Response to LHC Questions

By Noel H. Runyan

July 1, 2018

Q-1A. In your conversation with staff, you discussed a tension between accessibility and security for voters who require accessible voting equipment.

Runyan Response: Security versus access tension was intense in the early years around 2006, as many disability advocates felt they had to push hard to get the whole country switched over to having all voting place voting done on electronic machines. The leaders in the disability organizations did not want to hear anything about there being problems of the vendor-offered voting machines having security, accessibility, or quality issues.

As the HAVA was first being implemented around the 2006 timeframe, most folks with disabilities did not have any security expertise, so they did not appreciate or value the need for protections against security threats. They weren't saying, "Go ahead and make the system insecure, as long as it is accessible."

They could relate to the need for accessibility, but could not relate to what was or wasn't needed to make the systems secure.

Disability groups fought against paper ballots and paper trails for voting systems because some voters with motor disabilities could not manually handle paper trail or paper ballot systems. The DRE voting systems offered no accessible verification of the printed VVPAT paper trail for voters who were visually impaired.

Disability leaders also felt that, if sighted voters were allowed to verify the paper records, equal treatment dictated that all voters should have access to verifying the paper records. At the time, there were no good OCR (Optical Character Recognition) reading systems available for permitting accessible verification by OCR reading of the paper ballots.

Initially, I, like many others in the access field, felt that accessible computerized voting machines sounded like a good idea. However, the results of subsequent voting machine testing such as the CA Top-To-Bottom Review and the OH “EVEREST” testing, demonstrated that the early voting systems offered by the vendors were shoddily designed, had serious security flaws, and had severe accessibility limitations.

As the AutoMark and other BMD (Ballot Marking Device) designs began to be offered as alternatives to the insecure paperless DRE voting machines, most of the leaders of disability advocate organizations have started to accept that security and accessibility can be integrated together in voting system designs without conflict. Systems such as the LA County VSAP voting system have also shown that, when included from the very beginning of a voting system design process, security and access features can be compatible.

Q-1B. You also mentioned that the number of voters using accessible equipment probably is not high enough to change the outcome of an election through compromised accessible voting equipment.

If this is the case, why should Californians care that accessible voting equipment is secure?

Runyan Response: My observation was in the context of the current systems used in California, where only a small fraction of voters with disabilities are actually able to use the current machines. My observation also assumed that only a small portion of the votes recorded on these machines could be altered without it being so obvious that the vote tampering would be detected.

One of the more effective strategies for vote tampering is to implement several types of small and less obvious vote alterations, so the accumulated vote tampering of several types can add up to change an election outcome.

If most voters with disabilities are forced to use voting systems with which they cannot verify the correct marking of their cast ballots, their unverified ballots can represent a significant opportunity for ballot tampering that could be difficult to detect.

If the Remote Accessible Vote By Mail (RAVBM) or other new voting systems are adopted by large numbers of voters, with or without declared disabilities, security vulnerabilities could be exploited to tamper with significant numbers of ballots, enough to easily alter election outcomes.

Also, if it is known that an accessible voting system is vulnerable to being hacked, voters with disabilities will not tolerate being forced to use it or any other system with second class security.

There is also a misconception, by some, that accessible voting systems are necessarily very expensive. With modern technology, adding enlarged characters on a visual display, speech output, some large input control keys, and a switch input control jack onto a computerized voting machine amounts to only a small increase in the cost of the voting machine. It is not correct to say that accessibility makes voting machines significantly more expensive. If the only means for accessible voting in a county is by use of a special "accessible voting only" machine in each polling place, then the price of accessible voting might be considered by some to be high.

However, counties in California are now able to provide several options for voting accessibly. As the state switches to supporting VBM ballots sent to all voters and allowing RAVBM voting, counties may soon not be required to have "accessible voting only" machines in every polling place. Because all voters with disabilities do not have access to computers for RAVBM voting in their homes, counties may need to supply some accessible voting systems in vote centers and other physically accessible centers.

Q-2A. Please outline the general security threats present in accessible voting equipment, both in currently-used equipment and in the remote access systems being tested.

We understand that different threats may be present in different types of brands or equipment; the Commission is interested in a high-level overview of the threats out there, not a machine-by-machine breakdown.

Runyan Response: Most of the major security threats to the voting systems were documented in the 2007 CA Sec. of State's Top-To-Bottom Review of the voting machines and their related systems.

There are not as many threats that are unique to the use of the machines only as accessible voting systems. As the head of the accessibility testing lab, I discovered, and the Red team confirmed, that the Hart e-slate voting machines were transmitting the audio responses of the voting machine as a radio frequency signal, across much of the AM band, and centered around 6.7 MHz. This signal could easily be listened to with just an inexpensive shortwave receiver, even from the parking lot outside the polling place.

It is very common for digital devices that produce audio output to be found to transmit usable strength signals in the radio spectrum. Because the federal testing of the machines did not catch this problem during its e-Slate certification, it appears that all voting systems to be certified by the state of CA should be tested for all forms of Tempest Threat or radiated signals, including light, radio, near-audible, and power line transmission.

Because the user interface interactions of voters with disabilities are quite different from those of able bodied voters it is assumed that possible malicious software in a voting machine might be able to recognize when it may have a good opportunity to tamper with the ballot of a voter that may not have full access to catch the tampering.

In a similar vein, some operatives may consider voters with disabilities to be less able to detect voter mail spoofing or impersonation attacks, and might start to more frequently exploit VBM and RAVBM vulnerabilities of voters with disabilities.

Also, because it is quite difficult to keep full track of all the activity on a webpage, while using a speech or large print screen review system, it may be easier for Man-in-the-middle attacks to be used against voters with disabilities. For example, there might be a malicious web site using a name that is easily confused with the name of the site the county offers for accessing RAVBM ballots. The Man-in-the-middle web site might be mistakenly accessed by some voters, at which point it would invisibly pass all the voter transactions back and forth between the voter and the county web site, until it gets the blank ballot download file, which it modifies maliciously before passing it on down to the voter.

Because the US Postal Service has not been designed to assure partisan-neutral chain of custody control, switching to a large portion of the voting population using VBM will require many changes to reduce security exposures.

Q-2B. Please also discuss how verifications measures designed to ensure security for sighted voters are lost in certain accessible voting settings.

Runyan Response: Replication or transcribing of VBM ballots to optical scan ballots does not allow verification of the final ballot.

Paper ballots or paper audit trails that are displayed under a glass window on a voting machine may have too much glass glare, blocking accessible verification with OCR reading systems.

Some systems, such as the Sequoia Edge, make the assumption that, if the voter is using audio output, they cannot read at all, so the machine prints the paper ballot and quickly runs it on out, past the viewing window, so voters are not able to verify the printout, even though they might have wished to do so with a magnifier, a trusted friend, or a portable OCR reading device.

Obviously, poll worker assisted ballot marking also does not allow private or independent verification.

Some vendors of voting systems have made false claims that their systems allow accessible verification of the ballot, but the truth is that they are only providing review of the electronic ballot stored in the machine's electronic memory. They are not providing verification by optically scanning what actually was printed on the paper ballot or paper audit trail, nor are they using OCR to convert that paper scan into text that can be accessed with speech or large print.

The narrow thermal printout of the paper audit trails on most of the DRE voting machines used in CA have very small, low contrast, and poor quality printing that is very hard to read for anyone with less than good eyesight. This poor quality printing also has proven to be impossible to read by portable OCR reading devices.

Because it typically takes voters with disabilities a long time to vote on the accessible voting machines, they often feel pressured to not take the time to try to struggle through a tedious printout verification process, especially if it is just verifying "that audit stuff" of a paper audit trail. On the other hand, verifying the printout on a paper record that they know is their ballot of record is a lot more important to the voters.

[See also response to Q-3B, below.]

Q-3A. What best practices can the state implement to ensure that accessible voting is secure?

Runyan Response: The term "accessible voting" must be interpreted in context. In the context of RAVBM systems:

Do not use systems with marked ballot return/submission by email or online file transfers.

Do not use systems with online ballot marking. Online ballot marking involves sending a voter's ballot choices over the Internet, exposing the voter's selections to privacy violations and/or to being maliciously altered.

Do not use color printers for RAVBM ballots. Because of the Treasury Department's requirement that hidden MIC printer identifiers be printed on all color printouts, voters should be clearly informed that they should avoid using color printers for printing their RAVBM ballots.

Although there are some risks, it currently appears to be generally reasonable for voters to receive unmarked ballot files by email or by download from county web sites, as long as the ballot marking, printing, and verification can be performed offline, without further connection to the Internet.

Remote voting exposes voters to vote selling and voter coercion threats.

Older voters may not have the familiarity with or access to computer systems needed for remote access voting systems.

After being used to print their RAVBM ballot, a voter's marked ballot file might remain on a computer, allowing their ballot privacy to be violated through access by other parties. The RAVBM systems must be changed to make it easy to assure that the ballot printing file is deleted at the end of a ballot printing.

For many counties remote printed ballots may need to be "duplicated" or transcribed into the standard optical scan ballot format required by a county's central tabulation system. Replication or transcription of RAVBM ballots does not permit voters to verify the accurate marking of the ballots resulting from the transcription. This is more of a concern when the transcription is done by hand and may inject errors accidentally or intentionally. When ballots are transcribed by hand, there should be at least two people, preferably from different political parties, working together to check each other. Some counties may be able to use bar codes printed on the ballot as a method of automatically scanning and transcribing or tabulating the voter’s original RAVBM ballot, all without the use of manual transcription by human workers.

Some people are worried that the bar codes may not faithfully represent the voter choices that are in the text that is printed on the RAVBM ballots. To help establish meaningful public confidence in these bar coded ballot systems, the state should make sure that the counties only use systems that employ bar code checking scanner apps and translation data bases are freely available.

A major public information campaign must accompany the implementation of counties switching over to sending all voters VBM ballots. As is already happening in the first five counties to try mailing all voters VBM ballots, voters are showing up at their polling places without their VBM ballots to surrender, so they are only being allowed to vote provisionally. In the case of voters who need to vote on accessible DRE voting machines (in contrast to BMD machines like the AutoMark) they are being denied the opportunity to vote on the voting machines. This is because the DRE machines do not support provisional voting.

VBM ballot mailings from counties must include clear large print labels and tactile indicators, including braille labels to make sure voters recognize that the contents are important and not just a sample ballot or more junk mail to be tossed out.

The remote access VBM systems presented in the CA Sec. of State's testing have not developed methods for the voters' to accessibly locate and sign the signature page of the printout and for its packaging, with the correct marked ballot pages, into a properly addressed envelope for mailing to their county elections center. There have been proposals that the envelopes should include a paper hole punch to help identify them.

I recommend that the counties using the RAVBM systems also adopt accommodation procedures such as telling the voter to fold in half the printout page that requires their signature, so the voter can then use the fold as a guide for signing their name, date, and other required information.

There is an extremely big difference between systems that employ online delivery of blank ballots to voters and the systems that incorporate online marking and/or return of marked ballots.

The use of the internet to deliver blank ballots to voters has much less opportunity for vote tampering or privacy violation. Using the Internet to do online marking of a voter's ballot or to submit marked ballots to the county has enormous risks to vote privacy and also introduces major vulnerabilities to massive vote tampering.

Many have unwisely suggested that insecure and non-private online ballot return systems should be acceptable, if limited to only overseas military and folks with disabilities. Such a "limitation" is frequently offered as justification for acceptance of systems with seriously flawed security and privacy exposures. However, in practice, it doesn't work to try to specify "disability access limits", as there are no effective means to define who is disabled enough to need to use the system. As Barbara Simons and others observed in the Canadian attempts to define who could be qualified to use a remote voting system, advocacy groups for folks with disabilities rebelled forcefully against any attempts to define limits on who was disabled enough to qualify. They insisted that anyone should be able to use the remote voting system, without having to publicly state and justify what their personal disabilities might be. Requiring public declaration of one's personal disabilities becomes a seriously unacceptable violation of personal privacy.

Voting systems with known bad security and privacy flaws should never be accepted with false promises that their use will be "limited" to a small (therefore presumably insignificant) number of voters. Such insecure and non-private systems represent a serious slippery slope, that could lead to a lot of voters using bad systems that might eventually end up being used by all voters.

Q-3B. Similarly, how can the state make sure that voters who use accessible equipment have the same opportunities to verify their vote as voters who do not use accessible equipment?

Runyan Response: It is not adequate for a voter to be only allowed to review their ballot selections from the electronic memory of the same machine that may have just made errors in recording the voter's choices. The voting system should present the paper ballot record in a manner that allows the voter to verify by separately scanning the paper printout and accessibly reading back their ballot selections.

Any paper ballot must be readable and intelligible with personal OCR technology so that voters with disabilities that affect their print reading ability can independently verify their ballot.

In the case of poorly designed voting machines for which the paper record is always kept inside the voting machine and only displayed in a window, the display window should not cover the paper printout with glass that would cause glare problems that inhibit the voter's use of portable OCR-reading devices.

In the case of properly designed BMD machines, the voter should be allowed the option of removing their marked ballot from the machine, to allow them to take their ballot to

another system that can scan and read back their paper ballot. This would allow them to scan and accessibly verify their paper ballot with an OCR-reading device, with another similar BMD voting machine, or even allow them to return to their original BMD voting machine, after the marking session had ended, at which point it would not be able to recognize the ballot as the one it had just printed out (perhaps with incorrect marking).

For assuring that these machines were not tampering with the votes of only voters with disabilities, it would only be necessary for a few voters to occasionally perform the extra security check of removing their ballot from their original vote marking machine and separately scanning and accessibly verifying their paper ballot marking.

Q-3C. What would be the challenges or objections to implementing these best practices, and how could the state overcome those?

Runyan Response: As more able-bodied voters have been switching to voting on hand-marked paper ballots, CA's use of voting machines has increasingly been for providing accessibility for voters with disabilities. The predominant voting machines in CA were purchased around 2006, with funding supplied by the HAVA (Help America Vote Act). Hence, the lack of significant subsequent funding has meant that the machines have become obsolete, have long since passed their support life time, and have become worn out and unreliable.

The obsolete DRE voting machines need to be replaced with modern machines that can supply accessible verification. Although, in the past, the absence of funding has been one objection to eliminating such outdated equipment, the legislature has recently approved funding for equipment replacement. Generally, equipment lifecycle must be taken into consideration and elections should be fully funded.

For standard mark sense optical scan ballots, the ballots are difficult for visually impaired voters to accessibly verify, because the available OCR reading programs have not been designed to interpret marked bubbles or other mark sense targets. It should be possible for the state to fund or otherwise encourage someone to develop a version of an OCR program that could do an OCR scan of mark sense ballots and include interpretation of the marked zones. There are open source OCR programs available that could be modified and used to make this an inexpensive development, hopefully resulting in a free app that would be available on all the more popular platforms.

Similarly, the state should make sure that RAVBM ballots that employ bar codes can be easily accessed by freely available software for reading bar coded ballots and performing offline translation of bar codes into accessibly readable race names and choices.

In the case of new voting systems, it should be reasonable for the CA Sec. of State to require that the voting system vendors either make it possible to do an OCR-reading scan on the paper record while it remains in the voting machine, or the machines should be required to offer the voter an opportunity to remove their printed ballot, to allow voters to scan and accessibly verify their ballot separately.

The human factors public working group (responsible for drafting requirements for the new Federal Voluntary Voting Systems Guidelines or VVSG 2.0's Principles 5-8) defines a

voting session as marking, verifying and casting. Accessibility for voters with disabilities must be supported throughout the voting session, including ballot activation, ballot marking, verification, and casting.

Q-4A. In your documentation of your voting experiences, it seems that the expertise of a trusted sighted computer scientist – your wife – facilitated your ability to cast a vote on some occasions.

How do voters using accessible equipment, but who do not have a trusted knowledgeable companion, navigate the challenges at the voting booth?

Runyan Response: Many cannot surmount those challenges and end up going away disenfranchised or being forced to give up their voting privacy by having someone else mark their ballot for them. In some cases, voters who encountered major problems have used cell phones to call other voters with disabilities for advice that might help them and the poll workers to successfully navigate past the barriers to accessible voting.

Q-4B. Are there ways the state can make voting accessible and secure while also protecting the voter's privacy and ability to cast a secret ballot?

Runyan Response: Yes. The LA County VSAP system is a good example of how this might be done across the state.

Q-5A. Please discuss the process of incorporating both security and accessibility, among other features, into Los Angeles County's voting equipment.

Runyan Response: The LAC VSAP project began by initiating an extremely open, inclusive process that brought together election officials, poll workers, security and usability/accessibility experts, and a diverse host of advocacy groups from throughout the county.

We started by developing a lengthy and agreed upon list of the key principles we all felt should guide the research, design, testing, implementation, and operation of a voting system that could meet the diverse needs of LA County. In sharp contrast to most other voting system design projects, the LAC VSAP was not limited by any requirements for meeting the compatibility needs of any vendor's legacy products.

The design principles stressed that requirements such as strong security and broad spectrum accessibility/usability were to be included from the very beginning of the design process. By integrating all these design principles from the beginning, we were able to synthesize a design that successfully merged the requirements of the guiding principles so they worked together compatibly.

Q-5B. What were the challenges experienced during that process?

Runyan Response: Initially, progress was extremely slow and frustrating, as all the agencies and individuals involved endeavored to develop the main principles. A tremendous amount of effort and patience was required of all the parties. It took a while before fears of being excluded or ignored faded and most folks realized that the project was developing inclusively.

There were some serious design challenges, such as a perceived need to raise and lower the whole BMD machine to accommodate voters in wheelchairs, as well as standing voters. However, as a result of testing a variety of voting machine mock-ups with a diverse group of human subjects from all over LA County, the design engineers were able to innovate a much better answer to the challenge, one that allowed just the visual display to be moved, instead of the whole machine.

Another example of the success of the VSAP design process was the challenge of using paper ballots on the BMD machines without presenting a manual handling barrier for voters with severe manual dexterity restrictions. Incorporating a ballot box attached to the back of the BMD was initially strongly opposed by poll workers on the VSAP team. However, the engineers and poll workers on the VSAP teams sat down together and identified each of the reasons for the poll workers' objection to the attached ballot box. Then, design changes were developed for each of those issues, until the poll workers were satisfied that an attached ballot box could be acceptable. The structure of the LAC VSAP project is what made it possible, for the first time, to overcome these formerly intractable voting system design challenges.

The frustrations inherent in including the interests of so many differing special interests and diverse advocacy groups was most definitely worth while, as the design has proven to be extremely robust and flexible, and it now has the strong support of virtually all voting interests in the county.

Q-5C. Is the model used by Los Angeles County of building the voting system from scratch the only realistic model to creating a secure accessible experience for the voter, or are there other models that can achieve these results?

Runyan Response: The LAC VSAP is an open design that can be used by other counties throughout the world. The thorough exploration of principles, the human factors R&D, and the iterations of mock-ups and prototypes are all open to the world and available to serve as a firm foundation upon which other voting system designs can build, without starting from scratch.

It is extremely difficult for traditional vendors of voting systems to completely shelve their own legacy of product designs and backwards compatibility requirements, to make it possible to develop a completely new voting system design that truly incorporates security, accessibility/usability, reliability, flexibility, and other best-practice principles of design.

The LAC VSAP system was designed to meet the needs of an extremely large county with great diversity of languages and cultures, so it is not necessarily the best design for all counties of all sizes.

As demonstrated by the Travis County, Texas “Star-Vote” system design, it appears that there may be voting system designs that can meet secure and accessible design principles through the use of mostly off-the-shelf hardware, to minimize the amount of voting hardware that must be designed from scratch. (Article from May 2018: https://www.npr.org/2018/05/13/609443797/many-electronic-voting-machines-are-insecure-one-county-is-trying-to-fix-that)

Q-6. What other recommendations do you have for the State of California to make its voting equipment secure?

Please include any recommendations you have for accessible voting equipment and non-accessible voting equipment.

Runyan Response: requiring paper ballots, banning wireless components and implementing statistically sound audits of election results are some of the obvious general best practices.

Some more examples of best practice recommendations are:

Setup and testing of voting machines before the polls open should be required for all polling places. The testing should include starting an audio ballot, to confirm that the speech output is working and can be heard in the earphones. In order to avoid generating problems with the ballot count totals, the audio test ballot can be discarded ("spoiled") before completion and casting. Adoption of this policy would avoid most of the all-too-common situations in which voters who need to use the voting machines are forced to endure long waits while unprepared poll workers have to interrupt their other duties to scramble around to unpack the machines, assemble them, print zero tape logs, and possibly go through trouble shooting procedures.

In many counties, they are still enabling the voting machine ballots for each voter with a separate ballot card encoder machine, such as the obsolete HAAT card encoders used with Sequoia Edge voting systems. In most cases, use of these card encoders is not necessary and adds significant complexity, unreliability, and security risks. Use of ballot enabling card encoders is the leading reason for failure of polling places to provide working accessible voting machines to voters, resulting in much disenfranchisement of voters. Instead of using the card encoders to enable each voter's voting session, poll workers can simply enable the voting machines more directly, using the touch screen controls, in "manual setup mode".

Flexible zipper bags should not be used to "secure" memory cards and other sensitive materials, as they can be opened by the "butterfly loophole" method, without breaking the tamper-evident seals or any locks.

There should be a total ban on the commonly denied but often used policy of leaving voting equipment unprotected in unsafe locations at polling sites.

Voting systems that employ thermal printing should be required to accommodate and be used with protective-coated thermal printing paper to assure the print record is secure and long lasting.

Q-7. (Should be asked) What can be done to increase participation in voting by voters with disabilities?

Runyan response: The main reason that more California voters with disabilities are not voting on the available accessible voting machines in their polling places is the pervasive lack of awareness that there is an accessible voting system available for them to use. This lack of awareness is usually due to completely inadequate public outreach and public education efforts on the part of counties. Printed information in newspapers, mailed fliers, and billboards is generally not readable in accessible form for a large portion of potential voters with disabilities. Appropriately accessible outreach through PSA and other mechanisms must be increased substantially.

Many counties assume that they do not have serious problems with voters being able to access their voting systems and claim that there are no reported problems with their voting systems. However, we have found that most of the problems with accessible voting machines go unreported to county officials. One reason for this is that the poll workers for most counties do not want to be seen as having made mistakes, so they will rarely report problems, if they can avoid doing so. Even when a voter is kept waiting for over an hour, without a help desk call, if an access problem can be fixed or the voter sent away, the poll workers may not file a report.

Also, counties generally only document polling place troubles if they result in a call to the county's hot line help desk. For example, one of the counties in the San Francisco Bay area insists that it has never had a reported incident of poll workers plugging the audio keypad into the inoperative jack next to the proper jack on the back of the voting machine. However, close examination of their access incident reporting procedures and reports clearly demonstrates that an incident report would never have been filed, if that jack problem had been encountered.

By not collecting reports about all incidents, including their resolutions, the counties are passing up an excellent opportunity to gather information that could help them improve their help desk trouble responses and their poll worker training, all of which could lead to more reliable access to voting.

Counties should encourage poll workers to document all polling place incidents, especially accessible voting incidents.

Privacy is lost when voting machines are only used by a single voter in a polling place, so properly designed voting systems should assure that many voters, not just the disabled, can and do use the same voting system.

The current Sec. of State rules for conditional certification of the DRE voting machines in California require that, if one voter uses a voting machine, poll workers are required to get at least four more voters to vote on that machine. In practice, this attempt to increase privacy is not working, and in fact it has backfired and caused some voters to be disenfranchised. Especially near the end of the election day, when poll workers figure they will not be able to achieve a five-voter minimum, they have been known to tell voters that

the voting machine cannot be used or even "It is broken." This rule requiring five voters should be eliminated.

Because voting with audio ballots typically takes five times longer than visual voting, accessible voting machines should always be supplied with a chair for seated voting.

For voting machines that do not have the capability of blanking the screen, eavesdropping can be a problem, especially if the voter is sitting down and their body is not blocking the screen. Poll workers should be trained to place the accessible voting machines in locations where the screen faces near-by walls and is not exposed to eavesdropping through windows or off reflective surfaces such as windows.

All new voting machines should be required to have a control to allow the voter to blank the screen, if they don't need to use it or when they suspect someone walking behind them might be able to see their screen.

Poll workers should be required to always set up and test the audio ballot on each accessible voting machine before the polls open, rather than waiting for a voter to show up requesting to use the accessible machine. Waiting to set up the machine means that voters with disabilities will typically endure long waits while poll workers scramble around to find the machine, unpack and set it up, go through all the boot up delays, zero tape printing procedures, and trouble shooting delays, before the voter is allowed to attempt voting on the machine.

Many of the voting machines, such as the Sequoia Edge voting machine, have vendor-supplied stands that block physical approach by voters in wheelchairs. Instead of using the vendor-supplied stands, these machines should be set up on tables that do accommodate access by voters in wheelchairs.

Elections help desk hot line and trouble support staff training should include each staff member personally completing a hands-on (ears-on and screen-off) audio ballot voting session.

Post-election results should be available in an easily accessible per-precinct form, to allow all voters to view election results listed just like their own ballot was, but with the winners marked. These results might be made available through requested emailing, county web site access, smart phone apps, and by telephone enquiry response. This "curb cut" could be used by all voters and would serve to make voting more meaningful and thereby increase voter participation.