The Voting Technology Project: Looking Back, Looking Ahead

The Caltech/MIT Voting Technology Project

July 2016

CALTECH/MIT
VOTING TECHNOLOGY PROJECT
A multi-disciplinary, collaborative project of the California Institute of Technology and the Massachusetts Institute of Technology

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Introduction

The Caltech/MIT Voting Technology Project (VTP) was formed in the immediate aftermath of the 2000 presidential election. For over fifteen years, the VTP has developed scientific approaches for the study of election administration and voting technology, guided public policy in these areas, and examined the real issues behind the technology and conduct of democratic elections in the United States and in other nations. The VTP is a unique collaborative effort, a research and education initiative that has brought together faculty and students from two of the leading science and engineering universities in the world. Through our interdisciplinary approach to research, we have forged lasting collaborations between our two campuses, and between scholars who work in highly disparate fields, including political science, computer science, economics, operations research, mechanical engineering, and design.

This briefing is the first of a series that the VTP will provide in the 2016 election cycle, as we look back on the history of the VTP's accomplishments since the tumultuous 2000 presidential election, and from that history examine the current state of scientific knowledge about election administration and voting technology. We use that perspective to discuss the research priorities of the VTP for 2016, and to provide our analysis of the states where we will focus our attention in the 2016 presidential and federal legislative general elections this fall.

A Brief History of the VTP

The idea for what became the Caltech/MIT Voting Technology Project in November 2000 came from David Baltimore and Charles Vest, at the time the presidents of Caltech and MIT. With financial support of the Carnegie Corporation of New York, they quickly recruited a diverse faculty group on each campus to work on the project. The MIT faculty group included Stephen Ansolabehere, Stephen Graves, Ron Rivest, Ted Selker, Alex Slocum, and Charles Stewart III; at Caltech the original faculty were Michael Alvarez, Erik Antonsson, Jehoshua Bruck, and Thomas Palfrey. The charge to the project members was simple — to figure out what had gone wrong with the voting technologies used in the 2000 presidential election, and how to mitigate or eliminate those problems by the 2004 presidential election.

The investigation initiated by the VTP in 2000 and 2001 was sweeping; the research groups at Caltech and MIT quickly surveyed the existing research on voting technologies and election administration. It became immediately apparent that there was a distressing lack of previous research on the problems that were at the heart of the disputed presidential balloting we witnessed in Florida: unreliable and inaccurate voting technologies. Furthermore, as we talked with election officials and other stakeholders throughout the nation, we heard of a large array of other technological and administrative problems that were of concern to many in the aftermath of the 2000 presidential election, especially issues regarding voter registration, polling place practices, absentee and early voting, and the cost and financing of elections.

With scant previous research to guide our work, the VTP set out to develop new metrics that we could use to assess the problems seen in the 2000 presidential election. There were two metrics that the VTP developed, refined, and utilized to determine the extent of the problems facing election officials throughout the nation: the specific metric of residual votes, and the more general metric of lost votes. The residual vote rate metric was novel; the VTP found that it was both relatively easy to collect, and a very powerful tool that could be used to assess the reliability of different voting technologies. The lost votes metric was also useful; by collecting data from different sources and estimating how many eligible votes might have been lost in many different ways (both technological and administrative), the VTP was then able to compare the number of votes that were lost because of bad technology to the number that were lost because of problems with voting by mail, long lines, registration errors, and the like.

The residual vote rate metric was originally measured by the VTP as the fraction of the total ballots cast which had no recorded presidential vote. The simplicity of this metric was important, especially in the immediate aftermath of the 2000 presidential election, because it could be calculated using data already gathered by local election officials — the total number of votes cast for presidential candidates (which all jurisdictions reported) and the total number of voters who cast a ballot (which *almost* all jurisdiction reported).[1] The residual vote rate was also helpful because it could be used both to compare jurisdictions with each other, and to compare a single jurisdiction with itself across time.

What we called a residual vote could occur for two types of reasons. First, a voter could just abstain. Second, a voter could attempt to cast a ballot, but the vote wouldn't be counted because of problems associated with the technology. Because there was no reason to suppose that different types of voting machines (punch cards, hand-counted paper, etc.) led voters to abstain at different

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[1] See the Appendix to the VPT's 2001 report, "Voting: What Is, What Could Be" (available online at http://vote.caltech.edu/sites/default/files/voting_what_is_what_could_be.pdf), especially the section, "Estimating Lost Votes." Also see R. Michael Alvarez, Stephen Ansolabehere, and Charles Stewart III, "Studying Elections: Data Quality and Pitfalls in Measuring the Effects of Voting Technologies." *Policy Studies Journal* 33, no. 1 (2005): 15–24.

rates, it was reasonable to assume that differences in the residual vote rate across jurisdictions using different voting machines was primarily due to issues related to using those machines.

The first study that the VTP released, made available in late March 2001, used the residual vote rate metric. That study, "Residual Votes Attributable to Technology: An Assessment of the Reliability of Existing Voting Equipment," was widely disseminated after its release, and was a foundational study providing support for a number of subsequent election reform efforts (especially the development of the *Help America Vote Act*). This study, and the version later published in the *Journal of Politics* (2005), also helped to spark an explosion of academic research on voting technology.[2]

The 2001 residual votes study used data collected from a variety of sources. In conducting the original study, data coverage was an issue, because about a dozen states did not report how many people turned out to vote in the presidential election. (Ensuring the accurate, timely, and comprehensive reporting of election administrative data has since become an important goal of the VTP). However, the data we were able to gather was sufficient to yield two important conclusions, which were revealed through county-by-county analysis of the residual vote rate data by voting technology used:
-    Residual vote rates were relatively high in counties using punch card voting systems and hand-counted paper ballots.
-    Counties using voting systems that let voters check their ballots for common errors before their ballots were submitted had lower residual vote rates than counties using voting systems that did not allow a voter to check their ballot for errors.

These conclusions from this 2001 study by the VTP factored importantly into the policy proposals that we made at the state and federal levels. In particular, these findings helped to justify the project's call for the phasing out of punch card voting machines and for requiring the use of voting technologies that allow voters to check their ballots for common errors before casting them.

The residual vote rate metric developed by the VTP has now become a standard tool used by researchers and policymakers in the past fifteen years. A recent Google Scholar search using the term "residual votes" returned approximately 22,400 results since 2001, while the term "residual vote" produced 35,000 results during the same time period. Many of studies that these Google Scholar searches returned were ones produced by VTP members, including research using residual vote measures to study more recent elections, voting rights issues, voting system transitions, and the reliability of voting-by-mail.[3]

[2] Stephen Ansolabehere and Charles Stewart III. "Residual Votes Attributable to Technology." *Journal of Politics* 67, no. 2 (2005): 365–389.

[3] Charles Stewart III has written a number of research studies which have used the residual vote rate metric to examine more recent elections ("Residual Vote in the 2004 Election." *Election Law Journal* 5, no. 2 (2006): 158–169, and to study changes in residual voting rates when states adopt new voting technologies ("The Reliability of Electronic Voting Machines in Georgia." Caltech/MIT VTP Working Paper 20). The residual vote measure has been widely used

The residual vote metric was one of the important components that went into the calculation of the broader and more comprehensive notion of lost votes, which was one of the most significant contributions of the VTP's June 2001 report, *Voting: What Is, What Could Be*. Residual votes were used to estimate the number of potential votes which might have been lost in the 2000 presidential election because of voting machine problems, which the VTP then estimated as 1.5 to 2 million. However, to calibrate the magnitude of the issues of problematic voting systems, the VTP also estimated the number of votes that were lost in the 2000 presidential election because of other problems, especially snafus with voter registration (1.5 to 3 million votes estimated to have been lost) and problems in polling places (up to a million votes lost). While the VTP at that time was unable to put a precise estimate on the number of votes that were lost in 2000 because of problems with absentee and voting by mail, we estimated that overall between 4 and 6 million votes were lost in that election. Like the residual votes measure, the general concept of lost votes has been used in many subsequent studies and analyses of voting technology and election administration.

Importantly, the residual and lost vote metrics weighed heavily in the debates about voting technology and election administration in the immediate aftermath of the 2000 presidential election. The VTP's two initial reports, released in March and June 2001 — fifteen years ago — helped to shape and guide the discussions of election reform in statehouses throughout the country, and in the halls of Congress, in 2001 and 2002. The immediate consequences of the VTP's first two reports were:

1. We helped to frame the debate about voting technology by calling for an immediate replacement of punch card voting systems with voting technologies that allowed voters to verify the accuracy of their ballot before it was cast.
2. We pointed out that voter registration was an important point of failure for many potential voters, and called for efforts to clean up and modernize voter registration databases as well

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in studies examining racial and ethnic disparities in election administration, for example, Stephen Ansolabehere, "Voting Machines, Race, and Equal Protection." *Election Law Journal* 1, no. 1 (2002): 61–70; Michael C. Herron and Jasjeet S. Sekhon, "Black Candidates and Black Voters: Assessing the Impact of Candidate Race on Uncounted Vote Rates." *Journal of Politics* 67, no. 1 (2005): 154–177; and Justin Buchler, Matthew Jarvis, and John E. McNulty, "Punch Card Technology and the Racial Gap in Residual Votes." *Perspectives on Politics* 2, no. 3 (2004): 517–524. The transition to voting-by-mail has been studied using the residual vote metric as well (R. Michael, Dustin Beckett, and Charles Stewart III. "Voting Technology, Vote-by-Mail, and Residual Votes in California, 1990–2010." *Political Research Quarterly* 66, no. 3 (2013): 658–670). The pros and cons of the residual vote metric have been discussed by R. Michael Alvarez, Stephen Ansolabehere, and Charles Stewart III, "Studying Elections: Data Quality and Pitfalls in Measuring of Effects of Voting Technologies." *Policy Studies Journal* 33, no. 1 (2005): 15–24, and by Charles Stewart III, "The Performance of Election Machines and the Decline of Residual Votes in the United States." In *The Measure of American Elections,* Barry C. Burden and Charles Stewart III (eds.), New York: Cambridge University Press, 2014.

as to implement procedures like provisional balloting as fail-safes for potential voters for whom the registration process might have lost.

3. We noted that the federal government needed to develop a clearinghouse for information on election administration information, for election performance data, and the dissemination of best practices.

4. We outlined a new architecture for voting technologies, based on commercial, off-the-shelf, components (the FROG architecture).

5. We called for more research on voting technologies and election administration.

In each of these areas, the VTP's work fifteen years ago became enshrined in county, state, and federal election reform efforts — culminating in the passage of the *Help America Vote Act* in 2002 (HAVA). VTP faculty members assisted in the development of key components of HAVA, especially in each of the four areas listed above. And equally important, members of the Caltech/MIT Voting Technology Project helped counties and states in their efforts to implement their election reforms, especially HAVA, by working with state HAVA implementation committees, by participating in efforts to guide the development of voting systems standards and testing guidelines, and by assisting the U.S. Election Assistance Commission once it was established and staffed.

Fast-Forward: The Science of Elections Today

While the early work of the VTP in the days leading up to the passage of HAVA in 2002 was very consequential in the development and implementation of election reform efforts in the United States, we are also proud to reflect upon our efforts to develop a science of elections in the last fifteen years. There were many research groups, task forces, committees, and teams of academics who banded together in the aftermath of the 2000 presidential elections to help guide election reform, groups and efforts that the VTP collaborated with. But as far as we are aware, the VTP is the only interdisciplinary academic research group that has continued to be highly active, providing quality scientific research on election administration and voting technology.

This lasting scientific legacy of the VTP has meant that today there is much more of an established science of election administration and voting technology. Unlike the situation we found when the Caltech and MIT presidents asked us to start the VTP in the fall of 2000 — where there were few scientists who studied these issues, little published research, and scant data to assist our evaluative analyses — VTP faculty members have written and published books on voting technology and election administration, published by the top academic presses in the world. VTP faculty and students have authored over a hundred working papers, and have published widely in peer-reviewed academic journals. We have helped to turn the study of election administration and voting technology into an interdisciplinary enterprise, as there is now an established body of

scientific research, with many fellow academics at universities, colleges, think tanks, and in both the public and private sectors, who now contribute to the growing science of elections.

Today it is common to see in the pages of the top social science research journals articles about voting technology, early voting, voter registration practices, and tools to detect election fraud (to give a few examples of current research topics). At professional conferences, entire panels are devoted to research on voting technologies and election administration. A number of annual conferences and workshops focus on promoting research in these areas (for example, EVT/WOTE, and the E-voting conferences in Europe). Journals like the *Election Law Journal* and the *Journal of Election Technology and Systems* have sprung up to provide important outlets for peer-reviewed research.

While much progress has been made to develop a science of elections, much more needs to be done. Resources for research, in particular the collection and dissemination of data about election administration practices and outcomes, must be increased. The post-election data collected by the U.S. EAC through the Election Administration and Voting Survey has been a boon to research, but it is still spotty in places. Beyond the data the EAC collects about administrative practices at the county or town level, there is still a gaping hole in the collection, retention, and dissemination of administrative and voter registration data at the precinct level.

Funding for the science of elections has been often scarce. The Carnegie Corporation of New York has been particularly generous to the VTP, having provided initial financial support to launch our project in 2000 and also having supported a number of other VTP activities over the past sixteen years. We have also received significant support for our research and policy activities from the John L. and James S. Knight Foundation, the Pew Charitable Trusts, the Democracy Fund, the Boston Foundation, and the James Irvine Foundation. We wish to thank these organizations for their support, and call on other organizations like them to help support efforts to develop the science of elections.

Additional venues for the publication of peer-reviewed research on election administration and voting technology need to be developed, in particular ones that provide open-access research so that the work of the scientific community is readily available to election officials and policymakers. Efforts to internationalize the scientific study of elections much continue — the VTP and other research groups currently active in these areas must continue to build collaborations with election officials and scholars outside the United States. And we all must continue to insure that our research is timely, accessible, and relevant for election officials and policymakers.

VTP and the 2016 General Election

Election are complex; the former election administrator running elections in Los Angeles County, which is one of the largest election jurisdictions in the United States, used to compare the preparations and deployments necessary for an election in LA County to those associated with mobilizing an army for battle.[4] In places like LA County, thousands of polling locations must be found and secured for election day; many thousands of poll workers and election judges must be recruited and trained; ballots appropriate for each precinct in the county must be developed, tested, and readied for the election; materials for the election must be distributed to every polling location prior to election day; rapid response teams must be established to help resolve problems before, during, and after the election; and all of the materials associated with the conduct of the election must be secured, returned, and accounted for within the days and weeks of a major election. In short, elections are complex administrative operations.

Elections are about people. Not only is a vast army of poll workers, sometimes armed with only a few hours of training, deployed with little oversight on election day, but the consumers of their services — the voters — are not necessarily well-informed about the issues on the ballot, or how to use polling place technology. Voters who stand in long lines can get impatient and angry, leading to confrontations between voters, and between voters and poll workers.

Elections are contentious. Candidates, parties, interest groups, and many organizations devote considerable time and effort to winning for their candidates and causes — in these situations, passions run high, personalities get involved, and close elections end up being recounted — and sometimes the apparent losers of an election contest take the matter to court.

We have worked with countless election officials, polling place workers, election judges, advocates, and other observers of elections over the past fifteen years. Our conclusion is that the people who make elections possible have excellent intentions: they want elections in their area to be successful, and they don't relish the spotlight that comes when an election is close, problems arise, and intense scrutiny is placed upon the hard work that they have done to insure a successful election in their jurisdiction.

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[4] In the VTP archives, we have a copy of the media guide for the 2002 Los Angeles County media guide for the primary election. The introduction to the guide, by Registrar-Recorder/County Clerk, Conny B. McCormack states in the second paragraph: "**Akin to a major military deployment** — The logistics of administering a statewide election in Los Angeles County is without equal. This election involves processing paperwork for 579 candidates, recruiting 19,380 poll workers, registering and re-registering approximately 100,000 voters on the deadline, and mailing sample ballot booklets to 4.1 million registered voters. It will culminate in counting an anticipated 1.5 million ballots cast at 4,845 voting locations (and an additional 350,000+ are expected to be voted via the absentee mail ballot process)." This is from "Elections FYI: 2002 Gubernatorial Primary Election." March 5, 2002, Los Angeles County Registrar-Recorder/County Clerk.

Despite the best intentions, diligent planning, and hard work by state and local election officials, it does not take scientists from Caltech and MIT to predict that administrative and technological problems will arise in the U.S. November 2016 general election. Unfortunately, we are confident in predicting that there will be states and counties where administrative, technological, or people problems will occur that may lead to post-election battles like the one we witnessed just sixteen years ago in Florida.

Thus, the question is not whether problems will arise in November 2016, but where they will occur, what form they will take, and how significant they will be.

Our research has shown that there are perennial problems that arise in each presidential election cycle in the recent past — the same set of problems that we identified in our 2001 studies. It is likely that voters in some states will face long lines when they go to vote. In some places, voting machines will malfunction or not be reliable. Ballots sent by mail may not arrive, or may not be received by election officials before their jurisdiction's deadline. New voter identification requirements might be impossible for some voters to meet, or the requirements might be incorrectly or inappropriately administered by poll workers. Questions about election fraud will surface.

The hard-fought primary contests we have been through in 2016 have renewed a lingering suspicion on the part of many in the political system that election outcomes are somehow "rigged" and that the electoral system is untrustworthy. One thing that makes the tenor of these suspicions different this year is that they have often emanated directly from the major candidates themselves. The fact that major candidates have given voice to doubts about the honesty of the electoral system undoubtedly helps explain why so many Americans have become distrustful of the honesty of the electoral process. In a poll conducted by the Associated Press and NORC in May of this year, only 36% of respondents said they had "a great deal of confidence" that their vote in November 2016 would be counted accurately — a rate roughly half what it has been in previous presidential elections.[5]

With confidence in the electoral process lagging so much, it is imperative for election officials and policymakers throughout the country to redouble efforts to ensure both that electors are conducted cleanly and that mechanisms are in place to enhance the transparency of elections.

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[5] The Associated Press-NORC Center for Public Affairs Research, "The Frustrated Public: Views of the 2016 Campaign, the Parties, and the Electoral Process." May 112-15, 2016, available online at http://www.apnorc.org/PDFs/Voting/APNORC_Elections_Topline.pdf. Cf. Michael W. Sances and Charles Stewart III, "Partisanship and Confidence in the Vote Count: Evidence from U.S. National Elections since 2000." *Electoral Studies* no. 40 (2015): 176–88.

One transparency mechanism the VTP has championed has been post-election audits, particularly new forms of audits, such as "risk-limiting audits" and the "Bayes audit."[6]

Voter confidence will be an issue nationwide in 2016. In addition, as in past years, election administration is more likely to be a special issue in some states more than others. In trying to anticipate the states where issues of election administration are most likely to become part of part of the election story, we have considered two factors.

The first is the closeness of the presidential election in a state.

Election administration is more likely to be part of the election story when the outcome is close. In recent presidential elections, a relatively small handful of states have been closely contested, the so-called "battleground states." Despite the diligence of election administrators in these states, they will be more closely scrutinized. The five relatively large states we anticipate will be the most closely contested are Florida, North Carolina, Ohio, Virginia, and Colorado.

The second factor to consider is the type of administrative practices that are most likely to attract litigation or excite public controversy.

Long lines and congestion, for instance, provide easy photo opportunities to illustrate problems with election administration. The heavy use of mail and provisional ballots leaves a large number of ballots uncounted until after Election Day — and thus likely to be challenged by the candidates if there is a recount. Old voting machines are more likely to malfunction, leading to long lines and a sense of uncertainty in polling places.

We have a great deal of respect for the election administrators in all the battleground states. Nonetheless, in each state there is at least one feature of how elections are administered that is likely to draw the careful scrutiny of the press, the public, and the candidates in the event the vote margin in the Electoral College is razor-thin. Here, we describe what these features are, as a way of highlighting what the VTP will be scrutinizing in the days immediately before and after the November election.

Florida

As we noted earlier, the VTP's work originated as a result of technological problems that marred the 2000 presidential election in Florida; as the result of the efforts of both federal and state election reforms, problematic punch card voting systems were eliminated in the state. After the replacement

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[6] We discuss both of these methods, plus the general issue of post-election audits, more thoroughly in our 2012 report, *Voting: What Has Changed, What Hasn't, and What Needs Improvement,* pp. 17–18, available online at http://vote.caltech.edu/reports/6.

of punch card and mechanical lever machines in the state in the aftermath of the 2000 controversy, concerns about voting systems died down in Florida. (One exception was a controversy that focused on electronic voting machines in Sarasota County in the 2006 midterm election, which ultimately led to the elimination of electronic voting machines in the Sunshine State.)

However, Florida has continued to be a battleground state and other election administration issues have supplanted voting technologies as the focus of attention on Florida elections. Battleground states such as Florida see a great deal of media attention, attract an enormous amount campaign advertising, are frequently visited by the major party candidates, and are places where vast resources are spent on the "ground game" of modern presidential elections (that is, personal contact with voters to persuade them to turnout in the election). All told, this leads to high turnout in battleground states like Florida, and high turnout means long lines at polling places.

This was the case in both 2008 and 2012; in state-by-state voter evaluation surveys overseen by the VTP's Charles Stewart III (Survey of the Performance of American Elections, or SPAE), those who voted in person were asked how long they waited to vote.[7] Based on these survey reports, average voter wait times in 2008 in Florida were 29 minutes, while in 2012 the average wait time was 45 minutes. These were some of the longest voter waiting times in the nation in these two elections.

Because the contest for Florida's electoral votes will be intense this fall, the ground is set for polling place congestion in 2016, just like 2008 and 2012. Long lines have many problematic implications for election administration: they make voters irritable and frustrated, leading some to avoid voting altogether or to leave before voting, producing uncounted numbers of lost votes. Irritated voters also put pressure on overworked polling place workers, and are likely to lead voters to mark their ballots quickly or in uncomfortable ways, leading to administrative or ballot marking mistakes which might result in other lost votes. Long lines also sometimes lead to judicial intervention, for example court orders seeking to keep polling places open after their official close, further fueling the potential for post-election contests over the results.

In fairness, efforts have been undertaken in Florida since 2012 to mitigate the conditions that led to long lines in that election. Examples of these mitigation efforts include a limit on the length of ballot questions and a relaxation on restrictions about early voting sites. County supervisors of elections have updated equipment and many have added additional early voting sites. Supervisors are scrutinizing how they run polling places and train their poll workers in an effort to speed up the check-in process. Still, long lines have been a feature of presidential elections in Florida for so long that it is only natural to continue to watch out for long lines in Florida on Election Day and during early voting.

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[7] Charles Stewart III, "2012 Survey of the Performance of American Elections: Final Report."

North Carolina

Another battleground state where we will be watching for long lines and related polling place problems is North Carolina. North Carolina has a history of congested polling places and long lines, as reflected in the SPAE data. In the 2008 presidential election, the reported average wait time in North Carolina was 23 minutes, which like the estimate for average wait time for Florida is relatively lengthy. And as we noted before, long lines and lengthy waits lead to problems for voters and poll workers alike, and tend to provide fuel for post-election contests, recounts, and litigation. The good news is that the average reported wait for those voting in person fell in the state to 14 minutes in 2012.

However, since the 2012 election many of the reforms that expanded early voting opportunities in North Carolina have been eliminated or rolled back, meaning that many voters will likely have little option but to vote in person on Election Day again, or vote during a compressed early voting period. Also, North Carolina has been among the states recently seeking to stiffen its requirements that voters provide government-issued photographic identification to obtain a ballot; these new regulations might produce significant implementation problems in the state this fall, which in turn might further exacerbate long lines and crowded polling places.[8]

Thus, we will be watching North Carolina carefully for evidence about problems arising from issues associated with implementing the state's new policies regarding early voting and voter identification. These administrative changes may lead to long lines and congested polling places.

Ohio

Ohio is yet another perennial member of the Battleground State Club. Being in the heart of the industrial Midwest, with a demographically and ideologically diverse electorate, Ohio has been the scene of a great deal of presidential campaigning in recent cycles, and based on that we expect that it will yet again be among the battleground states in 2016.

However, the issues in Ohio are different than what we have seen in the Florida and North Carolina. Lines have not been a statewide issue in Ohio, although they have been an issue in some localities, most famously Cuyahoga County in 2004. In 2008 the average wait time as estimated by the data from the SPAE was 15 minutes, and in 2012 it was 11 minutes. Instead, Ohio is a state where we'd put the spotlight on a different issue — provisional ballots.

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[8] A similar phenomenon was seen in New Mexico, surrounding that state's implementation of voter identification policies. See Lonna Rae Atkeson, Lisa Bryant, Thad Hall, Kyle L Saunders, and R. Michael Alvarez, "New Barriers to Voter Participation: An Examination of New Mexico's Voter Identification Law." *Electoral Studies* 29, no. 1 (2010): 66–73.

Provisional balloting is an important fail-safe for voters, as it gives them a mechanism by which to obtain and mark a ballot, even if their name does not appear in the precinct's voter rolls. Typically, a voter who votes provisionally will mark their ballot, and then (usually under the supervision of a poll worker or judge) complete and sign information on an envelope that provides their identify; the marked ballot is then sealed inside that envelope, and the ballot would only be included in the subsequent tally if the voter is confirmed as an eligible voter in that jurisdiction.[9]

Before the passage of HAVA in 2002, about half of the states had provisional balloting procedures on their books. Many groups that studied the 2000 presidential election, including the VTP, concluded that provisional balloting was an important procedure that could reduce the number of votes lost through registration problems. As a consequence, HAVA mandated that states implement provisional balloting procedures.

Frequent use of provisional balloting has a number of implications; given that a provisional ballot requires that voters spend considerable time and effort providing their registration information, and typically that the process needs to be overseen by a poll worker or election judge, frequent use of this procedure can slow down polling place operations and fuel long lines. But more importantly, in a hotly contested, battleground state, large numbers of provisional ballots "leaves a lot of paper on the table" that provide the evidence necessary for election lawyers to file post-election contests.[10]

In 2012, Ohio voters reported a relatively high rate of the sorts of issues that can lead to provisional balloting. For instance, 17% of in-person voters reported a problem with their voter registration, which is a relatively high rate compared to other states. In addition, provisional ballots have come to be used almost as the equivalent of a change-of-address process. As a consequence, provisional ballot usage is very high in Ohio. According to the post-election survey data collected by the U.S. Election Assistance Commission, in 2012 over 200,000 provisional ballots were submitted in Ohio, making it among a handful of states that saw a large number of provisional ballots submitted in the 2012 election.[11]

Ohio changed its election laws in such a way that the use of provisional ballots should decline, but it remains to be seen how effective the new law will be. So watch Ohio's use of provisional ballots, and if the state is very close on Election Day this fall, these provisional ballots might provide the impetus for post-election legal battles and litigation.

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[9] There are considerable differences in how provisional ballots are tabulated across the states, if the voter is confirmed as eligible but has completed the ballot in the incorrect precinct. In some jurisdictions, such provisional ballots are tabulated, but only for the races that the voter would otherwise be eligible to cast a ballot for; however, in other jurisdictions such provisional ballots are not tabulated at all.

[10] Edward B. Foley, "A Big Blue Shift: Measuring an Asymmetrically Increasing Margin of Litigation." *Journal of Law and Politics* 28 (2013): 501–546.

[11] Others were California (over a million provisional ballots submitted), New York (450,000), and Arizona (180,000).

Virginia

Virginia is another battleground state, and a state where in recent presidential elections there have been long lines: the SPAE data from 2008 and 2012 found that voters experienced average wait times in Virginia of 28 minutes and 24 minutes respectively. Virginia recently came under a consent decree in federal court to undertake a systematic effort to shorten lines in 2016. Members of the VTP are participating in a program to help Virginia comply with this agreement, which makes us especially interested in following events on Election Day for evidence that these efforts have been effective.

Virginia has also had voting technology struggles. In a recent Brennan Center study, it was noted that Virginia had a problem with aging voting machines.[12] As voting technologies age, they become less reliable, less accurate, and are more likely to develop problems on Election Day. Problems with Virginia's voting machines were widely reported in 2014, but the issue of Virginia's aging technologies came to a head just weeks before its November 2015 state election. In that instance, one model of Virginia's aging machines, the "WINVote" electronic machines, was shown to have severe security problems. As a result, the state immediately decertified the WINVote and ordered the localities using this system to find replacements immediately.

While the decertification of the WINVote was an excellent response by the state, the replacement systems have yet to be utilized in a high-profile and competitive presidential election — so they will be tested in this fall's elections. Many voters will show up in polling places unfamiliar with these voting systems, and other unknown problems might emerge with their use in a high-turnout election.

Furthermore, other counties in the state continue to use other aging voting systems; we thus will be paying close attention to voting technology issues in Virginia this fall, in addition to monitoring the length of polling places lines in the state.

Colorado

Finally, Colorado is another battleground state that will likely come under scrutiny in 2016 because of its recent transition to same-day voter registration and all-mail balloting. This system has been in place since before the 2014 elections in Colorado, and thus has been used in one federal election cycle. But it has yet to be tested in a high-turnout and possibly close presidential election.

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[12] See Lawrence Norden and Christopher Famighetti, "America's Voting Machines at Risk." September 15, 2015, available online at https://www.brennancenter.org/publication/americas-voting-machines-risk.

The VTP has expressed concerns about voting-by-mail since our June 2001 report. In that report, we noted that while voting-by-mail can make the process of obtaining and returning a ballot much easier for many voters, it also raises a host of concerns — unknown numbers of ballots can be lost in the mail; because voting-by-mail occurs outside the security of a polling location, concerns about fraud and coercion arise; and voting-by-mail may not be as accurate a voting method as in-person precinct balloting. This last concern is significant; voters who cast their ballot in a polling place have the opportunity to have their ballot checked for common mistakes, which they can correct, before their ballot is put in the ballot box. Voters casting their ballots by mail do not have access to these error-checking technologies, and VTP research has shown that with the increasing use of voting-by-mail in many states, many of the gains we have seen in the reductions of residual votes since the implementation of HAVA are jeopardized.[13]

Colorado's implementation of vote-by-mail, with the accompanying use of voter service centers, attempts to address some of the problems identified with this mode of voting. In 2014, when the vote-by-mail system was first rolled out, most voters returned their ballots in person. Denver has implemented a program called "Ballot TRACE," which tracks returned ballots through the postal system. These developments address some of the chain-of-custody concerns we have previously identified, but they do not address the lack of a "second chance" to review a ballot and correct it for errors that lead to over- and under-votes.

Thus, we expect that if the election is close in Colorado, there will be questions about fraud, due to ballots being unaccounted for in much of the state while in the mail system, and the possibility of an increased residual vote rate.

Conclusion

Sixteen years ago, the United States experienced one of the closest presidential elections in its history. The close and contentious Florida vote count and recount ended up in the hands of the U.S. Supreme Court, and their actions in the *Bush v. Gore* decision helped to resolve the Florida controversy and an eventual victory by George Bush.

That same controversial election led to the forming of the Caltech/MIT Voting Technology Project, and to our first two research reports were issued fifteen years ago. With this report, we have reflected upon our research effort in 2001, and we are proud to note that our work in that controversial election led to important state and federal election reform efforts (in particular the passage of HAVA in 2002). We are also proud that our interdisciplinary scientific effort has continued since 2001, and we are the only such team of academic scientists who have remained

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[13] R. Michael Alvarez, Dustin Beckett, and Charles Stewart III, "Voting Technology, Vote-by-Mail, and Residual Votes in California, 1990–2010." *Political Research Quarterly* 66 (2013): 658–670. Also see 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, no. 3 (Fall 2010): 573–601.

committed to our research mission — providing unbiased scientific research, which is relevant to election administrators and policy workers, on important questions about election administration and voting technology.

Who We Are

The Caltech/MIT Voting Technology Project is directed by R. Michael Alvarez (Professor of Political Science, Caltech) and by Charles Stewart III (Kenan Sahin Distinguished Professor of Political Science, MIT). Members of the VTP are Stephen Ansolabehere (Professor, Department of Government, Harvard University), Stephen C. Graves (Abraham J. Siegel Professor of Management Science, MIT), Jonathan N. Katz (Kay Sugahara Professor of Social Sciences and Statistics, Caltech), and Ronald L. Rivest (Institute Professor, MIT). The analyses and opinions expressed in this report are the sole responsibility of the VTP directors and project faculty members.

Acknowledgements