Creating Trustworthy Voting Machines

Restoring Trust in Elections

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

I am working on the topic of security in voting systems. Specifically, I want to find out why people lack trust in these systems, and how the designs of voting systems can increase or decrease trust in elections. This is important because elections are the cornerstone of our democracy, yet now more than ever people in the United States lack trust in the democratic process. Democracy can only function if the people in a country are invested and participate in it, and establishing trust is key in this process. I want to explore how technological designs can, whether intentionally or not, lead to confusion over their use, and explore how we can design technology in a way that is approachable to the average person and communicate ideas in a way that raises trust in our systems.

The technical dimension of this problem involves how voting systems are made, including both the hardware used for voting machines and the software ran on these machines. This dimension would explore elements such as what algorithms are used to securely transfer data, what security measures are in place to prevent cyber-attacks, and what physical tools prevent malicious actors from gaining access to a voting machine. The human/social dimension of this problem involves how people perceive the security of voting systems, the effects of a lack of trust on democracy, and how people can be convinced of the security of a system (or lack thereof). Sometimes, the perception of security is just as important as the actual security of a system, and elections are no exception to this. This dimension could explore why people distrust the technology involved, and how we can more effectively communicate the algorithms and machinery involved in the process so that people can understand and trust voting systems. This could attempt to bridge the gap between the knowledge of those designing technologies and those using them.

Creating Trustworthy Voting Machines

The technical dimension of this paper analyzes the hardware and software that are necessary for voting systems to function, and specifically looks at what technologies are being used to ensure secure elections. First, I want to analyze the current technologies commonly used and the benefits and drawbacks of these technologies. I then want to look at what new technologies we could implement to address some of these issues, and if solutions currently exist or need to be developed. Specifically, how can we ensure new technologies are making our infrastructure more secure instead of less? This review builds on my personal internship experience working with the Arlington County elections office as part of a program with the University of Virginia.

One central debate is around the use of electronic versus paper ballots. Whenever new technologies are introduced, we often attempt to integrate them into systems even if they are not a better solution than existing technologies. Electronic voting is not without its benefits. Removing paper ballots can lead to increased efficiency and cost savings. Removing the need for humans to count ballots can improve accuracy, making it less likely that votes change in recounts which could lead to higher trust in the system. Fully electronic systems can lead to increased accessibility (Ikrissi & Mazri, 2024). Over the past two decades, many states have shifted towards fully electronic systems in hopes of improving these areas. That being said, the claim that switching to electronic machines can improve these aspects of voting is disputed. One study compared voting wait times between Rhode Island, using paper ballots, and Georgia, using direct recording equipment (DRE). Despite the theoretical advantages of DREs, voters in Rhode Island actually had lower average wait times (Wadowski et al., 2023). Additionally, the mean wait

times for both locations was reasonably low, raising questions about how big an impact these machines can actually have on voter experience.

However, many of these potential improvements can come at a significant cost. Adding more technical elements to a voting system can often lead to more vulnerabilities. At a security conference, DEFCON, participants attempted to breach many commonly used voting systems. The results were concerning - every piece of equipment tested was able to be breached, suggesting that our voting infrastructure may be much more vulnerable than we realize. One machine had a publicly known vulnerability from a decade prior that had not been patched. Another machine was compromised using an unchangeable default password. A third machine contained actual voter records despite being decommissioned. The ease with which seemingly any voting machine could be breached suggests that a comprehensive reform of our voting systems could be necessary (Blaze et al., 2017).

While electronic voting technologies promise to improve voting, the implementation of these technologies does not seem to have accomplished this goal, and has raised massive security concerns. How can we implement emerging technologies without compromising electoral integrity? One potential solution could be a voting machine running on open source software. In New Hampshire, many local officials have explored switching to such a system, arguing that it would reassure voters of election integrity without compromising security. Open source software can often increase security, as anyone can review source code and contribute to patching vulnerabilities (Mestel, 2024). My research would seek to identify technologies like this that could improve the voting process without the tradeoff that many current electronic voting systems have. Finally, I would like to review the security concerns for our current electoral

process and identify which do not currently have a solution in order to identify where future research should be done.

Restoring Trust in Elections

For the STS section, my research question analyzes why people lack trust in voting systems, how we can communicate effectively in order to inspire confidence in our institutions, and how we can use technologies that promote trust rather than lower it. I first analyze why people lack trust in elections, and effective solutions to address this mistrust. I would also like to research how election officials as well as engineers can effectively communicate the security of election systems. Finally, I would like to analyze how we can take this into consideration when designing systems in a way that inherently promotes trust.

Americans' confidence in institutions as a whole is at an all time low, and trust in elections specifically is declining (Rainie & Perrin, 2019). Research suggests that trust can be influenced by demographic factors including race and political affiliation. Greater knowledge about both the electoral process and technology involved in elections is associated with higher levels of trust (Alvarez et al., 2008). Different groups of people may have different reasons for skepticism, so any attempt to improve trust needs to take into account these different viewpoints and consider who the intended audience is. It is important to make a distinction between trust in elections, referring to how people perceive the security of elections, and trustworthiness of elections, referring to how secure elections actually are. While trust has been declining, this has not necessarily corresponded with a decrease in trustworthiness of elections, showing that perception does not always align with reality (Stewart, 2022). In spite of this, American institutions depend on people's trust, meaning that this lack of trust is just as great a threat as any actual vulnerabilities in our voting infrastructure. Misinformation can explain some of this

disconnect, which is increasingly prevalent due to technologies such as social media and generative AI. Media, researchers, and government should be more proactive in addressing misinformation, but it can be difficult for this to be done without complaints of infringement upon free speech (Ecker et al., 2024).

Some studies have found that including nonpartisan election observers can dramatically raise trust. Dedicating more resources to local election offices and taking steps such as increasing poll worker training can improve voter experience and repair trust at a grassroots level (Bush & Prather, 2023). A study comparing optical scan machines and DREs found inconclusive results to suggest which could more effectively induce voter trust. It did find, however, that the technology used seemed to significantly impact how voters perceived election security, suggesting that voting machines should be chosen carefully and resources should be dedicated towards designing machines that intentionally promote trust in their users (Claassen et al., 2012). One potential solution could be using open source software for voting machines. In New Hampshire, many local officials have explored switching to such a system, arguing that it would reassure voters of election integrity. Open source software can often increase security, as anyone can review source code and contribute to patching vulnerabilities, which would allow voters to review the software and feel confident their votes were counted correctly (Mestel, 2024).

One final potential reason for the loss of political trust is political losing. Put simply, people who vote for the losing candidate in an election are more likely to distrust the outcome of the election. This trend can be observed irrespective of any other factor, making this a difficult problem to address since every election will involve people voting for the losing candidate. When electoral integrity is weaker, meaning there are legitimate reasons to doubt the electoral process, this effect is stronger, whereas it is diminished when integrity is very high. While this

does suggest that generally increasing electoral integrity will increase public trust in elections, it also suggests that regardless of how secure an election is, there may always be a baseline level of mistrust that cannot be properly addressed (Mauk, 2022).

Overall, it seems the reasons for declining trust in elections are reasonably well understood, but the solutions that can address these problems are much less obvious. My research would seek to find more actionable solutions and identify how we as engineers can communicate to people in a way that will inspire trust in our elections.

Conclusion [(150-250 words)]

For the technical project, I intend to deliver a review of current technologies that can raise public trust in elections, as well as identify what areas do not currently have solutions and should be researched further. For the STS project, I will review what causes people to trust elections or not, how we can work to increase public trust, and how specifically engineers can communicate their technical designs in a way that is understandable and trustworthy. Together, these projects will allow us to not only address the actual technical issues related to cybersecurity, but also address the social issues of restoring faith in our political system. Put simply, it is not enough for our election systems to be secure - people must also believe that our elections are secure. My project would explain how we can address both of these issues and work on restoring trust in our democracy and institutions.

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