May 12, 2016 (parts 1-5)
Black Box Voting
(Formatted to PDF by Dick Atlee, w/size changes on some illustrations)

Bev Harris is a writer and founder of Black Box Voting. She has researched and written about election transparency and computerized voting systems since 2002. Harris was featured in the Emmy-nominated HBO documentary Hacking Democracy, and is the author of Black Box Voting: Ballot Tampering in the 21st Century, a book purchased by the White House Library and also reportedly found on Osama bin Laden's bookshelf. Harris's research has been covered in The New York Times, Vanity Fair, Time Magazine, CNN and several international publications, including the Philippine Daily Inquirer and Agence France Presse. Contact by text or phone 206-335-7747 for media inquiries.

Bennie Smith is a Memphis-based application developer for an electrical manufacturing company. He is also a political strategist who has developed a micro-targeting application that predicts voter turnout. In August 2014 he was approached by a number of candidates who insisted that their elections had been stolen. He disagreed with the group and offered to look into how the system works. After discovering a number of irregularities, Smith began to research how votes that originate from the same source can change once they get into the GEMS vote tabulation program. Smith's attention to these anomalies uncovered an extraordinarily high-risk tampering mechanism and ultimately provided a new infrastructure for analyzing questionable election results.

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Part 1: Votes are being counted as fractions instead of as whole numbers
http://blackboxvoting.org/fraction-magic-1/'

Summary

This report summarizes the results of our review of the GEMS election management system, which counts approximately 25 percent of all votes in the United States. The results of this study demonstrate that a fractional vote feature is embedded in each GEMS application which can be used to invisibly, yet radically, alter election outcomes by pre-setting desired vote percentages to redistribute votes. This tampering is not visible to election observers, even if they are standing in the room and watching the computer. Use of the decimalized vote feature is unlikely to be detected by auditing or canvass procedures, and can be applied across large jurisdictions in less than 60 seconds.

GEMS vote-counting systems are and have been operated under five trade names: Global Election Systems, Diebold Election Systems, Premier Election Systems, Dominion Voting Systems, and Election Systems & Software, in addition to a number of private regional subcontractors. At the time of this writing, this system is used statewide in Alaska, Connecticut, Georgia, Mississippi, New Hampshire, Utah and Vermont, and for counties in Arizona, California, Colorado, Florida, Illinois, Indiana, Iowa, Kansas, Kentucky, Massachusetts, Michigan, Missouri, Ohio, Pennsylvania, Tennessee, Texas, Virginia, Washington, Wisconsin and Wyoming. It is also used in Canada.

Fractionalized vote:

Instead of "1" the vote is allowed to be 1/2, or 1+7/8, or any other value that is not a whole number.

What fractionalized votes can do:

They allow "weighting" of races. Weighting a race removes the principle of "one person-one vote" to allow some votes to be counted as less than one or more than one. Regardless of what the real votes are, candidates can receive a set percentage of votes. Results can be controlled. For example, Candidate A can be assigned 44% of the votes, Candidate B 51%, and Candidate C the rest.

GEMS fractionalizes votes in three places:

- The "Summary" vote tally, which provides overall election totals for each race on Election Night
- The "Statement of Votes Cast", which provides detailed results by precinct and voting method (ie. Polling, absentee, early, provisional)
- The "undervote" count

Fractions in results reports are not visible.Votes containing decimals are reported as whole numbers unless specifically instructed to reveal decimals (which is not the default setting). All evidence that fractional values ever existed can be removed instantly even from the underlying database using a setting in the GEMS data tables, in which case even instructing GEMS to show the decimals will fail to reveal they were used.

Source code: Instructions to treat votes as decimal values instead of whole numbers are inserted multiple times in the GEMS source code itself; thus, this feature cannot have been created by accident.

Fractionalizing the votes which create the Summary Results allows alteration of Election Night Web results and results sent to the Secretary of State, as well as results available at and local election officials.

Fractionalizing the "Statement of Votes Cast" allows an extraordinary amount of precision, enabling alteration of results by specific voting machine, absentee batch, or precinct. Vote results can be altered for polling places in predominantly Black neighborhoods, and can parse out precincts within a mixed batch of early or absentee votes.

Fractionalizing the undervote category allows reallocation of valid votes into undervotes.

Voting rights abomination

According to programmer notes, a weighted race feature was designed which not only gives some votes more weight than others, but does so based on the voter's identity. Ballots are connected to voters, weights are assigned to each voter per race, stored in an external table not visible in GEMS. Our testing shows that one vote can be counted 25 times, another only one one-thousandth of a time, effectively converting some votes to zero.

The study was prompted by two issues: (1) Anomalies in elections in Shelby County, Tennessee, which uses the GEMS election management system, in which inconsistencies were observed in reporting of results by GEMS; and (2) Concerns raised regarding the presence of middlemen during the election process, such that a single individual gains remote access to the election management program, in some cases in multiple jurisdictions.

The questions we examine are these:

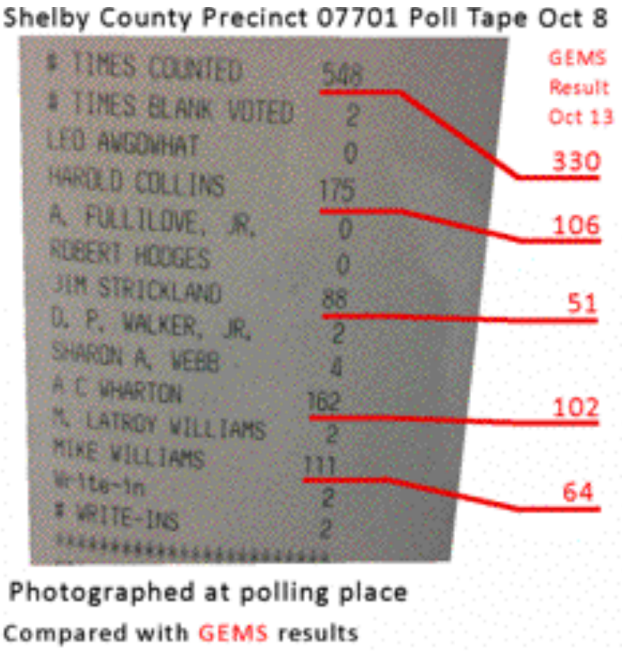
- Can election outcomes be controlled with enough versatility to allow a national impact? Does any mechanism exist that would enable a political consultant or technician to capture elections for repeat customers?
- If the necessary features exist within the election management system to facilitate this:
- Were such features embedded accidentally or on purpose; for what stated purpose were such features installed; if a reason was given, is that reason justifiable?
- How might risks associated with inside access be mitigated?

Part 2: Context, Background, Deeper, Worse
http://blackboxvoting.org/fraction-magic-2

> *Totals dropping mid-count; poll tapes don't match; missing single-votes like round-off errors; e-mails from programmers; and voters being personally "weighted" for unequal value*

In August 2014 Bennie Smith was approached by a number of candidates who insisted that their elections had been stolen. He disagreed with the group and offered to look into how the system works.

In October 2015, Smith received a report from a candidate named Wanda Halbert. On Election Night, she had noticed that as votes accumulated, the number of votes in her race were somehow getting subtracted as new votes were added.



On Election Day, as a part of his continuing research, Smith had taken a photo of a precinct 07701 poll tape (a results total printed from the memory card in a voting machine). In comparing the poll tape to the GEMS central tabulator report, Smith saw that the totals did not match. More votes were shown on the voting machine tape on Oct. 8 than on the GEMS central tabulator on

Oct. 13. Smith brought this to the attention of Shelby County elections officials but only after Halbert pressed the issue was the inconsistency corrected.

Smith began to research how votes that originate from the same source can change once they get into the GEMS program, beginning with the premise that sophisticated election theft would be near impossible, difficult at best; perhaps achievable in a crude or one-shot or localized way, but certainly not on a national scale, or as part of a plan to capture repeat elections. For that, one would need a system that is configurable, quick, precise, and usable by persons who are not master programmers.

His combined his political acumen with database expertise, a way of considering voting technology that contrasts with traditional studies (which tend to analyze voting systems academically, isolated from political metrics to focus on theoretical penetration and reliability tests).

The question

A viable business model for election control needs repeat customers. The most frequent purchase pattern would involve local elections, which select tens of thousands of public officials every year, and enact thousands of public policy choices. The amount of money at stake is far greater with local than national elections, though this might seem counterintuitive. National and state elections generate a large amount of visible spending, but local elections control hundreds of millions in budget expenditures per jurisdiction, the U.S. has over 3,000 different jurisdictions, and there are elections every year.

Smith examined the question of whether election results could be controlled in a single way under various election circumstances. Could the mechanism be subtle enough to alter results without being detected? Could it function a way that was configurable? Could it work for different "customers" across geographic areas? Does such a mechanism exist?

The Detective Story

His approach was to consider design requirements for what a person with inside access would need to alter election outcomes in a marketable way. Smith often refers to passage from a book by Gary Kasparov:

> *"Too often we set a goal and head straight for it without considering the steps required to achieve it. What conditions are necessary for our strategy to succeed?"*

Vote results would have to be customizable and flexible enough to target:

- **Precinct demographics:** by ethnic community, college areas, partisan strongholds, religious areas…;
- **Voting methods:** Early Voting, Election Day, Vote-by-Mail, Combined vote centers;
- **Counting methods:** Cumulative counts, precinct counts, central counting;
- **Different types of voting machines:** touch-screens, paper ballot scanners;

- **Vote counts** occurring at different time periods: early votes counted before polls close; polling place votes flowing in throughout Election Night; absentee counting before and after the election
- **Different batching methods:** some votes consolidated by precinct, others in mixed batches.

Most important would be the ability to create a plausible false count to conform to precinct demographics and prior voting histories, along with the ability to customize which vote subsets would be targeted so as to minimize risk under various administrative procedures.

The absolutely essential design feature needed to achieve all of the above specifications is: **Fractions**. So Smith began his research by looking for just one thing: Floating point capability (decimals). He found them.

What does a decimalized vote look like?

One person, one vote: "1"
One person, 3/5 of a vote: "0.60"
One person, one-and-a-half votes: "1.5"

Smith contacted former Shelby County Election Commissioner George Monger for an introduction to all things Shelby and GEMS. While looking at GEMS he saw the floating point command for decimals: "DOUBLE." This term tells GEMS to treat votes as decimals, or fractions, rather than as whole numbers.

The next step was to take a modeled concept for a test run using GEMS. He tested alteration of election results by controlling vote percentages. Vote outcomes could be controlled. Smith set percentages for vote results for each candidate. Vote totals changed to match the results he selected.

But while demonstrating that vote totals could be weighted, Smith saw small fractional vote debris accumulate. The Alaska example, below, shows some of these tiny fractional vote remnants.

The sum of these tiny fractions can add up to 1 or 2 votes and become visible. Smith realized that round-off errors would need to be considered in some way. To reduce these tiny discrepancies, programmers would want to use at least three, preferably more decimals.

Such errors can be cleaned up – or even left as is, since prevailing explanations in the elections industry tend to discount discrepancies if they "did not affect the election." It is reasonable to assume that one vote should not seem to affect the outcome, but if that one vote is actually the accumulation of thousands of small fractional remainders, the real result may be incorrect by thousands, and even tens of thousands.

The next step was to see if any evidence exists showing one-vote discrepancies. In large vote databases, these accumulated fragments can add up to 1, 2, or even more votes, but a succession of one-off errors certainly should raise concerns. Smith compared:

- Total votes cast minus votes that don't count (blanks, overvotes etc.)
- Total votes of all candidates

The total votes cast minus no-votes should result in the number of votes counted for candidates. Smith searched for a difference of one or two votes during live results uploads on Election Night and shortly afterwards,, finding what he believed could be round-off errors in a number of races. He found errors in Morrow County, Ohio; DeKalb County, Georgia, and Shelby County, Tennessee, including an error in the race of high profile candidate and television personality "Judge Joe Brown" when he ran for Shelby County District Attorney in 2014. Here is the discrepancy:

Race: DIST ATTORNEY GENERAL August 2014

# of Ballots cast: 148,494
who skipped this race: 3,885
Total votes for this Race ... 144,609 (148,494 – 3,885)

Votes for Amy Weirich: 94,248
Votes for Joe Brown: 50,161
Write-in Votes: 199

Total of Candidates ..... 144,608 (94,248 + 50,161 + 199)
Number of votes missing: 1

The Answer

After performing a series of testing iterations on the voting system used in Shelby County, Smith's opinions as to whether a robust, configurable election tampering mechanism exists evolved from "doubtful" to "maybe" to "yes."

He began collaborating with Bev Harris of BlackBoxVoting.org. Together they studied a conceptual model and checked voting databases from dozens of locations. Smith, a technical thinker, and Harris, a writer, approached the issue with different kinds of questions.

Smith reasoned that if fractionalized votes were actually used to weight races, GEMS programmers would have discussed issues pertaining to how many decimals to use. Harris wondered if the decision to use decimals was deliberate; whether it had always been in the program and if not, when was it put in and by whom; and whether the decimals demonstrate intention to weight a race.

Smith searched for evidence that GEMS programmers had discussed methods to reduce round-off, truncation, or lost value errors. He began searching online e-mail databases for messages about issues with decimal votes.

These are available because over 13,000 e-mails were leaked in 2003. They were initially

published at BlackBoxVoting.org, resulting in a DMCA takedown order, which produced push-back from students across the U.S. First at Swarthmore University, then at over a dozen more colleges and grass roots Web sites, the blocked, leaked e-mails were re-posted, resulting in successive takedown orders by Diebold, an article in the New York Times, U.S. Representative Dennis Kucinich posting some of the e-mails on his congressional Web site, and a successful lawsuit by the Electronic Frontier Foundation in which a court revoked Diebold's claim to protection of the e-mails on the grounds that they serve a greater public interest.

Smith entered search term 'diebold, decimals' into Google search and found this e-mail thread:

http://instinct.org/diebold/bugtrack.w3archive/200108/msg00100.html

----- Original Message -----
From: Ken Clark
To: bugtrack@dieboldes.com
Sent: Friday, August 03, 2001 6:22 PM
Subject: weighted results total votes displayed without two decimal places

Reported for Brian. 1.18.2. Weighted races summary report candidate totals with two decimal places (xxxxxx.xx), but the race total votes truncates down to the whole value (xxxxxxx). The total needs to also display the fraction.

Ken

----- Original Message -----
From: Ken Clark
To: bugtrack@dieboldes.com
Sent: Tuesday, August 21, 2001 11:49 AM
Subject: RE: weighted results total votes displayed without two decimal places

Quick follow up to this. The number of decimal places displayed for each candidate is three, not two. The number of decimal places in the *total* for the candidates is two.

The observant will note that the percentages shown in JResultClient work this way as well. The percents are shown with two decimal places, while the total is 100.0.

The reason it works like this is for esoteric statistical reasons. 12.23 might actually be 12.234, and 12.24 might be 12.237. When you sum a list of floating point numbers, the sum has one less decimal place of significance than the elements. Or just trust me -- I didn't like stats in school any more than you did.

es·o·ter·ic
adjective
understood by or meant for only the select few who have special knowledge or interest;

http://www.dictionary.com/browse/esoteric

The above e-mails indicated to Smith that programmers may have been grappling with lost value

errors. To Harris, the same e-mails meant that programmers were weighting votes, and that the fractional vote counting was directly related to the concept of weighting elections.

Harris found the "DOUBLE" setting in all GEMS databases from all states for version 1.18 forward. Looking at older GEMS databases, version 1.17 and before, votes were instead configured as whole numbers (LONG INTEGER).

Smith found instructions in the source code to convert vote counting from whole numbers to decimals.

Therefore it can be shown that a choice was made to convert the system to counting decimalized votes; it is not accidental; and it is directly connected to weighting a race.

An examination of GEMS release notes shows that this change shows up on June 27, 2001:

Global Election Systems
GEMS 1.18.1 Release Notes
Jun-27-01

1.18.1 Jun 27, 2001

- Add new "Weighted" race type.
- Add functionality to save reports settings in SOVC and Summary Repo
- Break results by counter groups in SOVC report.
- Add support for 17 inch long ballots. Required 1.96 AVOS firmware

But what exactly did they mean by "weighted race"? Further research shows that 'weighted race' is defined in a way that removes the one-person, one-vote expectation from elections:

> "Weighted voting systems are voting systems based on the idea that not all voters should have the same amount of influence over the outcome of an election. Instead, it can be desirable to recognize differences by giving voters different amounts of say (mathematical weights) concerning the outcome."

https://en.wikipedia.org/wiki/Weighted_voting

Harris researched use of weighted voting in U.S. elections, and did locate one example, found in California and used for small "special district" elections. This could appear to explain the next e-mail clip:

> The number of decimal places should all be configurable, but weighted races are really just a one-shot thing for Sacramento right now. When we get more weighted customers, this will be enhanced.
>
> Ken

However, further research showed that Sacramento didn't and still does not use GEMS; that California law specifies how weighted races are to be conducted, and that they do not involved decimalization of votes.

The Decimals Toggle

In the GEMS "race" table is a field called "Race Type." By experimenting with different settings, Smith found that by inserting the number "10" (a mostly undocumented setting), decimals appear in results reports for viewing. To be clear, *ALL votes are counted as decimals whether or not the "10" flag is set*. Toggling "10" on and off simply allows the user to view decimals, or not, in results reports.

Below we show a results report for Alaska which we weighted to ensure Kerry would win. (See Part 4 and Part 5 of this series.) We turned on the 'show decimals' feature, demonstrating that: a) votes can be counted with decimals; b) fractional "debris" can accumulate, with very small remnants being stored, such as 1/50th of a vote for Cobb. It is these fragments which can accumulate to produce very small telltale errors of one or two votes; and c) the existence of this "show decimals" option demonstrates that programmers clearly intended to enable vote values containing decimals.

STATE OF ALASKA
2004 GENERAL ELECTION
NOVEMBER 2, 2004
UNOFFICIAL RESULTS

Registered Voters 472160 - Cards Cast 314492 66.61% Num. Repo

US PRESIDENT / VICE PRESIDENT

		Total	
Number of Precincts		439	
Precincts Reporting		439	100.0 %
Times Counted		292811/472160	62.0 %
Total Votes		218111.00	
Times Blank Voted		1524	
Times Over Voted		158	
Number Of Under Votes		0	
NADER / CAMEJO	POP	0.11	0.00%
COBB / LaMARCHE	GRN	0.02	0.00%
PEROUTKA / BALDWIN	AI	0.05	0.00%
KERRY / EDWARDS	DEM	120360.63	55.18%
BADNARIK / CAMPAGNA	LIB	1916.17	0.88%
BUSH / CHENEY	REP	95126.02	43.61%

STATE OF ALASKA
2004 GENERAL ELECTION
NOVEMBER 2, 2004
OFFICIAL RESULTS

Date
Time
Pa

US PRESIDENT / VICE PRESIDENT

	NADER / CAMEJO (POP)		COBB / LaMARCHE (GRN)		PEROUTKA / BALDWIN (AI)		KERRY / EDWARDS (DEM)		BADNARIK / CAMPAGNA (LIB)		BUSH / CHENEY (REP)	
Jurisdiction Wide												
Ketchikan No. 1	0.00	0.00%	0.00	0.00%	0.00	0.00%	487.11	55.29%	7.86	0.89%	385.03	43.70%
Ketchikan No. 2	0.00	0.00%	0.00	0.00%	0.00	0.00%	545.31	51.69%	10.17	0.96%	498.52	47.25%
Ketchikan No. 3	0.00	0.00%	0.00	0.00%	0.00	0.00%	330.28	45.12%	7.97	1.09%	390.74	53.38%
North Tongass No. 1	0.00	0.00%	0.00	0.00%	0.00	0.00%	159.89	42.64%	4.28	1.14%	209.83	55.95%
North Tongass No. 2	0.00	0.00%	0.00	0.00%	0.00	0.00%	381.82	45.29%	9.18	1.09%	449.99	53.38%
Saxman	0.00	0.00%	0.00	0.00%	0.00	0.00%	82.89	57.16%	1.24	0.86%	60.87	41.98%

It is unnecessary to embed a weighted race feature into every election in America to accommodate minor special district elections (which sometimes involve less than 10 voters and can easily be hand counted). The fractional vote capability is built into GEMS for all races, whether they are weighted or not; it is embedded in all locations including states which do not have weighted elections, and it is the default setting for all races everywhere.

The risk clearly out-weighs any obscure potential benefit that might be anticipated. Undocumented features are not allowed in voting systems. Some acknowledgement of the weighted vote feature however cryptic, had to be provided to voting system certifiers should they ask about it.

The issue of intentionality

GEMS programming has often been referred to as amateurish, sloppy, and unsophisticated, explanations used whenever its high-risk features are exposed. Such explanations provide deniability of intent. But GEMS is more sophisticated than most researchers realize. It contains subtleties, showing obvious functions anyone can see in its MS Access tables, but hiding other functions within its executable. Still other functionality seems to appear only when connected to external parts. As far as we could determine, some of these are undocumented in the GEMS system and are unviewable when looking at GEMS databases.

For example:

> "Bar codes are assigned by the voter registration system, containing encoded information identifying the voter, tags identifying races as well as weight values for every voter and every race. .. Weighted results are reflected in the election results reports in candidate totals as well as votes cast … Since GEMS does not contain the weight information …"

The above excerpts indicate that GEMS interacts with an external module containing encoded information which assigns a weighted value to each voter.

Each individual voter's vote assigned a weight

Our vote-weighting example involved reallocating votes, It can be done and it presents a grave risk to voting rights. The actual weighted race function, however, is much worse. We did not, and will not attempt to create a working demo for what follows.

We have documented that weighted race functionality is fully available in GEMS, but documentation pertaining to how it works seems to be missing in user manuals. We did, however, locate documentation in a development version of the GEMS manual.

In a document called "GEMS 1.18 Users Guide Revision 4.0" we find the following on page 158:

Weighted

Weighted races are tallied by weights, assigned from the voter registration system, and may be counted in Central Count vote centers only.

Bar codes are assigned by the voter registration system, containing encoded information identifying the voter, tags identifying races as well as weight values for every voter and every race.

The tag defined for each weighted race should correspond to the race tag in the voter registration system.

This indicates that votes are being tied to voter names.

The weighting of the voter is contained in "encoded information" stored outside of GEMS.

This leaves no doubt that the intent is to allow votes for some voters to be counted less than votes for other voters. Particularly in the South, where voters' race is identified in the voter registration system, this quite literally allows each Black voters' vote to count as, for example, 3/5, while White voters' vote would count as 1+ 2/5. Whatever the claimed reason for doing this, it is a voting rights abomination.

Page 158, continued:

Examples

Voters vote on two propositions in a weighted election, Proposition A and Proposition B. Three voters vote in the election, John Doe, Jane Doe, and Bill Smith. John Doe is defined in the voter registration system with weight 25 for Proposition A and 50 for Proposition B, Jane Doe with weights 33 and 45, and Bill Smith with weights 20 and 40, respectively for the two propositions.

They provide an example using whole numbers, as required by law for California's few oddball special elections.

However, they implement the weighted race function using decimals, not whole votes. Then they insert programming to achieve this, strip out reference to how it works, and make fractional votes the default setting for every race in every election.

Here is the entire section as originally written on page 158:

> Weighted
>
> Weighted races are tallied by weights, assigned from the voter registration system, and may be counted in Central Count vote centers only.
>
> Bar codes are assigned by the voter registration system, containing encoded information identifying the voter, tags identifying races as well as weight values for every voter and every race.
>
> The tag defined for each weighted race should correspond to the race tag in the voter registration system.

Race types

A weighted race has the same attributes as a candidacy, and other than being weighted, is counted in thesame manner as candidacies. In order to configure a question as a weighted race, two candidates are defined as positive and negative values in a vote for one race.

Preference and endorsement races control weighted races in the same manner as candidacies.

Election results

Weighted results are reflected in the election results reports in candidate totals as well as votes cast, and results are reported with two decimal places. Likewise, weighted results are manually entered in decimal amounts. Note that totals are not verified when manually entering the results of weighted races.

Since GEMS does not contain weight information, it is not possible to perform verification of manually entered weighted results, so that it is critical that these results entered be verified independently both prior to and following manual entry.

Examples

Voters vote on two propositions in a weighted election, Proposition A and Proposition B. Three voters vote in the election, John Doe, Jane Doe, and Bill Smith. John Doe is defined in the voter registration system with weight 25 for Proposition A and 50 for Proposition B, Jane Doe with weights 33 and 45, and Bill Smith with weights 20 and 40, respectively for the two propositions.

The three voters then vote as follows:

Race	Selection	Voters	Tallies	Total
Proposition A	Yes	John Doe	25	
		Jane Doe	33	58
	No	Bill Smith	20	20
Proposition B	Yes	Jane Doe	45	45
	No	John Doe	50	
		Bill Smith	40	90

All this for a special district election in which GEMS was never used, or maybe it was. Which did not use decimalized votes, or maybe it did.

Which brings us back to the question we set out to answer in this report: Does a mechanism exist that is precise, configurable, quick, and usable by persons who are not expert programmers, which can control results of elections? The answer is “Yes.”

What we do know for certain is this:

- Fractionalized counting is exactly the feature needed in order to rig the state of Alaska in four seconds, and many other jurisdictions as well. (See Part 4 and Part 5)
- The design of GEMS contains the most important design requirement for a business model based on selling elections.

Part 3: Proof of code
http://blackboxvoting.org/fraction-magic-3

Programming to treat votes as decimals

The term "DOUBLE" means to store and process numbers with "double precision floating points" – in other words, to enable large numbers of decimal values.

In contrast, the term "INT" instructs the program to treat numbers as whole integers.

Source Code:

Below are clips from GEMS source code showing that it converts votes from whole numbers (previous version, GEMS 1.17) to store and process them as decimal values by setting them to "double" in GEMS version 1.18:

"ALTER TABLE SumCandidateCounter"
"ALTER COLUMN TotalVotes DOUBLE"
"ALTER TABLE SumRaceCounter"
"ALTER COLUMN NumberOfUnderVotes DOUBLE"

***

"CREATE TABLE SumCandidateCounter (
ReportunitId INT,
VCenterId INT,
CounterGroupId INT,
CandVGroupId INT,
TotalVotes DOUBLE)"

***

"CREATE TABLE SumRaceCounter (
ReportunitId INT,
VCenterId INT,
CounterGroupId INT,
RaceId INT,
TimesCounted INT,
TimesBlankVoted INT,
TimesOverVoted INT,
NumberOfUnderVotes DOUBLE) "

***

“ALTER TABLE CandidateCounter ”
“ALTER COLUMN TotalVotes DOUBLE ”
“ALTER TABLE RaceCounter ”
“ALTER COLUMN NumberOfUnderVotes DOUBLE”

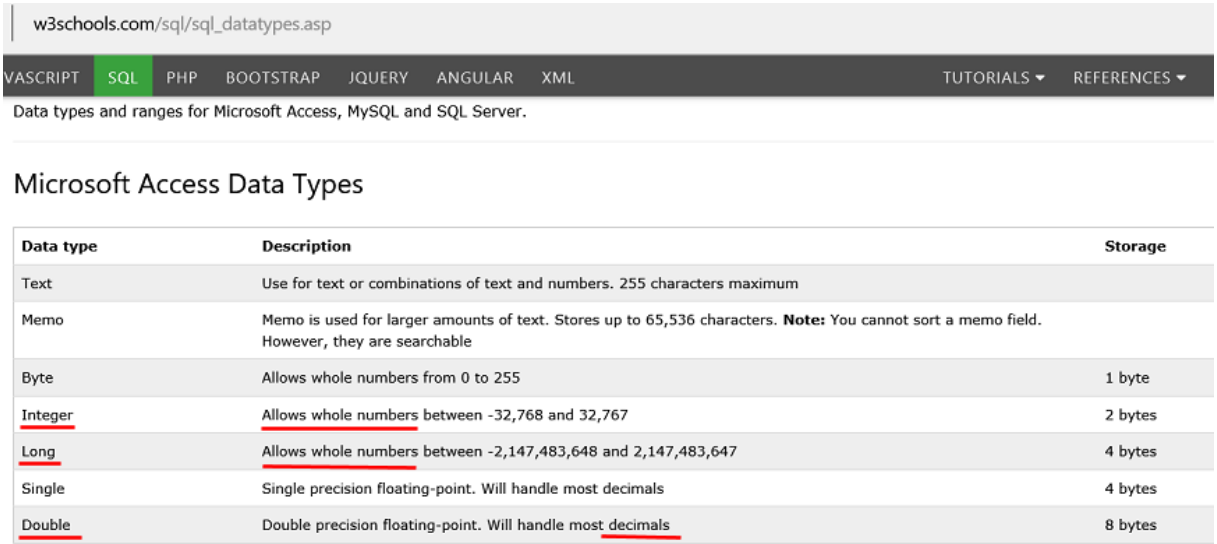
***

```
# Contains the candidate counts for the race
“CREATE TABLE CandidateCounter (
        CounterBatchId INT,
        ReportunitId INT,
        CounterGroupId INT,
        CandVGroupId INT,
        TotalVotes DOUBLE
# Number of votes ) ”
```

***

```
“CREATE TABLE SumCandidateCounter (
        ReportunitId INT,
        VCenterId INT,
        CounterGroupId INT,
        CandVGroupId INT,
        TotalVotes DOUBLE ) ”
```

Non-programmers may not have seen the term "double" used to describe processing numbers with decimals. Here is an SQL tutorial -- there are many -- showing that "Double" means to process numbers as decimal values:



w3schools.com/sql/sql_datatypes.asp

VASCRIPT | SQL | PHP | BOOTSTRAP | JQUERY | ANGULAR | XML | TUTORIALS | REFERENCES

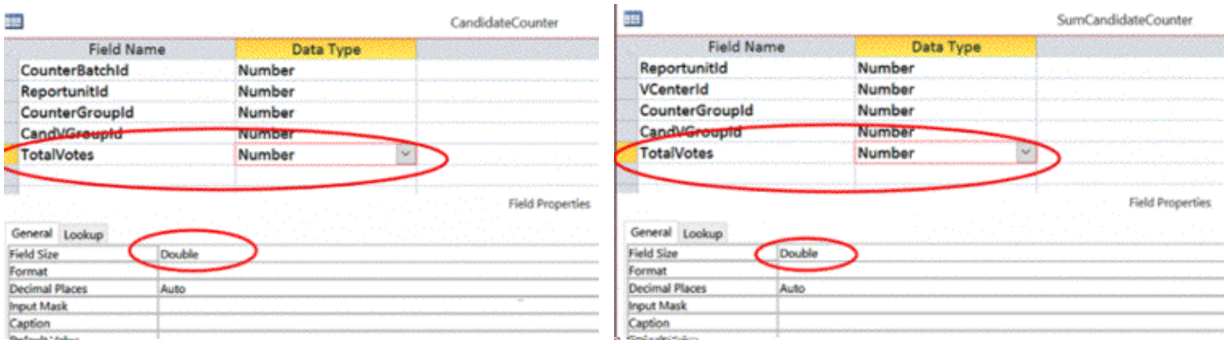
Data types and ranges for Microsoft Access, MySQL and SQL Server.

Microsoft Access Data Types

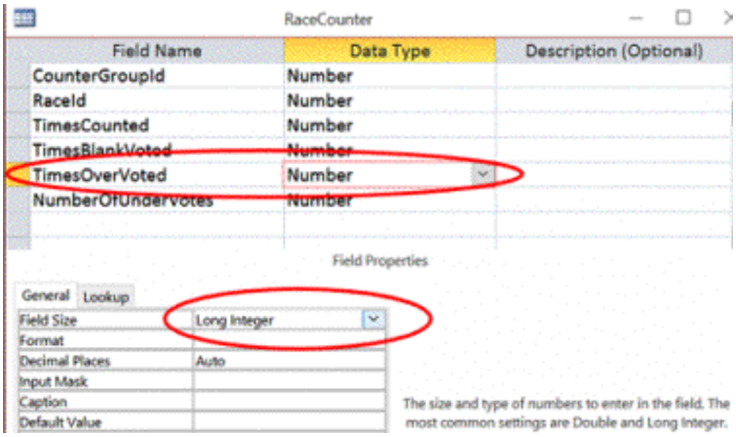
Data type	Description	Storage
Text	Use for text or combinations of text and numbers. 255 characters maximum	
Memo	Memo is used for larger amounts of text. Stores up to 65,536 characters. **Note:** You cannot sort a memo field. However, they are searchable	
Byte	Allows whole numbers from 0 to 255	1 byte
Integer	Allows whole numbers between -32,768 and 32,767	2 bytes
Long	Allows whole numbers between -2,147,483,648 and 2,147,483,647	4 bytes
Single	Single precision floating-point. Will handle most decimals	4 bytes
Double	Double precision floating-point. Will handle most decimals	8 bytes

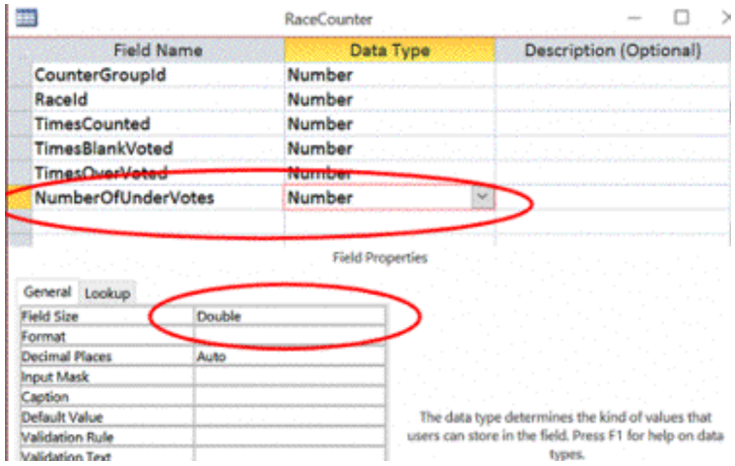
The above source code instructions create and define data structures in Microsoft Access tables, used by GEMS to create results reports. By opening the GEMS tables using MS Access, and

right-clicking “design view” for the tables related to vote-counting, you see that the instruction to treat vote counts as “double” is implemented. The vote format in each is set to “double,” counting votes as decimals.



Overvotes are counted as whole numbers but undervotes are counted as decimals:





Because the “double” configuration for votes is built into the source code, the most important requirement for sophisticated, configurable election tampering exists wherever the program is used.

Part 4: Presidential race in an entire state switched in four seconds
http://blackboxvoting.org/fraction-magic-4

Proof of Concept: Election Night Results

We used the GEMS fractional vote feature to alter an actual statewide vote database, rewriting all the polling place votes in the state of Alaska for the 2004 presidential election to change the outcome.

This database was obtained by the Alaska Democratic Party in 2006 pursuant to a court order.

Below is the Summary Results Report for the polling place votes* as originally provided by the state of Alaska.

This simple reporting form is used on Election Night and, in various formats, is transferred to Web sites to broadcast election results to the public. Note that Bush/Cheney won with 145,836 votes; Kerry/Edwards received 75,665 votes. A number of other candidates receive a small number of votes.

STATE OF ALASKA
2004 GENERAL ELECTION
NOVEMBER 2, 2004
Polling Summary Results
President of the United States

Registered Voters 472160 — Num. Report Precinct 439

US PRESIDENT / VICE PRESIDENT

		Total	
Number of Precincts		439	
Precincts Reporting		439	100.0 %
Times Counted		219093/472160	46.4 %
Total Votes		217886	
NADER / CAMEJO	POP	3501	1.61%
COBB / LaMARCHE	GRN	688	0.32%
PEROUTKA / BALDWIN	AI	1549	0.71%
KERRY / EDWARDS	DEM	75665	34.73%
BADNARIK / CAMPAGNA	LIB	1164	0.53%
BUSH / CHENEY	REP	134836	61.88%
Write-in Votes		483	0.22%

*Alaska used several counting groups in 2004, labeled “polling,” “absentee,” “early,” and a number of other groupings. This example uses only the “polling” subset.

Altering results

Although we could have simply changed the few numbers on this Summary Results Report, we chose a more elaborate plan. We used a spreadsheet to create vote percentages for each polling place, resulting in changing Kerry’s overall percentage from 34.73% to 55.24%, and Bush from 61.88% to 43.66%; we chose to give all remaining votes to Badnarik. Even though we changed over 200,000 votes in hundreds of different locations, we were able to achieve this in just a few

seconds. Because it can be done so quickly, “Fraction Magic” can be performed as often as necessary on Election Night.

The existing votes were transferred among candidates according to pre-set percentages. Because the decimalized vote feature built into GEMS allows an extraordinary amount of precision, it is possible to instruct the voting system to produce a landslide, a squeaker, or just a solid but uncontroversial win.

Here is the same polling place vote Summary Results Report after using “fraction magic”:

STATE OF ALASKA
2004 GENERAL ELECTION
NOVEMBER 2, 2004
Polling Summary Results - After Fraction Magic
President of the United States

Registered Voters 472160 — Num. Report Precinct 439

US PRESIDENT / VICE PRESIDENT

		Total	
Number of Precincts		439	
Precincts Reporting		439	100.0 %
Times Counted		219093/472160	46.4 %
Total Votes		217886	
NADER / CAMEJO	POP	0	0.00%
COBB / LaMARCHE	GRN	0	0.00%
PEROUTKA / BALDWIN	AI	0	0.00%
KERRY / EDWARDS	DEM	120361	55.24%
BADNARIK / CAMPAGNA	LIB	1916	0.88%
BUSH / CHENEY	REP	95126	43.66%
Write-in Votes		483	0.22%

Notice that the number of votes never changes but Kerry now has over 120,000 votes and Bush gets about 95,000. We wiped out all but one of the minor candidates, a risky practice and not recommended unless you want a few families waving signed affidavits at the media.

Using a percentage formula to transfer real votes from one candidate to another almost always creates votes that are not whole numbers. Therefore it requires a voting a system that will process votes as decimals.

Where are the decimals?

The votes in the report shown DO contain decimals, but GEMS automatically rounds off decimalized votes in its results so you will never see them.

Part 5: Masters of the Universe
http://blackboxvoting.org/fraction-magic-5

Precision control to weight results –

Using the GEMS “double” configuration, users can control election results using amazingly

accurate vote percentages. We demonstrate this by assigning vote percentages using a children's letter-number cipher. A=1, B=2, C=3, etc. For example, H=8 and A=1 so 81.8181% is "hahaha." We helped Bush/Cheney dominate Alaska's Cheney Lakes, assigning 38.514525% of the votes, spelling CHENEY.

We used a simple Excel spreadsheet to plan desired results for each location, then injected allocations into GEMS. Smith, a programmer, used a USB stick containing a Visual Basic script to interact with GEMS. For Harris, who has no programming skills, Smith created a demonstration utility to read GEMS, display races, candidates and vote subgroups, then inject percentages typed into it to GEMS. Using exactly the same utility, Harris weighted results in Glades County, Florida against Mark Foley (U.S. Representative) and Charlie Crist (Florida Attorney General) races. In Marin County, California she controlled Measure F to defeat a private corporation named Veolia's bid to take over a water project, this time using only the absentee votes. She weighted the 2010 Shelby County, Tennessee sheriff's race to give it to Randy Wade.

Votes everywhere were instantly redistributed to match the planned result with no need to reprogram for different elections, races, precincts, candidates or voting methods. This demonstrates that the fractional vote capability in GEMS enables any private contractor to weight elections in different jurisdictions, even if he lacks programming skills. Wherever he can get the contract he can set the result.

Before:

STATE OF ALASKA
2004 GENERAL ELECTION
NOVEMBER 2, 2004
Polling Detail Results
President of the United States

Date:
Time:
Pa

US PRESIDENT / VICE PRESIDENT

	NADER / CAMEJO (POP)		COBB / LaMARCHE (GRN)		PEROUTKA / BALDWIN (AI)		KERRY / EDWARDS (DEM)		BADNARIK / CAMPAGNA (LIB)		BUSH / CHENEY (REP)	
Chuathbaluk:	0	0.00%	0	0.00%	0	0.00%	8	30.77%	1	3.85%	17	65.38%
Circle	0	0.00%	0	0.00%	1	2.86%	19	54.29%	0	0.00%	15	42.86%

After:

	CAMEJO (POP)		LaMARCHE (GRN)		BALDWIN (AI)		EDWARDS (DEM)		CAMPAGNA (LIB)		(REP)	
Chuathbaluk:	0	0.00%	0	0.00%	0	0.00%	13	50.86%	0	0.99%	13	48.16%
Circle	0	0.00%	0	0.00%	0	0.00%	5	15.15%	1	1.70%	29	83.15%
Copper Center	0	0.00%	0	0.00%	0	0.00%	127	44.59%	3	1.09%	153	53.61%
Crooked Creek:	0	0.00%	0	0.00%	0	0.00%	18	62.84%	0	0.74%	10	36.42%
Deltana	0	0.00%	0	0.00%	0	0.00%	171	32.38%	7	1.34%	348	65.90%

Planning sheet:

ReptUnitLabel	Magic% Kerry	Magic% Bush	Give Bush
Ketchikan No. 1	55.250000	98	98% of what
Ketchikan No. 2	51.340000	98	remains after
Ketchikan No. 3	45.310000	98	Kerry allocation
North Tongass No. 1	42.751323	98	give the rest
North Tongass No. 2	45.400943	98	to Badnarik
Saxman	57.160000	98	
South Tongass	50.315946	98	
Thorne Bay	38.536585	98	
Coffman Cove	40.224719	98	
Sitka No. 1	72.656357	98	
Sitka No. 2	71.076923	98	
Halibut Point	62.969984	98	
Sawmill Creek	68.016997	98	
Petersburg/Kupreanof	55.562549	98	
Wrangell	48.365062	98	
Pelican/Elfin Cove	58.888889	98	
Port Alexander	86.666667	98	
Douglas	77.760532	98	
Juneau No. 1	92.315140	98	9 23 15 14
Juneau No. 2	92.315140	98	"I won"

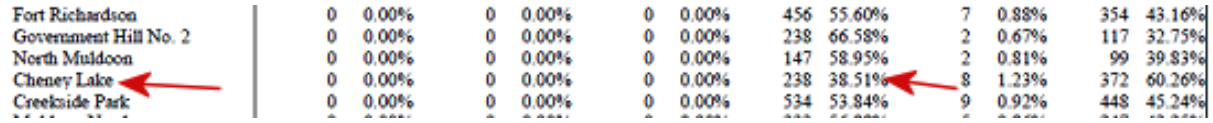
Result:

Pelican/Elfin Cove	0	0.00%	0	0.00%	0	0.00%	39	58.02%	1	0.81%	27	39.70%
Port Alexander	0	0.00%	0	0.00%	0	0.00%	26	86.73%	0	0.27%	4	13.01%
Douglas	0	0.00%	0	0.00%	0	0.00%	697	77.50%	4	0.44%	195	21.72%
Juneau No. 1	0	0.00%	0	0.00%	0	0.00%	354	92.32%	1	0.15%	29	7.53%
Juneau No. 2	0	0.00%	0	0.00%	0	0.00%	474	92.32%	1	0.15%	39	7.52%
Juneau No. 3	0	0.00%	0	0.00%	0	0.00%	662	92.19%	1	0.15%	54	7.52%
Juneau No. 4	0	0.00%	0	0.00%	0	0.00%	568	92.17%	1	0.15%	46	7.52%
Juneau Airport Area	0	0.00%	0	0.00%	0	0.00%	386	62.11%	5	0.75%	230	36.97%

Planning sheet:

Fire Lake	40.845921	98	
Fort Richardson	55.800971	98	
Government Hill No. 2	66.575342	98	
North Muldoon	59.200000	98	3 8 5 14 5 25
Cheney Lake	38.514525	98	"c h e n e y"
Creekside Park	53.836858	98	
Muldoon No. 1	56.886486	98	
Muldoon No. 2	53.333333	98	
Muldoon No. 3	55.668790	98	
Muldoon No. 4	53.382570	98	
Nunaka Valley	62.266824	98	
Northeast Anchorage	51.828979	98	
North Mtn View No. 1	65.327150	98	
North Mtn View No. 2	66.269231	98	
South Mtn View No. 1	65.167364	98	
Wonder Park	58.071066	98	
Baxter	59.161392	98	
Chester Valley	52.362460	98	
Chugach Foot Hills No	54.162521	98	
Chugach Foot Hills No	57.801047	98	
Reflection Lake	59.105691	98	
Scenic Park	48.450704	98	

Result:



Fort Richardson	0	0.00%	0	0.00%	0	0.00%	456	55.60%	7	0.88%	354	43.16%
Government Hill No. 2	0	0.00%	0	0.00%	0	0.00%	238	66.58%	2	0.67%	117	32.75%
North Muldoon	0	0.00%	0	0.00%	0	0.00%	147	58.95%	2	0.81%	99	39.83%
Cheney Lake	0	0.00%	0	0.00%	0	0.00%	238	38.51%	8	1.23%	372	60.26%
Creekside Park	0	0.00%	0	0.00%	0	0.00%	534	53.84%	9	0.92%	448	45.24%

We used letter-number ciphers only to demonstrate that our control over results is precise and unarguable. Any percentage can be created and you can insert your formula into some or all of the detailed vote subgroups.

Why aren't percentages exactly the same?

Percentages achieved are remarkably, though not perfectly precise. Variations in the number of total votes can create slight variations in the votes once you reach the hundredth place.

Errors

Use of an inadequate number of decimals will produce errors. An error of ± 1 in vote count addition can be a round-off error, as shown in the following example:

Vote cast = 10

Candidate A receives 2.5 votes which rounds to 3

Candidate B receives 7.5 votes which rounds to 8

3 + 8 = 11 votes, for a discrepancy of one.

Using three or more decimals helps reduce round-off errors:

Vote cast = 10

Candidate A receives 2.501 votes which rounds off to 3

Candidate B receives 7.499 votes which rounds off to 7

3 + 7 = 10 votes, producing no round-off error.

Because round-off errors will only occur with a minority of decimal values in the data, absence of an error will be the more common result. Round-off errors can be positive or negative and some will cancel others out. Lack of error does not mean the underlying vote total is a whole number.

Loss of value can be introduced when rounding downward. For example, 0.3245 may round off to zero, losing one-third of a vote. Loss of value accumulates when using thousands of vote decimals, increasing the chance that small, telltale errors may appear in certain parts of the data. Therefore it is important for election officials to provide interim results in real time, detailing all components of the vote total (total cast, blank, under, over, and candidate) and committing to a breakout by precinct and vote type (absentee, early, at polls), publishing updates frequently.

Because the decimalization feature in GEMS is so powerful, it is possible for programmers to

write scripts that reduce or remove errors, but such code typically involves assigning vote fragments into candidate or undervote pockets. Thus, the more immediate the public commitment of detail results, the more difficult it becomes to find a place to assign fragments.

Use of middlemen and private contractors to report results makes it easier to hide round-off and lost value errors.

Public commitment of immediate, detailed, directly sourced vote results makes it somewhat more challenging to alter results successfully. However, current election administration trends are traveling in the opposite direction.

Won't you see the decimals if you look in the Microsoft Access tables?

The tool needed to remove all floating points (decimal values) completely and permanently also exists in GEMS. Without going into further detail, any Fraction Magic programmer worth his salt will include clean-up commands in the script. We chose not to do so because, as you will see in a later section, we will be demonstrating other concepts by looking at the decimals we have retained.

Part 6: Execution capacity – coming
http://blackboxvoting.org/fraction-magic-6

Part 7: Solutions and Mitigations – coming
http://blackboxvoting.org/fraction-magic-7

Some Relevant Items From the Comments Sections To Which Bev Responded

Part 1

Randy Divinski (5/10/16)
Can you explain to readers how you got access to the GEMS source code you are analyzing?
Bev Harris · University of Washington (5/19/16)
Hi Randy. As was widely reported, and depicted in the HBO documentary "Hacking Democracy," I found approximately 40,000 files on an FTP server in 2003. This server was being used by programmers for what was at that time Diebold Election Systems to swap files. The source code we looked at was from this set of files. Diebold admitted that the files were theirs.

Debbie Sumner (5/15/16)
Maine also uses the AccuVote, programmed by LHS Associates. Are they using something BESIDES GEMS to do the programming or should Maine be included in your list?

Bev Harris · University of Washington (5/19/16)
Hi Debbie, and by the way thanks for your heroic work in New Hampshire to fight for vote-counting transparency there. Although most of New England does initial programming of its voting machines using GEMS, typically the voting machines do not use GEMS in New England to report results. However, I believe that Boston and Cambridge use GEMS to report results. Typically GEMS is used for two functions: To set up the election and create memory cards for voting machines, and to accumulate multi-precinct results for reporting. Since most of New England operates elections through individual municipalities, they don't need the accumulator function to report results. Large cities which must pull together results from multiple wards, and county-wide elections, do use the GEMS function which fractionalizes votes. I think Maine's major cities use a different system, however. That said, there is no reason to believe that other manufacturers don't also fractionalize votes.

Craig Johnson · Horace Mann School Alumni (5/18/16)
You state that your testing showed that a single vote can be counted 25x. Please provide testing data and methodology for this claim. You state that developer notes state that fractionalization of votes is possible with GEMS software. Please provide original source for these notes., can you identify any 2016 primary races where this has happened? You state that concerns were raised about a middle-man gaining access to election management software . Are You refering to Tennessee or some other state? what became of this investigation?

Bev Harris · University of Washington (5/19/16)
Hi Craig, and welcome to Black Box Voting. Most of your questions are answered in Parts 2,3,4,5 and 6 of this report. Part 6, on the middleman, has not been posted yet so I'll provide a preview: states where individuals or entities (in addition to the vendor, who can also be shown to remote into the tabulator during live elections) get access include: Arizona, California, Texas, West Virginia, Kentucky, Ohio, Tennessee, Illinois, Michigan, North Dakota, South Dakota, Nebraska, Utah, South Carolina, North Carolina, Florida, Georgia, New Hampshire, Massachusetts, and Colorado. Some of these middlemen are also convicted felons.

Susan Buser Kallman (6/2/16)
Are there systems that count correctly? If so, which states uses it?

Bev Harris · University of Washington (6/12/16)
Hi Susan, and welcome to Black Box Voting. The only way we can know that a system counts correctly is to be able to see and authenticate the count. There are two ways to do this: 1) hand counted paper ballots at the polling place in public; 2) scan a photographic copy of every ballot at the polling place and make the set of ballot images available to anyone who wants to fork out 5 bucks for the disk. Vote by mail? Fahgeddaboudit! You can never actually authenticate who stuck the ballots into the pool. Even if the count is correct, you can't know if they counted all the ballots, only the ballots from actual voters, or whether counterfeit ballots are also being counted. The Germans got it right: "No voting system shall be used unless the public can see and authenticate all essential processes without need for special expertise." What method to use to do that? Any method that meets those criteria.

Part 3

Ted Apelt · University of North Florida (6/5/16)
One thing I must point out, and that is is many computer languages an integer is between -32,767 and 32,767. You would not have more than 32,767 votes in a precinct, but a grand total would usually be larger. What language and exact version of the language is being used here? Some computer languages use a "long integer" that is 4 bytes long, and can go from 0 to 4,294,967,295 - waay more than enough for any election in the US. Again, it depends on the language and exact version of the language.

Matt Meyer · Assistant Store Leader at GameStop (6/11/16)
This uses MS Access according to the article, which does have a max INT value of 32767.

Bev Harris · University of Washington (6/12/16)
Additional source code and documentation between programmers make it crystal clear that the intent was to weight races and decimalize votes. One of the examples in a programmer e-mail uses four decimal places in the vote. I will publish that e-mail in Part 7.

Part 4

Don Daniels · Captain at Major US Airline (6/11/16)
Bev, do you suppose this is how Bernie's vote total DECREASED during the evening in the precinct near Dover, Dellaware this last primary?

Bev Harris · University of Washington (6/12/16)
I know of at least two instances where something like Fraction Magic appears to have produced a visible mid-count decrease in votes -- but not necessarily the Dover situation. First thing to do is check whether source is AP results. (News stuff). If so it isn't results at all. The AP gets what they print from people standing around phoning it in. Always draw results only from official

govt. sources. If it's the government result, take it seriously. If it's the AP, it's coming out of the mouths of people, not the tabulations of voting machines.

Zhahai JustZhahai (7/6/16)
As a lifelong programmer, this seems like BS. If you have unrestricted access to the underlying database, you can of course alter the votes, period; there is nothing special about using Doubles reather than Long Ints that makes it any easier to do. It's no harder to manipulate Long Ints and it would actually make the results less detectable (so there are no frational votes anywhere at any time to be detected). You just transfer integer numbers of votes around. The concept that one would move votes using Doubles, and then afterward truncate them to integer values to avoid detection, is plain out nonsense.

So the whole "fractional vote" thing appears to be a silly distraction to fool non-programmers into thinking something is inherently fishy because of using Doubles for vote count.

That's not to say there could never be any kind of vote manipulation; better safeguards are indeed needed in the electronic age. We need paper trails and audits; we need audited firmware with transparent cryptographic signatures. And we need to be sure that nobody has special access to any internal databases (using Doubles or not). But this particular "analysis" appears to be pretty bogus.

Bev Harris · University of Washington (7/9/16)
Hi Zhahai, and welcome to Black Box Voting. Comments like yours are helpful because they show me what is unclear about the articles. We will be producing a short educational video this month -- 9 minutes or so -- demonstrating Fraction Magic. One of the areas a lot of people didn't quite understand is the difference between fraction magic and just flipping votes from one place to another. You write: "You just transfer integer numbers of votes around." Reread the design specs, download the Alaska database and just try dropping in pre-set percentages so precise you can literally spell words, without taking hours to babysit it. See if you can do that in every precinct in Alaska, separated by vote type (absentee etc), in four seconds or less, without knowing how many people are going vote or what the votes are going to be, and without changing the GEMS software at all. I invite you to prove your concept while still meeting the job specifications: 1) must be a utility doable by nonprogrammers across multiple jurisdictions at once 2) Must mimic precinct demographics 3) Must specify result percentage for each voting method within each precinct (absentee, polls, etc); 4) Must be absolutely accurate, both in parsed details and aggregate 5) Can be executed in less than a minute per jurisdiction -- using the same utility for every jurisdiction. Um, good luck doing that using only whole integers. :)
Working copy of actual GEMS software and Alaska database found in Diebold section here:
http://blackboxvoting.org/voting-system-technical.../

Part 5

Randy Divinski (5/18/16)
"This demonstrates that the fractional vote capability in GEMS enables any private contractor to weight elections in different jurisdictions, even if he lacks programming skills." After a few reading, I think I understand how the vote totals can be manipulated as they are uploaded from a

local site to the central GEMS tabulator. What isn't clear to me is whether the original (local) data is overwritten as well, or whether a discrepency would be found -- if anyone bothered and was allowed to look.

In other words, if this was done in an actual election, would there be any evidence left behind? (I gather that the manipulation on GEMS can cover its tracks, but what about the offsite local records?)

Bev Harris · University of Washington
Hi Randy. The way we did Fraction Magic, it did NOT overwrite the voting machine results. Thus, the poll tapes can provide telltale evidence when such an exploit is used, but only if election officials provide precinct results in a timely manner. We found almost all of the 1-vote round-off errors in early voting, which typically does not print a poll tape; thus, there is no way to compare GEMS result with voting machine result. Absentee voting also does not print a poll tape, and is at exceptionally high risk. Also, the current heavily-pushed trend in election administration is to use combined vote centers instead of precincts, which also eliminates the poll tape. For polling places, if lots of people do what Bennie Smith did and photograph poll tapes, and if election officials are required to provide immediate precinct-level GEMS results, Fraction Magic could get caught. But it won't be caught with early, absentee, and combined vote center votes.

_____

Bev Harris · University of Washington (6/12/16)
In most locations provisionals are hand counted and manually entered. California and Arizona have out-of-control crazypants provisionals and larger Calif. locations probably do count them by machine. Only machine counted ballots are at risk for fractionalization, but provisional ballots are at risk for other things, especially if they are caused by unauthorized shifting of voter to absentee list.