

Old Voting Technologies: Problems and Improvements

by Ted Selker

With so much attention focused on the development of direct record electronic (DRE) voting machines, it is easy to overlook that many simple, inexpensive modifications can be made to older voting technologies—from punch cards to mark sense ballots—that would greatly reduce opportunities for fraud and error to jeopardize the validity of an election. These include user-friendly ballots, helpful visual and audio feedback in the polling booth and audit trails recorded by video cameras or audio recorders. Here we discuss the problems encountered with older technologies and mention how they can be improved. Enhancements to DRE voting machines, such as checks and balances in the form of multiple software systems operating concurrently, were dealt with in the print edition and won't be repeated here.

Hand-Counted Paper Ballots

Voting has a long history of advancing with technology. In ancient Greece, Egypt and Rome, before paper was available for voting, marks were made for candidates on pieces of discarded pottery called ostraca, from which we get the word “ostracize.” The term “blackball” is said to come from a voting process in Athens in which depositing a black ball in a clay pot was a vote against giving someone membership in a group. Our word “ballot” comes from the Italian, *ballota*, for ball. In 1868 Edison patented the first electric voting machine. It created a secret ballot, which, while in use since the 1850s in Australia, was not yet a popular idea in the U.S. In the modern era, the earliest widely used voting technology in the United States has been the hand-counted paper ballot.

Today hand-counted paper ballots are still used in many countries and by 1.3 percent of American voters. Typically voters make their selections as a mark in a box next to a candidate. Counting involves multiple people viewing the ballot together.

I am not sure we should be nostalgic about the days when we hand counted ballots. In a recent counting in the U.K., a colleague of mine watched as official ballot counters looked at around 5000 votes. They started counting at 8 pm. First they found that one candidate had won by 9 votes. When they counted again, they found the other candidate had won by 13 votes. At 4 am, after five counts, they reached the same count twice and certified this count as official.

Paper ballots perform well when counties are willing to invest time and discipline to meticulously count each ballot. Paper ballots result in fewer reported uncountable “residuals” (1.5 percent) than any other voting system. Residuals are “undervotes” (the voter does not mark a candidate) and “overvotes” (the voter marks too many candidates). However, when there is a recount, with hand-counted paper

ballots the result differs from the original count on average by twice as much as by machine counted votes (a typical difference for the latter is 0.1 percent).

There are persistent allegations of paper ballots being removed or added, or changed after the voter marked it. The law typically allows paper ballots to be destroyed after a period; Florida's 2000 presidential ballots were destroyed in 2003. Paper ballots should be preserved for longer than the 60 days to 2 years that is the typical established practice.

A way to improve paper ballots is to treat the paper with light, heat or a coating material to make indelible the fact that a vote has been cast at a particular time. Another improvement, mechanical scanning of ballots, will be discussed separately below; one then has what is called a mark sense ballot.

Lever Machines

Shortly after the secret, so-called Australian ballot was introduced in the U.S., people became enamored with machines that would reduce the ability of poll watchers or poll workers to intimidate a voter into an advised selection. Thus, in 1892 lever machines were introduced in Lockport, New York.

A poll worker sets the ballot for the party or precinct that a voter gets to vote on with a lever on the outside of the machine. The voter then enters the machine and closes the curtain against onlookers watching. Rows and columns of levers are aligned with labels that indicate parties and candidates for each race. The ballot layout in rows gives perceptual cues to simplify voting. The sight of a misaligned lever lets the voter perceive that she has made the selections intended. Mechanical logic prevents overvotes. Finally, the voter uses a big red lever to cast the vote and open the curtain.

Lever machines are an amazing feat of industrial revolution technology, but unfortunately their mechanical nature is a huge flaw. Lever machines tally their votes on cascaded odometer wheels behind their back panels. A recent study found that 250 out of 800 lever machines had defective odometer counting mechanisms that would stick instead of turning over. Even when the devices are working properly, at the end of the day poll workers can misread the odometers. In the 2000 election in Boston, almost 20,000 votes were initially ignored because elections officials were confused about which odometer reading to include and tally. Although local voting law usually calls for more than one person to be present when the odometers are visible on the back of a voting machines, sloppy processes have been alleged to allow odometers to be misread or changed by unscrupulous officials.

Clearly lever machines must be thoroughly tested prior to an election to make sure they are in proper working order. In addition, lever machines could be improved by installing video cameras that view the odometers the entire time to make sure that no one tampers with them and that each counter operates properly and turns its numbers every time a vote is cast. At the end of the day, if an odometer shows a series that looks suspicious such as a row of zeros or nines, the video can be reviewed to see if

the odometer jiggled without properly changing count. The attempts for the odometer to increment are added in. If a district is not prepared to install such a video surveillance system on its lever machines, they should consider changing to a more modern voting system.

Undercounts could be reduced by making two improvements to the user interface. First, the addition of graphical separators to clarify which groups of levers make up each race of the election. Second, adjustable heights for the machines or ways for a voter to get eye level with the levers.

Punch Cards

Although Herman Hollerith first used the Jacquard punch card for the US census of 1890, punch cards were not used in American elections until the presidential primary in 1964 in Fulton and De Kalb Counties, Georgia. Because punch cards can be read directly by machines they remove the element of human error present in hand tallying of paper votes or transcribing of votes from odometers. Even in the 1960s, punch-card readers were more compact and easy to store than a typical 800-pound lever machine. They required less maintenance and were already a common and trusted method of counting.

Votematic punch cards have been used for decades but are fraught with problems. The punch can jam in the hole. Differences in punch dies make some punch cards more difficult to punch than others. Sometimes incorrectly prepared punch cards have allegedly been arranged to make it easier to vote for one party than another. The card must be right side up in the cardholder and the machine must hold it securely for a voter to punch a hole accurately. The template that a person presses through must also be correctly aligned. People often mistakenly punch a selection adjacent to the one they intended. A study of punch cards in the 2003 California Governor recall election found that relatively unknown candidates whose punch hole was adjacent a top candidate such as Schwarzenegger or Bustamante received five times as many votes as other similarly unknown candidates.

We are used to reading from left to right so the punch card ballot typically puts candidates' names on the left side and the holes on the right. To use fewer instruction cards some administrators display names on both sides of the exposed holes. This so-called butterfly ballot is confusing and contributed to about 16,000 unreadable ballots out of 300,000 in 1996 in Florida's West Palm Beach. This problem was not flagged, and was repeated with the infamous butterfly ballot of 2000, which disenfranchised some 19,000.

In Chicago in 2002 and 2003, I observed a system put in place to allow punch card voters to verify their votes at the precinct. It only added to confusion. The voter inserted his or her ballot into a card reader on the ballot box. If there were undervotes or overvotes, an LED lit up and a receipt like a vote log was printed. But it appeared that fewer than one in three people at that stage, even those who had spoiled a ballot with an overvote, were willing to get a new ballot and revote. Feedback is important

for people to know how they have performed at a task, but it is best supplied right when the action (in this case punching a ballot) is being carried out. Thus voters need a way to check their ballot while still in the voting booth.

Also, the punch card readers in the Chicago election jammed quite often. Some voting officials decided that they could fix the problems by putting their hand inside the ballot box and pulling the cards through by hand. In approximately 60 precincts where I watched voting with this system, fewer than 10 kept the ballot box locked during the election.

With central punch card reading, a separate “job control” card tells the card-counting machine what the holes on the ballots mean. An incorrect control card could be used to miscount votes.

Unlike Votematic, the Datavote punch card ballots have the names of the races and choices written on them, which solves several problems. The ease of associating a punched hole with the corresponding candidate leads to drastically fewer undervotes.

Mark Sense Ballots

Much the same technology as is used for reading a punch card is used to scan mark sense pages, which voters mark with a pencil or a pen. A mark sense optical scan system was first used in an election in California in 1962. Early machines were unforgiving and could only recognize marks in exactly the right locations, so accurate alignment of ballots was a problem. Modern scanners are more flexible about the location and the quality of voting marks. Optical scan systems have become popular replacements for the Votematic punch card systems. The voter can read the candidates on the ballot and making a mark is much easier than punching a hole. Since anyone looking at an optical scan reader ballot can view the selections, however, they have less secrecy than Votematic punch cards.

Two common kinds of marks are used on these ballots. “Fill in the circle” produces fewer mistakes. Nevertheless if a person puts a check, an X or some other mark in the circle, it is not counted. If a person writes next to a place, the machine is likely to count it as an overvote. The other common mark sense system requires the voter to connect the tail to the head of an arrow, which generates more mistakes by voters.

In Orange County, California, in the 2003 recall election, all 138 names and selection ovals were on one mark sense page. In neighboring Los Angeles County, where punch cards were used, a voter had to turn six pages to see all of the candidates for governor. Because mark sense ballots are larger than punch cards, however, the ballot readers are slower, harder to calibrate and more prone to jamming. Los Angeles County had counted all of their punch cards by 3 am, but their smaller neighbor Orange County took until late the next afternoon to count their mark sense ballots.

Jamming of ballot readers raises a dilemma for local election officials: has the jammed ballot

been counted or not? If there is any doubt, they simply have to start counting all over again from the beginning.

As with punch cards, in-precinct scanners can be used to signal voters to revote when their ballots are mismarked. Although it is not as good as feedback in the voting booth, with this practice, the number of residuals falls to the lowest of any mechanical means of counting. Still, process is crucial. In the precinct that I watched, the scanner had been set to throw out ballots with overvotes rather than tell the voter. To counter this problem, a poll worker checked people's ballots for mistakes before scanning them, spoiling the secrecy of the ballot. Another way that mark sense ballots could be improved would be to use a DRE machine to mark the ballots.