AFFIDAVIT OF DOUGLAS W. JONES

DOUGLAS W. JONES, being duly sworn, deposes and says the following under penalty of perjury.

1. I am an Associate Professor of Computer Science at the University of Iowa. I have a BS degree in physics from Carnegie-Mellon University and MS and PhD degrees in computer science from the University of Illinois. I have taught at the University of Iowa since 1980. I submit this affidavit in support of Jack Lackey's Petition for a hand recount of all ballots in the 6th Magesterial District of Christian County, Kentucky.

2. My involvement in elections began in late 1994 when I volunteered to serve on the Iowa Board of Examiners for Voting Machines and Electronic Voting Systems. I was appointed to the board in 1995 and resigned from the board in 2004. I was chairman of the board in 2000, when I testified before the U.S. Commission on Civil Rights about the Florida 2000 election, and before the House Science Committee about an early draft of what would later become the Help America Vote Act of 2002.

3. In 2004, I consulted with Miami-Dade County, Florida about problems they were having with their then-new voting system. In 2006, I helped investigate a problematic recount in Maricopa County, Arizona for a committee of the Arizona Senate. Earlier in 2016, I was a member of the Scott County, Iowa ad-hoc committee to select a new voting system for that county. I have served as an election observer in Kazakhstan in 2005 and 2007, and in Holland in 2006.

4. Between 2005 and 2011, I was a co-principal investigator in ACCURATE (A Center for Correct, Usable, Reliable, Auditable, and Transparent Elections), a 5-

university research project funded by the National Science Foundation, and I served on the U.S. Election Assistance Commission's Technical Guidelines Development Committee from 2009 to 2012 when the committee went dormant. I co-wrote, with Barbara Simons, the book *Broken Ballots*, published by the Center for the Study of Language and Information and University of Chicago Press in 2012.

5. My up to date curriculum vita is available online at http://homepage.divms.uiowa.edu/~jones/vita.pdf.

6. Many of my public statements about voting are indexed on-line at http://www.cs.uiowa.edu/~jones/voting/.

Background

7. I understand that the initial count for the race the 6th Magesterial District in Christian County, Kentucky had only a 2-vote margin with 1250 ballots cast, and I understand that the district contains 4 precincts. I understand also that the ballots involved were printed in the format used by the scanners made by Hart Intercivic, and that Hart scanners were in fact used to compute the election-day totals.

8. The *voting target* on an optical-scan ballot is the oval, box or broken arrow where a voter is supposed to mark in order to cast a vote. The voting target on Hart Intercivic paper ballots is a box to the left of the candidate or issue.

My Opinion

9. In a recount of a race with this margin, human examination of each and every ballot is essential, for reasons I will detail below. In brief summary, a hand count will more accurately determine the intent of the voters, and a hand count is likely to be faster and more economical than a machine count.

The Question of Accuracy

10. No optical scan technology, including that used in Christian County, Kentucky, is capable of perfectly uniform and reliable scanning and electronic tabulation of voter-marked ballots. The same ballot scanned by the same genuinely impartial machine may be seen as containing a vote on one pass through the scanner and not containing a vote on the next pass through the identical scanner. This is because a mark can be exactly at the threshold for discriminating between marked and unmarked ballots, so that even the slightest variation in paper alignment and other physical conditions can change the outcome. The potential for different interpretations by genuinely impartial scanners is even greater when ballots are initially scanned on one machine and recounted on another, or when marks in one candidate's voting target are compared with marks in a different candidate's voting target.

11. Ballot scanners are accurate only to a point. Most marks made with the intent of casting a vote will be counted, and most accidental marks and smudges will be ignored. However, problematic marks are possible, both marks intended as votes that some scanners will ignore, and accidental marks that may be counted as votes. My analysis of the data from the unofficial Florida 2000 recount done by the media shows that from one to ten votes per thousand votes counted involved a problematic mark; with considerable variation between local jurisdictions. Mark Ritchie, who was the Minnesota Secretary of State during the 2008 senatorial hand recount of optical scan ballots, informed me that the rate of problematic marks in that election was on the order of one or two marks per thousand votes cast. In general, it is difficult for a voter to predict how such marks will be treated. A few marks that are obviously not votes, to a person, can be

counted as votes by some scanners, and some that are obviously votes will be ignored by some scanners. When the margin in an election is wide, this is unlikely to make any difference, but when the margin is only 2 votes, this can be a problem.

12. Kentucky's rules for the uniform definition of a vote (31 KAR 6:030, Section 4) clearly recognize the possibility that human examination of ballots can identify votes that automatic ballot scanners cannot. Scanners are only expected to recognize votes where the voter has filled in the box next to the candidate's name (1a). In contrast, the rules requires humans to count, in addition, votes cast by circling or underlining the box (2b), the candidate's name (2c) or the candidate's party (2d), as well as several other types of marks.

13. Scanners are prone to at least two types of errors: failing to read votes that were cast, and reading votes where none were cast. These errors are triggered by the types of marks that voters make on their ballots, the type of pen, pencil or other devices they use to mark the ballot, and the ways in which ballots are fed into scanners.

14. The actual accuracy of the scanners in translating the voter's intent into an electronic record depends not only on the scanner technology but on the ballot marking instructions. I have seen significant variation in these instructions from one local election jurisdiction to another. For example, In Florida 2000, 16 counties used Global AccuVote-OS ballot scanners. Most had instructions that merely said to "completely fill in the oval." Only Leon County's instructions added "use only a #2 pencil or a blue or black pen." In the same election, 15 counties used Election Systems and Software central-count scanners. Most had instructions saying "blacken the oval completely ... using only the pencil provided." Charlotte County, however, said "... using only a #2 pencil."

Hendry and Lake Counties omitted the restrictions on marking device. 8 counties used Optech scanners, mostly with instructions that said "Complete the arrow(s) pointing to your choices ..." Baker, Escambia and Holmes counties added "... using only a #2 pencil or the special pen provided."

15. While most voters conscientiously mark their ballots following the instructions they are provided, completely filling the voting targets for the candidates they prefer with the correct ballot marker and leaving the others unmarked, some do not. With absentee ballots, voters frequently use whatever pen or pencil is handy, without regard to the ballot marking instructions. When the marker provided at the polls fails, voters are likely to reach for whatever they have in their pockets, particularly when the polling place is busy.

16. Where the ballot marking instructions ask for the voter to completely darken the voting target, some voters will just make an X or a checkmark. In my experience, ballot scanners can be programmed to count such marks, but they do not always accept them.

17. I have not seen the instructions provided to voters in Christian County, Kentucky, and the two voters I have spoken to in the county did not recall seeing any instructions. Under these circumstances, I would not be surprised if, in a manual recount, a small number of ballots were found where voters made irregular markings that could not be interpreted correctly by the scanner.

18. Unfortunately, some voters use their ballot marking pen or pencil as a pointer while they work their way through the ballot, leaving faint dots wherever they rest the tip while they are reading. These marks are common enough that they have a

name, *hesitation marks*. Ideally, a scanner should not detect a hesitation mark as a vote, but it is difficult for a scanner to distinguish between a dark hesitation mark and a lightly filled voting target.

19. When I tested ballot scanners for the state of Iowa, and in my tests in Miami-Dade County, Florida and Maricopa County, Arizona, I always tested the scanners with a wide range of pens and pencils and a wide range of marks. What I have found is that scanners made by different vendors can have distinctly different sensitivities to different markers.

20. For example, when I tested the Election Systems and Software M650 scanners used by Miami in 2004, I found small differences in sensitivity between pen and pencil.[1]

21. When I conducted more extensive tests on the Optech 4C scanners used by Maricopa County in 2006, I found larger differences. The Optech 4C was almost entirely insensitive to red ink, extraordinarily sensitive to even the smallest pencil marks, and only marginally sensitive to some common ballpoint pen marks. Sadly, the marking device recommended by the county (a Black Bic Round-Stik pen) was among those the marking devices I found to be marginal.

22. A significant issue I noticed in Maricopa County was that different scanners had different sensitivities, so that a mark that was counted on one machine would be discounted on another. This is the probable explanation for the discrepancy between the first count and the recount in the election I was asked to investigate, although

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1 *See* Section 8 of my Observations and Recommendations on Pre-election Ttesting in Miami-Dade County, Sept. 9, 2004, available fromat http://www.cs.uiowa.edu/~jones/voting/miamitest.pdf

we will never know for certain because visual inspection of the voted ballots was never permitted. The *only* way to confirm that the sensitivity of a given scanner is properly calibrated is to manually examine ballots and compare them to the machine count.[2]

23. When we humans look at a ballot, we view it in the full range of colors visible to the human eye. In contrast, most of the scanners designed in the previous century use infrared light invisible to the human eye, and many current models use a single very sharply defined color, usually red or green. A mark may appear very dark to the human eye and yet be invisible to a scanner viewing the mark in infrared or a single narrowly defined color. For example, the reason that the scanners I tested in Maricopa County were insensitive to some red inks was that they used red LEDs to illuminate the ballot. Scanners that use infra-red light may be insensitive to some dye-based inks.

24. Voters cannot be expected to judge their marks on the ballot by the standards used by a voting machine. Voters can only judge such marks by eye.

25. Election officials' assurances that the scanners used in their jurisdictions are tested to rigorous federal standards is not sufficient to indicate that the scanners are reliable. The standards they cite do specify a target error rate of no more than one error per 10,000,000 votes. This figure comes from Section 3.2.1 of the Federal Election Commission Voting System Standards, Volume 1. Unfortunately, this is a target error rate, while the standards permit a much higher error rate of one error per 500,000 votes during testing[3]. More recent standards promulgated by the Election Assistance Commission appear, at first glance, to be more rigorous.

2*See* Statement of Douglas W. Jones Regarding the Optical Mark-Sense Vote Tabulators in Maricopa Couty, Jan. 12, 2006, available at http://www.cs.uiowa.edu/~jones/voting/ArizonaDist20.pdf

3*See* Fed. Elec. Comm'n Voting System Standards, Volume 1 § 3.2.1

26. As rigorous as these standards may appear, they are used to measure machines' ability to measure ballots that are perfectly filled out, and do not account for the normal variation with which humans record their votes. In reality, therefore, federal standards do not effectively police error rates for scanners reading ballots actually completed by voters. This problem was created by the Help America Vote Act of 2002 ("HAVA"). HAVA contains this text: "The error rate of the voting system in counting ballots (**determined by taking into account only those errors which are attributable to the voting system and not attributable to an act of the voter**) shall comply with the error rate standards established under section 3.2.1 of the voting systems standards issued by the Federal Election commission ... [Section 301 (a) (5)]." The effect of the parenthetic section I have set in bold face above is that human factors are explicitly excluded from the accuracy requirements set by the law.

27. Because the Election Assistance Commission's authority to establish Voluntary Voting Systems Guidelines is founded on HAVA, this effectively forbids the EAC from setting accuracy guidelines that are based on human-factors considerations such as how real voters actually mark their ballots. In practice, what this means is that the accuracy of optical mark-sense ballot scanners is tested with artificially marked ballots. In testing, unmarked voting targets are left entirely blank, while marked voting targets are filled in exact compliance with the voting machine manufacturer's recommendations.

28. Crucially, the FEC standards and later EAC guidelines cannot address the issue of whether a ballot scanner has been hacked with malware. Testing cannot reveal such problems, and the security requirements of the current standards are rudimentary at

best. The State of California has conducted source code review of the Hart eScan ballot scanner, where they found inadequately secured network interfaces, poor or no use of cryptography and inadequate protection of ballot secrecy.[4] In the light of these design failures, we cannot be sure that these machines have not been subject to some kind of hacking. Therefore, again, hand examination of the ballots is essential.

The cost of recounts

29. In any recount, the canvassing board and observers from all interested parties must be convened. The ballots must be recovered from secure storage, and the seals, custody records or other security measures must be inspected to assure that the ballots in hand are the actual ballots cast by voters. These costs do not depend on whether the recount is done by hand or by machine. Similarly, at the end of the recount, the ballots that were recounted must be properly sealed, accounted for and returned to secure storage.

30. In a machine recount, technicians must be brought in to set up and test the machines prior to the recount and extract the totals afterward. Set-up activities include clearing any previous totals from the machines, configuring them to count ballots for the correct precincts, and then feeding test ballots to assure that the precinct setting is correct and that the machine operates correctly. This will take an appreciable part of an hour.

31. In contrast, the set-up time for a hand count involves, at most, moving a few chairs and tables around and then instructing the canvassing board and the observers in their roles in the process. This can be done in minutes.

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4 See , California Secretary of State Top to Bottom Review, 2007. Archived at https://web.archive.org/web/20100605182827/https://www.sos.ca.gov/voting-systems/oversight/ttbr/Hart-source-public.pdf

32. In a machine recount using the Hart eScan ballot counter, ballots must be fed into the counter. In the case of the eScan, ballots must be hand fed at a rate of about one every second, or under an hour for fewer than 2000 ballots.

33. The best practice for configuring scanners for a machine recount requires that the scanners be set to reject all ballots that scan as blank or as containing an overvote in the race being recounted. While the number of votes sorted out in this process should be small, this requires that the canvassing board and observers all be properly informed of how such ballots are to be handled and interpreted.

34. I expect the total time taken by a hand recount of fewer than 2000 hand marked ballots to take under two hours. The total time and staffing required should therefore be less than that required for a machine count. My estimate of the time per ballot is predicated on following reasonable procedures for a hand count, although I do not doubt that alternative procedures can be devised that are equally just and equally transparent.

Conduct of a Hand Count

35. The best procedure for hand counting I have seen in my studies involves teams of two to four people. For example, a 4-person board of elections can operate as a single team.

36. After each ballot has been examined by the team, everyone on the team declares their interpretation. In most cases, there will be a consensus, allowing the team to examine ballots very quickly. Ballots that have been ajudicated should be stacked, face down, in the appropriate stack, one stack per candidate, and one stack for ballots that have no discernible indication of intent.

37. All people allowed to touch the ballots should be required to wash their hands prior to the process or to wear white gloves, in order to prevent accidental smudging or worse, intentional marking of the ballots.

38. Only after all of the ballots have been divided into stacks should each stack be dealt into piles of ten ballots, and then piles ten and the remainder counted to arrive at the final total. This is one way to avoid the likelihood of errors in counting each stack while the ballots are being examined.

39. Close observers on behalf of each candidate or issue should be permitted to lean over the shoulders of team members or to sit beside one of them, just out of reach of the ballots themselves. I presume that partisan observers will prefer to look over the shoulder of or sit beside the team members representing the opposing party.

40. Observers should be allowed to ask for brief pauses in the canvassing process during which they may request closer examination of a ballot, without touching it, and the team should honor such requests, as a matter of courtesy, unless it appears that such requests are being made capriciously.

41. In the event that there are too many people interested in observing, others should be allowed to observe quietly and at greater distance, and party chairs or their designees should be allowed to select observers on behalf of their parties. My purpose in outlining these rules for observers is to assure that the entire process is conducted with sufficient transparency that everyone can be convinced of the justice of the outcome.

42. I offer the above opinions on a pro-bono basis.

This affidavit was executed on the 19th day of November, 2018, in Iowa City, Iowa.

DOUGLAS W. JONES

Sworn to before me this 19 day of November, 2016.

Brenda A. Gritsch
Notary Public, State of Iowa
County of Johnson
My Commission Expires: 8/26/19