

# The Trials and Tribulations of Electronic Voting

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A Center for Correct, Usable, Reliable, Auditable, and Transparent Elections  
(ACCURATE)

# What is E-voting?

Voting using any electronic mechanism.

Not just touch screen  
voting machines

Machine-counted paper  
ballots are a kind of e-voting

Even punched cards!



# Scanned Paper Ballots

Oldest type of E-voting, emerged in the 1960s.

- Punched Cards
- Optical Mark-Sense Ballots

**OFFICIAL BALLOT**  
Random County, Somestate

INSTRUCTIONS: To vote for a candidate, fill in the oval to the left of the name. Use pencil or black ink!

**PRESIDENT**  
(vote for one)

G. Washington

A. Lincoln

\_\_\_\_\_  
(write in)

**U.S. CONGRESS**  
(vote for one)

S. Rayburn

J.G. Cannon

N. Longworth

\_\_\_\_\_  
(write in)

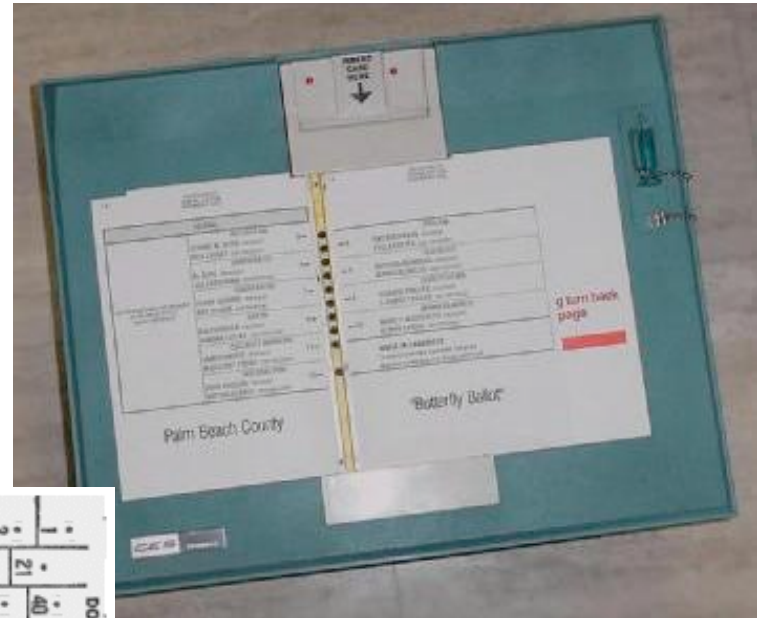
Advantage: Voter verification

Disadvantage: Voter mistakes

# Punched-Card Ballots

## Voter Verification Failure

It is possible for voters to check their ballots



TO BE FILLED IN BY COUNTING BOARD ONLY

PRECINCT NO. WRITE IN NO.

|    |    |    |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |    |    |    |    |    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      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| 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 21 | 40 | 59 | 78 | 97 | 116 | 135 | 154 | 173 | 192 | 211 | 230 | 249 | 268 | 287 | 306 | 325 | 344 | 363 | 382 | 401 | 420 | 439 | 458 | 477 | 496 | 515 | 534 | 553 | 572 | 591 | 610 | 629 | 648 | 667 | 686 | 705 | 724 | 743 | 762 | 781 | 800 | 819 | 838 | 857 | 876 | 895 | 914 | 933 | 952 | 971 | 990 | 1009 | 1028 | 1047 | 1066 | 1085 | 1104 | 1123 | 1142 | 1161 | 1180 | 1199 | 1218 | 1237 | 1256 | 1275 | 1294 | 1313 | 1332 | 1351 | 1370 | 1389 | 1408 | 1427 | 1446 | 1465 | 1484 | 1503 | 1522 | 1541 | 1560 | 1579 | 1598 | 1617 | 1636 | 1655 | 1674 | 1693 | 1712 | 1731 | 1750 | 1769 | 1788 | 1807 | 1826 | 1845 | 1864 | 1883 | 1902 | 1921 | 1940 | 1959 | 1978 | 1997 | 2016 | 2035 | 2054 | 2073 | 2092 | 2111 | 2130 | 2149 | 2168 | 2187 | 2206 | 2225 | 2244 | 2263 | 2282 | 2301 | 2320 | 2339 | 2358 | 2377 | 2396 | 2415 | 2434 | 2453 | 2472 | 2491 | 2510 | 2529 | 2548 | 2567 | 2586 | 2605 | 2624 | 2643 | 2662 | 2681 | 2700 | 2719 | 2738 | 2757 | 2776 | 2795 | 2814 | 2833 | 2852 | 2871 | 2890 | 2909 | 2928 | 2947 | 2966 | 2985 | 3004 | 3023 | 3042 | 3061 | 3080 | 3099 | 3118 | 3137 | 3156 | 3175 | 3194 | 3213 | 3232 | 3251 | 3270 | 3289 | 3308 | 3327 | 3346 | 3365 | 3384 | 3403 | 3422 | 3441 | 3460 | 3479 | 3498 | 3517 | 3536 | 3555 | 3574 | 3593 | 3612 | 3631 | 3650 | 3669 | 3688 | 3707 | 3726 | 3745 | 3764 | 3783 | 3802 | 3821 | 3840 | 3859 | 3878 | 3897 | 3916 | 3935 | 3954 | 3973 | 3992 | 4011 | 4030 | 4049 | 4068 | 4087 | 4106 | 4125 | 4144 | 4163 | 4182 | 4201 | 4220 | 4239 | 4258 | 4277 | 4296 | 4315 | 4334 | 4353 | 4372 | 4391 | 4410 | 4429 | 4448 | 4467 | 4486 | 4505 | 4524 | 4543 | 4562 | 4581 | 4600 | 4619 | 4638 | 4657 | 4676 | 4695 | 4714 | 4733 | 4752 | 4771 | 4790 | 4809 | 4828 | 4847 | 4866 | 4885 | 4904 | 4923 | 4942 | 4961 | 4980 | 4999 | 5018 | 5037 | 5056 | 5075 | 5094 | 5113 | 5132 | 5151 | 5170 | 5189 | 5208 | 5227 | 5246 | 5265 | 5284 | 5303 | 5322 | 5341 | 5360 | 5379 | 5398 | 5417 | 5436 | 5455 | 5474 | 5493 | 5512 | 5531 | 5550 | 5569 | 5588 | 5607 | 5626 | 5645 | 5664 | 5683 | 5702 | 5721 | 5740 | 5759 | 5778 | 5797 | 5816 | 5835 | 5854 | 5873 | 5892 | 5911 | 5930 | 5949 | 5968 | 5987 | 6006 | 6025 | 6044 | 6063 | 6082 | 6101 | 6120 | 6139 | 6158 | 6177 | 6196 | 6215 | 6234 | 6253 | 6272 | 6291 | 6310 | 6329 | 6348 | 6367 | 6386 | 6405 | 6424 | 6443 | 6462 | 6481 | 6500 | 6519 | 6538 | 6557 | 6576 | 6595 | 6614 | 6633 | 6652 | 6671 | 6690 | 6709 | 6728 | 6747 | 6766 | 6785 | 6804 | 6823 | 6842 | 6861 | 6880 | 6899 | 6918 | 6937 | 6956 | 6975 | 6994 | 7013 | 7032 | 7051 | 7070 | 7089 | 7108 | 7127 | 7146 | 7165 | 7184 | 7203 | 7222 | 7241 | 7260 | 7279 | 7298 | 7317 | 7336 | 7355 | 7374 | 7393 | 7412 | 7431 | 7450 | 7469 | 7488 | 7507 | 7526 | 7545 | 7564 | 7583 | 7602 | 7621 | 7640 | 7659 | 7678 | 7697 | 7716 | 7735 | 7754 | 7773 | 7792 | 7811 | 7830 | 7849 | 7868 | 7887 | 7906 | 7925 | 7944 | 7963 | 7982 | 8001 | 8020 | 8039 | 8058 | 8077 | 8096 | 8115 | 8134 | 8153 | 8172 | 8191 | 8210 | 8229 | 8248 | 8267 | 8286 | 8305 | 8324 | 8343 | 8362 | 8381 | 8400 | 8419 | 8438 | 8457 | 8476 | 8495 | 8514 | 8533 | 8552 | 8571 | 8590 | 8609 | 8628 | 8647 | 8666 | 8685 | 8704 | 8723 | 8742 | 8761 | 8780 | 8799 | 8818 | 8837 | 8856 | 8875 | 8894 | 8913 | 8932 | 8951 | 8970 | 8989 | 9008 | 9027 | 9046 | 9065 | 9084 | 9103 | 9122 | 9141 | 9160 | 9179 | 9198 | 9217 | 9236 | 9255 | 9274 | 9293 | 9312 | 9331 | 9350 | 9369 | 9388 | 9407 | 9426 | 9445 | 9464 | 9483 | 9502 | 9521 | 9540 | 9559 | 9578 | 9597 | 9616 | 9635 | 9654 | 9673 | 9692 | 9711 | 9730 | 9749 | 9768 | 9787 | 9806 | 9825 | 9844 | 9863 | 9882 | 9901 | 9920 | 9939 | 9958 | 9977 | 9996 | 10015 | 10034 | 10053 | 10072 | 10091 | 10110 | 10129 | 10148 | 10167 | 10186 | 10205 | 10224 | 10243 | 10262 | 10281 | 10300 | 10319 | 10338 | 10357 | 10376 | 10395 | 10414 | 10433 | 10452 | 10471 | 10490 | 10509 | 10528 | 10547 | 10566 | 10585 | 10604 | 10623 | 10642 | 10661 | 10680 | 10699 | 10718 | 10737 | 10756 | 10775 | 10794 | 10813 | 10832 | 10851 | 10870 | 10889 | 10908 | 10927 | 10946 | 10965 | 10984 | 11003 | 11022 | 11041 | 11060 | 11079 | 11098 | 11117 | 11136 | 11155 | 11174 | 11193 | 11212 | 11231 | 11250 | 11269 | 11288 | 11307 | 11326 | 11345 | 11364 | 11383 | 11402 | 11421 | 11440 | 11459 | 11478 | 11497 | 11516 | 11535 | 11554 | 11573 | 11592 | 11611 | 11630 | 11649 | 11668 | 11687 | 11706 | 11725 | 11744 | 11763 | 11782 | 11801 | 11820 | 11839 | 11858 | 11877 | 11896 | 11915 | 11934 | 11953 | 11972 | 11991 | 12010 | 12029 | 12048 | 12067 | 12086 | 12105 | 12124 | 12143 | 12162 | 12181 | 12200 | 12219 | 12238 | 12257 | 12276 | 12295 | 12314 | 12333 | 12352 | 12371 | 12390 | 12409 | 12428 | 12447 | 12466 | 12485 | 12504 | 12523 | 12542 | 12561 | 12580 | 12599 | 12618 | 12637 | 12656 | 12675 | 12694 | 12713 | 12732 | 12751 | 12770 | 12789 | 12808 | 12827 | 12846 | 12865 | 12884 | 12903 | 12922 | 12941 | 12960 | 12979 | 12998 | 13017 | 13036 | 13055 | 13074 | 13093 | 13112 | 13131 | 13150 | 13169 | 13188 | 13207 | 13226 | 13245 | 13264 | 13283 | 13302 | 13321 | 13340 | 13359 | 13378 | 13397 | 13416 | 13435 | 13454 | 13473 | 13492 | 13511 | 13530 | 13549 | 13568 | 13587 | 13606 | 13625 | 13644 | 13663 | 13682 | 13701 | 13720 | 13739 | 13758 | 13777 | 13796 | 13815 | 13834 | 13853 | 13872 | 13891 | 13910 | 13929 | 13948 | 13967 | 13986 | 14005 | 14024 | 14043 | 14062 | 14081 | 14100 | 14119 | 14138 | 14157 | 14176 | 14195 | 14214 | 14233 | 14252 | 14271 | 14290 | 14309 | 14328 | 14347 | 14366 | 14385 | 14404 | 14423 | 14442 | 14461 | 14480 | 14499 | 14518 | 14537 | 14556 | 14575 | 14594 | 14613 | 14632 | 14651 | 14670 | 14689 | 14708 | 14727 | 14746 | 14765 | 14784 | 14803 | 14822 | 14841 | 14860 | 14879 | 14898 | 14917 | 14936 | 14955 | 14974 | 14993 | 15012 | 15031 | 15050 | 15069 | 15088 | 15107 | 15126 | 15145 | 15164 | 15183 | 15202 | 15221 | 15240 | 15259 | 15278 | 15297 | 15316 | 15335 | 15354 | 15373 | 15392 | 15411 | 15430 | 15449 | 15468 | 15487 | 15506 | 15525 | 15544 | 15563 | 15582 | 15601 | 15620 | 15639 | 15658 | 15677 | 15696 | 15715 | 15734 | 15753 | 15772 | 15791 | 15810 | 15829 | 15848 | 15867 | 15886 | 15905 | 15924 | 15943 | 15962 | 15981 | 16000 | 16019 | 16038 | 16057 | 16076 | 16095 | 16114 | 16133 | 16152 | 16171 | 16190 | 16209 | 16228 | 16247 | 16266 | 16285 | 16304 | 16323 | 16342 | 16361 | 16380 | 16399 | 16418 | 16437 | 16456 | 16475 | 16494 | 16513 | 16532 | 16551 | 16570 | 16589 | 16608 | 16627 | 16646 | 16665 | 16684 | 16703 | 16722 | 16741 | 16760 | 16779 | 16798 | 16817 | 16836 | 16855 | 16874 | 16893 | 16912 | 16931 | 16950 | 16969 | 16988 | 17007 | 17026 | 17045 | 17064 | 17083 | 17102 | 17121 | 17140 | 17159 | 17178 | 17197 | 17216 | 17235 | 17254 | 17273 | 17292 | 17311 | 17330 | 17349 | 17368 | 17387 | 17406 | 17425 | 17444 | 17463 | 17482 | 17501 | 17520 | 17539 | 17558 | 17577 | 17596 | 17615 | 17634 | 17653 | 17672 | 17691 | 17710 | 17729 | 17748 | 17767 | 17786 | 17805 | 17824 | 17843 | 17862 | 17881 | 17900 | 17919 | 17938 | 17957 | 17976 | 17995 | 18014 | 18033 | 18052 | 18071 | 18090 | 18109 | 18128 | 18147 | 18166 | 18185 | 18204 | 18223 | 18242 | 18261 | 18280 | 18299 | 18318 | 18337 | 18356 | 18375 | 18394 | 18413 | 18432 | 18451 | 18470 | 18489 | 18508 | 18527 | 18546 | 18565 | 18584 | 18603 | 18622 | 18641 | 18660 | 18679 | 18698 | 18717 | 18736 | 18755 | 18774 | 18793 | 18812 | 18831 | 18850 | 18869 | 18888 | 18907 | 18926 | 18945 | 18964 | 18983 | 19002 | 19021 | 19040 | 19059 | 19078 | 19097 | 19116 | 19135 | 19154 | 19173 | 19192 | 19211 | 19230 | 19249 | 19268 | 19287 | 19306 | 19325 | 19344 | 19363 | 19382 | 19401 | 19420 | 19439 | 19458 | 19477 | 19496 | 19515 | 19534 | 19553 | 19572 | 19591 | 19610 | 19629 | 19648 | 19667 | 19686 | 19705 | 19724 | 19743 | 19762 | 19781 | 19800 | 19819 | 19838 | 19857 | 19876 | 19895 | 19914 | 19933 | 19952 | 19971 | 19990 | 20009 | 20028 | 20047 | 20066 | 20085 | 20104 | 20123 | 20142 | 20161 | 20180 | 20199 | 20218 | 20237 | 20256 | 20275 | 20294 | 20313 | 20332 | 20351 | 20370 | 20389 | 20408 | 20427 | 20446 | 20465 | 20484 | 20503 | 20522 | 20541 | 20560 | 20579 | 20598 | 20617 | 20636 | 20655 | 20674 | 20693 | 20712 | 20731 | 20750 | 20769 | 20788 | 20807 | 20826 | 20845 | 20864 | 20883 | 20902 | 20921 | 20940 | 20959 | 20978 | 20997 | 21016 | 21035 | 21054 | 21073 | 21092 | 21111 | 21130 | 21149 | 21168 | 21187 | 21206 | 21225 | 21244 | 21263 | 21282 | 21301 | 21320 | 21339 | 21358 | 21377 | 21396 | 21415 | 21434 | 21453 | 21472 | 21491 | 21510 | 21529 | 21548 | 21567 | 21586 | 21605 | 21624 | 21643 | 21662 | 21681 | 21700 | 21719 | 21738 | 21757 | 21776 | 21795 | 21814 | 21833 | 21852 | 21871 | 21890 | 21909 | 21928 | 21947 | 21966 | 21985 | 22004 | 22023 | 22042 | 22061 | 22080 | 22099 | 22118 | 22137 | 22156 | 22175 | 22194 | 22213 | 22232 | 22251 | 22270 | 22289 | 22308 | 22327 | 22346 | 22365 | 22384 | 22403 | 22422 | 22441 | 22460 | 22479 | 22498 | 22517 | 22536 | 22555 | 22574 | 22593 | 22612 | 22631 | 22650 | 22669 | 22688 | 22707 | 22726 | 22745 | 22764 | 22783 | 22802 | 22821 | 22840 | 22859 | 22878 | 22897 | 22916 | 22935 | 22954 | 22973 | 22992 | 23011 | 23030 | 23049 | 23068 | 23087 | 23106 | 23125 | 23144 | 23163 | 23182 | 23201 | 23220 | 23239 | 23258 | 23277 | 23296 | 23315 | 23334 | 23353 | 23372 | 23391 | 23410 | 23429 | 23448 | 23467 | 23486 | 23505 | 23524 | 23543 | 23562 | 23581 | 23600 | 23619 | 23638 | 23657 | 23676 | 23695 | 23714 | 23733 | 23752 | 23771 | 23790 | 23809 | 23828 | 23847 | 23866 | 2 |
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# Central-Count Mark-Sense

Widely used for absentee voting  
Ballots subject to handling by many people

No second chance!

- If you mismark a ballot, it may be ignored.

4% miscount rate in some counties, depending on ballot design and handling.



# Precinct-Count Mark-Sense

Ballot counted immediately on deposit in ballot box.  
Emerged in 1970's.

Ballot returned to voter

- on overvote
- if scans as blank

Miscount rate around  $\frac{1}{2}\%$   
(instructions and ballot  
layout have major impact)



# Direct-Recording Electronic

The newest E-voting technology emerged in 1970s to 1990s

Push-button voting machines

Touch-screen voting machines

Dial-a-vote mechanisms

A serious attempt at handicapped accessibility.

Miscount rate around 1%



# Elections are hard because:

Two requirements conflict:

- Secret ballot

You can't disclose and nobody can see your vote.

- Transparency

You can be sure all votes were counted correctly.

**AND**

Elections are run by temps –

2 election workers per 100 voters, on average.



# Loss of Transparency

## The central problem with E-voting

With hand-counted paper ballots, *voters* and *candidates* could observe and know what it was they were seeing.

With computers, *even experts* cannot tell what is going on.

What does this photo show?



# Vulnerability of E-Voting

- *Analysis of an Electronic Voting System*  
Kohnno, Stubblefield, Rubin & Wallach, July 2003
- *Risk Assessment Report, Diebold AccuVote-TS*  
Science Applications Int'l Corp., September 2003
- *DRE Technical Security Assessment Report*  
Compuware Corporation, November 2003
- *Trusted Agent Report, Diebold AccuVote-TS*  
RABA Technologies LLC, January 2004

# Vulnerability of E-Voting

- *Security Analysis of ... Diebold AccuBasic ...*  
Wagner, Jefferson, Bishop, February 2006
- *Diebold TSx Evaluation – Security Alert*  
Harri Hursti, May 2006
- *Security Analysis of ... Diebold AccuVote-TS ...*  
Feldman, Halderman & Felton, September 2006
- *Nedap/Groenendaal ES3B ... a security analysis*  
Gonggrijp & Hengeveld, October, 2006

# Voting System Certification

- Independent Testing Lab Certifies voting system to Federal Standards
- Standards set by
  - Federal Election Commission, 1990
  - Federal Election Commission, 2002
  - Election Assistance Commission, 2005
- States may set additional standards
  - New York's new standards look good, on paper
  - Many states consider Federal standards enough

# Regulatory Capture

“Gamekeeper turns poacher or, at least, helps poacher.” [The Economist]

Richard Posner of the University of Chicago argued that “REGULATION is not about the public interest at all, but is a process, by which interest groups seek to promote their private interest ... Over time, regulatory agencies come to be dominated by the industries regulated.”

Voting system vendors are clearly playing this game

# Election Official Buy-In

- Once you spend public money on something,  
You cannot afford to be wrong.
- If you are tied to a single source for a decade,  
You will avoid asking hard questions.
- Public confidence in elections is very important,  
So by all means, keep all criticism private.

The result? Election officials are predisposed to:

- Believe what the vendors tell them.
- Discount what critics have to say.

# Winning Back Some Transparency

## Voter Verified Paper Ballots

- Punched cards demonstrated verification failure
- Precinct-count optical mark sense work well
- An idea:

Equip DRE machines with printers, so that voters can verify that their selections have been properly recorded to paper.

- Required, to varying extents, in Nevada, Colorado, Minnesota, New York, and several other states.

# The Importance of Hand Recounts

- If recounts are always done by machine  
A recount cannot discover machine failures
- Therefore some recounts must be done by hand  
A reasonable rule [from Ohio]:  
Count 3 percent, at random, by hand,  
if this finds no discrepancies,  
count the rest by machine.
- Without hand recounts,  
paper ballots are no better than DRE



# The Importance of Auditing

- If you only recount controversial or close elections  
You will not catch the most competent thieves  
You will miss many careless errors
- Therefore, do routine recounts of random precincts  
A reasonable rule [from California]:  
After each election, pick random precincts  
until you have 1 percent of the ballots, then  
do hand recounts in those precincts.

# The Help America Vote Act of 2002

- Proposed in early 2001
- Died in Committee (we all thought)
- Passed very quickly, fall 2002

Why did it pass?

The August 2002 primary in Florida.

New E-voting systems replaced punched cards

Change was done to avoid a repeat of 2000

Change was planned very badly!

# Good things about HAVA

- Eliminated punched cards
- Eliminated mechanical voting machines
- Restrict central-count scanning to absentee ballots
- Created emphasis on handicapped accessibility

# Bad things about HAVA

- Created Byzantine administrative structure
  - Dominated by elected officials (NASED, NASS)
  - Very little requirement of technical competence
  - Charged with overseeing voting system standards
- Spend millions of dollars on new voting systems
  - Before any new standards could be set
- Badly underfunded and Seriously delayed
  - Except for purchase of new machines
- Forced massive upheaval in voting system market

# This Fall, I expect:

More of the same:

- Widespread patterns of clerical errors
- Scattered fraud, mostly in local political machines

With problems compounded because

- 30 percent of the country will be voting on unfamiliar machines in the same election.
- Many jurisdictions will be using mixed systems to meet accessibility requirements of HAVA.

# Emergency Paper Ballots

Voting Systems can break.

What do you do when this happens?

Iowa Code 721-22.431(52)

Temporary use of printed ballots  
in voting machine precincts.

Sets a model for the nation. Other states  
would be well advised to adopt our rules  
in this area.