The Voting Technology Problem

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Introduction

Nationwide, voting equipment urgently needs to be replaced. The technology currently employed by most jurisdictions is obsolete, and the consequences of continued use include lost votes, threats to the integrity of vote-counts, security risks, and undermined voter confidence in election outcomes, among others. Yet replacement is an exceptionally convoluted challenge, influenced by a range of distinct but interdependent breakdowns.

This paper will discuss the history that led to the current technology problem, including the Help America Vote Act and the controversy over electronic voting, explain the various types of voting technology in use today, and identify the funding deficiencies, market and administrative failures, and security concerns that comprise the problem. Further, this paper will briefly highlight jurisdictions that have created their own, independent solutions. Finally, this paper echoes the warnings made by stakeholders elsewhere; the swift, lasting replacement of voting equipment should be a nationwide priority.

History

Influential Studies and Reports

In order to understand the current voting technology environment and its complex problems, it is essential first to identify the events leading up to the Help America Vote Act (HAVA), as well as the Act itself, and their influence on the voting technology problem.

The 2000 presidential election and subsequent controversy from the Supreme Court's decision in *Bush v. Gore*, led many academics and analysts to examine and critique the way Americans vote and the overall election process.[1] The consequent reports and studies ultimately proved highly influential in both highlighting the need for legislation overhauling American

[1] Leonard M. Shambon, *Implementing the Help America Vote Act*, 3 Election L.J. 424, 426 (2004).

election administration, as well as in providing the foundation for what that legislation should entail. Influential studies and analyses include "a series by the United States General Accounting Office[2] as well as . . . by the Constitution Project,[3] the National Association of Counties (NACo) and the National Association of County Recorders, Election Officials, and Clerks (NACRC),[4] the Election Center,[5] the Caltech/MIT Voting Technology Project,[6] and the United States Commission on Civil Rights."[7]

Of these studies, the Voting Technology Project as well as the National Commission on Federal Election Reform (commonly referred to as the Carter-Ford Commission), were the most influential in spurring congressional action and serving as conceptual foundations for HAVA.[8] The Voting Technology Project found that between four and six million votes were lost during the 2000 election,[9] and of these, 1.5 to 2 million lost votes resulted from faulty equipment and confusing ballots.[10] The report's authors coined the term "residual votes," i.e., the number of "uncounted, unmarked, and spoiled ballots," to demonstrate the impact faulty voting machines

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[2] *Id.* at 426-7 (citing U.S. GEN. ACCOUNTING OFFICE, ELECTIONS: THE SCOPE OF CONGRESSIONAL AUTHORITY IN ELECTION ADMINISTRATION (2001) [hereinafter GAO]; GAO, ELECTIONS: PERSPECTIVES ON ACTIVITIES AND CHALLENGES ACROSS THE NATION (2001); GAO, ELECTIONS: STATUS AND USE OF FEDERAL VOTING EQUIPMENT STANDARDS (2001); GAO, ELECTIONS: A FRAMEWORK FOR EVALUATING REFORM PROPOSALS (2001)).

[3] *Id.* at 427 (citing FORUM ON ELECTION REFORM, THE CONSTITUTION PROJECT, BUILDING CONSENSUS ON ELECTION REFORM (2001)).

[4] *Id.* (citing NAT'L COMM'N ON ELECTION STANDARDS AND REFORM, REPORT AND RECOMMENDATIONS TO IMPROVE AMERICA'S ELECTION SYSTEM (2001)).

[5] *Id.* (citing NAT'L TASK FORCE ON ELECTION REFORM, THE ELECTION CTR., ELECTION 2000: REVIEW AND RECOMMENDATIONS BY THE NATION'S ELECTIONS ADMINISTRATORS 4, 30–31 (2001); *See also* THE NAT'L COMM'N ON FED. ELECTION REFORM, TO ASSURE PRIDE AND CONFIDENCE IN THE ELECTORAL PROCESS 25 (2001) [hereinafter CARTER-FORD COMM'N]).

[6] *Id.* (citing CALTECH/MIT VOTING TECH. PROJECT, VOTING: WHAT IS WHAT COULD BE (2001) [hereinafter VOTING TECH. PROJECT]).

[7] *Id.* (citing U.S. COMM'N ON CIVIL RIGHTS, VOTING IRREGULARITIES IN FLORIDA DURING THE 2000 PRESIDENTIAL ELECTION (2001)).

[8] *See* Daniel P. Tokaji, *Early Returns on Election Reform: Discretion, Disenfranchisement, and the Help America Vote Act*, 73 Geo. Wash. L. Rev. 1206, 1211 (2005).

[9] *See* VOTING TECH. PROJECT *supra* note 6, at 8.

[10] *Id.* at 9.

can have on the overall incidence of lost votes.[11] The authors revealed that the type of ballot machine used correlates with an increase or decrease in the number of residual votes; specifically, paper ballot systems tended to result in lower residual votes than lever and electronic machines.[12] However, punch cards systems, the machines responsible for the problematic Florida recount process in the 2000 presidential election, were the exception to this phenomenon, losing at least fifty percent more votes than optically scanned paper ballots. As a result of this finding, the authors concluded that:

> Punch cards have averaged a residual vote rate of 2.5 percent in presidential elections and 4.7 percent down the ballot. Over thirty million voters used punch cards in the 2000 election. Had those voters used optical scanning there would have been 300,000 more votes recorded in the 2000 presidential election nationwide and 420,000 more votes in Senate and gubernatorial elections . . . . The immediate implication of our analysis is that the U.S. can lower the number of lost votes in 2004 by replacing punch cards and lever machines with optical scanning. Punch cards and levers are, in our assessment, dominated technologies. That is, there are voting technologies available today that are superior, from the perspective of lost votes. Scanners consistently perform better than punch cards and levers.[13]

The Carter-Ford Commission was particularly influential in serving as the foundation for HAVA. Its report was published in August 2001, and its principle recommendations included (among other things):

- A requirement that each state set a uniform benchmark for voting system performance;[14]
- That the federal government develop a comprehensive set of voting equipment system standards for the benefit of state and local election administration;[15]

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[11] *Id.* at 20.
[12] *Id.* at 21.
[13] *Id.* at 21-2.
[14] CARTER-FORD COMM'N, *supra* note 5, at 9.
[15] *Id.*

- That the federal government supply funding to the states for election administration;[16]
- That a new agency, the Election Assistance Commission (EAC), be charged with the federal responsibilities listed in the report's recommendations;[17] and
- That Congress enact legislation that includes federal assistance for election administration, "setting forth policy objectives for the states while leaving the choice of strategies to the discretion of the states."[18]

Ultimately, Congress incorporated many of these recommendations into what became HAVA.[19]

The Help America Vote Act

After some partisan back and forth, HAVA was finally signed into law on October 29, 2002.[20] There are three key components to the law.[21] Title I authorized $650 million to the states, half of which could be used for eight enumerated general election purposes.[22] The other half was used to incentive states to replace punch card or lever voting machines in those precincts that used such machines in the November 2000 election.[23] Title II established the EAC "to serve as an information clearinghouse, oversee the testing, certification, decertification and recertification of voting system hardware and software, provide election assistance and adopt voluntary guidance."[24] Title III contains "minimum requirements for voting systems, provisional voting

[16] *Id.* at 12.
[17] *Id.* at 13.
[18] *Id.*
[19] Tokaji, *supra* note 8, at 1213.
[20] *See* Shambon, *supra* note 1, at 427-8.
[21] Shambon, *supra* note 1, at 428.
[22] *Id.* (citing 52 U.S.C. § 20901 (2002)).
[23] *Id.* (citing 52 U.S.C. § 20902 (2002)).
[24] *Id.* (citing 52 U.S.C. § 20922 (2002)).

and required information for voters, computerized state-wide voter registration lists and requirements for first-time voters who register by mail."[25]

The EAC "was designed to have as little regulatory power as possible."[26] It was initially a bipartisan body[27] comprised of four members[28] who serve four year terms with the possibility of reappointment for one additional term.[29] Any action taken by the Commission must be approved by three members,[30] and the EAC does not "have any authority to issue any rule, promulgate any regulation, or take any other action which imposes any requirement on any State or unit of local government" except as necessary to carry out its duties.[31]

Title II also establishes the Technical Guidelines Development Committee (TGDC), led by the director of the National Institute of Standards and Technology (NIST),[32] to assist the EAC in the development of the Voluntary Voting System Guidelines (VVSG).[33] With regard to the EAC's duties concerning certification of voting systems, the director of the NIST is also charged with the evaluation and accreditation of laboratories responsible for the testing, certification, decertification, and recertification of voting system hardware and software.[34]

Finally, the EAC is authorized to make Title III requirements payments to the states,[35] allocated on the basis of voting age population with certain minimum payments.[36] States must

[25] *Id.* at 429 (citing 52 U.S.C. §§ 21081-21084 (2002)).
[26] *Id.* at 428.
[27] 52 U.S.C.A. § 20923(b)(2) (2002).
[28] 52 U.S.C.A. § 20923(a)(1).
[29] 52 U.S.C.A. § 20923(b)(1).
[30] 52 U.S.C.A. § 20928 (2002).
[31] 52 U.S.C.A. § 20929 (2002).
[32] 52 U.S.C.A. § 20961(c)(1) (2002).
[33] 52 U.S.C.A. §§ 20961(a)-(b)(1).
[34] 52 U.S.C.A. §§ 20971(a)-(b)(1) (2002).
[35] 52 U.S.C.A. § 21001 (2002).
[36] 52 U.S.C.A. § 21002 (2002).

first use the funds to meet Title III requirements, but if those requirements have been met, states can use the remaining funds for other election administration improvements.[37]

With regard to voting equipment, HAVA did not explicitly require states to replace punch card or lever machines, but rather made provision of $325 million conditional on the removal of those machines.[38] States that qualified for the funds under the buy-out provision were required to replace punch card and lever machines in qualifying precincts by the November 2004 election, but could obtain a waiver (extending the deadline to 2006) if they could show good cause for failure to meet the deadline.[39] Of thirty states that received money for the replacement of punch card and lever machines, twenty-four sought a waiver.[40]

Additionally, Title III required that voting systems allow voters the opportunity to review and verify their vote, and to change it or correct any error before the ballot is cast and counted.[41] Though this would seem to have the effect of disallowing paper ballot systems, which lack the capacity for what's commonly referred to as "last chance" or "notice" technology,[42] HAVA provided a work-around for those systems. Specifically, HAVA asserts that the establishment of a voter education program informing the voter of the effect of casting multiple votes, as well as the provision of instructions to the voter on how to correct the ballot before it is cast and counted, is sufficient to meet the Act's notice requirements.[43] Therefore, HAVA does not require voting systems that provide actual notice and the opportunity to correct mistakes.[44]

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[37] 52 U.S.C.A. § 21001(b).
[38] Tokaji, *supra* note 8, at 1214-15.
[39] *Id.* at 1215.
[40] *Id.*
[41] *Id.* (citing 52 U.S.C. § 21081(a)(1)(A)).
[42] *Id.*
[43] *Id.* (citing 52 U.S.C. § 21081(a)(1)(B)).
[44] *Id.*

In addition to the voting system requirements discussed above, Title III also requires that voting systems:

> (4) Produce a permanent paper record with a manual audit capacity; (5) Be accessible for individuals with disabilities, with the same opportunity for access and participation, including privacy and independence, as for other voters; (6) Meet the preexisting alternative language requirements of the Voting Rights Act; and (7) Meet the laboratory ("out of the box") error rate requirements of the existing Federal Election Commission's existing Voting System Standards ("VSS"). Finally, each state is to adopt a uniform standard for what constitutes a vote for each category of voting system used in the state.[45]

Finally, HAVA required states to submit plans for implementation,[46] and the 2004 plans reflected an uncertainty about voting machines that persists today.[47] Much of the uncertainty centers around electronic voting machines, often referred to as Direct Record Electronic (DRE) machines. While many states moved to purchase them before 2004, other states chose to wait due to uncertainty about funding, about what the EAC would eventually decide constitutes compliance with Title III, anticipation of technological improvements or price declines, and concerns about security. [48]

The Electronic Voting Controversy

Though HAVA provided states the funding necessary to make improvements to voting systems, it did not mandate which voting systems were to be implemented, though it did require that each polling place in a federal election have at least one machine fully accessible for those with disabilities – at the time, DRE machines were the only machines capable of meeting that

[45] Shambon, *supra* note 1, at 429 (citing 52 U.S.C. §§ 21081(a)(2)-(6) (citations omitted)).
[46] 52 U.S.C.A. § 21004 (2002).
[47] *See* Shambon, *supra* note 1, at 432.
[48] *Id.*

requirement.[49] Ultimately, however, the decision as to which voting system to implement was left to the states and their localities, thereby contributing to the lack of nationwide uniformity.

Moreover, though DRE machines constituted the most technologically advanced choice, they were becoming increasingly controversial for their perceived security risks.[50] This uncertainty over security was reflected in HAVA itself, as it required a paper audit trail of voter's choices and further study of security problems.[51] In 2003 however, scrutiny of DRE machines increased, as Professor David Dill of Stanford University's computer science department publicly posited that DRE technology is "error prone and vulnerable to fraud."[52] Furthermore, researchers at Johns Hopkins and Rice Universities published a study ("The Hopkins Study") calling into question the security of DRE machines manufactured by Diebold Election Systems, a voting system vendor with contracts in Georgia and Maryland to provide touchscreen DREs.[53] The study's authors concluded that the computer source code corresponding to a version of Diebold's voting system "had serious security flaws that could permit tampering by persons at various levels, including voters, election workers, Internet 'hackers,' and even software developers."[54]

The Hopkins Study prompted calls for a "voter verified paper audit trail" (VVPAT), which would allow voters to verify a contemporaneous paper record of their vote.[55] Though HAVA mandated a paper trail, it did not require that the paper record be contemporaneous. In order to produce such a record, electronic machines would require an attached printer capable of

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[49] ERIC A. FISCHER, CONG. RESEARCH SERV., ELECTION REFORM AND ELECTRONIC VOTING SYSTEMS (DREs): ANALYSIS OF SECURITY ISSUES 5 (2003).
[50] Daniel P. Tokaji, *The Paperless Chase: Electronic Voting and Democratic Values*, 73 Fordham L. Rev. 1711, 1734 (2005).
[51] *Id.* (citing 52 U.S.C.A. §§ 21081, 20981 (2002)).
[52] *Id.* at 1735 (citing VERIFIED VOTING, http://www.verifiedvoting.org (last visited Jan. 30, 2005)).
[53] FISCHER, *supra* note 49, at 9.
[54] *Id.*
[55] Tokaji, *Paperless Chase*, *supra* note 50, at 1735.

generating a paper record at the time of voting.[56] The necessity and benefit of VVPAT with electronic voting systems is described below:

> The concern expressed by some DRE skeptics is that, without a contemporaneous record that the voter can see, malicious codes in the DREs software could result in the voter's intended choice appearing on the screen, while a different selection is recorded in the machine's memory. A contemporaneously generated paper record would, it is argued, eliminate this possibility. If there is a discrepancy between the paper record and the intended choices, then the voter could either revise her choices or call the discrepancy to the attention of the poll worker. If a candidate or voter suspected foul play, then a recount of the paper records could be conducted. At least in theory, then, the contemporaneous paper record would provide a secure and auditable record of voters' intended choices.[57]

VVPAT was controversial at the time. While some scholars argued that it was necessary to ensure public confidence in electronic voting, others argued that it was "unnecessary, burdensome, and likely to discourage adoption of accessible voting technology."[58]

Thus, a tension developed as a result of HAVA's Title III voting system requirements. States were compelled to use voting machines capable of meeting those requirements, such as electronic voting machines, but also faced potential security risks in implementing those same machines. The result is that in 2004, three-quarters of the American electorate used the same voting machine as during the 2000 presidential election.[59] This outcome was caused not only by the controversy surrounding electronic voting machines, but by a delay in federal funding to states for the replacement of existing equipment.[60] By 2006 however, all states, with the exception of New York, had replaced all punch card and lever machines with optical scan or electronic voting machines (see Table 1 and Figure 1, infra).[61]

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[56] *Id.*
[57] *Id.* at 1735-36 (citing FISCHER, *supra* note 49, at 15, 28-9).
[58] *Id.* at 1736.
[59] *Id.* at 1737 (citing Jim Drinkard, *Remember Chads? They've Hung Around*, USA TODAY, July 13, 2004, at 1A).
[60] *Id.* at 1738.
[61] VOTING TECH. PROJECT, WHAT HAS CHANGED, WHAT HASN'T, & WHAT NEEDS IMPROVEMENT 13 (2013).

Technology

This section considers the various kinds of voting technology and how they differ. In 2001, there were five types of voting machines, with variations within each category.[62] Three of the five types were paper-based technologies: hand-counted paper ballots, punch cards, and optically scanned paper ballots.[63] The two remaining types include machines that directly record the vote: mechanical lever machines and electronic voting machines (DREs).[64]

Paper Ballots

Paper ballots are the oldest technology used in national elections.[65] The basic ballot used is the Australian or mark choice ballot, in which the names of all the candidates are listed and voters mark their choices, which are secret.[66] In 2001 this technology was used in approximately three percent of all precincts, mostly in rural areas.[67] That percentage represented a decline by half since 1992.[68]

Punch Cards

Developed in 1964, punch card systems were the first voting machines that used computers to count votes.[69] They are described in detail in the following Congressional Research Service report:

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[62] VOTING TECH. PROJECT, VOTING, *supra* note 6, at 18.
[63] *Id.*
[64] *Id.*
[65] *Id.*
[66] ERIC A. FISHER, CONG. RESEARCH SERV., VOTING TECHNOLOGIES IN THE UNITED STATES: OVERVIEW AND ISSUES FOR CONGRESS 3 (2001).
[67] *Id.*
[68] *Id.* (citing KEVIN J. COLEMAN ET AL., CONG. RESEARCH SERV., THE ELECTION PROCESS IN THE UNITED STATES 69 (1995)).
[69] *Id.*

> In this system, the voter records choices by punching holes in appropriate locations on a paper computer card that is later fed into a computer reader to record the vote. The piece of card that is punched out is called a *chad*. The computer card serves as the document ballot on which the votes are recorded. As with other document ballots, punchcards can be manually recounted and audited.
>
> There are two basic types of punchcard systems. In one, numbered boxes are printed on the card, with each box corresponding to a particular ballot choice. The choices corresponding to those numbered boxes are indicated to the voter in a posted ballot in the form of a booklet attached to a voting machine, with the appropriate places to punch indicated for each candidate or other ballot choice. A voter slips the card into the "throat" of the voting machine, where it rests on a set of rubber strips under the ballot book. A simple stylus is used to punch out the chad for the box(es) corresponding to the candidate(s) chosen for each race or other item on the ballot. Turning a page in the booklet exposes another set of boxes on the card, corresponding to another set of ballot choices. The card may be prescored — partially cut through — at the locations within each box where a hole can be punched. The Votomatic[6] system used in Palm Beach County, Florida, and elsewhere is an example of this system.[70]

The other kind of punch card system is Datavote, in which there is no ballot book, but rather voters punch holes next to ballot choices that are printed on the cards themselves.[71] In 2001, about thirty-three percent of precincts used the Votomatic system, while four percent used the Datavote system,[72] making punch cards the most widely used voting machines at the time.[73]

Optical Scan

These machines are also referred to as "Marksense forms," and use the same technology as is used to grade standardized tests.[74] They have been available for use in elections since the 1980s.[75] In this system, a voter fills in an oval or box or completes an arrow corresponding to

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[70] *Id.* at 3-4 (noting, "Originally a brand name, the term *Votomatic* has passed into general usage to refer to this kind of technology, of which there are now several different models by different manufacturers").
[71] *Id.* at 4.
[72] *Id.*
[73] *Id.* at 2 tbl.1.
[74] *Id.* at 4.
[75] *Id.*

each ballot choice.[76] The ballot is then read by a computer. In 2001, about twenty-five percent of precincts used this technology, nearly double the number of those that did so in 1992.[77]

Optical scanning is performed two ways: at the polling place ("in-precinct count") or at the local election office ("central count").[78] The former is considered the preferred method, as it allows voters the opportunity to change their ballots to correct any mistakes detected by the scanner at the polling place, i.e. second chance voting. This error notification may prevent voters from marking more choices than allowed.[79] Second chance voting is impossible with central count systems, as scanning is not performed at the polling place. Consequently, mistaken overvotes are allowed to occur, and machines cannot be programmed to notify voters that they have undervoted.[80]

The above paper-based technologies differ in the way they are counted. Paper ballots are hand-counted by election officials, while scanning devices tally punch card and optical scan ballots.[81]

Lever Machines

The lever voting machine was introduced in 1892.[82] There is no document ballot; instead voters make choices listed on a posted ballot by pulling a lever for each choice.[83] The votes are recorded by a counting mechanism, therefore eliminating the need for a manual count.[84]

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[76] *Id.*
[77] *Id.*
[78] VOTING TECH. PROJECT, VOTING, *supra* note 6, at 19.
[79] Tokaji, *Paperless Chase*, *supra* note 50, at 1722.
[80] *Id.*
[81] VOTING TECH. PROJECT, VOTING, *supra* note 6, at 18.
[82] FISCHER, VOTING TECHNOLOGIES, *supra* note 66, at 3.
[83] *Id.*
[84] *Id.*

Recounts and audits are therefore limited to a review of each machine's total count.[85] In 2001, approximately twenty-two percent of precincts employed this technology.[86]

Electronic Voting Machines

DRE technology first became available in the 1970s.[87] Voters make choices from a posted ballot, either printed and posted on the machine or displayed on a computer screen.[88] Specifically, voters make choices by "pushing a button, touching a screen, or using a similar device."[89] Once submitted, votes are directly stored in a computer memory device, "such as a removable disk or nonvolatile memory circuit."[90] In 2001, approximately seven percent of precincts used this technology.[91]

There are two kinds of DRE machines. Older machines were modeled on lever machines; they use push buttons and are known as "full face" systems because they present the entire ballot to the voter at once.[92] These were the most common DRE machines used in 2001, accounting for approximately two-thirds of precincts using electronic technology.[93] Newer machines include touchscreens and keypads, similar to ATM machines.[94]

Change in Use Over Time

Table 1 and Figure 1 infra detail the difference in voting technology employed between the

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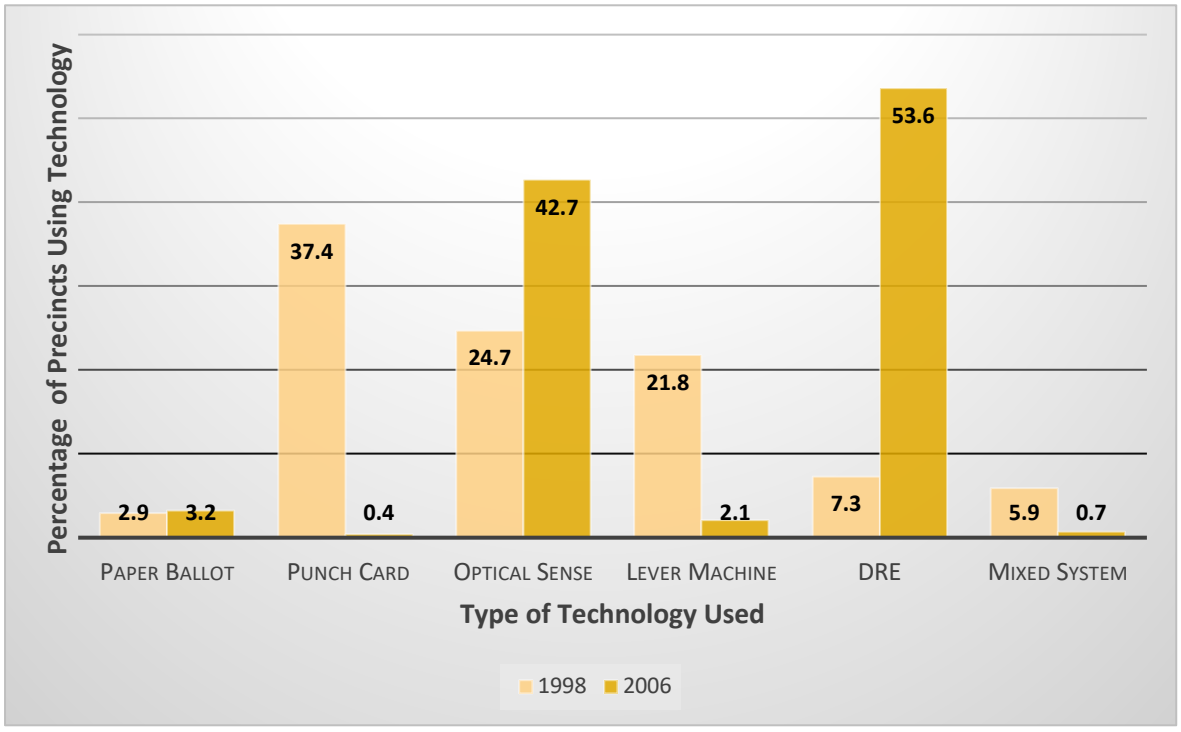
[85] *Id.*
[86] *Id.*
[87] *Id.* at 4.
[88] *Id.*
[89] *Id.*
[90] *Id.*
[91] *Id.*
[92] Tokaji, *Paperless Chase*, *supra* note 50, at 1723.
[93] VOTING TECH. PROJECT, VOTING, *supra* note 6, at 19-20.
[94] *Id.* at 20.

1998 and 2006 elections. As illustrated by the table, while punch card technology dominated elections in 1998, with very few precincts employing electronic technology, that trend reversed substantially by 2006. Figure 1 illustrates the change in proportion to the whole among voting technologies used in 1998 versus those used in 2006. The outside circle represents 1998, while the inside circle illustrates the data from 2006.

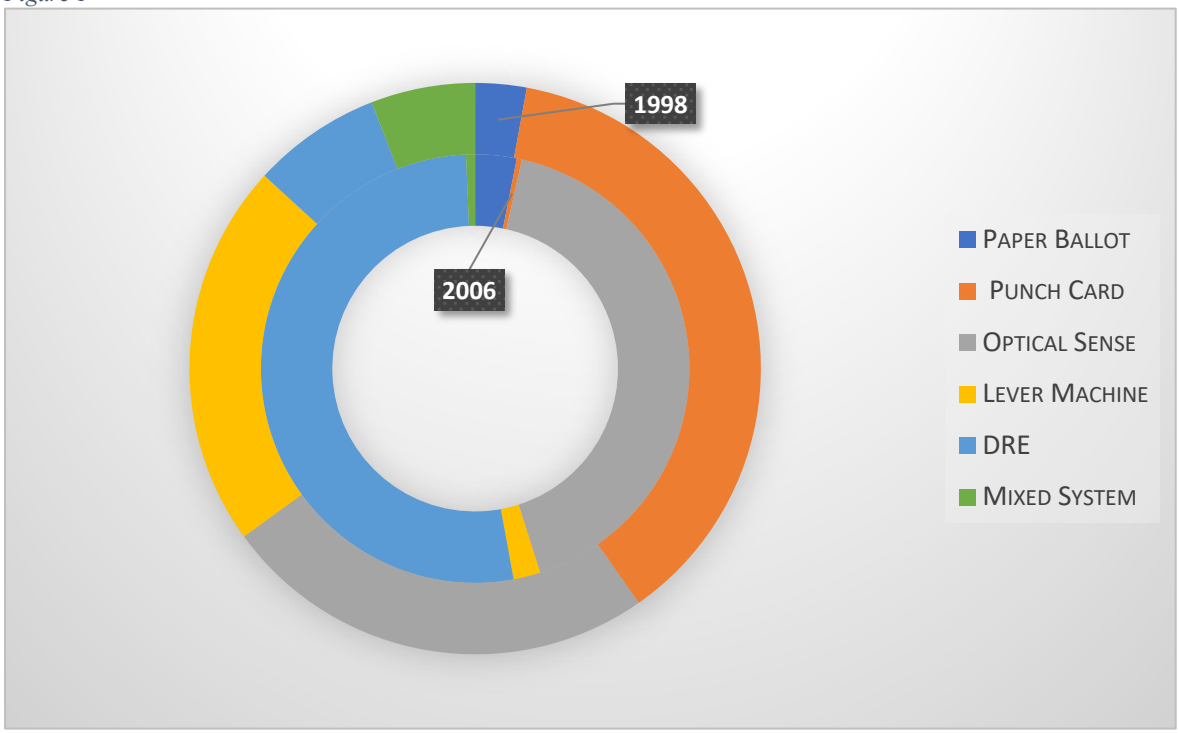
As of 2013, approximately three out of every five counties used optical-scan technology and two out of five used electronic equipment; a very small number continued to use hand counted paper.[95]

Table 1[96]



[95] VOTING TECH. PROJECT, WHAT HAS CHANGED, *supra* note 61, at 13.
[96] 1998 data comes from FISCHER, VOTING TECHNOLOGIES, *supra* note 66, at 2 tbl.1; 2006 data comes from U.S. ELECTION ASSISTANCE COMM'N, THE 2006 ELECTION ADMINISTRATION AND VOTING SURVEY: A SUMMARY OF KEY FINDINGS 24 (2007). The survey methodology from the EAC report explains that not all jurisdictions in each state are covered, as some states submitted incomplete data.

Figure 1[97]



The Problem

The primary problem is that current voting machines need to be replaced nationwide. Before HAVA, jurisdictions purchased voting machines on a rolling basis across the country, such that only a fraction of jurisdictions purchased new voting systems at a time.[98] HAVA provided an infusion of money to replace voting equipment in 2002, but without clear standards or testing programs in place.[99] As a result, most states purchased new voting technologies around the same time, with estimated lifespans of 10-20 years,[100] though some scholars posit that the estimate is closer to ten than to twenty.[101] Thus, the majority of voting systems used in the United States

[97] *Id.*
[98] THE PRESIDENTIAL COMM'N ON ELECTION ADMIN., THE AMERICAN VOTING EXPERIENCE: REPORT AND RECOMMENDATIONS 11 (2014).
[99] LAWRENCE NORDEN & CHRISTOPHER FAMIGHETTI, THE BRENNAN CTR. FOR JUSTICE, AMERICA'S VOTING MACHINES AT RISK 8 (2015).
[100] *Id.*
[101] *Id.*

today are "perilously close to or past their expected lifespans."[102] Consequently, the Brennan Center estimated in 2015 that forty-three states would use voting machines purchased ten or more years ago in the 2016 election.[103] Moreover, though these machines were bought several years ago, many were designed and engineered in the 1990s.[104]

There are a number of consequences for failure to replace or maintain aging machines, one of which is a potential increase in the incidence of lost votes, or a higher residual rate. In a 2013 report, the Voting Technology Project found that new machines bought and implemented as a result of HAVA cut the residual vote rate in half:

> 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).[105]

Of course, the technologies that were new in 2006 and 2008 are now considered antiquated, suggesting that, like their predecessors, they could contribute to an increased number of unmarked, uncounted, and spoiled ballots.

Furthermore, antiquated machines are at risk of simply failing to perform on election day, which has consequences beyond an inability to cast and count votes. As the Brennan Center described it, "Ultimately, the election official's greatest fear is that equipment failures undermine confidence in election results."[106]

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[102] *Id.* at 9.
[103] *Id.*
[104] *Id.* at 21 (quoting E-mail from Dana Chisnell, Civic Design, to Lawrence Norden, Deputy Dir., Democracy Program, Brennan Ctr. for Justice (May 25, 2015, 13:18 EST)).
[105] VOTING TECH. PROJECT, WHAT HAS CHANGED, *supra* note 61, at 14.
[106] NORDEN & FAMIGHETTI, *supra* note 99, at 12.

The Brennan Center identified election officials' three most common concerns about using antiquated equipment: "1) the failure of equipment to work as intended; 2) an inability to connect voting machines to current computers because the software is unsupported and outdated; and 3) difficulty finding replacement parts for machines that are no longer manufactured."[107] Examples of the first concern include problems with touchscreens on DRE machines, which can result in machines registering a voter's selection for a different candidate than intended, i.e. an "alignment error."[108] Similarly, touchscreens are vulnerable to "calibration" problems that can result in "vote flipping," i.e. registering a voter's choice for the wrong candidate. Additionally, memory cards used to transfer election results data are susceptible to more errors as they age.[109] These memory cards therefore have to be replaced often at exceptionally high expense; each card costs $100 to replace and only stores 512 kilobytes.[110]

Examples of the consequences of unsupported and outdated software include the inability to replace hardware because newer software can't run on it.[111] Moreover, outdated software is susceptible to security threats.[112] Finally, with regard to the third concern, an estimated forty-three states and the District of Columbia were using voting machines in 2015 that are no longer manufactured, meaning their ability to replace broken parts is substantially limited.[113]

Yet replacing old machines is a far more difficult task than simply purchasing new ones. The voting technology issue has morphed from one primarily concerned with the quality and security of voting machines, to one that includes broader political, market, and administrative difficulties

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[107] *Id.*
[108] *Id.* at 13.
[109] *Id.* at 14.
[110] *Id.*
[111] *Id*. at 15.
[112] *Id.*
[113] *Id.*

that have hampered technological development and manufacturing. The Voting Technology Project has labeled the voting machine problem as such:

> 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. [114]

These components are all related and interdependent. In order for manufacturers to produce reliable voting equipment, they need standards by which to develop that equipment. And without a viable market for the voting machine industry, vendors will not be incentivized to develop technological advances capable of producing reliable and secure machines.

Ultimately then, the inability to replace voting machines is a consequence of several failures.

Lack of Funding

As an initial matter, few states have budgeted to update machines, and without federal funds, will have to do without or alter the voting process to serve more voters with fewer machines.[115] The Brennan Center estimates that it would take well over $1 billion to replace old machines.[116] Though some states have remaining HAVA money, it is insufficient and often that money is earmarked for maintenance and operating costs.[117] In September 2013, thirty-four states had less than twenty percent of their HAVA disbursements remaining, and twenty-four states had less than ten percent.[118]

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[114] *Id.* at 12.
[115] THE PRESIDENTIAL COMM'N ON ELECTION ADMIN., *supra* note 98, at 11.
[116] NORDEN & FAMIGHETTI, *supra* note 99, at 17.
[117] *Id. (citing* Telephone Interview with Ryan Macias, Voting Sys. Analyst, Cal. (Mar. 13, 2015); Telephone Interview with Matt Kitzman, Electronic Voting Sys. Election Specialist, Wis. (Apr. 1, 2015)).
[118] *Id.* (citing U.S. ELECTION ASSISTANCE COMM'N, FISCAL YEAR 2013 INTERIM ANNUAL GRANT EXPENDITURE REPORT 12 (2015)).

Unfortunately, many state election officials reported in 2015 that, rather than receiving an influx of funds toward the purchase of new voting equipment, many have had their budgets cut or remain uncertain of future funding.[119] Part of the problem is the inability of election officials to convince state legislators to supply more funding.[120] Among those states that do not supply additional funding for voting equipment, only wealthier counties will be able to afford new voting equipment, leaving poorer counties with few options.[121]

Unsatisfactory Machines and Deficiencies in the Market

Yet, even if states could afford new machines, the selection of available machines is unsatisfactory.[122] Many state and local election officials reported to the Presidential Commission on Election Administration that machines currently available do not meet the technical, operational, regulatory, or other needs of jurisdictions.[123] This is due in part to deficiencies in the voting machine market and the industry's inefficient business model, which the Voting Technology Project identified in 2001 as the greatest challenge to the future of voting machine

[119] *Id.* (citing Telephone Interview with Ed Packard, Dir. of Elections, Ala. (Mar. 3, 2015); Telephone Interview with Ryan Macias, Voting Sys. Analyst, Cal. (Mar. 13, 2015); Telephone Interview with Peggy Reeves, Dir. of Elections, Conn. (Mar. 19, 2015); Telephone Interview with Kyle Thomas, Dir. of Voting and Registration Sys., Ill., and Kevin Turner, IT Dir, Ill. (Mar. 17, 2015); Maryellen Allen, Exec. Dir., Board of Elections, Ky. (Apr. 15, 2015); E-mail from Angie Rogers, Comm'r of Elections, La., to Christopher Famighetti, Voting Rights Researcher, Brennan Ctr. for Justice (Mar. 13, 2015, 12:30 EST) (on file with author); Telephone Interview with Paul Aumayr, Voting Sys. Dir., Md. (Feb. 26, 2015); Michelle Tassinari, Dir. of Elections, Mass. (Mar. 19, 2015); E-mail from Lisa Kimmet, Deputy, Elections and Gov't Division, Mont., to Christopher Famighetti, Voting Rights Researcher, Brennan Ctr. for Justice (Mar. 16, 2015, 10:50 EST) (on le with author); Telephone Interview with Matt Damschroder, Sec'y of State, Ohio (Feb. 23, 2015); Telephone Interview with Mark Thomas, Dir. of Elections, Utah (Mar. 24, 2015); Telephone Interview with Edgardo Cortes, Elections Dir., Va. (Mar. 20, 2015); Telephone Interview with Layna Brown, Elections Dir., W. Va. (Mar. 20, 2015); Lori Augina, Dir. of Elections, Wash. (Apr. 1, 2015); Telephone Interview with Matt Kitzman, Electronic Voting Sys. Election Specialist, Wis. (Apr. 1, 2015)).
[120] *See id.* at 17-18.
[121] NORDEN & FAMIGHETTI, *supra* note 99, at 19.
[122] THE PRESIDENTIAL COMM'N ON ELECTION ADMIN., *supra* note 115, at 11.
[123] *Id.*

equipment.[124] Voting machine firms are "highly specialized, providing voting equipment [a]nd little else."[125] As of 2013, the industry's annual revenue was only $300 million.[126]

Traditionally, voting equipment firms would develop a technology, submit it for testing and certification, then attempt to sell the equipment to individual counties, sometimes providing service contracts to aid with service and maintenance of machines.[127] The industry's primary efforts were devoted to its sales force.[128] In 2001, the Voting Technology Project identified four challenges to sustaining the voting machine industry:

> 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.[129]

Based on these challenges, the Voting Technology Project made recommendations that included an immediate infusion of federal funds, contracting at the scale of states or clusters of states (rather than counties), cost sharing, leasing equipment, and new contracting models based on those employed in Brazil.[130] In its 2013 report on election changes since 2001, the Voting Technology Project noted that the most significant change to the industry was the fact that many states have adopted statewide contracting as recommended.[131] Though HAVA provided the "immediate infusion of federal funds," it did so only once, and that money has since dissipated.

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[124] VOTING TECH. PROJECT, WHAT HAS CHANGED, *supra* note 61, at 22.
[125] *Id.*
[126] *Id.*
[127] *Id.* at 23.
[128] *Id.*
[129] *Id.*
[130] *Id.*
[131] *Id.* at 24.

Despite these two advances, the industry's business model remains largely unchanged, though the structure of the industry is somewhat altered.[132] In 2000, four midsized firms had control of most of the market.[133] One firm, Election Systems & Software, now controls a large portion of the market.[134] Diebold, the company whose DRE machines were the focus of the Hopkins Report, left the market after six years.[135] The Voting Technology Project characterized the Diebold example as "emblematic of the industry's problems:"[136] "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."[137]

Historically Unreliable Standard-Setting and Certification Process

The market alone is not the sole problem for the industry. The problem is compounded for voting machine vendors due to administrative and legal obstacles.[138] HAVA requires the EAC to develop a program that provides for the accreditation of independent, non-federal laboratories to test voting systems.[139] EAC developed its Testing and Certification Program to meets its statutory obligations both with regard to adopting standards via the VVSG, and the "testing, certification, decertification, and recertification of voting system hardware and software to these

[132] *Id.*
[133] *Id*. at 23.
[134] *Id*. at 24.
[135] *Id*.
[136] *Id*.
[137] *Id*.
[138] THE PRESIDENTIAL COMM'N ON ELECTION ADMIN., *supra* note 98, at 11.
[139] U.S. ELECTION ASSISTANCE COMM'N, STATE REQUIREMENTS AND THE FEDERAL VOTING SYSTEM TESTING AND CERTIFICATION PROGRAM 3.

Federal standards."[140] Thus, the EAC's program provides standards, testing of voting equipment by accredited laboratories, and certification of voting equipment.[141]

With regard to standards, the EAC did not adopt the new VVSG until 2015 (VVSG 1.1.), compounding the problem for manufacturers who had no reliable standards by which they could develop new, statutorily-compliant machines.[142] Before HAVA, the only federal standards for voting systems were those supplied by the Federal Elections Commission in 1990.[143] Though these standards were voluntary, by 2001 a majority of states required conformity.[144] A revised set of standards were adopted in 2002 prior to HAVA's passage.[145]

After HAVA's adoption, the TGDC set its first round of VVSG in 2005; they went into effect in December 2007, but were largely a "modest rewrite" of the 2002 standards.[146] In August 2007, the TGDC proposed new guidelines which implemented a number of significant changes, including the requirement for "software independence," i.e. the requirement that operations of software-based voting systems be auditable.[147] Yet this set of standards was only just adopted by the EAC in March 2015.

Part of the resistance to adoption centered on the requirement for software independence.[148] The primary issue however, stemmed from discord over the EAC, both internal and external. The Presidential Commission on Election Administration noted in 2014 that the standards may only be adopted by the EAC, which, "due to a lack of commissioners and the related problem of

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[140] *Id.*
[141] *Id.*
[142] Press release from U.S. Election Assistance Comm'n, EAC Updates Federal Voting System Guidelines (Mar. 31, 2015) (https://www.eac.gov/assets/1/28/EAC%20Updates%20Federal%20Voting%20System%20Guidelines-News-Release-FINAL-3-31-15-website.pdf).
[143] VOTING TECH. PROJECT, WHAT HAS CHANGED, *supra* note 61, at 20.
[144] *Id.*
[145] *Id.*
[146] *Id.* at 21.
[147] *Id.*
[148] *Id.*

disagreement over the agency's mission and past direction, cannot currently carry out this task."[149] This political strife over the EAC has continued despite adoption of the new guidelines; a congressional resolution introduced in early 2017 sought to eliminate the Commission altogether.[150]

As a consequence of this uncertainty over voting system standards, voting machine vendors have been dis-incentivized from investing resources in the development of new equipment. As the Presidential Commission on Election Administration report put it in 2014:

> The existing legally operational standards were developed five years before the product launch of the first-generation iPad. Any firm that wishes to invest in election applications for commercial off-the-shelf-tablets or computers does so in an uncertain regulatory environment. The confusion surrounding the standards has had the perverse effect of complicating the move to certification of the very technologies most current and familiar to voters.[151]

While the Brennan Center applauded the EAC's adoption of VVSG 1.1, it recommended that the VVSG be overhauled such that future guidelines "balance the need for quality assurance with the flexibility needed for technological innovation."[152]

Additionally, according to vendors, election officials, and advocates, the certification process "takes too long, is too expensive, and is a barrier to market entry."[153] Specifically, certifying a new machine can cost millions of dollars, a price tag for which vendors are responsible.[154] While participation in the Testing and Certification Program is voluntary, as of 2015, forty-seven states relied on the certification process in some way[155] (via legislation or administrative mandate).[156]

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[149] THE PRESIDENTIAL COMM'N ON ELECTION ADMIN., *supra* note 98, at 12.
[150] Election Assistance Commission Termination Act, H.R. 634, 115th Cong. (2017).
[151] THE PRESIDENTIAL COMM'N ON ELECTION ADMIN., *supra* note 98, at 12.
[152] NORDEN & FAMIGHETTI, *supra* note 99, at 34.
[153] *Id.* at 33.
[154] *Id.* at 34.
[155] *Id.*
[156] U.S. ELECTION ASSISTANCE COMM'N, *supra* note 139, at 3.

Moreover, many states have their own certification process which vendors must submit to after a machine has been certified by the EAC.[157]

The Presidential Commission on Election Administration noted that the process inhibits progress:

> Indeed, the certification process even retards improvement of existing, certified equipment as it requires additional certification for even small modifications or upgrades. As a result, the certification process simply does not fit with an election calendar. Because of the time it takes to discover flaws following an election, to develop a "fix," and then to have it certified, it is likely that the known solutions to problems discovered in one election will not be in operation for the next one.[158]

Ultimately, the certification process and the delayed adoption of VVSG 1.1 have created an environment that has worked to "keep[] machines in the laboratory and off the market."[159]

Security Concerns

Russia's interference in the 2016 presidential election magnified and compounded the issue of security and voting machines. There are currently some inherent protections in place; these include decentralized election administration, the removal of voting machines that had their own remotely-accessible wireless networks, standards for certification of voting systems, and voter verified paper audit trails.[160] However, concerns remain, largely due to aging machines.[161]

As discussed supra, aging machines rely on unsupported software which no longer receives security patches and is more vulnerable to cyber attack.[162] Moreover, the Brennan Center notes in a 2017 report on securing elections that, "The fact that voting machines themselves are not

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[157] NORDEN & FAMIGHETTI, *supra* note 99, at 34.
[158] THE PRESIDENTIAL COMM'N ON ELECTION ADMIN., *supra* note 98, at 64.
[159] *Id.*
[160] LAWRENCE NORDEN & IAN VANDEWALKER, THE BRENNAN CTR. FOR JUSTICE, SECURING ELECTIONS FROM FOREIGN INTERFERENCE 8 (2017).
[161] *Id.* at 9.
[162] *Id.*

connected to the internet does not, by itself, fully protect us from such cyberattacks."[163] This is because "brief physical access" to machines or their memory cards could allow a perpetrator to change election results, or manipulate machines in an effort to undermine voter confidence.[164] Furthermore, remote attacks are also possible, as malware can be distributed among machines via memory cards.[165] There are no nationally mandated security requirements for vendors who program pre-election memory cards, and not all jurisdictions ban the computers used for programming from being connected to the internet.[166] Finally, hacking state level central tabulators and election night reporting systems, while unlikely to change the outcome of an election, can undermine voter confidence.[167]

Despite the public fervor over election security resulting from the 2016 presidential election, voting machine security has always been a leading concern and source of disagreement among stakeholders. The Presidential Commission on Election Administration noted that a conflict has emerged between election officials and technologists over the use of computer technology in elections; computer scientists have concerns about the technology's security.[168] This conflict has contributed to a lack of new technologies and continued reliance on single-use machines.[169]

The Voting Technology Project has identified three "themes" in election security: 1) the need for software independence; 2) the necessity of evaluating end-to-end voting systems; and 3) requirements for post-election auditing.[170] As mentioned above, a voting system is said to be "software independent" if an "undetected change or error in its software cannot cause an

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[163] *Id.*
[164] *Id.* (citing COMMONWEALTH SEC. AND RISK MGMT., VA. INFO. TECHNOLOGIES AGENCY, SECURITY ASSESSMENT OF WINVOTE VOTING EQUIPMENT FOR DEPARTMENT OF ELECTIONS (2015).
[165] *Id.* at 10.
[166] *Id.*
[167] *Id.*
[168] *Id.*
[169] *Id.*
[170] VOTING TECH. PROJECT, WHAT HAS CHANGED, *supra* note 61, at 17.

undetectable change or error in an election outcome."[171] A straightforward approach to making a system software independent is to require a VVPAT.

End-to-end voting systems are defined as providing "verifiability from the starting point (the choices in the voter's mind) to the final tally."[172] Machines that are now widely used do not offer this level of verification, though proposals for end-to-end voting systems have been made and implemented.[173] One example is the "Scantegrity" system, which has been used in at least two elections in Takoma Park, Maryland.[174]

Election audits seek to verify the accuracy of election outcomes, and the most "holistic" audits consider the election process from end to end, without assuming that paper ballots have not been tampered with.[175] Specifically, post-election audits count a large random sample of cast paper ballots, and technology since 2001 has substantially improved.[176] As of 2013, at least half the states were conducting post-election audits.[177]

While the Voting Technology Project notes that the increased implementation of post-election audits, a movement toward paper-based voting systems, strong interest from computer experts in solving security problems, and the independent development and design of new voting systems in some jurisdictions, are all positive changes in security, negative trends have also emerged.[178] These include an increased interest in vote-by-mail and internet voting, systems which are vulnerable to voter coercion and vote-selling, increased interest in more complex voting systems

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[171] *Id.*
[172] *Id.*
[173] *Id.*
[174] *Id.*
[175] *Id.*
[176] *Id.* at 18.
[177] *Id.* (citing VERIFIED VOTING, http://www.verifiedvoting.org (2012)).
[178] *Id.* at 18.

that will complicate auditing, a dysfunctional federal certification system, and an over-centralized industry with little investment in research and development.[179]

All of the above failures – lack of funding, unsatisfactory machines, deficiencies in the voting technology market, historically unreliable standard-setting and inefficient and costly certification processes, and security concerns – have rendered the replacement of antiquated voting machines an exceptionally difficult task. There is some future promise however, as evidenced by two jurisdictions that opted out of the market and its deficiencies altogether, and chose to design and develop their own voting technology.

Potential Solutions and Lessons Learned

Election officials in Los Angeles County and Travis County, Texas have each chosen to develop unique voting systems as a result of dissatisfaction with technology available on the market. Los Angeles sought to create a system that enhanced the voter's experience, while Travis County officials wanted more secure technology.[180]

In Los Angeles, election officials elected not to purchase new machines after HAVA and so as of 2015, had a remaining balance of state and federal funds totaling almost $70 million.[181] In deciding what type of technology to develop and implement, election officials first spent two years surveying voters about what kind of voting system they would like to see.[182] Officials

[179] *Id.*
[180] NORDEN & FAMIGHETTI, *supra* note 99, at 22-5.
[181] *Id.* at 22.
[182] *Id.*

derived fourteen "guiding principles" from the survey results, which informed their design.[183] Officials explained to the Brennan Center in 2015 what the new design will look like:

> The proposed design combines touch screen technology with a human-readable and auditable paper ballot of record: Voters would use a touch screen ballot marking device to fill out a ballot, print it out, and then place it in a ballot box. The county intends to own the new system, which will free it from the expensive maintenance contracts that vendors often bundle with traditional voting systems.[184]

Los Angeles officials partnered with a design consulting firm, IDEO, to "develop the specifications for an electronic ballot marking device and associated components of a comprehensive, modernized voting system."[185] They hope to implement the new equipment across the county by the 2020 election cycle,[186] but the collaboration is already serving as a nationwide example. In November 2017, the County Clerk, Dean C. Logan, and Matt Adams from IDEO, were special guests at a presentation called "A Better Ballot Box" in Brooklyn, which "focused on the manufacturing phase of the new ballot marking device and the importance of human-centered design in the public sector."[187] Moreover, in December 2017, Logan received the 2017 Electoral Ergonomy Award from the International Center for Parliamentary Studies.[188] The award is granted to election officials "who have tailored electoral procedures to the psychology of the voters and the specific characteristics of their electorate."[189]

Though Travis County officials also sought to develop innovative and secure new technology, in contrast to Los Angeles County, they were unable to implement their design in large part due

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[183] *Id.*
[184] *Id.*
[185] *Id.* at 23.
[186] *Id.*
[187] Monica Flores, *A Better Ballot Box*, VOTING SOLUTIONS FOR ALL PEOPLE (Nov. 28, 2017), http://vsap.lavote.net/2017/11/28/a-better-ballot-box/.
[188] Monica Flores, *Dean Logan Wins International Electoral Award*, VOTING SOLUTIONS FOR ALL PEOPLE (Dec. 14, 2017), http://vsap.lavote.net/2017/12/14/dean-logan-wins-international-electoral-award/.
[189] *Id.*

to a lack of "funding, time, or support,"[190] illustrating the risks of seeking to be innovative in an old-school industry.

After the 2012 election, the Travis County Clerk assembled a multidisciplinary advisory board that recommended the county replace its equipment, and that replacements include the capacity for a paper audit trail.[191] In response, officials convened a group of experts to create the new system, called "STAR-Vote" (Secure, Transparent, Auditable, and Reliable).[192] The Brennan Center described the technology as such:

> A voter using the STAR-Vote system will fill out an electronic ballot on a commercial-off-the-shelf (COTS) tablet device running open-source software, confirm their selections on a printed paper receipt, and then feed the ballot into a scanner. The system will provide the voter with a tangible receipt to confirm the machine recorded their choices correctly. Once home, voters use their receipt to log into a website and confirm their ballot was cast and counted — a testament to the system's transparency and auditability.[193]

Unfortunately, in 2016 when county officials sent Requests for Proposals seeking vendors who could build STAR-Vote, the response was insufficient, and the project had to be abandoned.[194] Specifically, "the proposals left Travis County without any design for the basic part of the software that handles ballot definition, by-mail balloting, and the tally of results among other related tasks."[195] Ultimately, the County Clerk attributed the failure to STAR-Vote being too far ahead of an industry upon which it nonetheless relied:

> STAR-Vote was a special case of expertise, ingenuity, and passion coming together in a sector that normally does not practice venture capital investment or product development. We now see that the people who served on the County Clerk Study Group, the STAR-Vote Design Team, and the Travis County Commissioners Court were ahead of their time. They recognized the financial reward of opting out of the private-sector, licensing-fee world that is today's voting system market.[196]

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[190] DANA DEBEAUVOIR, TRAVIS COUNTY CLERK, STAR-VOTE: A CHANGE OF PLANS 3 (2017).
[191] NORDEN & FAMIGHETTI, *supra* note 99, at 24.
[192] *Id.*
[193] *Id.*
[194] DEBEAUVOIR, *supra* note 190, at 1.
[195] *Id.*
[196] *Id.* at 2.

Despite the setback, the County Clerk posits that important lessons were learned from developing STAR-Vote, including the identification of several security features that could be incorporated into the current voting process.[197] As of September 2017, Travis County was still in need of a new voting system.[198]

Conclusion

The current state of voting technology is dire. Nationwide, voting machines are too old, putting election integrity and voter confidence at risk. While security concerns have gripped public attention, the fallout from a machine malfunction can have many of the same effects; if voters do not have faith in a machine's output, they may not have faith in an election's outcome.

While the inability to replace machines is the result of funding, innovation, and administrative complexities giving rise to a multi-dimensional and complex problem, solutions are possible. This is evidenced by recent reports and recommendations made by the Voting Technology Project, The Brennan Center for Justice, and the Presidential Commission on Election Administration, among others. It is further illustrated by the success that Los Angeles County has had in developing a new, "human-centered" design, as well as the valuable lessons Travis County has learned.

If solutions are to be implemented, they must be immediately. Though widespread election-day crises have thus far been avoided, the evidence detailed in this paper suggests that kind of catastrophe is not only conceivable, but perhaps inevitable. Given the unprecedented partisan climate in which the country now finds itself, and the possibility that disputes over election outcomes may further contribute to this divide, it is now more than ever imperative that election

[197] *Id.* at 1.
[198] *Id.* at 5.

officials, advocates, state and congressional legislators, and the American public take meaningful steps toward an enduring solution to the voting technology problem.