Effect of Voting-Machine Allocations on the 2004 Election -- Franklin County, Ohio

Despite unprecedented registration and get-out-the-vote efforts in Franklin County, with predicted record turnout, only 61% of the county's registered voters turned out in the 2004 general election. Coupled with a time-consuming complicated ballot and the same number of voting machines as in 2000, the system was unable to handle the load of approximately 25% increase in registration rolls and high voter interest in what was billed as the most important election of a lifetime. Indeed, the county did process an increase of 23% in total voters compared to 2000. Many would-be voters were deterred by long lines and hours-long waits, prompting one observer to cite:

Ohio's new poll tax: if you can't afford to wait four hours in line, you don't vote.

The shortage of voting machines was particularly acute in high-Democratic precincts. New registrations and GOTV efforts by 527 organizations were also largely concentrated in these shortchanged Democratic precincts. The lines thus created by the unequal machine allocation throttled the effect of registration and GOTV efforts of ACT, MoveOn and other 527 groups in Franklin County.

This graph shows how there are more registered voters per machine in Kerry precincts (click on any graphic in this document to get a larger version):

![Graph showing voting machine allocation in Franklin County, Ohio]

However, Democratic precincts are known to generally have a lower turnout (% of registered voters) than Republican precincts. Rather than basing machine allocations directly on the total registered voters, the Board of Election uses another figure called "active voters" which is the number of people in the precinct who have actively voted in the last two election cycles (8 years). Even by this measure though, it can be seen that Kerry precincts had more voters per machine.
E.g., 30% Kerry precincts had about 200 active voters per machine while 80% Kerry precincts had about 250, on the average. The following chart summarizes the situation:

There was a 5-minute time limit on voting, and people averaged about 4.3 minutes according to some reports. Therefore in the nominal 13-hour polling day (780 minutes), a machine could handle 780/4.3 or about 181 voters. People still in line at nominal poll closing were allowed to vote. In some cases polls were thus kept open until 11:00 pm. In that case about 230 voters could be handled.

Many polling places were operating at or near the maximum throughput based on the number of
machines, as the following graph of actual voters in each precinct shows:

With the servers (polling booths) operating at maximum capacity, queuing theory predicts long queues and that was observed all over Franklin County. The above graph does not reflect the number of people who were dissuaded or unable to vote because of the lines. It shows a system throttled by the hardware, not by the desire of people to vote. [For more on the effect of overloading the machines beyond their maximum capacity, see the addendum below.]

Long lines would be expected to have a negative effect on turnout, and the following graph shows:
Lots of scatter above but the moving-average line shows a depression of turnout as the number of voters allocated per machine goes up. At 150-200 active voters per machine, the precincts show a 60% turnout. At 300 active voters per machine, an average turnout of about 48% is seen.

Another way of looking at the effect above is to color-code the precincts, blue for Kerry and red for Bush:

The Kerry precincts would be expected to be the lower turnout ones, so that's not the salient point above per se. Rather that the population of Kerry precincts is shifted to the right, i.e., fewer machines per active voter on the average were allocated in the Kerry precincts. This would be expected to depress turnout in those precincts, more than normal. The Board of Elections has yet to justify these decisions.

The following diagram gives an idea of how the variation in machine allocation was distributed over the county:
The red (greater than 250 active voters per machine) precincts concentrate in the OSU, Clintonville, Linden, Hilltop, Olde Towne East, East Side and South End areas, all high-D areas.

Anecdotal accounts support the conclusion that machine shortages (and thus lines) were greatest in the high-D urban precincts and less in the high-R suburbs. See: Ohio Voter Suppression Hearing, Nov. 15, 2004

What Might Have Been Different

The BOE allocation of machines was inequitable and resulted in suppression of votes tending to favor Republican precincts.

What if they had instead optimally distributed the machines, based on minimizing the number of active voters per machine?

Here again is the machine allocation chosen by the BOE:
If those same 2,798 machines were optimally distributed:

![Optimal machine allocation diagram]

Well, that looks better! No precinct is over 275 or so, and the trendline shows no tendency to favor Democratic or Republican precincts.

The algorithm to produce the optimal result was:

- allocate one machine to each precinct
- dole out the remaining machines, one at a time, to the neediest precinct based solely on active voters per machine
- repeat until all machines are allocated

http://copperas.com/machinery/
That allocation is more equitable. There is still the problem that with a maximum throughput of 181 voters per machine during normal polling hours, and up to 275 active voters per machine, even the equitable machine allocation would not have solved the problem of a generally overloaded system. Rather that at least Democrats and Republicans would have been suppressed equally.

The bottom line of this article, in the accounting sense, is what effect did the allocation of machines have on the plurality of votes for Kerry in Franklin County. A total of 515,472 people voted on the 2798 machines, for an average of 184 voters per machine. To a first approximation, in the overloaded situation, a extra machine for a precinct would simply mean 184 more votes for that precinct. Conversely, removing a machine from a precinct would result in 184 suppressed votes.

Kerry won in Franklin County by a plurality of 41,385 votes. Processing all the changes in machine allocation specified by the optimal distribution, and assuming that votes thus lost or gained in a precinct would be in proportion to the Kerry/Bush percentages in that precinct, Kerry's plurality would have been 9,971 votes more, or 51,356. He would have won by an additional 1.9% of the vote.

other links:

Spreadsheet with Franklin County election data (zipped Excel file)

More 2004 election data from Franklin County

Wedge effect of Issue 1 in Franklin County

More testimony about machine shortages (Columbus Free Press)

Thanks to Cliff Arnebeck, attorney with Common Cause, for sending me the data on machine counts in each precinct.

Addendum 11/26/04

Elizabeth Liddle of the University Nottingham, UK, suggested the following graph to show the differential of of machine loading on Democratic (blue) and Republican (red) precincts:
While the number of actual voters per machine is approximately linear up to about 180 or so in each case, the curves start flattening out beyond that. Democratic precincts, for whatever reasons, are shown to be more sensitive to machine crowding in this regard. These curves provide a measure of the suppressive effect of machine crowding in general.

As for the differential effect between red and blue precincts, one factor might be a longer time taken to vote on the average in minority and urban precincts.

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