

A RESEARCH ROADMAP FOR ASSESSING ELECTRONIC VOTING TECHNOLOGY

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Central to the election of the political leadership in any democratic country is a voting process that confers legitimacy on its political leaders, and maximizes public participation, trust, and confidence. Controversy continues to swirl around the use of various electronic voting technologies in the United States. The roller-coaster events of the 2000 presidential election led to new initiatives and funding to modernize the voting process. As a result, alternative voting procedures and systems have been proposed or adopted in several states and localities, and used by some jurisdictions in the spring 2004 primary elections.

While the use of electronic voting machines has grown dramatically since the 2000 election, experience has been mixed. In some instances, voting, and all of the procedures associated with it, have proceeded without a hitch. In other cases, there have been accusations of tampering and fraud, and litigation challenging the accuracy and reliability of the voting systems used. Serious questions remain about the design, use, and impact of electronic voting technologies, even as we move inexorably toward the November 2004 general election.

To make effective and fair decisions about the future of electronic voting technologies, open, public discussions are required about the promise and risk of adopting those technologies. These discussions must be firmly grounded in an understanding of new technology and its impact on the voting system, from voter registration, to balloting, to counting, and to certifying elections. Informed by such deliberations, the country can develop appropriate and trustworthy mechanisms for protecting the accuracy, integrity, and privacy of the voting process.

Yet, for a matter as critical to the functioning of society as voting, there is a conspicuous dearth of useful data — caused in part by underfunding of research — on how well the voting system works and on how the introduction of new technologies or practices affect individual voters or the larger system. To help remedy the paucity of data, the American Association for the Advancement of Science (AAAS), with support from the National Science Foundation, convened a workshop on September 17-18, 2004, that included experts in cybersecurity and voting machine technology, election officials, social and behavioral scientists, legal scholars, and representatives from public interest groups. They highlighted issues and helped AAAS develop a set of recommendations for research on various aspects of electronic voting technologies, pointing researchers and those who fund research toward potentially fruitful avenues of study and interdisciplinary collaboration. By making the research agenda widely available, AAAS seeks to facilitate

dialogue on these important issues among researchers, government officials, and the general public. This effort should contribute to a greater understanding of the comparative advantages and disadvantages of various voting systems and to knowledge that can inform critical personal and policy decisions about voting in the United States.

As one of the participants at the workshop observed about the voting system, “There is a lot we don’t know that could get us into trouble.” The post-2000 election experience indicates that “trouble” has already occurred and has shaken the public’s confidence in the system. Solutions must be grounded in rigorous research to generate better knowledge than exists now. The lack of funds for research on a process so central to the practice of democracy is startling. Research has the potential to improve the functioning of the voting process and increase the legitimacy of voting outcomes. The political will is required to invest adequately in research and to act on findings in a non-partisan manner.

Setting the Context for Research

To guide the design of a research program on the voting system, workshop participants identified a series of contextual “givens” that constitute the backdrop of whatever studies are undertaken. This context includes the following:

- Voting in the United States must be understood as a complex system. Components include the factors that motivate citizens to engage the system, the process of voter eligibility and registration, the casting of ballots, recording and counting of those ballots, the recounting of ballots, if necessary, and certification of the election. The introduction of new technologies, laws, or practices at any point in the system will affect the way the system is perceived and actually works. By understanding the risks and opportunities presented by such changes, ways can be found to optimize behavior of the system according to its goals.
- The voting system in the United States is highly decentralized, including more than 3,000 election jurisdictions, with responsibilities distributed among national, state, and local governments. This means that voting is affected by an exceedingly diverse set of legal requirements, procedures, and practices. This decentralized system will affect not only the introduction of new voting technologies, but also the conduct of research. On the one hand, it presents challenges to the collection and analysis of data from states and localities that can differ greatly in the manner by which they accumulate, format, and archive them. On the other hand, it offers an excellent opportunity for researchers to focus on the states as a “living laboratory” and take advantage of their natural variation to identify some of the best and worst practices. Recent redistricting initiatives have compounded the complexity by imposing more demands on the system related to, for example, the greater number of ballots that must be introduced and counted, and the number of election workers who must oversee the counting.

- The voting system’s decentralization and diversity signal the need to be attentive to the characteristics of voters. There is no “average” voter. People engage the voting system with different levels of education and technical skills, cultural backgrounds, languages, accessibility issues related to a disability or socio-economic circumstances (e.g., income or transportation availability), and so on. Research must take into account those differences, carefully scrutinizing the relationship between the voting system and various subpopulations.
- The United States is not alone in introducing new technologies into the voting system. Some countries have had more experience, and fewer problems. Researchers and policy makers should examine models used in other democratic venues to see what lessons might be applied to similar efforts in this country.
- Research must take into account the goals of the voting system, identified by the workshop participants as: maximizing voter participation; maximizing the probability that votes are captured as the voter intended; maximizing voter trust and confidence in the system; and achieving simplicity in the voting process while maintaining the accuracy, integrity, and privacy of the system.
- The same accuracy, integrity, and respect for voter rights and interests must be integral to the conduct and reporting of research. Adherence to accepted research practices and ethical guidelines is essential if findings are to be seriously considered in what is often a highly partisan environment.

Establishing Research Requirements

Workshop participants identified three overarching goals for research on the voting system: (1) to improve understanding of the current system; (2) to contribute to the assessment of how different components of the system interact; and (3) to help the system prepare for change, including anticipating and responding to mistakes or mischief.

To maximize the value of any research conducted, workshop participants acknowledged the importance of achieving a common understanding across research fields of key concepts on which further study should focus, and of identifying useful data and research methods. They recommended a set of 13 key concepts that warrant clearer definitions and more precise methods for measuring them and assessing their impact on the voting system:

- *accessibility* and *equal protection* regarding all components of the voting system;
- *accuracy* as it applies to recording and counting votes;
- *anonymity* and *privacy* as they relate to the casting of a vote as well as to efforts undertaken to ensure accountability in voting systems;
- *error* and *fraud* with regard to their occurrence throughout the system;

- *intent* with respect to determining whether voting technologies capture the vote as it was intended;
- *transparency* in terms of maximizing accountability while preserving legitimate privacy rights;
- *vulnerability, threat, and risk* so that comparative assessments can be made of alternative voting technologies and other proposed changes to the voting system; and
- *usability* to evaluate how any technology can be assessed for ease of use by voters or other actors in the system.

Useful data to collect include those that would lead us to an understanding of how the current voting system operates and is perceived by all stakeholders. Examples cited were: which voting technologies were being used and where; the problems encountered in their use by voters, election officials, and poll workers; how frequent were “overvotes” and “undervotes” in the various election jurisdictions; who is or is not voting and why; perceptions of voters, election officials, and political leaders and their attitudes toward current voting technologies and procedures; which election laws are applicable in various jurisdictions; the extent of documented fraud and error, and where in the voting system they occur; and the cost and economics of the voting process, from voter registration to election certification. This is by no means an exhaustive list, but participants made clear that without such data researchers cannot draw sound conclusions about how well the current system works in achieving its goals and how it responds to change.

A wide range of research methods was endorsed by the workshop participants, including survey research, ethnographic studies, field and laboratory experiments and testing. Comparative risk assessments of alternative versus current technologies were viewed as potentially very valuable. Participants saw rich opportunities for collaborative, multidisciplinary research, with teams of researchers joining forces with election officials in developing and executing research protocols. Factors that would facilitate or impede such collaborations also should be examined.

The creation of national data sets and data archives, on voting behavior, laws, and technologies used, for example, was recommended to bring critical data together in formats accessible to researchers across disciplines. This would help to overcome some of the obstacles posed to researchers by the decentralized voting system.

Other potential constraints on research posed by secrecy related to the engineering of voting technology and copyright restrictions on software also should be studied to determine if changes in intellectual property law should be considered.

Research on Voting Technologies

Several research questions were identified related to the design, adoption, use, evaluation, and certification of alternative voting technologies. “Electronic voting technology” means more than just the particular voting machine used. It also encompasses the databases used for voter registration, the ballots used on election day, and the techniques used to test and evaluate the performance of the voting machines. Participants strongly recommended a comparative assessment of different types of voting technologies, their design, and their use. More research is also needed on performance expectations and standards of voting technologies. A number of research questions were identified to contribute to a comparative assessment.

- What does it mean for a voting technology to perform “up to standard”? What are the best ways for developing and monitoring standards, and how should various stakeholders be involved? How can voting technologies best be tested in the field for meeting performance standards?
- What is the error rate of existing technologies, and how susceptible are they to tampering, fraud, and lost ballots? At what stages (e.g., voter registration databases, the casting of ballots, the counting or recounting of ballots) are fraud and mistakes most likely to occur, and with what frequency? How can technologies be engineered to withstand physical abuse, software malfunctions, and human mistakes, and to protect against error and fraud? How often are recounts done, and how accurate are they? What are the impacts of various system designs on voter privacy?
- In making voting technologies more secure, are there lessons to be learned from other venues where secure technologies are critical, such as ATM machines in banking, or gaming technologies in legalized gambling?
- What are the trade-offs in relying on either open source or proprietary software in the design and evaluation of alternative voting technologies?
- How does ballot design affect voter understanding? To what extent are inaccuracies in casting, recording, or counting ballots because of design or human error?
- How can the usability of alternative voting technologies, documentation, and training of users be evaluated?

Research on Voter Knowledge, Perception, and Behavior

A recurring reminder that surfaced during the workshop was that the voter is the central stakeholder in the system. Research should be aimed at discovering ways in which the voting system does or does not serve the needs of the voter.

- What factors discourage or encourage citizens to engage the voting system? What impact is the provisional ballot having on voter participation?
- When voter turnout in a specific jurisdiction is underestimated, how does it affect voter access to the polls? How are lines of voters managed and how long a wait are people willing to tolerate in order to vote?
- From where do voters acquire information about the voting system? What are the strengths and weaknesses of alternative strategies for disseminating voting information?
- What is the extent of high or low voter satisfaction with the voting system, and why?

- How are people’s perceptions and participation affected by concerns raised about the voting process, for example, through the media, lawsuits, or legislative hearings?
- Does a person’s facility and comfort with voting technology correlate with his or her skill level and experience in using other technologies? Are there tools to help citizens “practice” voting on the technologies as they evolve?

Research on Election Administration

One of the more overlooked components of the voting system by researchers has been how the voting process is administered. Key players include election officials (some appointed and some elected), the political administration in power at the state and local levels, poll workers (who are typically volunteers paid only a nominal stipend, and in some cases, politically appointed), and the legion of support personnel, from computer technicians to electricians, to keep the local voting infrastructure operating. Workshop participants identified this “management group” as a subject requiring more research.

Workshop participants noted the increasing responsibilities that the voting system places on election officials. Questions surrounding their role, preparation, and resources received considerable attention.

- What is the level of professionalism among election officials? How do differences in skill sets affect their performance, and with what impact?
- What efforts are taken by election officials to help voters navigate the voting system?
- Who makes decisions about which voting technologies to adopt, and what factors are considered? What is the nature of the relationship between technology vendors and election officials? Is there oversight of the relationship; if so, by whom?
- As election officials seek to centralize and link voter databases to achieve greater efficiencies, what are the implications for voter privacy and system security?
- Do election jurisdictions differ in their capacities to support the work of election officials, and if so, what consequences do those differences have for election administration?
- How can the results of research most effectively be disseminated to those responsible for administering the voting process?

The need for poll workers to interact with both voters and increasingly sophisticated technology led participants to consider a series of research questions

- What are the backgrounds of poll workers with regard to their education, skill, and experience that bear on their role in the voting process? What methods are there to train them effectively in a role that only surfaces every few years? Who should do the training?
- What are the effects of their demographic features (e.g., age, socio-economic status) on a technologically driven voting process?
- What strategies are used to recruit and retain poll workers from one election to the next, and how effective are they? How are poll workers supervised and held accountable?

For both election administrators and poll workers, participants asked,

- Is there a need to establish a credentialing system for them? If so, what should be the content of a training program and level of performance expected, for example?
- How does a change in a jurisdiction's political leadership affect election administration?

Research on Accountability Mechanisms

Holding people and technology accountable is critical to conducting and certifying elections and to generating public confidence in the system. Workshop participants identified several research issues associated with investigating the impact and effectiveness of various accountability mechanisms.

- How can voters be assured that their votes were cast and counted as intended?
- What are the “best practices” for auditing elections, and who should be involved?
- What are the means by which voting technologies can be designed to provide effective audit trails (e.g., paper or computer images)? How can they be tested and validated?
- How well do different methods, paper and electronic, work to verify votes cast? How would they affect voter privacy?
- Are there ways to verify that the software used in voting technology on election day is what was certified previously?
- If problems are found, what enforcement tools are available? How often have they been used and with what results?
- To what extent do proprietary claims by voting technology vendors affect accountability efforts?

Research on Alternative Future Voting Scenarios

Participants noted a number of future voting scenarios that warrant careful assessment. While some of the proposals for altering the voting landscape are already being touted as “inevitable” or as “solutions to all current problems,” none has been subjected to rigorous analysis on how they would work and what impacts they might have. Research on how innovation of new voting technologies is affected by and affects the existing voting system is needed if we are to better positioned to shape our “alternative future.”

“Voting anywhere” refers to voting that is not confined to a specific location. It usually means voting via the Internet on a personal computer, but may also include voting from a hand-held device.

- What impact would this approach have on voter participation, especially those subpopulations with minimal access to or experience with the types of technologies that could be used?
- What security and privacy issues are raised by such a distributed voting system?

- What effects would this have on efforts to influence people's votes?

Alternative models of voting registration were also discussed by workshop participants, including both registering and voting on election day. Recent incidents involving the purging of legitimate voters from registration rolls in some states have led to consideration of how best to protect the integrity of voter registration lists and databases.

- What criteria should there be and what documentation required for registering on the day of the election?
- How could challenges to a person's same-day registration attempt be handled in a just and expedited manner?
- What impact would same-day registration have on voter participation?

The failure to develop a research program on the voting system following the 2000 national election has left the nation with many more questions than answers about what to expect in this year's election, only six weeks away. We should begin now to prepare for future elections, guided in part by the research roadmap presented here.