mail." New York University Journal of Legislation and Public Policy, Symposium Issue—Helping America Vote: The Past, Present, and Future of Election Administration, 13.3 (Fall 2010), 573-602.

PART THREE
THE FUTURE

BUILDING A SCIENTIFIC INFRASTRUCTURE FOR ELECTION IMPROVEMENT

More than half a century ago, one of the founders of modern political science, V.O. Key, wrote that "over most of the United States, the conduct of elections is the most neglected and primitive branch of our public administration."[37] Although Key wrote this in 1949, most observers of the 2000 Florida recount might conclude that his observations were still true. A goal of the VTP has been to improve elections through the scientific principles that are at the core of our institutions, so that the conduct of elections in the U.S. could become less neglected and primitive. As we review the past decade, are we closer to this goal, of seeing election administration develop in a more systematic and evidence-based fashion?

We can identify ways in which the science of election administration has been advanced since 2000, and other ways in which efforts have either, or have been taken steps backward. Before delineating the good and the ugly in the science of election administration as it currently exists, we should first sketch out what a scientifically based election administration might consist of, and what an infrastructure to support it might look like.

When we talk of a scientific basis for election administration, we mean the administration of elections that is based on agreed-upon facts that are available for scrutiny by anyone, and where these facts are assessed in a framework of a common understanding of what constitutes professional practice. These two features—evidence and a community of common practice—have been at the core of all scientific endeavors since the Renaissance.

The fact that election administration is prone to being captured by individuals with a political interest—and that judgments are prone to being swayed by political sentiments—makes it important that election administration is removed as far from politics as is practically possible. In the end, some questions in election administration will come down to politically derived values. Our hope is that the number of such questions be kept as small as possible.

States and localities have an important role to play in building the basis for a fact-based election administration, through the publication of election returns, registration statistics, and other data that are the natural byproduct of running elections. All states should report thorough returns of all elections—report results at the level of the precinct, and then break down those results by mode of voting (in-person on Election Day, in-person early voting, and mail-in absentee ballots). Turnout—the number of people who cast a ballot—should also be reported for each precinct, and also by voting mode in each precinct. Through the reporting of election returns and turnout at the precinct level, it is possible to calculate the residual vote rate, which is the basic of diagnostic measure of the performance of voting equipment.

[37] V.O. Key 1949, *Southern Politics in State and Nation*, New York, Random House, p. 443.

Almost all states now report election returns and turnout at the county level—only six states failed to do so in 2008, compared with 19 in 2000—but few report this information at the precinct level, and fewer still do so breaking out voting modes. A decade ago, when some states and localities were still struggling with paper-based accounting systems to manage election data, it was a challenging goal to expect states to do this. Now, with the ubiquity of election management systems that count and organize the reporting of election returns across the country—integrated with Web-based interfaces that help serve up detailed information to anyone who wants it—there is no longer a technological excuse for states and localities not to report this information. The only excuse is administrative and legal inertia.

With the rise of different types of voting, and the expansion of provisional ballots, reporting basic information about the work flow associated with these modes and procedures is critical for transparency in the conduct of elections. In addition to election returns, all states should report the number of provisional ballots given out (along with the reasons) and rejected (along with the reasons), and the number of absentee ballots mailed out, returned, and rejected (along with the reasons). The Election Assistance Commission's (EAC) Election Administration and Voting Survey (EAVS) is now the framework in which such data is reported. In its early days, states struggled to provide basic work flow data such as this to the EAVS project—only 72% of counties reported basic work flow information related to new voter registrations, the sources of turnout, absentee balloting, UOCAVA ballots, and provisional ballots in 2006, a figure that grew to 85% in 2008 and 95% in 2010.[38]

The final source of information that needs to be made public on a regular basis is the cost of elections. This is the one area of election data reporting that has become no more transparent since we published our original report in 2001. North Dakota remains the only state that collects cost data from its local jurisdictions in a consistent, systematic way statewide, and publishes the statewide totals on the Web.

A wise person long ago observed, "data is not information, and information is not understanding." The reporting of basic election data is an important first step in raising the standards for assessing and improving how elections are conducted in the United States, but it is still only a first step. To turn election data into information, a community of practice must be built up to help provide a framework in which the data might be understood, standards might be set for the creation and dissemination of data, and best practices for the conduct of elections might be established and disseminated.

Such a community of practice rests on institutions that carry on with the business of improving election administration long after reform enthusiasm has waned. Here, we emphasize two such types of institutions: a national commission, and a national network of researchers and educators.

A decade ago, we recommended that the office within the Federal Election Commission (FEC) that served as a clearinghouse for election administration and sponsored an informal voting systems standard either be expanded, or be spun off to create a separate federal agency. HAVA responded to this recommendation, and others like it, by creating the Election Assistance Commission (EAC), to assist in the search for solutions to the shortcomings of election administration. It also initiated a one-time grant program that helped states replace inferior voting machines and create modern computer-based voter registration systems.

The EAC's efforts to improve voting systems paid off. Because of the voting technology replacement program, the number of votes lost because of malfunctioning voting machines has dropped by two-thirds. Voting registration problems have begun to be addressed. And, the EAC has begun disseminating best practices in various areas of election administration.

[38] Pew Center on the States, *Election Administration by the Numbers: An Analysis of Available Datasets and How to Use Them*, February 2012, p. 13.

However, the EAC has also accumulated enemies, for a mix of reasons. While in its infancy, the EAC's chair was quoted in such a way that suggested his agency should develop contingencies for canceling federal elections in the event of a national emergency. It also got entangled in the brewing controversy over whether voter impersonation fraud was a major problem in this country. These blunders, along with a general distrust among the state and local election administration community when it comes to federal involvement in election administration, has led to efforts to abolish the EAC. The U.S. House of Representatives passed a bill in 2011 to accomplish just this—a bill that died in the Senate.

Outright abolition of the EAC would be a mistake. Doing so would leave no federal agency responsible for collecting and disseminating data about elections and voter registration—a function that even opponents of the EAC seem reluctant to curtail. It would also leave in limbo the voting systems standard process, which many states depend on.

Instead of abolishing the EAC, Congress should revitalize its leadership and encourage it to adopt new strategies. These efforts would help it play a more active role in providing the best information about election administration to states and localities.

» The EAC should continue its efforts to insist that election jurisdictions report basic election information, such as voter turnout, in a timely and detailed fashion. This will help build overall confidence in how local officials are running elections.

» The EAC should be the leader in developing data standards and work procedures to facilitate the linking of voter registration lists across states and government agencies, so that more eligible voters can be registered and that fewer ineligible names remain on the rolls.

» The EAC should lead the way in developing standards of geocoding the location of polling places, so that local governments and private vendors can develop electronic applications to guide voters to their polling places.

» The EAC should work with state and local governments to develop common accounting standards and financial vocabularies, so that the costs of running elections can be tracked better, and so that towns and counties can better understand their financial performance.

» The EAC should help establish standards for authenticating elections through standardize auditing techniques.

The place to start is appointing new commissioners to fill the current vacancies on the EAC. One new commissioner should have experience leading research-and-development organizations, whether business, government, or university. Next, the EAC should learn from the experience of Great Britain's Electoral Commission, which is a highly respected source of best-practices research in a nation that also has sharp political divisions. Finally, the EAC should learn from other government agencies, such as the FDA, that are responsible for aggregating scientific findings into policy recommendations that can be politically charged. One successful practice the EAC could easily adopt is the creation of ad hoc expert panels, drawn from a variety of perspectives, to establish best practices and benchmarks in various aspects of election administration.

The final institutional resource we advocate is the creation of a more robust network of academic and applied researchers, dedicated to the improvement of voting technology and election administration across the country.

When we began our project more than a decade ago, there was not much scholarship that we could use to frame and base our own research. Fundamental questions about how to measure the accuracy, reliability, security, and usability of voting machines were really not well developed, nor were there studies of polling places, pollworkers or election administration. The lack of a scientific infrastructure for studying voting technology and election administration meant that in many ways those of us who were studying these topics after the 2000 presidential election were forced to develop new measurement approaches, and to find ways to deploy scientific methods from other fields to the study of the many questions we asked about elections in the United States in late 2000.

As we look back at the explosion of research in the past decade, we see that a new science of elections is developing. As it is documented in other components of this report, the VTP itself has involved dozens and dozens of undergraduate and graduate students in our research and policy work—and our collaborations have expanded beyond our two campuses and even outside the borders of the United States. VTP researchers have published more than a hundred working papers on our website, and have presented our research at a vast array of conferences (both domestic and abroad), and we have published most of our work in peer-reviewed academic books and journals.

But the new science of elections is bigger than the VTP, and now it is common to see studies about voting technologies or election administration in mainstream academic research journals—and presented at important research conferences—from scholars and students at a broad array of colleges and universities. Prominent academic societies and institutions have helped us, and other scholars stage panels, workshops, and conferences on the many different areas of new scholarship that have developed since the 2000 presidential election.

A model for this is the Agriculture Department's Cooperative Extension Service, a research-based network, centered in state land-grant colleges, which disseminates practical scientific knowledge in agriculture and other subject areas relevant to rural America. An Electoral Extension Service, similarly headquartered in each state's land-grant colleges, could help disseminate new ideas about managing elections in the United States.

RECOMMENDATIONS

As we have studied the areas where progress has been made since 2001, and where progress has stalled, we have developed the following recommendations. All have been discussed earlier in our report, and we summarize them here. They are not in priority order.

First, regarding voting technology, we recommend:

» Legislation mandating effective election auditing, which at a minimum would require post-election auditing of all voting technologies used in an election.

» Continued strong support for voting systems security research, emphasizing auditing and the verifiability of election outcomes.

» A movement toward mandating statistically meaningful post-election audits, rather than setting security standards for election equipment, as the primary way to safeguard the integrity of the vote.

» A new business model led by states and localities, with harmonized standards and requirements.

Second, regarding voter registration, we recommend:

» Streamlining the provisional balloting process in many states and the creation of common best practices and voluntary standards across states.

» The development of voter verification systems in which states bear the cost of stringent voter ID regimes, in those states that desire to increase ID requirements for in-person voting.

» Continued standardization of voter registration databases, so that they can be polled across states.

Third, with respect to polling places and pollworkers, we recommend:

» Continued improvement of pollworker training and more reliance on network technologies to facilitate pollworker training.

» Development of applications deployed on mobile devices that bring more information to pollworkers, and transmit real-time data about Election Day workloads back to the central voting office and the public at large.

» Increased functionality of electronic pollbooks and their wider adoption.

» Development of applications that gauge how long voters are waiting in line to vote, so that wait times can be better managed and reported to the public.

Fourth, regarding absentee and early voting our first two recommendations repeat those we issued a decade ago; the third is new:

» Discourage the continued rise of no-excuse absentee balloting and resist pressures to expand all-mail elections. Similarly, discourage the use of Internet voting until the time when auditability can be ensured and the substantial risks entailed by voting over the Internet can be sufficiently mitigated.

» Require that states publish election returns in such a way that allows the calculation of the residual vote rate by voting mode.

» Continue research into new methods to get usable ballots to military and overseas civilian voters securely, accurately, and rapidly and to ensure their secure return in time to be counted.

And, finally, regarding the infrastructure and science of elections:

» Continued development of the science of elections.

» Continued, and expanded, support for the research functions of the Election Assistance Commission.

» Development of an Electoral Extension Service, headquartered in each state's land-grant colleges, to disseminate new ideas about managing elections in the United States.

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PERSPECTIVES

PERSPECTIVES

In this section we provide eight short essays from Doug Chapin, Dana Chisnell, Paul DeGregorio, Dean Logan, Noel Runyan, Peter Ryan and Thea Peacock, Michelle Shafer, and Pam Smith. Each has a lengthy involvement in election administration and voting technology.

We sought their perspectives because the VTP has worked over the years to facilitate open discussion and deliberation about how to study and improve election administration and voting technology. By providing their perspectives along with our own, we wish to demonstrate that there are other views of the same issues that we have discussed in this report, but we also note that there are commonalities between our views and each of those represented here. All of the authors here wish to improve the administration and technology of elections.

These essays are written from the unique perspective of each author—we asked that they "focus on what you see as the most important challenge facing election administration and voting technology in the next decade." The essays were written independently of the VTP, and represent the opinions and perspective of each of these authors. We have not edited these essays, and they do not represent the opinions or perspectives of the VTP.

DOUG CHAPIN

On Building Better Vote-Traps: Voting Technology and Elections After 2000

In the aftermath of the 2000 Presidential election —where punch-card voting, butterfly ballots and hanging chads created a controversy that took a 5-4 majority of the U.S. Supreme Court to resolve—it was perhaps inevitable that voting machinery would play a starring role in efforts to reform America's election system.

Indeed, after Congress enacted the Help America Vote Act of 2002 (HAVA) voting technology became, in many ways, the driving force behind the reform debates of the next few years. Armed with the promise of nearly $4 billion in federal funds courtesy of HAVA, states and localities across the nation set out to replace and/or upgrade their voting machines in the hopes of addressing many of the problems that had surfaced in Florida and elsewhere in November 2000. The unspoken premise was that the challenges facing the U.S. election system were primarily technological and that by building better machines—"better vote-traps", if you will—the entire process would show improvement as new technology showed the way to adoption of new best practices in election administration.

We now know (with the benefit of hindsight, of course) that those assumptions were wrong. In fact, I would suggest that since the 2000 election and enactment of HAVA, election administration has changed voting technology more than the other way around.

For example, as states began to spend their HAVA funds, a fierce debate erupted immediately over the security of voting machines, especially the new breed of touchscreens that had essentially been endorsed for state and local purchase by HAVA. For the next several years these arguments raged on, involving election officials, advocates for the disabled, computer scientists and even the political parties. These debates led many jurisdictions to rethink their voting technology decisions, with the result that the majority of the country now uses paper-based optical scan voting rather than touchscreens.

Partly because of this, the voting technology industry—which had (reasonably) expected to ride the federal funds included in HAVA to steady business and profits—was forced into a period of consolidation and restructuring, emerging as a smaller group of companies emphasizing the sale of services instead of products. It didn't help, of course, that Congress never fully funded HAVA; add to that the general scarcity of funding of any kind after a recession and resulting tough fiscal times at every level of government and it's easy to see why voting technology was no longer the sure thing it appeared to be in the wake of HAVA.

It wasn't just budgets that were changing, however. In the years since enactment of HAVA, the field of election administration has evolved in a number of significant ways that has had a ripple effect on voting technology in America.

The first is the growing adoption by election officials (and embrace by voters) of alternatives to the traditional neighborhood polling place. Since enactment of HAVA—and especially in the last 5-6 years—we have seen an explosion in the number of voters who are using absentee ballots, vote-by-mail, early voting and vote centers to cast ballots rather than visiting a local precinct. In 2008, various estimates suggested that as many as one in three voters cast their ballots before Election Day, and those numbers are likely to climb even higher in 2012 and beyond.

Growing adoption of non-precinct-place voting (NPPV) has stretched election administration temporally (i.e. before Election Day) and geographically (outside the neighborhood precinct), but most significantly has added multiple modes of voting to the process in numerous jurisdictions. In this environment, voting machines that assume every voter will be casting an Election Day ballot in a neighborhood polling place risk becoming obsolete. As NPPV expands and ballots begin to arrive from voters at different times and in different forms, election officials are looking for voting technology to help them manage the flow—and give voters the flexibility they crave.

An important corollary to this development is the newest federal voting law, the Military and Overseas Voter Empowerment (MOVE) Act of 2009. MOVE's requirement that military and overseas voters receive ballots well in advance of Election Day—and its encouragement of the use of technology to aid the process—is reviving interest in the notion of Internet voting. Those developments, and the debate they engender, will almost certainly affect the next generation(s) of voting machines.

A second driving force shaping the future of voting technology is the growing desire for votes—and the entire voting process—to be verifiable after Election Day. In this environment, pre-election testing and certification (traditionally the foundation of voting technology laws and procedures at the federal/state level) is not as important as post-election auditing to ensure that votes were counted as cast. As the auditing groundswell grows, however, it is sparking conflicts between transparency advocates and election officials about whether voter privacy can be compromised in an audit. As a result, you can expect lots more discussion in the months and years to come about how to use technology to ensure that voters' choices were honored without revealing those choices.

A second driving force shaping the future of voting technology is the growing desire for votes to be verifiable after Election Day.

Finally, the field of voting technology is being shaped by the increasing focus on the voter as the ultimate "customer" of the voting experience. Americans' access to mobile devices like smartphones and tablets—combined with expanding access to on-demand data—is driving business and government providers alike to find ways to make any transaction "user-friendly"; that is, clear and straightforward for the individual as opposed to the provider. In the field of voting, we're seeing this in the spread of online voter registration as well as in the proliferation of lookup tools that harness the power of Internet and social media to help voters get the answers that they need about voting.

This voter-focused approach is driving an intense interest in the concept of design to create voting interfaces (whether on print, on a voting machine or online) that allows a voter to cast her ballot as intended. Indeed, "design thinking" isn't just looking at words and pictures on a page; it's also being used in places like Los Angeles to envision a voting process that works for voters of all languages and abilities. These efforts will require everyone associated with voting technology to rethink just about everything involved with voting technology, from the nuts and bolts of the machines to the laws and regulations that govern the "look and feel" of the election process.

Looking back at the decade-plus since the 2000 presidential election and enactment of HAVA, the relationship between voting technology and election administration is reminiscent of the last line of the 1970 classic *Ball Four* by former major league pitcher Jim Bouton: "You spend a good piece of your life gripping a baseball and in the end it turns out that it was the other way around all the time."

The same idea in the field of elections—namely, that voting technology doesn't affect election administration as much as it is the other way around—is a powerful notion that helps make sense of much of what has occurred in the last 10-12 years. It's also a vivid reminder not to put too much stock in better vote-traps as we look for ways to improve the American election system for the next 10-12 years and beyond.

Doug Chapin

DOUG CHAPIN is the director of the Election Academy at Minnesota's Humphrey School of Public Affairs. Chapin came to the Humphrey School after 10 years at The Pew Charitable Trusts, where he served as director of Election Initiatives for the Pew Center on the States. Under his leadership, Pew's elections team successfully lobbied for enactment of military and overseas voting reform in Congress and state legislatures; enlisted dozens of states and technology partners like Google, Microsoft, and Facebook to provide official voting information online and via mobile technology; and worked with election officials, academics, and technical experts to design and implement efforts to upgrade the nation's voter registration systems. Prior to serving at Pew, Chapin was an attorney in private practice specializing in election and ethics law. He served as elections counsel to the Democrats on the U.S. Senate Rules Committee from 1997 to 2000, where he focused on federal election legislation and participated in the review of the disputed 1996 Senate election in Louisiana. He holds a law degree from Georgetown University, a master of public administration degree from Harvard's John F. Kennedy School of Government, and an A.B. in politics from Princeton University.

DANA CHISNELL

Democracy is a design problem

Here we are in 2012, and voting is astonishingly difficult in the United States.

Leaving off questions of voter ID, once voters get to the polls, there are dozens of ways votes are left in the voting booth. Almost all of them have to do with design and usability of the ballot and the voting system.

Twelve years after the "butterfly" ballot of Palm Beach County and 10 years after the Help America Vote Act provided funding to replace mechanical lever machines and punch-card voting systems, all states do have new systems. But not every voter gets a ballot that makes it easy for her to carry out her intent.

The physical act of marking the ballot isn't difficult for most voters. Tap a screen, fill in a bubble or a box, connect an arrow. But poor or lacking instructions and confusing visual design and navigation can leave some voters wondering whether what they've done is correct and others may be completely unaware that they've made mistakes. For voters with disabilities, while it is possible for many to vote privately and independently, the task is not as accessible and easy as it could be.

But voting is so much more than putting a mark on a ballot. There are dozens of factors within the design of voting systems and ballots that prevent voters from voting as they intend. The large body of research from the last 10 years shows us that all voters make mistakes when they vote. Even experienced, well-educated voters.

NEW SYSTEMS HAVE NOT CURED LOST VOTES

Electronic voting systems haven't cured lost votes. Although computer-based voting systems prevent voters from voting for too many candidates in one contest, they don't prevent unintended under voting. The mid-term election for US representative in congressional district 13 in Sarasota County in 2006 clearly demonstrates the problem.

The contest was close all through the campaign. And yet, 13.9% of voters who cast a ballot Sarasota County did not vote for their Representative to Congress. Typically, the rate of voters not voting in a contest like this one is 2-5%. In neighboring Charlotte County, also in the same congressional district, using the same voting system, the undervote rate for that contest was normal, about 2.5%. What happened?

In Sarasota County, the congressional race appeared on the same screen as the state contest for governor, with the contest for representative at the top, and the gubernatorial contest below taking up about two thirds of the screen space below it. The congressional contest appeared on its own screen in Charlotte County. It showed a normal rate of voters not voting in the contest. But the contest for attorney general appeared at the bottom of the same screen as the gubernatorial race. The undervote rate for attorney general in Charlotte County was 20.9%.

Voters simply missed the congressional contest in Sarasota County, and the attorney general contest in Charlotte County. Several investigations cleared the voting systems of software, hardware, and security issues. This episode illustrates a series of design choices that point to serious usability problems. These usability problems could have been detected and remedied before Election Day, with a small, inexpensive usability test. Sarasota CD 13 is just one example from the last 10 years of detectible design and usability problems going undetected until Election Day or later.

Some of what we know about what makes good ballot design comes from post hoc analyses, many of which come in the form of recounts, such as Sarasota County's CD 13 contest in 2006 and the Minnesota Senate recounts in 2008. There has also been considerable academic and independent behavioral research about what makes ballots and voting systems usable. We have learned a great deal just by observing thousands of people individually using ballots and voting systems in usability studies.

For example, we know that on a paper optical scan ballot when you split a long contest over two vertical columns people are prone to vote twice. In ballot designs where response areas for marking the ballot line up on either side of candidate names, people vote twice. Voting systems that use arrows rather than bubbles to designate selections cause voters to mark the ballot improperly, leaving votes uncounted by tabulators. Ballot designs that make it difficult to tell what is a contest versus an instruction, or to see how many choices are allowed, or to tell the differences in types of contests—all cause voters to miss their chance to cast a vote.

Poor design and instructions on ballots make understanding, marking, and casting difficult, time-consuming, and complicated. But poor design and instructions also make counting, canvassing, and verification difficult, time-consuming, and complicated. Poor usability for voters shows up in lost votes. Poor usability for poll workers and election administrators adds to expense and degrades security.

With new systems the recounts didn't end. The close margins didn't end. The lost votes didn't end. In fact, with every new voting technology, we introduce new ways to lose votes.

RESEARCH-BASED GUIDELINES AND BEST PRACTICES HELP

There has been substantial progress in design and usability in elections. There are excellent, research-based guidelines and certification tests from the Election Assistance Commission (EAC) and the National Institute of Standards and Technology. The publication in 2007 by the EAC of Design for Democracy's *Effective Designs for the Administration of Elections* was the first time a Federal agency had investigated and provided design direction in voting.

Over the years, local election officials have begun to see the importance of good design for voters, poll workers, and election administrators. There has been gradual but spotty improvement not just in the design and usability of ballots, but also in other voter-facing materials, such as voter registration forms, sample ballots, signage, and in-booth instructions. Even the Federal Voting Assistance Program has redesigned the Federal Post Card Application and the Federal Write-in Absentee Ballot used as a "back up ballot" by military and overseas citizens.

Most of the design improvements in the larger "voting system" come from the desires of individual election officials to eliminate frustrations for voters and improve the administration and operation of elections. They are empowered when they see the benefits of making it easier for voter to vote the way they intend: recounts are less likely, and when there are recounts interpreting votes is easier; poll workers do a better job of serving voters and opening and closing the polls; processing vote-by-mail ballots is smoother and more efficient.

TOOLS AND SKILLS HELP

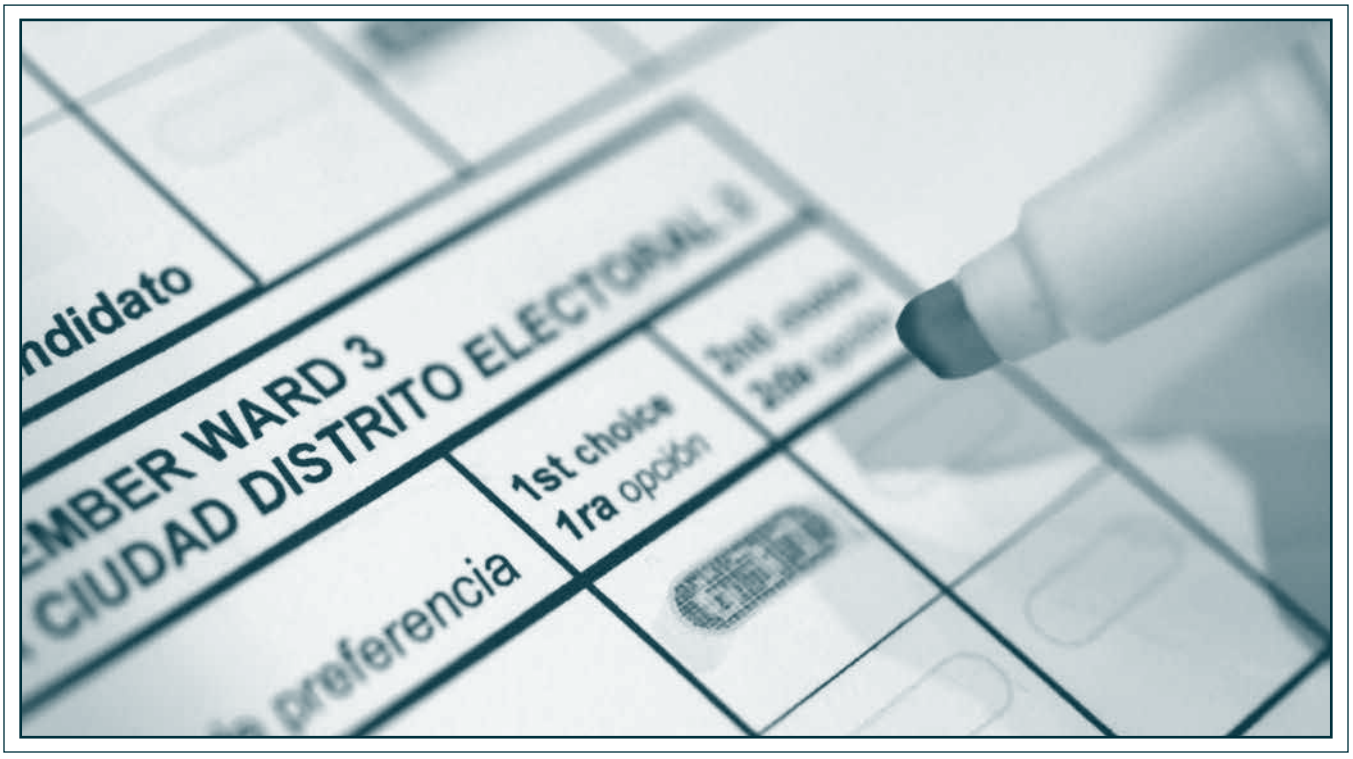
Gradually, states are seeing the benefits of good design in elections, too. We've seen more sessions on ballot design, plain language, and usability testing at state conferences and in continuing education that states offer to county election officials. Design and usability are dominant themes at election-related conferences in presentations about online voter registration and blank ballot delivery systems. Guidelines and best practices have become more practical, more available, and more implementable. Election officials are working hard to do the best design they can do within the many constraints they face.

TECHNOLOGY AND LAWS LAG BEHIND BEST PRACTICES

One of the major constraints is voting system technology. Unfortunately, most voting systems did not support the best practices when the EAC report came out in 2007, and, unfortunately, most of them don't now.

Legislation in most states has not reformed to support best practices. There are regulations in nearly every state that embed ballot design—typeface, type size, capitalization, grid, use of bold, italics, shading, illustrations, and the wording of instructions—in election code.

In addition, budgets for running elections are getting smaller rather than larger at a time when the voting systems HAVA funded are wearing out and need to be replaced. Local election officials are being asked to do more with less every year.



PRESSURES TO SAVE COSTS ON ELECTIONS INTERACT WITH UNRESOLVED USABILITY AND ACCESSIBILITY PROBLEMS

As we look out to the next major elections, there are some trends that have important implications for design and usability:

» More counties will have to provide ballots in languages other than English as the multi-lingual population grows. There is little research about the effects of including multiple languages on the same paper ballot. Local election officials are looking for guidance about how best to design ballots and other voter-facing materials.

» The largest ever cohort of voters will be in their 60s, 70s, and 80s, and with their wisdom will come age-related declines in vision, dexterity, mobility, and cognition. We're getting quite good at building accessibility in for physical limitations. But we don't know a lot about designing ballots and voting systems to assist people who have cognition problems and low literacy. In addition, hundreds of thousands of troops are returning from service in Iraq and Afghanistan who suffer from posttraumatic stress disorder and blunt force brain trauma. These health problems are difficult to detect, diagnose, and treat—and they affect cognition, which makes apparently simple tasks like voting difficult.

» States will implement liberal use of convenience voting and voting by mail to make it easier for people to vote, and to save money on administering elections. Mobilizing millions of poll workers across the country for a major election is extremely costly. But we know that voters make more mistakes when they vote outside the polling place.

» Jurisdictions will experiment with alternative counting methods such as instant run-off voting. As pressure to minimize costs in conducting elections increases, the idea of automating run-off elections rather than holding separate, live elections will become more appealing. But exploratory studies show that most voters don't understand how their votes are counted under these systems, and this can result in their voting *counter* to their intentions.

Working on any one of these trends to minimize lost votes will be challenging. Looking at how the elements interact is an even greater challenge.

The butterfly ballot was the first attention-getting "canary in the coal mine" of elections—a warning sign that elections are complex, with dozens of interacting elements any one of which has the potential for changing the outcome of elections. So many of the important stories about elections over the last decade stem from solvable usability problems. Now is not the time to dissolve the agencies that make standards, certification, and good design possible. There is still much to do to ensure that every voter can vote the way they intend, and that those votes are counted as cast.

Dana E. Chisnell

DANA E. CHISNELL is an elections nerd who has trained thousands of election officials to test the design of their ballots. She's the lead on a project to develop a series of Field Guides To Ensuring Voter Intent. The Field Guides, originally funded by a Kickstarter project, are designed to be quick, easy, and accessible help for local election officials to do the best possible design. She won a MacArthur grant in 2012 to expand the Field Guides series.

She also worked with Dr. Janice C. Redish on a 2-year, in-depth study looking at ballot instructions that established best practices for the use of plain language in ballots. San Francisco's former mayor Gavin Newsom appointed her to the country's only body chartered with writing clear, objective, and unbiased summaries of ballot measures to be included in Voter Information Pamphlets for each city-county election. In 2007, the AIGA sought Dana's expertise on the research methods behind their groundbreaking Design for Democracy project.

PAUL DEGREGORIO—FORMER CHAIRMAN, U.S. ELECTION ASSISTANCE COMMISSION

It's Time To Embrace Modern Technology In Our Elections

Ten years ago, in response to the intense scrutiny of the administration of elections following the 2000 presidential election, the United States took a major step towards improving the administration of elections with the bi-partisan passage of the Help America Vote Act (HAVA). The $3.7 billion dollars given under HAVA was a much-needed incentive to move towards modernization of the election process in the United States. It was an extremely important step since it was the first time that the Federal government had given funds for elections to States and local jurisdictions. Additionally, HAVA created the bi-partisan U.S. Election Assistance Commission, of which I was the first appointee and subsequent chair.

During my tenure, the EAC was truly a bi-partisan body, with a real spirit of cooperation and progress, and almost no partisan vote splits. We made significant progress where it was sorely needed. The Commissioners, two Republicans and two Democrats, believed strongly that the partisan debates so common in Washington needed to be put aside in favor of embracing the spirit of the task we had been entrusted to carry out. The EAC instituted Federal (but voluntary) voting system guidelines and pushed hard to provide the disabled community with the privacy and independence they deserved while voting. We instituted a solid certification program and brought together election officials and other important stakeholders to produce excellent best practices that election officials from all over the country have used to better serve their voters.

Regrettably, in recent years the EAC has been nearly eviscerated by the usual Washington DC partisan bickering. The appointment of commissioners who put political party agendas first and allowed the EAC to be used for partisan purposes greatly contributed to its demise. The collegial and cooperative atmosphere of the Commission's first years was, regrettably, left behind. The result has been a failure to update voting system guidelines from the first version we adopted in 2005. The certification of voting systems has also been slowed considerably. With no EAC commissioners in place during a crucial presidential election year, there is no independent and bi-partisan national leadership in place to highlight and address important election administration issues.

In recent years the EAC has been nearly eviscerated by the usual Washington DC partisan bickering.

I believe our two greatest challenges in the field of election administration today—and in the next 10 years—are: 1) embracing new technology that can provide election officials with greater flexibility in serving their voters and reduce election administration costs; and 2) the need for bi-partisan collaboration in the debate and development of public policy regarding our election laws—the kind of collaboration we experienced with the passage of HAVA and was clearly displayed during the first few years of the EAC.

When U.S. voters go to the polls this November, most will use paper and pencil to make their selections. Voting with pencil and paper is prone to mistakes in interpretation of voters' marks. (Just research any recount using optical scan ballots to see how subject to interpretation they really are.) Paper balloting, with requisite printing, storage, transportation and security costs, is also expensive. Printing one optical scan paper ballot cost can cost well over $1.00. Except for Presidential elections that have higher turnouts, many election officials are wasting much-needed funds by having to throw away large number of ballots they print but never use. Of course most officials don't dare to print too few ballots for fear of running out. Few things are more damaging to an election official's credibility than an insufficient number of ballots.

My 8-year-old granddaughter Victoria—who will be able to vote in ten years—recently showed me how I can download free apps and organize my iPad. She has mastered her mother's iPhone and taught her 3-year-old brother how to easily find Spiderman videos on YouTube. Ten years from now, when Victoria goes to the polls for the first time, if she is given a paper and pencil to cast her ballot I am certain she will say "this is lame."

And, Victoria will be right.

Technology is changing our lives every day. We can use voice commands to control our phones, our televisions and even our cars. We can check our bank accounts, pay bills and order anything we want with ease from different locations using many devices. Within minutes of completing my annual physical, I now go to a website to obtain my results and compare them with results from the past ten years on graphs and charts.

Yet in most states you cannot register to vote or change your name or address online. Nor can you access your ballot electronically unless you are a military or overseas voter. And, some election jurisdictions still take days and even weeks to get us the results from the election; with some of their web pages making it difficult to decipher the vote counts.

Since the recession of 2008 and reduction of tax revenues, election officials have had to do more with less. Tight budgets have led to the consolidation of polling places, causing many voters to travel further to cast ballots (at higher personal cost, due to high gas prices and increases in transit fares). Aging voting devices and software that have not or cannot be updated because of outdated regulations have led to fewer voting devices at the polls that can read those paper ballots. In most election jurisdictions voter registration documents are still being entered by hand and most voters will see poll workers looking their name up manually using a list printed on hundreds of pieces of paper.

With the technology that is available today, it doesn't have to be that way.

While the trend from 2005-2008 was back to paper, the good news is that in recent years election officials are realizing that in time of tight budgets and ever-changing technology, there are better ways to serve voters. Those methods include modern technology and the Internet.

A few states and many local jurisdictions are bucking the naysayers and using technology to their advantage—and serving their voters more efficiently in the process. In the State of Washington, Secretary of State Sam Reed pioneered online voter registration in his state—and the results were phenomenal. Some jurisdictions are using electronic poll books to check in their voters.

Wouldn't it be nice if voters could receive email reminders from election officials on how they can cast their ballot? How about if they could go to a polling place of their choosing, swipe their ID, have their ballot come up and cast their ballot then and there using a touch screen? Better yet, wouldn't it be nice if they could cast their vote on a day and time of their own choosing and from the comfort of their own home—or anywhere for that matter? Election officials would not have to print paper ballots, many of which (if not most) often go to waste. They would also save precious funds on polling places and outmoded counting devices. They wouldn't have to struggle to recruit the wonderful—but hard to find—poll workers who have to work 14-16 hour days to serve voters.

Technology exists today that can do all that. More election officials are taking notice and implementing modern practices, despite the protest from a small but vocal minority who want us to continue to vote in the Stone Age.

Organizations like the Election Center, International Association of Clerks, Recorders, Election Officials and Treasurers (IACREOT), National Association of State Election Directors (NASED), National Association of Secretaries of States (NASS), and the Association of European Election Officials (ACEEEO) are all discussing and highlighting the "what could be" in the field of elections.

Secretaries of State in Colorado, Oregon, West Virginia and Washington State have taken the lead on allowing their voters use modern technology and devices. Dozens of local election officials in the U.S. and other countries are pioneering the use of new technology in their offices—and allowing more flexibility on where voters can cast their ballots. Oregon Secretary of State Kate Brown even let voters mark their ballots on an iPad, something my granddaughter Victoria would applaud.

Thanks to the 2009 passage of the Military and Overseas Voter Empowerment Act (MOVE), our U.S. overseas voters now can request to receive their ballot electronically. This simple—but important—change has resulted in thousands of military and overseas voters finally having their ballot received and counted on time. Disabled voters (and all voters for that matter), should be given the same rights and opportunities as military and overseas voters and should be able to obtain their ballots electronically. Language in the Voter Empowerment Act, introduced in 2012 by Congressman John Lewis of Georgia, is a step in the right direction and will encourage pilots that would empower disabled voters by allowing them to vote from home using their own devices—including the telephone.

Of course there are the naysayers to progress and change. They believe paper and pencil is the answer to everything; that technology is not our friend—and that it cannot be trusted—under any circumstance. I dealt with such naysayers during my time on the EAC. As Chairman of the EAC in 2006 I went on national TV to defend the use of electronic voting devices. I had to explain how such devices have empowered disabled votes as never before, and that studies had proven they prevented thousands of voter errors.

So what can we do to encourage the use of modern technology so that my granddaughter doesn't have to use a paper and pencil to vote in 2022?

We can start by fixing the EAC. Appoint to the EAC practitioners with real election administration experience—not people with political agendas. Across this country there are hundreds—if not thousands—of excellent election officials representing both political parties who would proudly serve with distinction. A revitalized and non-partisan EAC could produce voting system guidelines for modern technology—and not for devices that were developed in the 1960s. They could also share modern best practices with the 7000 election officials in the country—so most would not have to reinvent the wheel to save funds.

Congress should provide a mechanism to give no-strings-attached grant funds to the states and to local election officials to try new and modern methods to serve voters and encourage greater participation. State legislatures and local governments, most of whom cast their votes on bills using an electronic device, should give their election officials the authority to modernize their election practices and try pilots that could allow voters to register to vote and cast ballots much more easily—and securely. That includes giving election officials greater flexibility to use commercial off-the-shelf (COTS) software and hardware to serve their voters.

Of course we should be concerned about fraud. Fraudulent votes negate valid votes. Modern technology can make it easier to confirm legitimate voters and also catch those who are trying to vote illegally. Election officials should be provided with funds to give them the ability to easily check their voter lists against deceased and non-citizen lists. In many states this process takes months to complete. States should have adequate funding and the ability to check voter rolls against other states immediately. You can be sure they'll be another article this year on how thousands of voters are registered in Florida and New York simultaneously. With modern technology, this simply doesn't have to be.

We shouldn't need another Florida 2000 to jump-start reforms. The need is there now.

I realize that we are in a period of deficits and limited Federal, State and local funding. However, it has been clearly demonstrated in the private and public sector that using modern techniques and procedures can save significant funds in the long run. When billions of dollars are spent on foreign aid to help other democracies grow (which I strongly support, by the way), surely Congress can and should come up with a few million to improve elections in the U.S. And, even in times of limited budgets, State and local governments need to continue to invest in our democracy.

It is my hope that I will be visiting my granddaughter Victoria at her college 10 years from now and she will tell me "Papa, I just registered and voted online. It was easy."

Paul Degregorio

PAUL DEGREGORIO has served as commissioner and chairman of the U.S. Election Assistance Commission (EAC), Chief Operating Officer and technical consultant for the International Foundation for Election Systems (IFES) and as an election expert and mission chief for the Organization for Security and Cooperation n Europe (OSCE). In addition, during his career DeGregorio was appointed Director of Elections for St. Louis County, Missouri, Director of Outreach for the University of Missouri-St. Louis, Co-Chair of the Missouri Commission on Election Reform and member of the St. Louis County Charter Commission. He current serves of the Chief of Elections for Everyone Counts, a U.S.-based company that provides modern technology expertise and solutions in the field of election administration. Among DeGregorio's numerous awards includes a Distinguished Alumni Award from the University of Missouri-St. Louis.

DEAN C. LOGAN—REGISTRAR-RECORDER/COUNTY CLERK, LOS ANGELES COUNTY, CALIFORNIA

Help America Vote Act: A Retrospective & Vision for the Future

When Congress passed and then President George W. Bush signed into law the Help America Vote Act[1] in October of 2002 it represented a significant shift in the way in which elections are administered and funded in the United States. It was a time of anticipation and opportunity as the nation recognized all at once the power of a single vote and the vulnerabilities associated with that power. Reflecting on the ten years since enactment, there is much that has occurred and much that remains to be addressed.

On the heels of the historic 2000 Presidential election countless commissions, task forces and study groups dissected and diagnosed the intricacies of America's electoral infrastructure. Volumes were published citing the need to modernize voting systems, provide better funding for elections, improve accessibility, safeguard against corruption and work to increase voter participation.

Congress spoke loudly and soundly in response, calling for swift and meaningful reform. For the first time in our nation's history, federal funding—significant funding—was allocated to the states with the promise of centralized statewide voter registration data bases, failsafe voting, accessible polling places and new voting equipment that would simultaneously assure accuracy, expand access and prevent fraud.

A new federal agency was created to provide the necessary oversight. The United States Elections Assistance Commission (EAC) was established and charged with overseeing the accountability of the funding allocations, regulating the commercial voting systems market, adopting standards for the development of modern voting systems and creating a clearinghouse of election-related data and best practices.

This unprecedented federal action was all premised on conclusions that the razor thin outcome of the 2000 Presidential contest was the result of an underfunded, weak and decentralized structure of elections administration; outdated systems and equipment used for casting and counting votes; inadequate technology standards; and a lack of federal support and oversight.

Now on the eve of the third Presidential election since the historic United States Supreme Court decision in Bush vs. Gore[2], it seems appropriate to step back and reflect on our nation's performance delivering on the promise of the Help America Vote Act. Without question, the ten plus years since the passage of the Act have been characterized by change.

The new federal agency took shape and its originating leadership moved without pause to distribute the federally authorized funding to the states. Regulators and election administrators alike responded in kind acting quickly to replace outdated punch-card voting systems that were the focus of the 2000 election controversy. Most states moved swiftly to set up centralized voter registration data bases under the direction of a statewide election official.

In many precincts throughout the country voters with disabilities experienced their first opportunity to vote independently, while all voters became empowered to review their ballots for inadvertent errors before depositing them in secure ballot boxes or precinct vote scanners. Still others who fall victim to administrative error—or in some states appear at the wrong polling place on Election Day—now see their votes protected through the issuance and processing of provisional ballots.

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[1] http://www.fec.gov/hava/law_ext.txt

[2] Bush v. Gore (2000) 531 U.S. 98

While these enhancements and improvements represent progress, questions remain regarding the usability, stability and sustainability of the core infrastructure of our elections process. Arguably, many of the concerns highlighted during the months and years following the 2000 Presidential contest and the drafting of the Help America Vote Act remain relevant today and new concerns have surfaced in the ensuing years.

The weighted focus on systems and technology has fallen short in adequately addressing issues of usability and in fully examining and recognizing changes in voter behavior and the inherent operational and human dependencies associated with voting and election administration. Likewise, the economic downfall of the past decade has left precious few resources available for further improvements to the nation's voting processes.

Prior to the establishment of uniform technology standards and testing protocols, the bulk of federal funding was depleted replacing punch-card voting systems with paperless touch screen voting interfaces that turned out, in many cases, to be unreliable and susceptible to tampering. Clunky efforts to retrofit the equipment with voter verifiable paper records has similarly been inadequate in quelling controversy associated with reliance on proprietary software and commercial industry as the means of securing and counting America's votes. As a result, the manner in which votes were cast and counted was once again a subject of controversy in the 2004 Presidential election.

Meanwhile, the regulatory environment set up to establish standards and protocols for modernizing voting systems has become increasingly unstable resulting in a shrunken market and a disincentive for research and development. The time frame and cost of getting a new voting system tested, approved and on the market is now prohibitively excessive and the new federal oversight agency charged with the responsibility is vacant of leadership and mired in partisan political maneuvering that is expected to last at least through the 2012 Presidential election.

The establishment of statewide voter registration databases has consolidated data collection, storage and reporting options but, until very recently, much less has been done to address the deficiencies, administrative barriers and inefficiencies of a paper-based voter registration system. The debate over the accuracy of voter registration data remains not just a policy question but an issue embedded in the political dynamics of the 2012 Presidential election contest.

Still, there are many bright spots in the expansive and increasingly collaborative work of non-governmental organizations (NGO), election administrators, voting integrity activists, academics, computer scientists, voting rights advocates and research institutions that has taken shape since 2000.

A growing focus on ballot design and usability is raising the profile of and addressing the human interaction inherent in the voting process. Much of the work in that area transcends the use of a particular type or flavor of voting system. The American Institute of Graphic Arts (AIGA) *Design for Democracy*[3] program and the Brennan Center for Justice report on *Better Design, Better Elections*[4] are examples of this work.

Research and pilot demonstrations using risk-based and ballot-level auditing techniques show great promise in offering options for independent verification of election results, establishing standards for accelerated auditing and recounts based on the margin of victory in a given contest or ballot measure and in streamlining the voting system testing and approval process at both the federal and state levels. The Department of Statistics at the University of California, Berkeley[5] and Verified Voting Foundation[6] have helped to spearhead these efforts.

[3] http://www.aiga.org/design-for-democracy/

[4] http://www.brennancenter.org/content/resource/better_design_better_elections/

[5] http://statistics.berkeley.edu/~stark/Preprints/pvalues09.pdf

[6] https://www.verifiedvoting.org/article.php?id=5816&printsafe=1

The Pew Center on the States' Election Initiatives[7] program has convened several working groups and has committed resources to solution-based initiatives focused on developing an elections performance index and introducing new structure and technological data matching tools to modernize and improve voter registration processes. Similarly, the Voting Information Project (VIP)[8] in partnership with Google has enhanced voter access to important public resources such as polling place information.

The Voting Technology Project (VTP)[9] jointly established by the California Institute of Technology and the Massachusetts Institute of Technology serves as an invaluable source of published research and data on voting trends, voter behaviors, residual voting statistics, use of various voting equipment and technologies and a host of related topics. VTP has convened numerous forums and published several reports documenting efforts aimed at identifying and addressing critical voting issues.

Perhaps the greatest benefit of the past ten years since the adoption of the Help America Vote Act is the quantification of *how* America votes in ways that have never been formally documented before. With that data now at hand, it is important that the data is used to more fully deliver ont he promise of the Act—helping the eligible electorate vote. Patterns and recurring themes embedded in these data can serve as guides in envisioning the voting systems and processes to be used in the future.

The civic voting experience and human interface associated with voting devices at the polling place, or in marking and returning ballots by mail continue to surface among the more critical elements in conducting better elections. Voters seek a user-friendly, intuitive interface with integrated accessibility features and one that mirrors the manner and range of options associated with other interactions common to functioning in an active and free society.

Similarly, there is a desire for a ballot design that provides a paper based record for audit and recount purposes, but that is small scale for ease of handling, storage and environmental sustainability.

Development of a common election mark-up language in the design of voting systems framed by principles associated with an open review of code, transparency and verifiability is fundamental in addressing voting system security and public confidence.

There is a decade or more of research and data defining the problems associated with voting and ballot counting. The risks and vulnerabilities have been highlighted; the delicate balance between accessibility and fraud prevention articulated. It is now time to move beyond the retrospective to a *future-spective*. Efforts should be on continuing to establish and support a research and development platform and a regulatory framework that is focused on securing solutions and sustainability.

Ten years into the expanded interest in elections integrity and a highlighted awareness of the nuts and bolts of election administration, it is highly appropriate to refresh and re-shape the dialogue. A shift in emphasis from risk analysis, problem identification and vulnerability assessment to innovative and proactive development solidly founded on principles adopted to mitigate risk and vulnerability seems in order.

As we look forward and shift to a solution-based focus, it is important to acknowledge and recognize new and emerging issues that have surfaced in the years since passage of the Act.

The demographics of the electorate are changing and an effective voting system—one built to facilitate participation and to functionally ascertain the will of the majority—must align with those changing demographics. A mobile society with growing numbers of voters expected to maintain multiple residences characterized by frequent travel and non-traditional work schedules elicits different needs and expectations for voting than one that is characterized by neighborhood-based community identity and traditional nine-to-five work schedules.

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[7] http://www.pewstates.org/projects/election-initiatives-328601

[8] http://www.pewstates.org/news-room/video-library/introducing-the-voting-information-project-85899379927

[9] http://vote.caltech.edu/

Local and state election officials are often ill-equipped to adequately respond and react to data-driven advocacy. Rising interest in and availability of raw election-related data through public records requests and other transparency initiatives brings with it the challenge of adequate time for data analysis and context. Advocacy organizations, online communities and individuals are acquiring raw election data, conducting independent analysis and drawing conclusions prior to election administrators' ability to review, analyze and provide context for the data. As a result, election administrators are increasingly spending time on defense, trying to respond to data analysis and conclusions without the necessary time and organizational review to provide context and to refute or clarify the relevance of the data. Time and staff capacity for internal data analysis is significantly limited and, where it does exist, spread thin.

In regions of the country that rely heavily on vote by mail as a means of assuring access and maintaining rates of voter participation, the economic and business trends impacting the United States Postal Service cannot be ignored. A change in levels of service and availability of postal service facilities is already beginning to impact the infrastructure of voting in some areas. This is symptomatic of the need for a broader discussion regarding expanded options for ballot distribution and collection.

And, what about the viability and sustainability of signature-based authentication? Almost every element of the electoral process is validated using voter signatures—initial registration, applications for ballots, attestations of oaths in voting rosters, initiative and referendum petitions for placing measures on the ballot, and certification of vote by mail ballots, for example. Yet, penmanship is no longer taught in schools and the consistency and reliability of individual signatures is depreciating. Very little discussion, research or policy development has been devoted to this issue—one which could fundamentally alter the elections process if left unaddressed.

As a country, America is hailed as a leader among big thinkers, visionaries and innovators. The United States established and has led from the epicenter of the technology boom that has changed the face of domestic and international commerce. When Americans put their minds to it; they go big. That sense of the possible and the achievable is needed to creatively address and envision the future of the nation's electoral process—the process most central to our citizen-driven form of governance.

At a time when government and businesses are reinventing the ways they do business and serve citizens; at a time when the preservation of an open, transparent and participatory democracy seems most important given what has been observed around the world in places like Syria and Egypt—at this time, the United States should be crafting and implementing a vision for 21st century elections.

If we do so, we will deliver on the promise originally envisioned by the Help America Vote Act. If we do not, we are almost assured to be caught unprepared and to repeat the patterns of the past.

Dean C. Logan

DEAN C. LOGAN is the Registrar-Recorder/County Clerk for Los Angeles County, California. He previously served as the Director of Records, Elections and Licensing Services in King County, Washington and as the Washington State Elections Director. Mr. Logan has 20+ years public service experience in state and local government and holds an Executive Master of Public Administration degree from the Evans School of Public Affairs, University of Washington and a Bachelor of Science degree in Organizational Leadership from Azusa Pacific University.

NOEL RUNYAN
Accessibility Perspective

ABSTRACT

Access to voting has improved in the last decade for some voters with disabilities, but not for all. However, despite good efforts and improvements, the accessibility of polling place voting systems is eroding.

THE PREVIOUS DECADE OF ACCESS TO VOTING FOR VOTERS WITH DISABILITIES

A decade ago, when attempting to vote in polling places, most voters who were blind had no options for privately and independently marking their ballot, so they were forced to have poll workers or others make their ballot selections for them.

Many would-be voters in wheelchairs could not even gain physical access to typical polling places, where they were often blocked by stairs or other barriers.

In nearly all states, the voter registration process and access to voter information were only available in print media.

As a result of the HAVA, electronic voting machines were adopted throughout most of the country, to provide accessibility and to avoid over-votes and "hanging chad" problems.

Some high function blind voters were delighted to find that they could manage to vote privately and independently for the first time in their lives on the new electronic voting machines. Many others did not find them to be accessible or usable. They were not as accessible as they should have been, for reasons such as the lack of simultaneous audio and video display mode needed by many elderly voters. Many of the voting machines also lack the screen font size magnification and foreground/background colors capabilities needed by many partially sighted voters.

In some cases, voters in wheelchairs found that, after successfully managing to gain physical access to the polling place, their wheelchairs were blocked from approaching the voting machines by the inappropriate support legs of the voting machines. Some voting machines lacked basic accommodation for voters with reach extension limits or other manual dexterity impairments.

Because of concerns about the lack of paper audit trails, many of the old DRE (Direct Recording Electronic) voting machines were modified to give a paper trail, but DREs with paper trails lack the needed access for verification by voters who are blind or have other print reading impairments.

CURRENT ACCESSIBILITY OF FIELDED VOTING SYSTEMS

While some of the voting systems have added improvements and a few, newly designed systems have passed certification testing and become available on the market, most of the old "accessible" voting machines currently in the field have severely inadequate accessibility accommodation and substantially do not comply with the minimum VVSG guidelines for accessibility.

For most of the early designs of electronic voting systems, accessibility features were added on to completed systems as modifications or "band-Aids", rather than being included at the start of the design process.

Generally, the early retrofit accessibility features accommodated access primarily for high function blind voters, and did not provide well integrated or good access for the elderly or voters with disabilities other than blindness.

Newer voting machines that were designed with accessibility needs in mind are now tending to support better access by voters with a wider spectrum of disabilities.

Most of the voting machine user interfaces used by poll workers are far too complex and difficult for them to learn and remember. Polling place operation is already too complex, and is made even worse by the addition of a different or segregated system for accessible voting machines.

In this author's experiences in voting on electronic voting systems, the poll workers were unable to get the voting system working properly by themselves in 7 out of 11 elections. More than half of their failed attempts were due to the voting system being too complicated for the pollworkers, given the limited time available for training themon the use of the accessible voting systems.

Many of the counties across the country now utilize a segregated ballot system, one in which the general public votes on paper ballots, and a second system for voters with disabilities, using electronic ballots on DRE voting machines. When the DRE voting machines are only used to give access to voters with disabilities, it is easy for there to be so few electronic ballots cast in a precinct that the privacy of the electronic ballots may be seriously at risk.

Paper Ballot Marking Devices (BMDs). Generally, electronic BMDs are accessible computerized systems that allow the voter to accessibly make vote selections, print out a standard mark sense ballot, and even verify correct marking of the ballot.

In the polling place, EBMDs can simplify operations and improve voter ballot privacy, as they allow the precinct to operate with a single type of ballot, instead of having to deal with the complexities of completely different electronic and paper ballot systems and procedures.

However, unlike some of the older fielded BMD systems, all in-precinct BMDs should have automatic ballot handling and casting, to assure that manual ballot handling will not be required for voters with manual dexterity challenges.

Vote by Mail Systems. Most VBM (Vote By Mail) systems do not provide private and independent voting for many folks who have print reading disabilities, because the systems require the voter to have a sighted assistant mark their ballot for them.

The VBM-only state of Oregon has developed their own AFB (Alternative Format Ballot) system for providing accessible VBM to many of its voters with disabilities. The AFB system lets voters with disabilities privately download their ballot from the web, mark, print, and verify the text format paper ballot on a personal computer. Each ballot printed with the AFB system can be mailed, to the county VBM center, where it must be manually "replicated" or transferred onto a standard optical scan ballot. It is not possible for an AFB voter to verify that their final ballot was accurately converted to the optical scan ballot which was cast and counted. Each Oregon county is required to have at least two publically available computers equipped with speech output, screen magnifiers, and other access features, to accommodate AFB access for voters without computers.

OCR (Optical Character Recognition) or text scanning ballot scanner/tabulators could help avoid the need to manually transfer or "replicate" any ballots printed by personal computers onto the standard optical scan ballots.

Vote by Phone Systems (VBP). There are some in-precinct VBP systems that use phones as the voter interface terminal and produce a printed ballot, functioning as a distributed BMD.

In contrast, the remote VBP system desired by many voters would be a distributed ballot marking system that would allow them to use their own home phone as a terminal and their county's centralized printer to print out their marked final ballot.

While considered to be very convenient for some, voting with home phones would not accommodate all voters with disabilities.

Online Voting. Many voters with disabilities and with good access to personal computers would strongly prefer to vote online, although they are generally unaware of the serious security risks associated with online voting through the Internet.

Access with personal computers, including smart phones, seems attractive to younger folks, but is not so eagerly embraced by the current population of elderly voters who might be disenfranchised if they were expected to vote with a personal computer.

It is possible, but unlikely that the common availability of smart phones might change the "computer phobic" mind set of most elderly voters, causing them to be willing to embrace online voting.

Other Access Concerns. In addition to the accessibility of the actual voting machines in a polling place, voters with disabilities need polling places to be free of physical access barriers, need better access to voting information, and need access to voter registration systems.

Most of these access needs are generally not technically challenging and have already been improved upon substantially. Typical polling places are now commonly chosen or modified to accommodate physical access with wheelchairs.

Many counties are starting to distribute voter information in audio and large print form, as well as posting it on their websites.

Many counties are moving to allow online access to the voter registration process, which can make it more accessible for computer savvy voters with disabilities.

Even more progress in these areas of voting access can be obtained if these efforts are encouraged and extended.

Turnout for Accessible Voting in Polling Places. In the author's own experience as a pollworker in 2010, as well as that of half a dozen associates from across the country who have recently been pollworkers, typical polling places will have only 1 or 2 voters attempt to vote on the accessible voting machines in an election day. Some poll workers report that their polling place has never had even one voter ask to use the accessible voting machines.

A related data point comes from a Pew Election Data Dispatch from March 2012, regarding the 2012 Miami-Dade and Orange counties Florida Presidential primary, in which only 49 votes (or .03 percent of over 190,000 votes) were cast on the accessible voting machines.[1]

A survey conducted by the National Federation of the Blind Jernigan Institute following the November 4, 2008 presidential election indicates that about 28.5 percent of the legally blind NFB members surveyed actually voted on accessible voting machines in their polling places.[2] This was because, of those who voted in the polling place, only 51% chose to or were able to vote on the accessible voting machines.

The NFB and Rice surveys of blind voters indicate that a range of from 12% to 38% of the blind voters did so by mail or absentee ballot in 2008.[3]

FUTURE TRENDS AND ISSUES

The bulk of the electronic voting machines were purchased around 2006 with HAVA money, and are now reaching the end of their product support life. Counties across the nation are beginning to be faced with tough decisions about buying new in-precinct voting systems or changing to provide alternatives to precinct voting. Access by voters with disabilities should be carefully considered in these decisions.

Western states are changing to mostly VBM systems. However, in states such as California, many counties are switching to VBM without the AFB option or other attempts to make them accessible.

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[1] Accessible Voting Machines, PEW Dispatch, March 2012, http://www.pewstates.org/research/analysis/accessible-voting-machines-85899377179#

[2] Hollander Cohen & McBride Marketing Research, Blind Voters Experience Assessment Study Research Summary, December, 2008, http://www.nfb.org/Images/nfb/documents/ppt/BlindVotersExpReport.ppt

[3] G.E. Piner. M.D. Byrne, Accessible Polling Places for the Visually Impaired: A Compilation of Survey Results, http://static.usenix.org/event/evtwote11/tech/final_files/Piner.pdf

Polling place voting machines used only for accessible voting are not usually set up and fully tested or even operational before the polls open on Election Day. This often results in machines not working because they're set up in a rush, or too often results in the voter being talked out of trying to use the accessible voting machine at all. Strict adherence to a requirement for a full setup and test of the accessible voting machines before the polls open could do a lot to assure that voters with disabilities will find working voting systems at the polling place.

As counties develop more voting options that do not require the voter's presence in a physical polling place, biometrics may be needed for assuring voter identification. Voter authentication with standard retina scan, fingerprint recognition, or hand-written signatures may be seriously problematic or infeasible for many voters with disabilities.

As more counties offer online ballot marking, online voting, VBM, or VBP options to in-precinct voting, fewer voters with disabilities will be willing to brave the challenges of voting in a physical polling place. If few voters with disabilities turn up at the polls, election officials will not be encouraged to expend many of their scarce resources on training and maintenance of the machines. When these forces are coupled with the aging of the HAVA-purchased voting machines, it appears likely that in-precinct accessible voting machines will become increasingly unreliable and unavailable. This is one more reason that voting officials and the public need to work together to make appropriate decisions about the future development paths of their general voting systems and their requirements for meeting the needs for both accessibility and security. Only when both are included at the beginning of a proper voting system design process, can good security measures and good accessibility features work compatibly.

Noel Runyan

With his degree in Electrical Engineering and Computer Science, NOEL RUNYAN has been working in human factors engineering for over 40 years, primarily developing access technologies for helping persons with visual impairments to use computers and other electronic devices.

Since February 2009, he has been a member of the National Braille Press Center for Braille Innovation, working to promote development of low cost and full page braille display technologies.

For the last nine years, he has been seriously studying and testing the accessibility of electronic voting systems, and he was an expert witness in six court cases, wrote the "Improving Access to Voting" report, testified at the PFAW Forum on Election Systems, testified to the US House Administration Subcommittee on Election Reform, testified to the Texas State House Committee on Voting Systems, and led the access testing teams for the California Secretary of State's 2007 Top-To-Bottom Reviews of voting machines.

PETER RYAN AND THEA PEACOCK

Verifiable Voting: Recent Advances and Future Challenges

ABSTRACT

Guaranteeing the integrity and secrecy of elections has been a major challenge since the dawn of democracy. For over a century the US has been experimenting with various technologies, lever machines, punch-cards, optical scan, touch screen etc., to try to foil attempts to manipulate the outcome of elections. All have been found to be problematic [1]. In the last few decades, the security and cryptographic research communities have turned their attention to this challenge. In many ways, cryptography seems to be the ideal means to achieve integrity and secrecy and indeed, in theory at least, a great deal of progress has been made. With very few exceptions though, this theoretical progress has yet to translate into practice.

In this short note, we outline some key advances over the past decade or so in the development of "end-to-end verifiable" schemes. We take stock and speculate on the prospects for the next decade. We focus on polling station, supervised schemes rather than remote schemes. Remote voting, e.g. Internet voting, poses still greater challenges.

INTRODUCTION

The first suggestion that cryptography could play a role in voting appears as an aside in the 1982 paper by Chaum in which he introduces the idea of anonymising mixes[2]. The key idea behind E2E verifiability is to provide voters with a "protected ballot" that contains their vote in encrypted form. All such ballots are posted to a secure Bulletin Board (BB), allowing voters to confirm that their ballot is correctly registered. The ballots can then be tabulated in an anonymising fashion, either via mixes or homomorphically. The goal is perform all of this with minimal trust in devices, code, officials etc. Assurance should be founded solely on auditability of all steps and not on claims of correctness of code etc.

It quickly became clear that the most delicate step in the process is the way in which the encrypted ballot is produced. Given that voters will not typically be able to perform RSA or ElGamal encryption, it is necessary to invoke a device to perform the encryption. The challenge now is: how is the voter to be convinced that her vote has been correctly encrypted, and in a way that cannot later be used to convince anyone else? Typically this is achieved by some form of cut-and-choose protocol: the device is required to commit to a number of encryptions and all but one of these is challenged and checked. If all challenged ballot is shown to encode the vote correctly, and the selection for audit was reasonably unpredictable, this gives good assurance that the remaining ballot will also be correct and can then be cast. Note that it is important the cast ballot is not audited as the audit process necessarily breaches the secrecy of the ciphertext. A variant of this, often referred to as "Benaloh challenges" is a kind of sequential version of cut-and-chose: the voter inputs her vote and the device commits, in printed form say, to an encryption of vote. The voter then elects to either audit this or cast it. She can audit as many times as they like before finally casting the last, unaudited ballot.

In 2004, Chaum proposed a scheme that utilised visual crypto [3]. At first glance, this seems to give the voters a way to confirm with their own eyes the correctness of the encryption. In fact, a further, conventional layer of encryption is needed beneath the visual crypto. This, along with the conceptual and technological complexity of the scheme seems to have led to its abandonment, but it remains as a seminal idea.

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[1] Jones, D., Simons B., *Broken Ballots; Will Your Vote Count*?, CSLI Publications 2012.

[2] Chaum, D., Untraceable Electronic Mail, Return Addresses, and Digital Pseudonyms. Commun. ACM 24(2): 84-88 (1981)

[3] Chaum, D., Secret-Ballot Receipts: True Voter-Verifiable Elections. IEEE Security & Privacy 2 (1): 38-47 (2004)

Around the same time, Neff proposed the MarkPledge technique for creating high assurance encrypted ballots [4]. The approach is notable in that it avoids the need for cut-and-chose mechanisms but instead provides direct assurance of the correctness of the ballot that is actually cast. In very simple terms, the idea is that the ballot carries the list of candidates against each of which there is an encryption of a "yes", for the chosen candidate and a "no" for non selected candidates. The voter engages in an interactive zero-knowledge proof of the "yes" term and the transcript is printed on the ballot. To mask the chosen candidate, the device also produces fake transcripts of proofs for the other terms. Anyone later seeing the ballot cannot distinguish the real from the fake transcripts, hence ensuring receipt-freeness.

Inspired by Chaum's visual crypto scheme, Ryan proposed the Prêt à Voter approach [5]. Prêt à Voter uses pre-prepared ballot forms with the candidate order permuted on each ballot. The voting ceremony is as follows. The voter picks a random ballot form at the polling station. A typical ballot form is shown in Figure 1. On each ballot form a permutation of the candidate list is printed on the LHS. The "onion" at the bottom of the RHS, carries the encrypted information defining the permutation and is required to extract the vote later.

Figure 1

A TYPICAL PRET A VOTER BALLOT FORM

Obelix	
Asterix	
Idefix	
Panoramix	
	7rJ94K

In the privacy of a booth, the voter marks the chosen candidate on the form. She then separates the two sides and destroys the LHS. This is an essential step as it ensures *receipt-freeness*: the inability to prove a vote. Exiting the booth, she takes the RHS to be scanned and recorded by the system and uploaded to the BB. The RHS is validated as cast, e.g. by digital signing and franking by the officials. This is retained as a receipt which she can later check against a BB to verify that her vote has been correctly registered.

The interesting features of Prêt à Voter are that:

1. The voter is not required to communicate her choice to an encryption device. This sidesteps the threat, present in most other schemes, of the device leaking this information.

2. Ballot auditing is rather clean, in two senses: 1) correctness of the encoding of the vote depends on the well-formedness of the ballot form and 2) auditing is independent of the vote or indeed of the voter and hence does not undermine ballot privacy.

This contrasts to most other schemes that do require the voter to communicate their selection to a device that then produces one or more encryptions of this. Ascribing blame can be delicate now: suppose that the voter claims to have voted for A but the audit shows that B was encrypted. How can we distinguish between the voter misremembering or lying on the one hand and the device cheating on the other hand? Furthermore, such an audit tends to undermine ballot privacy, unless voters are careful to make dummy choices for audit before making their real choice for casting.

[4] Adida, B. and Neff, A., *Efficient receipt-free ballot casting resistant to covert channels*, USENIX EVT/WOTE 2009

[5] Chaum, D., Ryan, P. Y. A. , Schneider, S., *A Practical Voter-Verifiable Election Scheme*, ESORICS 2005

Another scheme due to Chaum is Scantegrity II [6]. This scheme is backward compatible with optical scan voting machines and uses invisible ink to reveal a verification code for the chosen candidate. The notable feature of this scheme is the novel approach to validating challenges. Most schemes depend on anti-counterfeiting mechanisms, e.g. digital signatures, to support challenges. In Scantegrity II, the invisible ink mechanism ensures that the voter only learns the one code corresponding to their chosen candidate. Their challenge is based on the knowledge of this code: if the BB shows a different code and the code claimed by the voter is shown to be a valid one for the ballot in question then, due to the sparseness of the codes, the challenge is likely to be valid.

A recent development of interest is the Wombat system designed and implemented by IDC Hetzlya and TAU in Israel [7]. The design is rather conventional: a kiosk device into which the voter inputs her choice via a touch screen, except that now the device prints the vote in plaintext and in encrypted form. The voter should first check that the cleartext of their vote is correct and is now presented with a choice to audit or cast. In the case of auditing, note that if the cleartext is found to disagree with the plaintext embedded in the ciphertext, it is evident that the device was cheating. To cast the vote the voter separates the cleartext and ciphertext, takes the ciphertext to be scanned and uploaded to the BB and casts the cleartext in a conventional ballot box. The system thus generates both a paper and a digital, encrypted record of cast votes.

THE ROLE OF CRYPTOGRAPHY

Modern cryptography appears to be perfectly suited to solving the apparent conflict between verifiability and privacy in voting systems but there are obstacles to its deployment. Establishing understanding and trust in the mechanisms and guarantees provided by cryptographic systems is not straightforward. It seems that to many, cryptography is a mysterious black art to be regarded with suspicion.

In addition, proper implementation of cryptography can be complicated and problematic. Furthermore, as the privacy afforded by cryptographic means is usually computational, there may be (legitimate) concerns about the long-term privacy of votes. Schemes have been devised however, to provide everlasting privacy [8],[9].

An encryption-free, paper-based voting system, conceptually similar to Prêt à Voter was devised in [10], in which cryptography is replaced by a scratch strip mechanism. The ciphertext on the RHS of the ballot form is replaced by a cleartext representation of the permutation covered by a scratch strip, which in turn is overprinted with a serial number. Rivest also explores the possibility of voter-verifiability with crypto with his "ThreeBallot" scheme. Here the vote is encoded across three ballots and only one of these, chosen at random as the receipt, but in a way that ensures that the system does not learn which is retained. The single ballot does not reveal how the vote was cast but can be checked on the BB (on which all ballots are posted).

Both of these schemes achieve a degree of E2E verifiability without using cryptography. Both however have problems, and are unlikely to be viable for use in real elections.

CONCLUSIONS & PROSPECTS

We have briefly reviewed some important (but by no means all) recent advances in verifiable voting schemes, stressing the challenge of creating the protected ballots in way that gives confidence to the voter that her vote is correctly captured while preserving receipt-freeness. We now have several schemes that give high levels of verifiability with minimal trust assumptions and ballot privacy and a good level of usability. Despite this, we have seen very little deployment of such schemes outside the laboratory.

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[6] Clark, J., Essex, A., Popoveniuc, S., Rivest, R., Ryan, P. Y. A., Shen, E., Chaum,D., Carback, R., and Sherman, A., *Scantegrity II: End-to-end verfiability for optical scan election systems using invisible ink confirmation codes*, USENIX EVT/WOTE 2008

[7] http://www.wombat-voting.com/

[8] van de Graaf, J., *Voting with unconditional privacy: Cfsy for booth voting*, Cryptology ePrint Archive, Report 2009/574, 2009

[9] Moran, T. and Naor, M., *Split-ballot voting: Everlasting privacy with distributed trust*, Proceedings of the 14th ACM Conference on Computer and Communications Security, 2007

[10] Randell, B. and Ryan, P. Y. A., *Voting technologies and trust*, IEEE Security and Privacy, November 2006.

There is doubtless scope for further enhancements to the existing schemes, but it seems that the main theoretical challenges have largely been solved. We have schemes that have been carefully analysed and trialled under laboratory conditions. The major challenge now appears to be to convince the relevant stakeholders, candidates, election officials, voters, that cryptography, correctly used, can deliver demonstrably correct elections and guarantee ballot secrecy. Important tasks remain to both the research community and election administrators. The outstanding issue is trust in technology which impacts acceptance of a system by voters. Education and voter-based studies in socio-technical aspects e.g. usability and trust may be beneficial.

The optimistic view is that we will progress by modest steps towards deployment of such verifiable schemes via controlled trials and then on to small scale, low criticality elections (electing officials of professional bodies, local government elections etc.). We have already seen this so some extent: elections to student bodies, the use of Scantegrity II for county elections in Takoma Park, the adaption of Prêt à Voter for use in Victoria State in Australia.

The pessimistic view is that the stakeholders in the democratic process will never feel sufficiently comfortable with the role of cryptography for such schemes to be widely deployed.

Thea Peacock & Peter Ryan

THEA PEACOCK is a research associate at the Interdisciplinary Centre for Security, Reliability and Trust, University of Luxembourg. She obtained a PhD in Computing Science from Newcastle University, UK, based on a study in the areas of secure information flow and e-voting systems. Her main research interest is e-voting systems, currently focusing on developing a methodology for threat analysis.

PETER RYAN: In February of 2009, Peter Ryan took up a position as full Professor of Applied Security at the University of Luxembourg. He has over 20 years of experience in cryptography, information assurance and formal verification. He pioneered the application of process algebras to modelling and analysis of secure systems, presenting the first process algebra (CSP) formulation of non-intereference at the Computer Security Foundations Workshop in 1989. In 1993, while at DRA, he initiated and led the "Modelling and Analysis of Security Protocols" research project that developed the CSP and model-checking approach to the analysis of security protocols.

He has published extensively on cryptography, cryptographic protocols, mathematical models of computer security and, most recently, high assurance voting systems. He is the creator of Prêt à Voter, Pretty Good Democracy (with Vanessa Teague) and OpenVote (with Feng Hoa) verifiable voting schemes. Also with Feng Hao he has been developing and analysing a novel Password Authenticated Key Establishment Protocol J-PAKE.

Prior to joining the University of Luxembourg he was a Professor of Computing Science at Newcastle University. He has worked at GCHQ, the Defence Research Agency, the Stanford Research Institute in Cambridge and the Software Engineering Institute, CMU Pittsburgh.

He holds a PhD in mathematical physics from the University of London.

Peter Ryan has been on program committees of numerous prestigious security conferences, notably: IEEE Security and Privacy, IEEE Computer Security Foundations Workshop, the European Symposium On Research In Computer Security (ESORICS), WITS (Workshop on Issues in Security). He was Chair of WITS'04 (Workshop on Issues in the Theory of Security) and Co-chair of ESORICS'04, co-chair of Frontiers of Electronic Elections FEE 2005, Chair WOTE 2007 (Workshop On Trustworthy Elections). From 1999 to 2007 he was the Chair of the ESORICS Steering Committee. He is a Fellow of the BCS and IMA.

He is also a Visiting Professor at the University of Surrey (UK).

MICHELLE SHAFER

The Election Technology Industry: Observations from the Frontlines

I distinctly remember where I was on the night of November 7, 2000 and the early hours of November 8th, just as most people remember where they were when significant events in their lives or our world's history occurred. All true "election geeks" know where they were on Election Day of 2000.

It was late evening on November 7th and I was driving though Central Texas on my way home from conducting election site support in a small south Texas county for my company which at that time served as a provider of optical scan voting equipment in Texas. I was, in fact, training a new co-worker in the specifics of election site support as I had been helping with site support activities myself since 1997. I was on site to help the county election staff in case any issues occurred with their central count voting equipment while they were tabulating their election ballots. The supplies I had on hand included a set of screw drivers, canned compressed air and spare "pick belts" which were essentially large, extra-thick rubber bands that help move ballots through the scanners. Most small counties in Texas at this time transported their voted ballots back to the county's main election office or another central location for tabulation by a single, heavy-duty, high-speed central count ballot scanner while larger counties had a few central count scanners on hand to help them speed up the tabulation process and allow them to accumulate results. Election technology providers had back-up scanners and senior technical personnel staged at various geographic locations throughout the state so customers could be assisted as quickly as possible in case of a major equipment malfunction anywhere in the state.

In retrospect, with all of the advances in voting technology and election procedures since 2000, this scenario sounds in many ways like something that happened in the 1970s rather than 12 short years ago.

There were no optical scan issues in the county where I was working on November 7, 2000 and everything went smoothly with the county's vote tabulation process. My colleague and I were relieved of our duties for the evening and we headed back toward our office in Austin, Texas. George W. Bush was then the governor of Texas and with Austin as its capital, there was a festive atmosphere in downtown Austin that night with TV crews, lights, staging for speeches, music and people filling the city streets in anticipation of either a victory or concession speech by the presidential candidate. My colleague and I decided to drive into downtown Austin in an attempt to see—in person—either a victory or concession speech by a presidential candidate.

This was not to be on that night. There were no victory or concession speeches to witness in Austin, Texas or anywhere else that night. Instead, my colleague and I went to our respective homes and I proceeded to watch television news coverage in disbelief until the next morning. While watching the news, I thought about my then-company's launch of its electronic voting system earlier that summer. I left a voice mail for my then-boss saying innocently: "Hey, I think we may be able to get some media attention for our new electronic voting system due to the issues in Florida."

The expression, "be careful what you wish for" still echoes through my mind. From November 8th on, when I, like my colleagues at other election technology companies, had to figure out who to talk to first when reporters for both The Washington Post and CNN were on hold to talk to someone about voting technology, the election technology industry has never been the same. Prior to 2000, the election technology industry in the United States consisted of a small group of national and mostly regional providers of optical scan and punch-card voting equipment, first generation touchscreen voting machines (most of which were not true touchscreens in that the voter was actually touching a mechanical switch), lever voting machine supplies & service,

voter registration systems, ballot printing and other ancillary services like preparation of election kits for polling places and printing of campaign signage. Most Americans had never heard of the companies in this space, nor thought about what type of equipment was used in their polling places. Most people never thought about how or where their ballots were printed. Very few individuals gave thought to how military and overseas voters cast their ballots or how people with accessibility or linguistic challenges voted. It was an industry that most people never knew existed until that time in 2000 when the media came to focus on butterfly ballots, pregnant chads, the variety of state election laws, and the different methods for casting and tabulating votes. Regular people were becoming familiar with the names of U.S. election technology providers including Election Systems & Software, Sequoia Voting Systems, Global Election Systems, Hart InterCivic, and Unilect which were some of the larger election companies of the pre-2000 era.

After some inadequacies in U.S. election equipment, election laws and election procedures were exposed to, and debated by, the world as a result of the November 7, 2000 election, the Help America Vote Act (HAVA) of 2002 became law and the U.S. Election Assistance Commission (EAC) was formed. In addition to added focus on the needs of the changing U.S. marketplace by the current election technology providers of that time, some large technology companies including Dell, IBM, Accenture, and most notably Diebold, experimented in the election technology marketplace hoping to find a lucrative new market for their technology services with federal dollars being channeled into the election technology space as the result of HAVA.

The election technology marketplace was not—and is not—an easy industry to break into, and as a result, the newcomers to the marketplace had varying degrees of success. Many small companies that were established post-2000 no longer appear to be engaged in the election technology marketplace today. Before voting systems can be sold or implemented, costly and lengthy testing is required and voting systems must be federally and /or state certified in most instances with each state and U.S. territory having its own unique set of election laws related to voter intent, the conduct of primaries, straight party voting options and ballot rotation. Producing, certifying and implementing election equipment takes a wealth of subject matter expertise which was difficult for new companies to the space to attain immediately following 2000 as there was no time to develop this expertise- and no room for the mistakes inherent in such a learning process. Election technology companies also need to be positioned to manage the financial cyclicality of the industry from year to year which can present challenges to companies focused only on U.S. elections.

In addition to the financial and subject matter challenges of the election technology industry, public relations issues became a new factor for election technology providers to consider which did not really exist prior to the spotlight of the 2000 election. The advent of online editions of local, national and international newspapers and television media as well as blogs, Twitter, Facebook and other social media have helped to keep persistent attention focused on both election technology providers and election jurisdictions. Grassroots election integrity advocates, academics and voters have also taken to the internet to share opinions, concerns and research as well as to have technology debates and philosophical discussions. The widespread use of blogs and social media in addition to the mainstream media and has also enabled the lightning-quick proliferation of stories—many of which are accurate and many of which also contain errors, misinformation and conspiracy theories.

While mainstream and social media attention have at times made the election technology marketplace especially challenging for both election technology providers and election officials, the internet and social media have also helped to facilitate the creation of a global election community and technology marketplace.

U.S. election officials are engaged more with their international counterparts both online and in person through visits and conferences in an effort to share ideas, research and information in order to learn from one another and avoid recreating the wheel whenever possible.

No longer are most election technology companies solely focused on one geographic market as they can virtually provide information about, and demonstrations of, their products and services everywhere in the world with just a few clicks online. The internationalization of the election technology industry is evidenced by the current dominant players in the U.S. marketplace -Election Systems & Software, Dominion Voting, Hart InterCivic and Unisyn—most all of whom offer election technology and election support internationally as well as within the United States. Some of these companies—and others who provide election technology to U.S. election jurisdictions—have ownership, investors and marketing partners outside of the United States.

Aside from the previously-mentioned dominant providers of voting equipment in the US, there are newer companies that have entered the marketplace—or existing companies that have launched new software-based products for the election technology marketplace including VOTEC Corporation, Scytl, Democracy Live, Konnech, Know.Ink, Inclusion Solutions, Advanced Ballot Solutions, HAVA Partners, SOE Software, Robis Elections, Election Administrators, Data Defenders and Everyone Counts. These companies and others provide platform-independent electronic pollbooks, voter portals, election forensics services, assistive voting enhancements, online pollworker training platforms, asset tracking systems, election night reporting programs, ballot tracking solutions, electronic ballot delivery systems for military and overseas voters, voter registration solutions, absentee balloting systems and many others.

I believe that with the current push for an industry-wide election solutions common data format that would help facilitate the easy interchange of information from different providers' technologies combined with a possible shift from system testing to component testing of voting systems, updated Voluntary Voting System Guidelines from the EAC and the continued focus of the industry on research and development of software-based solutions combined with the continual globalization of the election industry, we will continue to see an influx of advanced

Michelle M. Shafer

MICHELLE M. SHAFER is currently Director of Communications & Government Affairs for Scytl & SOE Software and has worked in the election technology industry for 16 years. She formerly worked as an election industry consultant for national and international organizations and providers in the election technology space including CALIBRE Systems, IFES and the OSCE/ODIHR. Previous to her consulting endeavors, she served as Vice President of Communications & External Affairs for Sequoia Voting Systems and Director of Corporate Communications for Hart InterCivic. Ms. Shafer has a B.A. degree from Fordham University in New York.

The views and recollections expressed within are solely those of Michelle M. Shafer and are not attributed to her current or former employers.

PAM SMITH
Securing Elections: The Next Decade.

A great strength of our nation lies in our freedom to make our voices heard, with the vote being the strongest of the available means to do so. Those voices rise when voters have justifiable confidence that it matters, that they will be treated fairly at the polls and their votes counted as intended.[1] Elections are a great collaboration we share as Americans.

Demonstrating that all the votes are counted as intended, however, remains a major challenge for the decade ahead, because we still lack the tools and rules in place to do so in some of our states. We have made significant progress in the past decade toward the worthy goal of provably accurate elections, and many more states now have auditable systems and do audits. But too many states do not, and we face a logjam of obstacles like costs, a regulatory framework that does not appear to serve us sufficiently well, and the added pressure of rapidly aging systems. Making it the rest of the way, so that the entire nation can see votes are being captured and counted as intended, requires finding the common will to overcome these challenges, and collaboration among all the stakeholders is the most effective path. This effort is urgent, but the challenges appear attainable.

Attaining verifiable elections nationwide, in which the public can have justified confidence that the outcome is correct, requires not just the tools of verifiable voting systems but also the rules that allow us to demonstrate the evidence. This combination is part of a resilient framework of election systems as elegantly stated in "Evidence Based Elections.[2] A key property for these purposes is an independent record of voter intent, such as a durable ballot marked by the voter, which is then used in robust audits and recounts. We don't expect perfection, neither of systems nor of officials, but we should be able to expect a way to recover from failures and faults, and enough evidence to make clear the correct outcome.

Since the passage of the Help America Vote Act, voting system development has progressed, with mixed results. We've learned that elections can get a lot of help from technology but that there are limits before new technologies expose elections to new vulnerabilities. Software and hardware can have latent defects capable of disrupting or preventing voting and even changing election outcomes no matter how vigorously tested beforehand.[3]

Across the country, we have been acting on these insights. Because voting technology failures can and do occur, many states have put safeguards in place to assure system *integrity*, and to ensure system *availability* so that voters are not disenfranchised by equipment malfunctions. Adopting a baseline standard of resilient systems enables voting, enables strong verification of results, builds justifiable confidence, and can potentially save costs. When something goes wrong, resilient systems offer a way to recover without an expensive do-over.

When we go to the polling place in November 2012, most voters[4] in two-thirds of the states will be able to verify on an independent ballot or other record that their choices were captured as they intended.[5] Less than a decade ago, only a handful of states set such a standard. Some states have taken measures to improve their contingency plans to prevent long

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[1] See R. Michael Alvarez, Thad Hall and Morgan Llewellyn "Are Americans Confident Their Ballots Are Counted?" *Journal of Politics*, 80, 3 (2008): 754-766, for a discussion of the link between confidence and turnout.

[2] "Evidence-Based Elections" P.B. Stark & D.A. Wagner, available at: http://statistics.berkeley.edu/~stark/Preprints/evidenceVote12.pdf , where software independent systems [see R. Rivest and J. Wack, "On the notion of "software independence" in voting systems", Information Technology Laboratory, National Institute of Standards and Technology, Tech. Rep., 2006, http://vote.nist.gov/SI-in-voting.pdf] are used with compliance and risk-limiting audits, such that an undetected error or change to the system's software cannot produce an undetectable change in the outcome, and we can find the correct outcome without re-running the election.

[3] "Counting Votes 2012: A State By State Look at Election Preparedness," http://countingvotes.org

[4] Verifiability for voters with disabilities, particularly on certain types of voting records, remains an insufficiently solved challenge. Some currently used systems enable audio read-back from a marked ballot, whether marked through the use of an accessible interface that then prints the voter's choices or manually marked by the voter directly.

[5] http://verifiedvoting.org/verifier

lines and ensure voters are not left with no way to vote on Election Day.

This year, officials in half the states will carry out some kind of post-election audit using those records of voter intent to check the functioning of the vote counting technology in local use.[6] Though many of these audits lack robustness at present, enormous progress is being made as states examine more effective and efficient ways to audit.

Still, too many jurisdictions remain dependent in whole or in part on unverifiable, un-auditable voting technology. Sixteen states have unverifiable systems in some or all polling places. In a sharply divided era politically, inability to check outcomes is risky, and corrosive to the confidence voters may have in the outcome of elections.[7] "Trust us" is never enough for the aggrieved, nor should it be. Election officials and members of the electorate alike, and especially losing candidates, need hard evidence to support results.

The reliance on riskier systems is not necessarily by design or desire, in the states that have not moved to auditable systems yet. Several of these states[8] have passed laws that do raise the standard, requiring voter verifiable systems and audits, but have yet to fulfill these legislative mandates, due to cost. Still other states are moving toward more resilient systems, but in a gradual way.[9]

Still, some states have not yet taken any action. And they may have to continue to try to get by for a little while longer on what is currently in place,[10] if budgets are any indication. Financial constraints can make deciding what to do about a new voting system harder. In addition, there may be fewer options from which to choose, as the voting technology marketplace has shrunk dramatically, and there are significant costs to taking a system from design to that market if it must meet federal voting system guidelines for testing and certification.

The certification structure as it stands today also may be an obstacle to getting fresh concepts into broad use. The certification guidelines to which we test are monumentally detailed to provide some expectations we have of its proper functioning, but don't apply to many new elements that fall outside the old framework of a voting system (e.g. electronic poll books, online ballot marking wizards, election night reporting systems) even though they have an impact on the outcome. Components of voting systems rather than whole systems may offer a way to increase flexibility and reduce costs, but the guidelines only address whole systems testing, not component testing. Most importantly, the guidelines by themselves do not provide a way to ensure we can solve for real world election-day problems, nor identify the correct winners.

While it may seem the road ahead is blocked, that innovation is stifled by a combination of scarce resources, a shriveled marketplace and a possibly outdated regulatory structure, this isn't entirely the case. Outside-the-box thinking about voting technology and election administration actually is thriving—in elections offices, in academic institutions and nonprofits, and in stakeholder advisory groups convened for this precise purpose. This kind of thinking, focusing on essential properties in a voting system, is generating really useful stakeholder collaboration today.

In Travis County, Texas, County Clerk Dana DeBeauvoir reached out to technology experts, auditing experts and others in helping her county design a voting system for the future[11] from the ground up. In Los Angeles County, California, Registrar of Voters Dean Logan convened a voting system advisory panel[12] with a broad cross section of stakeholders and voter advocates to establish a baseline set of principles against which to frame any new voting system for the nation's largest voting jurisdiction.

[6] http://www.ceimn.org/searchable_databases/state_audit_laws

[7] Michael Traugott and Frederick G. Conrad, "Confidence in the Electoral System: Why We Do Auditing," in *Confirming Elections*, Palgrave MacMillan, 2012.

[8] New Jersey (2005), Maryland (2007) and Tennessee (2008) all passed laws calling for voter-verifiable systems; New Jersey also passed an audit requirement (2008).

[9] Virginia passed and has upheld a ban on purchasing any more unverifiable voting technology; Arkansas is in the process of replacing its last unverifiable systems in two remaining counties; Kentucky has moved a number of its counties toward verifiable systems over the past half decade; Colorado lacks verifiable equipment in only one county now and is expected to be fully verifiable by 2014.

[10] http://www.ncsl.org/legislatures-elections/elections/from-the-election-administrators-perspective.aspx

[11] https://www.co.travis.tx.us/county_clerk/election/pdfs/keynote_address_trustworthy_elections.PDF

[12] http://www.lavote.net/voter/vsap/

At a recent meeting about the future of the Election Assistance Commission, a respected county-level election official from the Midwest told of her increasingly pressing need to replace her aging and failing voting equipment, but bluntly said that she wanted to ensure that all the advocates—accessibility, usability, security—everyone would be at the table before deciding what kind of system to get, so that she could get their input on the front end, rather than wait to be criticized after the fact.

In Colorado, California and Ohio[13] officials are collaborating with experts in post-election auditing science to design more efficient mechanisms for carrying out essential checks on electoral outcomes. A convening[14] of local election officials, advocates and others in the non-profit sector is designing a roadmap for the Future of California Elections.

So ten years on from HAVA, we find ourselves at this crossroads, where the old way of doing things doesn't serve us sufficiently well, and the new path is not entirely clear. What is clear: collaborations among voter advocates and experts in election administration, usability and accessibility, auditability and security are critical to generating the will to overcome the remaining obstacles to better voting systems nationwide. Through the efforts cited, non-adversarial conversations about what principles are most important are becoming commonplace, and we are working together in ways that seemed unlikely ten years ago. Most importantly, we are finding agreement on key principles.

To be able to demonstrate that votes are counted accurately requires identifying and accepting principles and properties of resilient election systems as a floor beneath which we as a nation refuse to sink. This set of principles must apply whether we're adopting technology that exists today or considering that which is yet to be developed. Doing so sets an example around the world in which we can take pride. And it goes to the core of who we are as Americans; if we don't win an election because we failed to win enough hearts and minds, then we know what to do next time around. But if we failed to win because something went awry with the voting system, that's just wrong. Systems that offer resilience in the face of the inevitable issues that arise in elections solve for this.

Pamela Smith

PAMELA SMITH is President of Verified Voting, a non-partisan nonprofit working to safeguard elections in the digital age. She provides information and public testimony on verified voting issues at federal and state levels throughout the US, including to the US House of Representatives Committee on House Administration. She oversees an extensive information resource on election equipment and the regulations governing its use at the federal level and across the 50 states. Ms. Smith is co-editor of the Principles and Best Practices in Post-Election Audits and the author of an introductory chapter on audits for Confirming Elections: Creating Confidence and Integrity through Election Auditing. She has been a small business and marketing consultant and nonprofit executive for a Hispanic educational organization working on first language literacy and adult learning.

[13] http://www.eac.gov/payments_and_grants/la_and_postelection_audit_grant_winners.aspx

[14] http://irvine.org/news-insights/entry/civic-groups-election-officials-develop-roadmap-for-future-of-california-elections

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