Improving the usability and security of mail-in ballots

Ted Selker
Center for Cybersecurity, UMBC
Maryland, USA
ted.selker@gmail.com

Enka Blanchard
Univ. Polytechnique Hauts-de-France, CNRS,
UMR 8201 - LAMIH, F-59313 Valenciennes, &
Center for Internet and Society, CNRS, UPR
2000, Paris, France
enka.blanchard@cnrs.fr

ABSTRACT
While more prevalent than ever, absentee ballots and protocols for them have barely improved over the last decades. This paper describes opportunities for improving the accuracy, security but and especially accessibility & usability of paper ballots, using low-tech methods to help voters be systematic and aware of their selections as they are making them. Our proposals include stickers to show voters how many selections can be made and where, foldable envelopes that allows a user to slide their ballot through a viewing area in an organised way and auditing techniques to improve integrity of the election as well. These approaches address ways of reducing voting errors including for people with reading disabilities, short term memory problems, or motor difficulties.

Author Keywords
Voting, Mail-in ballots, universal design, accessibility

CCS Concepts
•**Applied computing** → **Voting / election technologies;** •**Security and privacy** → **Social aspects of security and privacy;** *Usability in security and privacy;*

DOI: 10.37789/rochi.2022.1.14

INTRODUCTION

In the USA, mail-in ballots have been responsible for a higher percentage of lost votes than in-person voting [17], and hamper independent and private voting while making it difficult to establish a chain of custody for the ballots. With the Covid-19 pandemic, the prospect of super spreader events at polling places deterred electors and election officials; mail-in voting helped elections to go forward. With increasing reliance on mail-in ballots, it seems critical to focus on addressing their deficiencies.

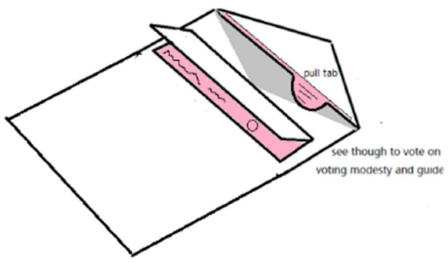

Figure 1. An example of unfolding envelope. The top folds up to partially cover what the voter is looking at.

The switch to Direct Record Electronic (DRE) marking voting machines improved usability, especially for voters with disabilities (such as visual impairments, tremors, reading disabilities and or short-term memory problems [12]), who have a higher number of issues when voting [1]. Well-designed systems can reduce the error rate when compared to paper ballots [16, 1, 12]. Moreover, DREs offer alternative modalities such as audio interfaces to help give independence and privacy to disabled voters. However, such elements are still missing from mail-in paper ballots, which we address in this paper. Our hypothesis is that paper ballot design can be improved from translating lessons learned in electronic marking research and in the disability community. A simple trick such as lining up the votes with a ruler — following the practice used by people with reading disabilities to improve reading — could be especially effective when used in conjunction with portable magnifiers [4]. If such a system is free standing it can also help people with hand tremor as well. While sending each person a structuring and magnifying voting prosthetic might be helpful, there also exists some simpler design changes that can reduce perceptual and memory demands for filling out and verifying one's selections on paper ballots.

OBSERVED ISSUES

Our goal here is to obtain a list of constraints to guide the paper ballot improvements described below, as some aspects can create new issues. For example, improving security and accuracy can come with a usability cost.

Accuracy and usability problems

Accuracy problems arise in at least two different contexts. First, the voters themselves make mistakes when filling in their ballot. For example, when faced with long lists of candidates, about 0.4% of the vote go to candidates adjacent well known candidates on the ballot [15]. Residual votes are lost votes where voters do not select the correct number of candidates, leading to their vote not being counted. Ballot design plays a large role in such mistakes, as shown with the massive undervote in one race in the Sarasota County, Florida, electionin 2004 [9].

Election officials have complained about folds fouling ballot counting machines and optical scanning, and selections close to a fold can be misinterpreted by the voter and or during tallying. Smoothing out ballots is problematic as manipulating uncounted ballots allows the introduction of errors. Such

accuracy issues are compounded in complex ballots[1] Ballots where voters rank or rate candidates can add complexity too.

Disabled voters' concerns on finding and marking desired selection highlight more general problems. Many solutions have been devised to improve polling place accessibility, with electronic marking systems offering variable font size and contrast, audio controls and audits, as well as different low-tech solutions for paper ballots [5], such as magnifying set-ups [13]. Although mail-in ballots lowers the cost of voting and increase voting accessibility for disabled voters, the latter are entitled to voting independently, without requiring assistance to fill mail-in ballots [10].

Security problems

Another critical issue with voting lies in security. Unlike with mail-in voting, in polling places ballot custody is monitored and contained within a physical space [2]. Having people vote from home exposes the system to two different kinds of risk. First is the risk that no ballot is sent to the voter or that the ballot could be misprinted, delayed during transit or intercepted. This can be addressed in several ways, with oversight in ballot printing and mailing being essential. Tracking systems through identifiable marks on the ballots or the envelopes could be useful, with care not to breach voter privacy (especially if the people organising the vote are corruptible) [7]. Despite accusations of security risks, there has been scant evidence of large-scale mail-in ballot fraud [19] Another serious concern is the lack of privacy and risk of coercion within one's home. The concern of household members coercing each other into voting in a particular fashion has been persistent [8].While a polling place affords better privacy, coercion is still a possibility, and nursing homes in the USA have also had a problem of supplying ballots that appear to all be identically filled out with voter assistance [6].

Goals

We can use standard terminology and apply it to the mail-in ballot problem, with two elements standing out.

Printed and delivered correctly
is the first compound step, and corresponds to making sure ballots are created and delivered correctly. This includes laying out a ballot; printing it correctly ; delivering it in time with no loss.

Cast as intended
is the second step and a main focus of this paper's solutions, corresponding to making sure that the ballot that is sent correspond to the voter's wish. This means avoiding unintended residual votes by helping people make selections as intended. It also means making sure that the voter chooses accurately, without the problems mentioned above, which mostly depends on usability. Finally, any mechanism we can include to prevent voter coercion in their home is important.

[1]Even in ballots with a single race, selection accuracy can be reduced by priming effects, layout, confusing or verbose language, or even having many candidates.

IMPROVEMENTS

We here describe multiple options that could lead to improvements in paper ballots and serve further developments.

Envelope improvements

Even envelopes for sending ballots can themselves become usability tools to help voters vote privately, navigate the ballot, and be more accurate while filling it.

Focusing mechanisms.
To help voters focus on a single race, a sliding ballot holder could be included, as shown on Figure 2 top, or could be made from the envelope itself. As stated above, lining up a task with a ruler is an effective way of helping people with various disabilities reduce reading and selection errors. This sliding ballot focuses the voter on the specific options and can serve as a privacy support as well. As a variation on this solution, part of the envelope could also be either transparent or removable. This could be especially helpful when using a single race per fold — as proposed below. In another variation to help visually impaired people, the transparent segment could be a magnifying Fresnel lens.

Modesty panels.
The closing folds of the envelope itself can be used to afford improvement to privacy to improve independent voting and help reduce possibility of coercion. The ballot and envelope can be designed to allow a voter to conceal the area the voter is focusing on from people in the same room, as is shown on Figure 1.

Sticking envelopes.
The bottom of the envelope can be made of removable adhesive. In conjunction with the previous methods, this could increase physical stability while marking a ballot, especially for voters with limited fine motor control.

Ballot improvements

One race per sheet.
To reduce accuracy issues, one could have a single race per sheet, for example by having each separate race on a different card, making the mail-in ballot an envelope containing a stack of cards. The problem for this approach is the possibility of a coercing agent later replacing part of the cards with fraudulently marked cards. An alternative is to have a single sheet of paper with a single race per fold to keep the ballot organised, serving as a memory and reading aid.

Tabs.
Indexing tabs on top of each card can help voters navigate the different races. Each card has a protruding tab, with the summary of the section (like "Federal" or "State") on it. This is compatible with folded ballots and easily adaptable to the ballot holder or scanner systems [14].

Stickers.
Adhesive stickers can give obvious feedback of selections being made.The stickers can be integrated with the ballot, e.g. on the side margins), such that voters unpeel them one at a time, to stick them on the selection of their choice. Stickers

show the voter where and how many selections are available at all times.

The stickers can be laid out on the corresponding tabs, as a memory aid. This way, voters can see at a glance (or feel) which races they have yet to vote on. An example of how to add this to an already existing ballot is shown on Figure 2 bottom. In this case, margins on each side of the ballot include indications of where races begin and end with stickers associated with each. The margins can easily be designed to pull off as a sticker or tear off on perforations.

A variation on the feedback stickers is to print the ballot like a packing label on a two-layered paper; with the top layer being a sticker that can be removed from the bottom layer. The ballot is printed so that each sticker is printed adjacent to the corresponding race, with as many stickers as allowed selections for that race. The voters peel one off for each race, and sticks it next to the candidate of their choice. The voter can remove the margins with unused stickers or put any unused sticker in a designated place at the end of the ballot to ensure that any undervote is intentional[2]. Stickers can be made compatible with write-in candidates, e.g. by leaving space for the candidate's name, and for the sticker next to it (to ensure that all stickers are used).

More usable ballots for visually impaired people.
The sticker approach could be designed to allow a non-sighted voter to find their way around an ballot[3]. The voter would still have to have the ballot read by a camera OCR or person, but could feel where overlays are and where stickers are as they commit to selections.

Off-the-shelf text-to-speech applications on phones that can be used to scan the ballot and read on private earphones what is viewed by the camera could suffice to list the candidates in order (after which the voter could put a sticker on the corresponding dent). This could be made secure with a diversity of available transcription applications and continuous auditing during the vote to detect eventual attacks.

Blind voters who can't read Braille can be guided by dents or cuts in the paper. Making an X cut in the ballot to indicate where to put the sticker can be a haptic guide. Such markings with the sliding ballot holder above would allow a voter to "view" one race at a time.

Ballot correction mechanisms.
If it is possible to correct mistakes without notice in a mail-in ballot, then, an intercepted ballot could be modified. On the other hand, if the decisions made are, as they should be, non-modifiable (for example with unpeelable stickers), any mistake requires the voter to spoil (void) their ballot, and obtain a new one. This complexifies the ballot distribution process and might prevent people from voting due to problems getting the replacement ballot. Ballots might be initially modifiable, with a way to make the ballot non-modifiable once completed. For example, a transparent adhesive sheet could be pasted onto the ballot to prevent further modifications, as is sometimes done on cheques with cellophane tape such as sellotape.

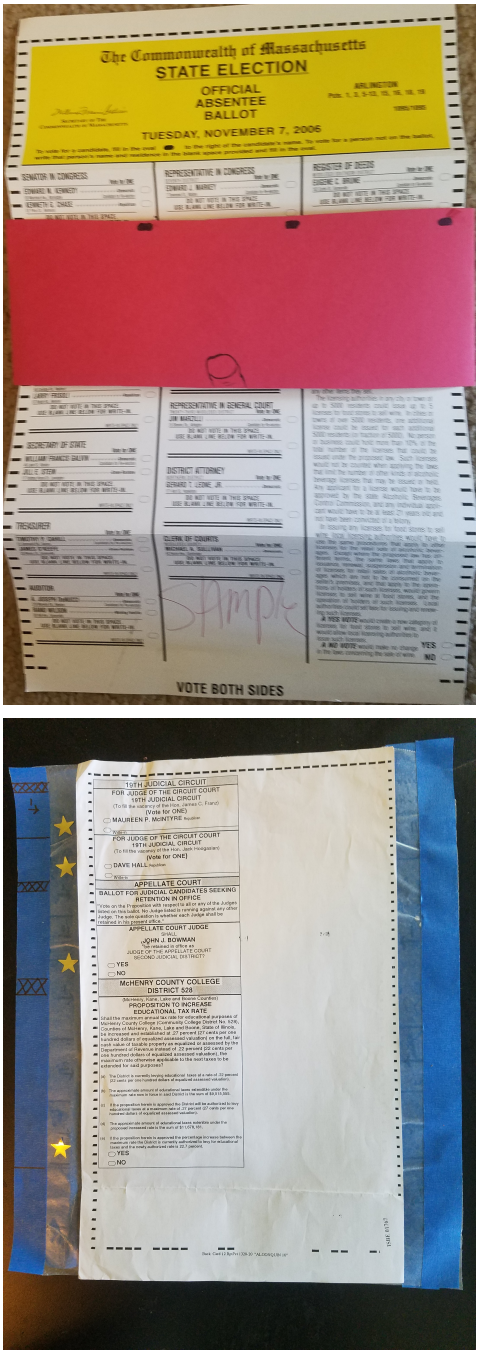

Figure 2. Top: a sliding ballot holder. The voter moves it along the ballot aligning races one by one. Bottom: A ballot with added stickers on the side. The indicators next to them make obvious which races they haven't voted on yet.

[2]Extra stickers that weren't initially with the ballot showing up when it is counted present evidence that it was doctored, by adding stickers after the ballot was deposited. This scheme for showing when a ballot has been altered reduces the available options for spoiling a ballot.

[3]Braille ballots have been made available in certain places in the USA, but only some 10% of visually impaired people have the ability to read it, and it could increase error rates in any case [11].

If stickers are used, a small number of duplicate stickers could be added in tandem with cover-up "undo" stickers that would void whatever sticker was underneath, allowing the voter to put a second sticker on that same race without it counting as an overvote. One approach to this is to have a couple "undo" stickers. If one or more of these are used, it would be visible as the remaining undo stickers are used to seal the ballot and reveal how many cover-up stickers were used before the ballot was sealed. This gives two indications that the voter put the undo stickers on while voting. This system will let people correct mistakes without spoiling their ballot.

Chain of custody improvements

Envelope tracking.

Making sure that the envelope gets safely from the voter to the ballot box without breaching voter privacy is the priority for the chain of custody of marked ballots. The simplest case uses our stickers as seal; the sticker seal and a signature across the closure flap makes tampering with the ballot evident if the seal is torn. In this case, the closure flap also covers any slide through race viewing slot. A 2-return-envelopes system (with one inside another) is another standard practice that could help.

To reassure voters that their ballot arrived safely, voters might apply for a pair of linked scratch-off tickets with unique numbers. They scratch the same digit on both tickets to check that they are indeed identical, and then put one inside their envelope. When the envelopes arrive at the polling office, the ballots are cast in a ballot box, and the tickets in another, to de-correlate them. The tickets are then scratched and the numbers made public. Inspired by systems already in place in countries like Portugal or Romania [18], incentives can be made for such statistical ballot authenticity verification by offering some lottery with the tickets (and a special prize if someone shows an inconsistency).

Identifiable ballots.

Subsequent recounts often finds slightly different totals. One method to improve the counting accuracy would be to make the ballots identifiable. Some ballots already include serial numbers, but another approach is not to make ballots identifiable when they are being filled (as it would break the privacy of the voter) but when they are first taken out of the ballot box. A numbering stamp would add a serial number for the purpose. This would make errors easier to track during audits and recounts. An alternative post-vote ballot identification is for the person counting the ballots to also be identifiable, for example by having a specific numbering stamp.

CONCLUSION

We introduced physical solutions for low-tech usability and security improvements of paper ballots, supported by previous research on Low Error Voting Interfaces. The reduction in errors for people with reading disabilities in earlier experiments was in the 30% range, with statistical improvement for able bodied voters as well [14], and these solutions are designed to be simple to test and implement. The CoViD-19 pandemic made in-person studies harder to organise, but at the same time, the potential massive deployment of mail-in voting in the intermediate future also makes those improvements all the more critical, as existing voting protocols might be too impractical not to make changes, even if change seems difficult. As voting officials are often a major part of practical experimentation on such procedures [3], we encourage anyone interested to communicate with the authors for any experimental engagements. A more detailed version of this paper can be found at: `https://hal.archives-ouvertes.fr/hal-02908417v2`

REFERENCES

[1] Stephen Ansolabehere and Charles Stewart III. 2005. Residual votes attributable to technology. *Journal of Politics* 67, 2 (2005), 365–389.

[2] Matthew Bernhard, Josh Benaloh, J Alex Halderman, Ronald L Rivest, Peter YA Ryan, Philip B Stark, Vanessa Teague, Poorvi L Vora, and Dan S Wallach. 2017. Public evidence from secret ballots. In *International Joint Conference on Electronic Voting*. Springer, 84–109.

[3] N. Blanchard and Ted Selker. 2018. Improving voting technology is hard: the trust-legitimacy-participation loop and related problems. In *Workshop on Socio-Technical Aspects in Security and Trust – STAST*. co-located with ACSAC 2018.

[4] Sharon B. Cohen. 2005. *Auditing technology for electronic voting machines*. Master's thesis. MIT.

[5] Sarah P. Everett, Michael D. Byrne, and Kristen K. Greene. 2006. Measuring the usability of paper ballots: Efficiency, effectiveness, and satisfaction. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, Vol. 50. SAGE Publications Sage CA: Los Angeles, CA, 2547–2551.

[6] Jessica A. Fay. 2005. Elderly Electors Go Postal: Ensuring Absentee Ballot Integrity for Older Voters. *Elder Law Journal* 13 (2005), 453.

[7] John C Fortier and Norman J Ornstein. 2002. The Absentee Ballot and the Secret Ballot: Challenges for Election Reform. *U. Mich. JL Reform* 36 (2002), 483.

[8] Steven C Hause and Anne R Kenney. 1981. The development of the catholic women's suffrage movement in France, 1896-1922. *The Catholic historical review* 67, 1 (1981), 11–30.

[9] David Jefferson. 2007. What Happened in Sarasota County? *Voting Technologies* 37, 2 (12 2007). https://web.archive.org/web/20190424175222/https://www.nae.edu/7665/WhatHappenedinSarasotaCounty.

[10] Blaise William Leeber and Joseph Lawrence Amato. 2011. Improving Voter Privacy for the Blind. *Worcester Polytechnic Institute* (2011).

[11] NFB Jernigan Institute. 2009. *The Braille literacy crisis in America*. Technical Report. National Federation of the Blind.

[12] Ted Selker. 2007. The technology of access: Allowing people of age to vote for themselves. *McGeorge Law Review* 38 (2007), 1113–1136.

[13] Ted Selker, Dan Gillette, Linda Avendano, Shama Hoque, Kate Liu, Minh Pham, and Mike Vroomen. 2014. *Research in accessible voting report*. Technical Report. US Election Assistance Commission.

[14] Ted Selker, Matt Hockenberry, John Goler, and Shawn Sullivan. 2005. *Orienting graphical user interfaces reduces errors: the low error voting interface*. Technical Report. Caltech/MIT Voting Technology Project.

[15] Sarah M. Sled. 2003. *Vertical Proximity Effects in the California Recall Election*. Technical Report. Caltech/MIT Voting Technology Project.

[16] Charles Stewart III. 2006. Residual vote in the 2004 election. *Election Law Journal* 5, 2 (2006), 158–169.

[17] Charles Stewart III. 2020. Reconsidering lost votes by mail. *Available at SSRN 3660625* (2020).

[18] M. D. Ungureanu and D. Dascălu. 2015. Tax Lottery Receipts in Romania, a Different Approach to Fight Against Tax Evasion. In *International Conference on Economic Sciences and Business Administration*, Vol. 2. Spiru Haret University, 267–275.

[19] Elise Viebeck. 2020. Minuscule number of potentially fraudulent ballots in states with universal mail voting undercuts Trump claims about election risks. (2020). https://web.archive.org/web/20200613121341/https://www.washingtonpost.com/politics/minuscule-number-of-potentially-fraudulent-ballots-in-states-with-universal-mail-voting-undercuts-trump-claims-about-election-risks/2020/06/08/1e78aa26-a5c5-11ea-bb20-ebf0921f3bbd_story.html.