

Caltech/MIT study

Caltech/MIT report

- Resulted from the catastrophe in the 2000 US Presidential election
- Initiated and signed by the presidents of the 2 schools
- Main focus
 - what happened and why
 - what is
 - what could be
- 2 fundamental problems
 - recounts
 - system failures

Recounts

- Elections, by definition have a least one unhappy loser
- stolen/fraudulent ballots
 - can result in revote, not just recount
- election officials and judges decide
 - what is recounted
 - how recount is to take place
- when humans count ballots, results are different each time
- voting machinery can lose votes
 - lever machines provide no clue about voter intention
 - the just count votes
- In 2000 election, margin was less than .5% for President
 - in Florida, Iowa, New Mexico, and Wisconsin
 - many other contested seats as well
- Much of the blame is given to punch card machines

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System Failure

- In real elections many votes that are cast correctly are not counted
- Illinois, S. Carolina, Georgia had higher rate of spoiled ballots than Florida
 - but count was not as close
- New York City
 - improperly printed ballots
- Beaver county, PA
 - high number of unrecorded ballots due to malfunctioning touch screen
- New Mexico
 - voting disrupted by bad weather and power outages

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Lost votes in 2000



- Misvotes
 - people think they voted for candidate A, but voted for B
 - Butterfly ballot, other confusing ballots

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Security

- Fraud is a fact of life in elections
- But, we should be able to reduce the problems due to engineering error
- Handle security problems with
 - penalties
 - audit
 - avoid:
 - secret and proprietary designs
 - one ballot at a time fraud = grains of sand on scale
 - more concerned: someone putting thumb on the scale

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Steps in an election

- registering to vote
- getting to the polls
- casting a ballot
- counting ballots
- certifying the vote

- Why no receipts?
 - invites corruption
- Secrecy & Anonymity of ballot protects
 - against coercion, intimidation, vote buying

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Decentralization

- Every county has its own voter registration system
- voter registration databases are distinct from other databases
 - such as motor vehicle registration
- Efforts are underway in some states to standardize within the state and link to other databases
- Privacy concerns
- Strong feelings in US against national ID card
 - gives govt too much power to monitor citizens

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Why not hand count hand-written ballots?

- That's what they do in Canada and some European countries
- Not feasible in US
 - Paper ballots are expensive to print, secure & transport
 - US elections are complex with local, state, national issues, as well as referenda taking place at once
 - e.g. some US districts have 20 elections and 20 questions
 - counting is slow and error prone
 - compared to optical scanning & touch screens, less effective

Equipment

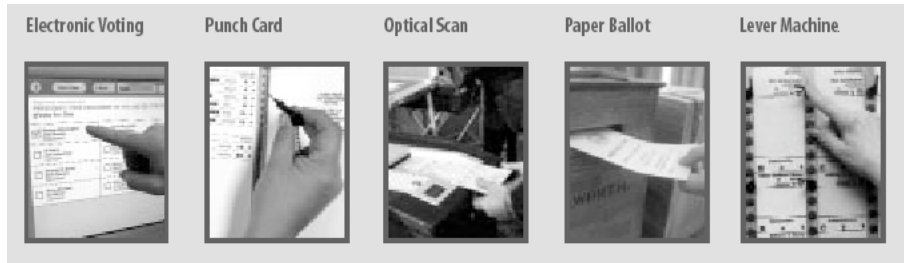
- Paper based
 - hand counted ballots 19th century but still in use
 - punch cards 1960s
 - optically scanned paper ballots 1990s
- Mechanical lever
- Electronic voting machines DRE (highly variable)

- Latter 2 methods do not capture voter intent and recount is not possible
 - also cannot audit election
- Two types of counting
 - in precinct
 - central



RECOMMENDATION

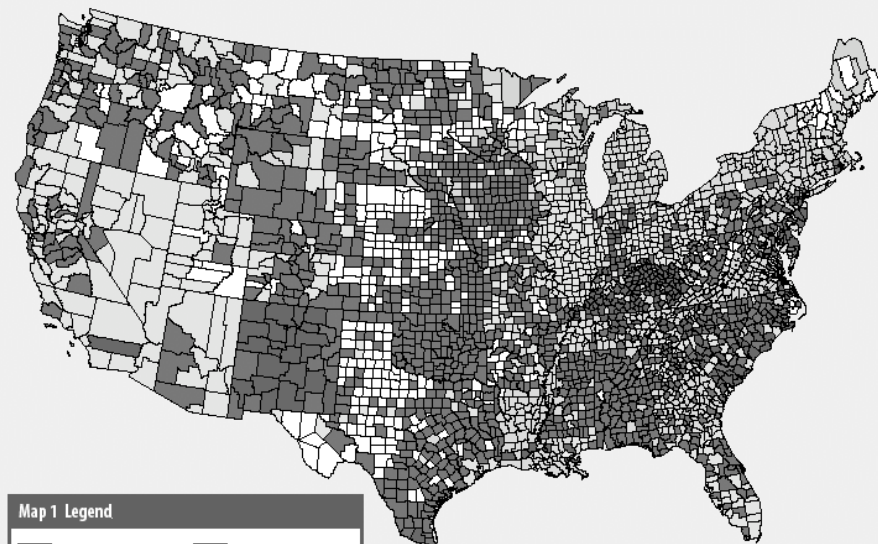
Replace types of equipment that show high rates of uncounted, unmarked, and spoiled ballots with optically scanned paper ballots that are scanned at the polling place by the voter (called "in-precinct optical scanning"), or any electronic technology proven in field tests.



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Voting Equipment Used by Counties in 1999



Electronic Machines	Optical Scanners
Lever Machines	Punch Cards
Paper Ballots	Mixed Systems

Source: Election Data Services

RESIDUAL VOTES =

Uncounted ballots + Unmarked ballots + "Overvoted ballots"

BALLOTS THAT CONTRIBUTE TO THE RESIDUAL VOTES

Uncounted ballots: Ballots that are cast by voters but uncounted by election officials for whatever reason.

Unmarked ballots: Sometimes termed the "undervote." May occur because the voter abstained or the recording device did not register a mark.

Overvoted ballots: Ballots that record a vote in more than one place for a given office (unless the ballot explicitly allows for more than one choice to be made.) May occur because the voter clearly marked more names than allowed. Often occurs when a voter places a legal mark next to a candidate's name and then writes the same name on the "Write-in candidate" line on the ballot.

Table 1

RESIDUAL VOTES AS A PERCENT OF ALL BALLOTS CAST, 1988-2000

Machine Type	President	Governor & Senator
Paper Ballot	1.8%	3.3%
Punch Card	2.5	4.7
Optical Scan	1.5	3.5
Lever Machine	1.5	7.6
Electronic (DRE)	2.3	5.9

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E-voting

"We see electronic voting as an improving technology. It has great potential. However, in terms of one very basic requirement---minimizing the number of lost votes---electronic voting does not have a very good track record. Paper systems have performed much better over the past dozen years. This problem means that the electronic voting industry is not working to the standards that it needs to. Our report holds this as a priority. It is unquestionably possible to make high quality, simple interfaces and manage complexity with computer technologies that exist today."

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Cost of voting equipment

- DRE machines are expensive
 - initial investment huge
- optical scanners are also not cheap
 - cost more per vote cast

ESTIMATED COSTS OF BUYING AND OPERATING VOTING EQUIPMENT		
	Acquisition	Operating
DRE Machines (Touchscreen)	\$18-25/voter	\$0.5-1/voter
Optical Scanning (in Precinct)	\$6-8/voter	\$1-2/voter

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Other considerations

- Auditability
 - audit the machines
 - count the votes
 - paper is easiest to audit
 - electronic machines should produce a printed tape
 - minimum level of auditability is a must for voting standards
- Management
 - (poll worker accidentally took home a box of ballots)
- Accessibility
 - disabled (e.g. trouble getting to the polls)
 - blind (hard to provide anonymity)
 - designs should take these into account
 - technology gives the opportunity to improve access

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Registration

- National Voter Registration Act 1993
 - Motor voter
 - designed to make it easier to register
 - has not significantly increased voter turnout
 - has increased number of “inactive” voters
- Voter Registration: 5 standards
 - accurate and complete
 - immune from fraud
 - dynamic and up-to-date
 - usable by election officials at a voting place
 - must be easy to register

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Dead voters

- 15,000 dead people were registered to vote in Georgia
- Over 20 years, 5,400 dead people actually voted
- audits of registration databases
 - revealed many duplicate registrations
 - in California audit, 1 in 4 registrations were duplicates (people who moved)
 - in Michigan 1 million out of 9 million registered were duplicates
- little evidence that duplicate registration results in duplicate voting (but it could)

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Why registration problems?

- large, massively complex problem
- registration is decentralized
- there are 200,000 voting precincts in the US
 - poll workers are not that well trained
- NVRA created database problems
- need a way to purge registrations without requiring people to constantly reregister
- Provisional ballot: (if registration problem arises)
 - separate form, vote for common, national posts
 - sign affidavit
 - ballot is sealed with signature and affidavit and only used if election was close

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RECOMMENDATION

Near Term

- Develop a system for allowing voters to check their registrations.
- Develop better databases (e.g., record some sort of numerical identification on each voter's registration).
- Make the county's or state's registration database accessible at each polling place.
- Provide polling places with the list of dropped voters and the reason they were dropped.
- Use "provisional ballots" aggressively when there are registration problems.

Long Term

- Computerize voter registration information and processes at both the local and state levels.
- Develop statewide qualified voter files.
- Fix gaps in the more open registration system created by NVRA.

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**BEST PRACTICES IN MANAGING
VOTER REGISTRATION**

The Michigan Qualified Voter File (QVF)

The QVF provides electronic linkage for elections officials throughout the State of Michigan to an automated and integrated statewide voter registration database (<http://www.sos.state.mi.us/election/qvf/index.html>).

California "On-line" Voter Registration

California's "on-line" voter registration process allows for easy distribution of voter registration forms via the Internet (<http://sosdev3.ss.ca.gov/votereg/OnlineVoterReg>). The system does not allow for truly "on-line" voter registration, as a paper-based signature is still required.

Orange County, Florida

County workers with laptop computers containing countrywide voter registration information assisted with voter authentication in the polling places, reducing registration problems at the polling places significantly.

Federal Voting Assistance Program (FVAP),
2000 Voting Over the Internet Pilot Program

The FVAP's 2000 Voting Over the Internet program developed an on-line voter registration process that involved a high degree of computer security.

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Polling places

- **Arrival process**
 - make sure people know when to go
 - encourage off-peak voting, radio, TV, Web
- **Authorization to vote**
 - make registration lists as useful as possible
 - deal w/registration problems locally
 - use provisional ballots
- **Voter education**
 - voter should be prepared before entering booth
 - know what ballot will look like
 - reexamine laws prohibiting bringing mock ballots to polls
 - just in time training for voters at polls
 - keep everything simple, avoid changing the process too much
 - train poll workers as service agents for voters

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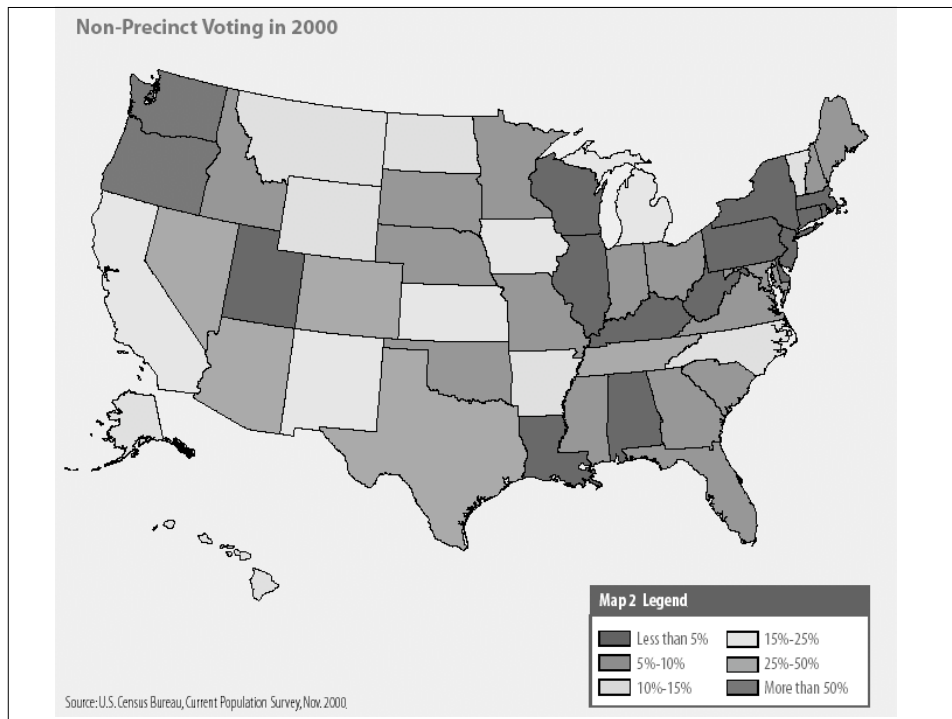
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Polling places (cont.)

- staffing practices
 - average poll worker works 6:00 a.m. to 9 or 10 p.m.
 - average age is over 65
 - expand the pool of potential precinct workers
 - some laws require that people live in the precinct
 - collect data on performance and continually try to improve

Absentee and early voting

- In 2000, 14% of ballots were cast outside traditional polling places
- Oregon votes by mail only
- In Arizona, Colorado, Nevada, Tennessee, Texas, and Washington, over 25% voted before election day
- Dangers:
 - coercion (not secret ballots)
 - fraud and security (interception of ballots in mail)
 - accuracy (especially when coupled w/punch card)
 - speed (slower to count mailed in ballots)
 - eliminates ceremonial aspects of voting



Does absentee help?

- Studies show that voter turnout in Oregon was not increased
- main result according to Michigan study is increased convenience for established voters

A Provocative Scenario: It is 2002, and in a tight race for the U.S. House, a voter complains that she did not receive her absentee ballot. The town election official says that the citizen actually voted. An investigation reveals that an organization applied for and filled out hundreds of absentee ballots of people on the "inactive" registration list. The election ends up going to the courts.

Recommendation



RECOMMENDATION

- Restrict or abolish on-demand absentee voting in favor of in-person early voting.
- Second, establish uniform reporting of absentee and precinct voting results.

Ballot security



RECOMMENDATION

- Move away from complex, monolithic machines.
- Make source code for all vote recording and vote counting processes open source and source code for the user interface proprietary.
- Make recording software openly auditable in the same mode that is used to conduct the counts.
- Adapt equipment so that voters can create a record of the vote that they can examine directly, and that can be used to audit equipment and elections.
- Conduct audits of votes and equipment, even without a recount.
- Design equipment that logs all events (votes, maintenance, etc.) that occur on the machine.
- Train election officials in the interior workings of their voting equipment.
- Delay Internet voting until suitable criteria for security are put in place.

Financing elections



RECOMMENDATION

- The federal government, working with state and local governments, needs to develop standard methods of accounting for election expenses and standard reports that are made publicly available.
- The federal and state governments should offer significant matching funds for upgrades to replace voting technologies—such as punch cards, lever machines, centrally counted optical scanning, paper, and some under-performing DREs—that are clearly dominated by existing equipment.
- The federal and state governments should pay for the maintenance of voter registration databases maintained at the state and local levels.
- The federal government needs to maintain a publicly available database of election expenditures.

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A Modular Voting Architecture (AMVA)

- FROG
 - list of votes cast
 - info. about official who signed in the voter
 - info about precinct
 - info about form of the ballot
 - a physical thing that gets deposited to be part of audit trail
- separate processes
 - recording a voter's choices on a FROG
 - casting the vote using the FROG as input
 - Help eliminate:
 - security threats, decline in openness and public control, need for improved ballot design, need for voter feedback

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FROG initialization

- Record identity of authorizing election official
 - perhaps each official has a unique key inserted to activate a device
- voter identifies itself
- options for that voter are “printed”
- or, voter shows up with an active FROG

Vote generation & casting

- initialized FROG is put into voting equipment
- voter presented with appropriate ballot choices
- voter enters selections
- voter enters that voting is finished
- votes recorded on FROG
- voter removes FROG from voting equipment
- Vote casting
 - FROG is read in (e.g. scanned)
 - voter confirms choices, if wrong, voter can go back to generation phase
 - FROG is digitally signed, identifies vote casting equipment
 - vote is copied, one copy for recording system
 - vote is sealed (blow a fuse, laminate, etc)
 - copy of votes are sent to recording system
 - FROG is captured, taken hostage for audit trail

Vote recording

- After election closes
 - vote casting equipment transmits data to recording system
 - each vote casting machine displays vote count
 - FROG initialization machine displays number of FROGs initialized
 - Recording system makes all votes and associated counts publicly available
 - Anyone can see who won, and verify the consistency of the counts & check signatures
 - universal verifiability

Types of FROGs

- Paper FROG
 - lacks authorization by election official on the ballot
- Electronic FROG
 - a memory card
 - card inserted into PC slot
 - difficult to audit
- FROG from anywhere
 - printed at home

Example

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State of Massachusetts, Middlesex County, Precinct 11  
Ballot Initialized by Election Official 10  
Election Closes November 7, 2004 at 8pm EST  
Ballot: MA/Middlesex/1; English; No rotation
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You have chosen:

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U.S. President: Mary Morris  
U.S. Vice President: Alice Applebee  
Middlesex Dog Catcher: Sam Smith (write-in)  
Proposition 1 (Casino): FOR  
Proposition 2 (Taxes): AGAINST  
Proposition 3 (Swimming Pool): FOR
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