



## **CALTECH/MIT VOTING TECHNOLOGY PROJECT**

A multi-disciplinary, collaborative project of  
the California Institute of Technology – Pasadena, California 91125 and  
the Massachusetts Institute of Technology – Cambridge, Massachusetts 02139

**TITLE**                      **Reflections on the VTP's contributions to science,  
policymaking and education**

**Name**                         **R. Michael Alvarez**  
**University**                 **Caltech**

**Name**                         **Charles Stewart III**  
**University**                 **MIT**

**Name**                         **Ron Rivest**  
**University**                 **MIT**

**Key words:**

**VTP WORKING PAPER #100**  
**September 2010**

# Reflections on the VTP's contributions to science, policymaking and education

---

## R. Michael Alvarez

In the immediate wake of the 2000 presidential election, the Caltech/MIT Voting Technology Project was initiated. The initial and primary concern of the VTP at that moment was to understand the problems that arose in the 2000 American presidential election, in particular with regards to voting technologies, and to develop scientifically-based proposals for reforms and perhaps even to propose new voting technologies. In the past decade, the VTP has moved from that original focus to become an internationally-renown group of researchers who now focus on a broad array of election administration issues.

One of the less obvious contributions of the VTP during this decade has been how VTP researchers have involved graduate and undergraduate students in these research activities, and how that has helped to fuel the development of what may eventually become a new, multidisciplinary academic research discipline examining election administration and voting technologies. The milestone event of the publication of our 100<sup>th</sup> VTP Working Paper, though, helps to shed light on the educational role that VTP researchers have played in the past decade.

For example, of the first ten VTP Working Papers that were published, five were either written by VTP-related students or were co-authored by VTP researchers with their students. For example, VTP Working Paper #1 was written by Melanie Goodrich, detailing her research while an undergraduate student at Caltech, on "19<sup>th</sup> Century Ballot Reform in California: A Study of the Huntington Library's Political Ephemera Collection." Goodrich closely studied the Huntington's collection of 19<sup>th</sup> century paper ballots, documenting the evolution of ballot design and styles in an important period of American electoral history. Goodrich has since gone to graduate studies in political science at NYU, and is now working for an international government consulting firm in the Washington D.C. area. Another of the early VTP Working Papers was written by Sarah Sled, a Ph.D. student at MIT --- Sled wrote about the "Vertical Proximity Effects in the California Recall Election", and her work was then also presented in Working Paper #9 (which was eventually published in the journal *PS: Political Science and Politics*). After receiving her graduate degree, Sled now works in the private sector.

Another important example here is VTP Working Paper #7, co-authored by Betsy Sinclair and myself. This paper, which was later published in the journal *Political Research Quarterly*, takes a close look at residual votes across precincts in Los Angeles County, thus holding voting systems constant. Other than the substantive and methodological contribution of this research paper, it is important to note that Sinclair was an undergraduate student from the University of Redlands when she began the data collection

and analysis that formed the basis for this paper; she then received her Ph.D. from Caltech and is now an assistant professor of political science at the University of Chicago.

Further examples abound when you scan the list of the first 99 VTP Working Papers. My unofficial tally indicates that 12 of the 99 are Working Papers that were single-authored by graduate or undergraduate students working with the VTP; 25 of the 99 have graduate or undergraduate students as co-authors with VTP faculty researchers. Thus, over a third of the VTP Working Papers published in the past decade have involved undergraduate or graduate student co-authors.

While I have not done an extensive study, I am aware of no other multidisciplinary, multi-institution research project that has existed for at least a decade --- and which has developed such a strong tradition of student involvement in research products. Many of the undergraduates who have been involved in VTP research have gone to get graduate degrees, and some are now producing additional research that is helping to improve our understanding of election administration in the U.S. and abroad. The graduate students involved in VTP research have taken academic positions in the U.S. and abroad, or are working in the private sector --- applying the research skills developed in their work with VTP faculty.

This is one of the most important, but hidden, ways in which the Caltech/MIT Voting Technology Project has influenced the science of election administration and technology --- helping to train the next generation of public and private sector researchers who are themselves now conducting further independent research. As we take this time to reflect upon the milestone of our project's publication of the 100<sup>th</sup> Working Paper, it is important to observe how this intellectual record reflects the educational impact of the Voting Technology Project.

## Ronald L. Rivest

Since its inception, the CalTech/MIT Voting Technology Project has helped to energize voting research in this country and to provide factual unbiased information to researchers, election officials, policy-makers, and vendors. Since it is not a lobbying organization nor an advocacy group for a particular cause, others have learned to seek out the VTP for guidance. The VTP has also on various occasions provided a neutral meeting ground for vendors, election officials, and researchers.

Running elections well is a tremendous challenge. As technology advances, this challenge increases, as one needs to ferret out technological risks hidden amongst the technological opportunities.

We are surely but slowly learning the lesson the "low-tech is good" with respect to security of voting systems. Complexity is the enemy of security (indeed, large complex systems are almost insecure by definition). It has been good to see many in this country return to simple paper ballots during the last decade, after realizing that the promise of DRE's was broken by the resulting unverifiability and unauditability of election outcomes.

The VTP has played a role in developing more efficient methods for conducting post-election audits, resulting in need to hand-count far fewer ballots to achieve a given level of confidence in the election outcome. This is still an active area of research, and the ability to work with single ballots at a time---instead of single precincts at a time---promises even further efficiencies.

We have also worked with others on the pioneering of techniques that utilize cryptography in ways that enable voters, and even the public at large, to verify the correctness of election tallies, without violating the privacy of ballots. One such method (the "scantegrity" method), was used successfully in the municipal election of Takoma Park, Maryland in November 2009.

Our work in voting technology has also been synergistic with my service on the Technology Guidelines Development Committee, advisory to the U.S. Election Assistance Commission, which is developing new standards for the certification of voting systems in the U.S. The notion of "software independent" voting systems was proposed to the TGDC as a way of capturing the fundamental requirement that election outcomes should be auditable without having to place trust irrevocably in the hands of a piece of complex software.

Looking ahead, it is clear that the promise of "internet voting" will have to be tempered with realistic assessments of the associated risks. At present, it is quite clear that the technology does not yet exist that would enable the electronic return of cast ballots over the Internet in a sufficiently secure manner. (On the other hand, the delivery of election information and even blank ballots to the voter over the internet seems quite reasonable.)

The improvement of election systems is clearly a never-ending process. Careful research, such as that performed by members of the CalTech/MIT Voting Technology Project, can continue help steer such improvements in Wthe best directions.

## Charles Stewart III

### Where are the cool gadgets?

As the name implies, the original aspirations of the Voting Technology Project pertained to the intersection of technology and democracy. To make the point, consider the language of the cover letter, signed by Caltech President David Baltimore and MIT President Charles Vest, that accompanied the VTP's often-cited 2001 report, *Voting: What Is/What Could Be*:

The California Institute of Technology and the Massachusetts Institute of Technology saw a need for strong academic guidance in this intersection of technology with democracy. As the presidents of these two Institutes, we are proud to have mobilized a team of computer scientists, human factors engineers, mechanical engineers, and social scientists to respond to this national need. [Note the ordering of the professions listed.]

The Voting Technology Project team began its research with a desire to evaluate existing voting technologies to determine whether they meet the country's needs for a secure, reliable, robust system of recording election preferences.

It is evident that problems with counting the votes of the citizens of Florida and elsewhere originated in unsound technology. In the last election, Americans learned that at the heart of their democratic process, their "can-do" spirit has "make-do" technology as its central element.

The establishment of the VTP as an organization that was focused on technology coincided with the nation's fixation on the technological breakdowns in Florida, exemplified by hanging chad (mechanical failure) and butterfly ballots (human factor failure). The substance of the summer 2001 report planted the seed for a reconsideration of this focus. Buried in the report was the startling estimate that of 4–6 million lost votes in the 2000 election, only 1.5–2 million were accounted for by machine failures, of the mechanical or human factor type. By far more numerous were problems associated with registration mix-ups (1.5–3 million) and polling place practices (up to 1 million). This was in addition to losses on the absentee vote side, which were un-estimated, but now appear to be equally as large, in total numbers, and much larger, as a percentage of ballots cast. Furthermore, no attempt was made at the time to estimate lost votes due to counting errors or less benign efforts to corrupt vote counting.

Both Caltech and MIT have a more expansive definition of what constitutes "technology" than simply gadgets you build on the shop table or the factory. Still, the core finding that the biggest problems confronting elections in the United States were caused by failures of *human organization* rather than voting machine breakdowns had a profound effect on how the larger world of election reform, as well as the VTP itself, framed problems and solutions going forward.

In the early days, the VTP was not the only player in the election reform space, but its initial quantification of the scope of the problem, and its fundamental agnosticism toward most established solutions to election administration failings, were clearly influential as the Help America Vote Act was marked up and eventually passed. (Indeed, the metric it developed and championed as a diagnostic for voting machines, the residual vote rate, is now enshrined into law as a quantity to be minimized by voting machines.) HAVA appropriated \$3 billion, for allocation to the states in order to allow them to improve elections. A major part of that allocation was for technology upgrades, which the VTP had demonstrated could reduce the lost vote rate, but it also funded administrative improvements. In addition, HAVA mandated that states establish statewide registration databases and “fail safe” provisional ballot laws, in order to minimize votes lost due to registration shortcomings.

In looking back over the past decade and 100 working papers, it is not hard to get a sense of pride in what the VTP has helped the nation accomplish. At the same time, it is hard not to ask, “What happened to the *technology* part of the voting *technology* project?” And, by technology, I do mean gadgets that can be built in the shop or the factory.

One answer is that the VTP continued to have an influence in the more conventionally understood side of voting technology. Examples include Ted Selker’s work on methods to facilitate voting by the disabled; Ron Rivest’s work on encryption, auditing, and the “Scantegrity” system; and the “frog” architecture that was advocated in the 2001 report, and is still considered by many to be the organizing concept for the “voting machine of the future.”

Another answer is that the VTP became distracted, like the rest of the nation, by the relatively easy solutions to the big problems the nation faced, which were to throw money at states to allow them to abandon lousy antiquated equipment in favor of pretty good contemporary equipment, and to mandate that states get their registration systems in order. These were appropriate distractions, given the nature of the problem and the available solutions at the time. Still, it has left the “gadget problem” unsolved, in an even more difficult political and fiscal environment.

Nowadays, when I am asked “could Florida happen again?” I answer, “We won’t have any more problems of hanging chad, but I actually think the chance of a large-scale meltdown in many parts of the county are *greater* now than they were. I at least expect ‘another Florida’ in my lifetime.” The reason I answer this way is that innovation in the core technology of voting has failed to keep up with the challenges of the voting environment. At the same time, the “new” machines purchased with HAVA money have proven to have shorter life spans than initially estimated. Just as the pregnant chad problem was caused by the failure to keep up the maintenance of old technology that inevitably degrades, the “next Florida” is likely to come when a cash-strapped county somewhere in America lets its maintenance contract lapse, or fails to update its software in time. (This is in addition to worrying about voting tabulation systems that were originally written in Cobol or FORTRAN, and are now just marking time.)

In the face of technology challenges that are confronting the voting system in America, the voting technology industry has shrunk over the past decade; skepticism about “black box” voting has discouraged searches for innovative technologies. And yet, it seems that the next round of challenges will need a larger, more robust voting technology market that can innovate, along with a willingness from Congress and state legislatures to fund a more active innovation system for voting technology improvements.

Therefore, looking ahead, I can easily see a role for these two great institutions, Caltech and MIT, to play in reawakening the nation to the technology problem facing the election system, and helping to navigate a path forward. It is sobering to recall that the Bush-Gore recount occurred *before* the deep partisan divisions that now beset us had arisen in the nation — indeed, many credit the recount for being the opening salvo in this new era of partisan warfare. How much more divisive should we expect a technology-failure-driven episode of “Bush-Gore II” to be? The next time, the problem really *will* be about the voting gadgets. The VTP still has a lot of work to do.