

Report to Anderson County Election Commission

Evaluation and Comments

On

MicroVote's Infinity

ES&S's iVotronic

Diebold's AccuVote-TSX

Hart Intercivic's eSlate

Prepared By:

**League of Women Voters – Oak Ridge
Voting Technology Committee**

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Executive Summary

The League of Women Voters – Oak Ridge has evaluated the four companies short listed to provide Direct Recording Electronic (DRE) voting machines to Anderson County. This report contains details of our review and evaluation. Following is an overall summary of our review:

- We were very favorably impressed with the quality of the presentation of Hart Intercivic's eSlate and MicroVote's Infinity systems.
- We are **very concerned** that the touchscreen technology of both the ES&S iVotronic and the Diebold AccuVote-TSX is subject to losing alignment during an election and this problem could go undetected.
- We are concerned that the MicroVote Infinity system is not yet certified and assume that they will not be considered until the certification process is completed.
- We found all four machines to be easy to use from a voter's perspective.
- Hart Intercivic's eSlate was considered the most impressive in regard to the array of assistive devices offered to voters with disabilities.
- We are concerned with the reputation of both Diebold and ES&S. We are very concerned with the level and volume of poor press revolving around both companies. The continual poor press surrounding the two companies serves to degrade our trust in both the management of these companies and their processes for resolving issues.

Background

Across America, the League of Women Voters is being requested to participate in the evaluation of voting systems. The League of Women Voters of the United States has adopted four criteria for local and state leagues to use when evaluating a voting system.

The League's stance is that a voting system should be:

- Secure
- Accurate
- Re-countable
- Accessible

Anderson County Election Administrator, JoAnn Garrett, invited The League of Women Voters of Oak Ridge to attend manufacturer demonstrations from four companies short listed to supply new voting machines for Anderson County. Our representatives have attended all demonstrations and gone on to perform additional research in an effort to assess and evaluate each system.

The four companies and machines evaluated were:

MicroVote's **Infinity**
ES&S's **iVotronic**
Diebold's **AccuVote-TSX**
Hart Intercivic's **eSlate**

- All four systems are Direct Recording Electronic (DRE) type systems.
- All provide means for the blind, visually impaired, and citizens utilizing wheel chairs to independently vote.
- At this time, all are certified by the State, with the exception of MicroVote's Infinity.
- The security of each system depends on the quality control, integrity, and processes followed by the poll workers, programmers, and election officials.

New Voting System for Anderson County

V. K. Paré

February 12, 2006

Security

For many years, vote-tampering has not been a problem in Anderson County. There are, however, two reasons why it is important to choose a voting system whose manufacturer pays serious attention to security.

The first reason is that the complexity and versatility of modern computers, such as those used in voting systems, have the potential to make tampering both more damaging and more difficult to detect than it has been in the past. Thus the temptation to try to bias the results of an election may increase as local governments move to more sophisticated computer-based voting systems.

The second reason is that, since there may still be many places in which vote-tampering is still a real possibility, local governments can help one another by preferring voting system manufacturers who have histories of designing their equipment and software with security in mind.

Training

Browsing the Internet yields many descriptions, often from newspaper reports, of malfunctions in computer-based voting systems. These problems range from inconsistencies in vote counts to complete failure to function. Usually it is difficult to determine from such reports what the cause might be; however there are some situations--such as failures occurring only in certain precincts--that imply that the systems might not have been set up properly by the local election officials. Although malfeasance is a possible explanation, a much more likely one is that the officials--or the part-time poll workers--did not fully understand the complexities of the systems they were dealing with.

Thus it is important that the Election Commission obtain the best possible training for its staff in the use of whatever voting system is purchased, and, before each election, make sure that the poll workers are thoroughly trained in their duties and responsibilities.

Detailed Summary

Feature	MicroVote Infinity	ES&S iVotronic	Diebold AccuVote-TSX	Hart Intercivic (sold in TN & KY by Harp Enterprises) eSlate
Will they allow local/state commissions to independently review code?	No	No	No	No
Will they allow local/state commissions to keep source code in escrow?	Yes. They will allow the State to place a copy in escrow for review in the event a judge deems a review of codes necessary due to an election challenge.	No	No	Yes. Hart has a current account for escrow storage with an independent company that can be expanded to include additional customers.
If programming of ballots is performed locally, will they review & certify & support the local election commission if a problem arises during the election?	Local programming is licensed to the County election commission. MicroVote will train the staff in the county to do the programming and will be glad to review their data base work upon their request.	Insufficient info to know	Insufficient info to know	Harp offers a full menu of election support including ballot creation. Alternately, the BOSS application is provided to customers who wish to build their own ballots. Harp is available to provide implementation and training services and post implementation support. It is the customer's responsibility to review the ballot for accuracy.
Does the company have a history of mishaps and	Yes, some problems have occurred. Most seem to have been	Yes, numerous. *Refer to Incident Report Section for a list.	Yes, numerous. *Refer to Incident Report Section for a list.	Yes, a few. *Refer to Incident Report Section for a list.

problems?	successfully resolved. *Refer to Incident Report Section for a list.			
How are re-counts performed?	(1) Vote totals are in the individual machines and can be recalled after the election. (2) Tally tapes from the election can be recalculated by hand. (3) Audit trail tapes can be hand counted. (The audit tape is a record of each individual ballot.) (4) Tally cards can be re-read. Authority overseeing the recount would determine the method.	The recount system allows replication of the entire election process. With the purchase of the "Election Manager Software", which is an optional expenditure, ballot images can be produced for re-verification.	The AccuVote-TSX voting terminal contains an internal thermal printer (not the printer used in the VVPAT option). Diebold literature says "A paper record of every vote cast can be printed so hand recounts can be conducted." This data may come from the internal flash memory rather than the removable memory card.	Recounts can either be performed electronically or manually. Votes are stored in three physically independent locations: in the eSlate voting unit, in the Judge's Booth Controller (JBC) and on the Mobile Ballot Box (MBB) flash-memory card. Electronic Recounts . A complete, electronic recount of an election is easily accomplished with the Hart Voting System by re-reading each Mobile Ballot Box (MBB) for the specified election into a "fresh" Tally database. This process duplicates the process used in the original tabulation, and provides the same results reports, audit trails, and back-up options.
Does the company have a history of elections with inaccurate results?	No	Yes. Refer to Incident Report Section for a list.	Yes. In the 2000 election Volusia Co., FL experienced a 16,000-vote discrepancy in reading a Global Elections Systems (now Diebold) memory card into the central tabulator. Yes. Refer to Incident	No.

			Report Section for a list.	
Does the company have an ethical reputation?	Yes. Have been supportive & helpful to their Clients. Seem to have good reputation.	Not in our opinion.	Not in our opinion.	Yes.
Is the machine easy to use and easy to explain to others?	Yes	Yes	Yes	Yes
Does the machine store vote data in more than one location?	Yes. Vote total is stored in 7 places, 5 in the machine, 1 prints on tape, and 1 on the tally card.	Yes. There are three independent memory paths.	Yes. An internal flash memory and removable memory card.	Yes. The Hart Voting System is designed for failsafe operation. Each vote is cast and stored in three physically separate devices to provide back-up and redundant storage in the event of any one of the components malfunctioning. Data from each device can be independently collected and verified against the other devices.
If so, are data independent and verifiable?	Yes	Yes.	Yes	Yes.
Has the machine been tested sufficiently before and during previous elections?	Yes. Infinity has been in use for 6+ years in other states. It has been certified and used in Tennessee for 4 years. With no major problems appearing, this seems sufficient	Yes.	Yes.	Yes. The eSlate voting unit was first placed in active use in 2000. Since introducing the unique eSlate, Hart InterCivic has sold more than 28,000 eSlate units to jurisdictions of all sizes in multiple states (including California, Colorado,

	testing during elections.			Hawaii, Illinois, Kentucky, North Carolina, Ohio, Pennsylvania, Virginia, Washington, and Texas), representing more than 9 million voters. Millions of votes have been cast securely and successfully on the Hart Voting System, including nearly 3.5 million votes in the November 2004 elections.
Is the cost of support prohibitive? Will they agree to a set price for support or is the cost subject to ramping up over time?	Election Day Support is \$2000 per day; Training is \$1000 per day; Voting machine set-up supervision is \$1000 per day; Voting machine set up is \$75 per machine.	unknown	unknown	Multiple years of support can be add to the contract at specified rates beyond the standard warranty period. Over time, support rates are subject to modest increases.
What method does the company have to prevent hacking?	Voting machine can only be accessed with the Licensed software, which is the only language machine understands. Machines are stand alone devices in each precinct. Software tracks who, when , and what is done in every election database. All users must have password to enter software. No computer with MicroVote software is	Insufficient info provided	Insufficient info provided	There are numerous elements used in the design of the Hart Voting System to prevent hacking. The eSlate includes both physical and electronic intrusion detection controls. It features a secure, real-time embedded operating system that is not Windows-based and thus not penetrable by the common hacker. There is no means of external access to the eSlate such as with smart cards or programmable devices. All components of the Hart Voting System create an

	connected to the local office server, or to the internet.			audit record that can be extracted and printed and archived for future reference. The system does not rely on reprogramming with new code for each election but instead only the election data is changed. All information managed in the voting equipment is saved in three physically separate devices and all information storage devices are solid state and thus not susceptible to magnetic fields, abusive handling or loss of power. The Hart Voting System software employs user entry validation, real-time error checking and cyclic redundancy checks to continuously test each data transfer within the system.
Does the machine allow the blind, the visually impaired, and people in wheel chairs to vote independently?	Yes	Yes.	Yes.	Yes. Has the widest array of adaptive aids and devices.

<p>What elements of design and other measures are in place to keep data at the precinct secure?</p>	<p>Voting machine is sealed before it leaves election central. Poll official has card, supplied by election central, to operate the voting machine. Cards are security coded with the licensed software.</p>	<p>Seal the memory card inside the machine.</p>	<p>During voting the removable memory card is in a locked compartment.</p>	<p>The eSlate voting units cannot be connected to any external network. All votes are recorded in three physically separate locations in the polling place equipment. Data cannot be altered or changed by unauthorized personnel because the database structure is proprietary and is protected by encrypted passwords.</p>
<p>What measures are in place to keep data being transported from the precinct to headquarters secure?</p>	<p>After the election is tilled in the precinct, the election officials place the information in a secured ballot box for transportation to the election office. Individual county provides the boxes. When the machine is tilled, the poll officials have no means to restart, alter, or delete any information regarding vote totals, audit trails, or tally tapes.</p>	<p>Physical security of the transporter.</p>	<p>Data transmitted by modem is said to be encrypted. If removable memory cards are carried, the poll workers must maintain security. Over a period of years computer scientists have found serious flaws in the security provisions for the removable memory cards and other parts of the system. As recently as 2005 it was found to be easy to bias or change the vote data on the cards.</p>	<p>The MBB removable flash-memory card is inserted into the JBC and secured with a security seal. Many customers transport the sealed JBC to headquarters where seal removal is witnessed by authorized personnel. The votes are then read from the MBBs and the software validates the identity of each MBB as it is processed. Should anything happen to the MBB, the JBC and the eSlate voting units can provide redundant back-up of cast votes</p>
<p>Is a modem, or could a modem, be used with any of the components of your</p>	<p>No.</p>	<p>Yes, there is a serial port for either a modem or a printer.</p>	<p>Yes.</p>	<p>Yes</p>

system?				
Is a modem required to use any component of your system?	No.	No.	No.	No.

MicroVote Infinity

Report to LWVOR Voting Technology Committee

Mary Uziel

February 14, 2006

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1. Introduction

According to the Tennessee Election Commission, as of February 14, 2006, the MicroVote Infinity has not been certified. MicroVote programmers are working with the Election Assistance Commission (EAC) and Wyle Labs, an independent testing authority, rewriting and fixing code on the spot as problems are uncovered. Until a certification number is issued, the Tennessee Election Commission will not approve a contract to purchase MicroVote machines.

Forty-six counties in Tennessee currently use MicroVote machines and 10 to 12 additional counties are considering purchasing MicroVote. MicroVote voting machines are used in nine states: AR, IA, IN, KS, KY, MI, NC, OH, TN.

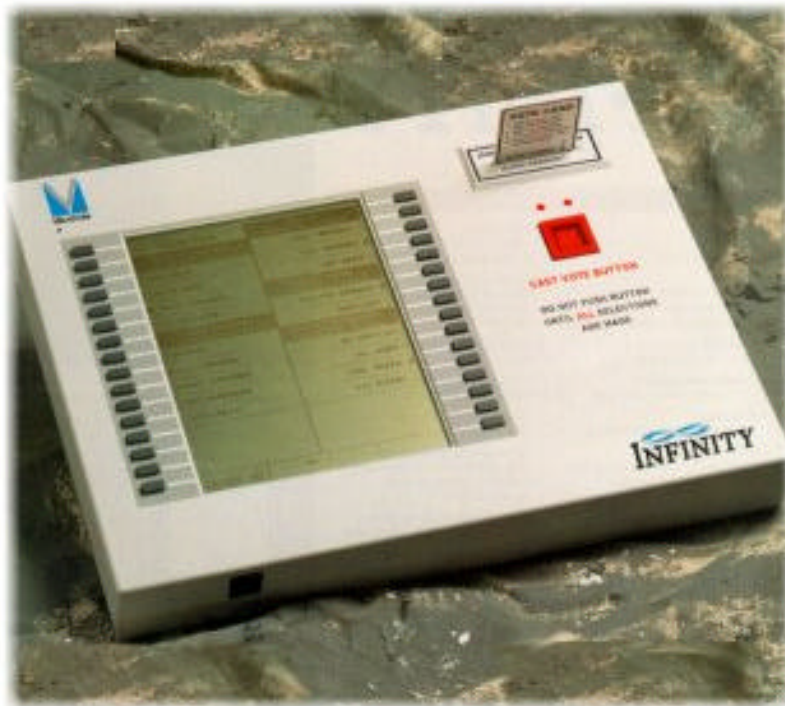
2. History [*from www.verifiedvoting.org*]

MicroVote headquarters is in Indianapolis. Their only business is Voting Machines. James F. Ries, Sr., is chief executive officer, and James F. Reis, Jr., is president. Reis (Sr.) was formerly a sales representative for the Automatic Voting Machine (AVM) Company (Jamestown, NY), the premier manufacturer of lever machines. AVM went out of business just as they had developed an electronic voting machine. Reis (Sr.) took the idea to his former college roommate, Bill Carson of Carson Manufacturing, and MicroVote was born in 1982. Carson Manufacturing makes all MicroVote voting machines and is located about one-half mile from the MicroVote headquarters.

3. MicroVote Infinity

Infinity Voting Terminal [*from www.microvote.com*]

The Infinity Voting Panel is a Direct Recording Electronic (DRE) voting device for use in governmental elections. It incorporates an LCD panel to display the ballot, individual buttons for operator control and voter selection, memory card technology for activation control and data collection/transport, integral battery operation capability and the latest embedded computer technology.



The Infinity is designed for portable stand-alone voting operation with no need for additional devices at the polling site. It is flexible enough to allow very sophisticated configurations meeting the needs of most jurisdictions. It is programmed using a PC connected via an interface connector operating proprietary database software provided by MicroVote. Results are retrieved using the same PC/software set via direct connection or a memory card reader.

The Infinity is designed to meet the requirements of the Federal Election Commission's standards (FVSS) for reliability, accuracy, performance and testing standards and allows voters with disabilities to vote unassisted on the same device as capable and sighted voters.

4. Demo of MicroVote Infinity at Anderson County Election Commission on December 14, 2005

Wayne Harris with the MicroVote Tennessee Regional Support Center presented the demo. An ex-marine, Wayne knew his product, came across as honest and trustworthy, and gave a convincing demonstration. He lives in Grundy, Tennessee. He can be

contacted at (931) 580-3410 or wayneharris@blomand.net. An e-mail to this address requesting answers to eight questions received prompt attention.

The MicroVote Infinity contains no hard drive and no moving parts. It uses EEPROM flash memory, which stays there, but is scrambled before it prints out. It uses EMS software. The MicroVote voting system is a stand-alone system that is not connected to any other system. The company provides a computer, a printer, a start card, and a vote card. The software reads the cards and produces the vote total.

Only the "Ballot Loader" has access to the system. The software tracks who goes into the database and what they do while they are there. An election official inputs the government structure from the U.S. president down to the constable and this information is stored permanently in the template. The ballot is set up by clicking on the office and entering the candidate's name. The system also provides the capability of making absentee ballots.

Complete instructions for starting up the machine are provided. You begin by inserting the "start" card, and the printer prints out verification that the machine is on zero at a specific date and time and lists all candidates. Cards are kept secure in the office. MicroVote uses "button technology" which is more reliable than touch screen. The buttons are gold plated like telephone buttons. Touch screens last only about 7 years, but button technology is very stable.

There are three ways to serve the handicapped: (1) the machine can be put in a voter's lap; (2) there are wide legs on machines so a wheelchair can get underneath; or (3) the machine can be put on a table and a wheelchair moved under the table.

Once a ballot is on the screen, the voter can page through the ballot, go back, and make changes any number of times until he presses the "Vote" button. The voter must make one selection before he can push the Vote button. Write-In candidates can be entered by typing in the candidate's name.

To adapt their voting machines for use by the blind with no assistance, MicroVote consulted the Indianapolis School for the Blind, near their headquarters, and learned that most blind people do not read Braille but are familiar with DoubleTalk. DoubleTalk changes text to speech. Most ATM's use DoubleTalk with a plug-in spot for the earphones on the front.

The Infinity software sets up a regular ballot, an absentee ballot, or DoubleTalk. The person setting up the ballot must check the phonetics of the spelling of candidates' names to get the right pronunciation from DoubleTalk. The blind person plugs the earphone into the DoubleTalk box, and can speed it up or slow it down as desired. The first time the machine is touched, it tells the voter what it does. Double click to select and double click to remove a vote. When push "Vote" (red button), the machine tells the voter how they voted. All machines are capable of DoubleTalk. A person who is both blind and deaf will need assistance.

The Infinity is very sturdy if dropped. It is not waterproof and may have problems if it gets wet (e.g., coffee or drink spill). A lot of other machines require the voter to pull up the ballot, but with MicroVote, the poll worker uses a card to pull up the ballot.

The machine puts all votes for each election in a folder. These folders can be opened with the "Get Votes" software. MicroVote now trains all election people on "Get Votes." The flash memory in the machine holds 28 megabytes. One ballot takes very little memory. The Infinity can hold 9,999 ballot styles, 9,999 positions, and 9,999 votes. The machine is set up with a laptop that has been synchronized with the tower in the election office. The election commission will need a laptop to set up machines.

The Start Card and Vote Card are used over and over, but a Tally Card is needed for each machine. The Tally Cards receives the memory from each machine. If you write to it a second time the new total replaces the original total. The audit trail remains in the machine. There are seven places the vote total is stored (five in the machine, one prints out on tape, and one on the Tally Card). The user can release Vote totals to a web page or burn them to a CD on the office tower and take to another computer to send to a web page. The system will e-mail results to the state.

A certified voting machine must produce an auditable trail with every voter's ballot. MicroVote does this in code (e.g., position 29 = No.1), which is not the same as a voter verifiable paper trail.

MicroVote software code is written by three contractors hired by MicroVote. North Carolina wants all companies to provide source code as escrow to be locked up, so if the company goes out of business, the state will have the code. MicroVote is willing do this.

When MicroVote does an installation in a county, they stay with the county through two elections.

5. Documented Failures [from www.votersunite.org]

Considering that Diebold and ES&S count 80% of the votes in the U.S. [*quoted from Black Box Voting, 4-28-04, by V. Jones, Optech Voting Machines, 1-16-06*], MicroVote is a relatively small company. For that reason fewer failures have been documented and most of these involve the MV-464. The Infinity has been in use for 6+ years and has been used in Tennessee for 4 years. Votersunite.org reports three problems with the Infinity. These problems occurred in Jasper County, SC; Pender County, NC; and Sumner County, TN.

Jasper County, SC, June 2004: Results of the June 8 election were certified before the county noticed that there were 1500 more ballots counted than the number of voters who signed in to vote. The problem had occurred when the precinct totals were accumulated in the central tabulation computer. Vote data from a previous election had not been deleted and those votes were included in the 2004 totals.

Pender County, NC, July 2004: One of the county's 74 machines would not tally the votes. The precinct worker brought the machine to the central headquarters where the votes were extracted and counted manually.

Sumner County, TN, May 2005: An Infinity voting machine locked up around 2:00 p.m. on election day and was taken out of service. A technician from Indianapolis came to the office and retrieved 110 votes the next morning. The election director expressed complete confidence in the results.

Presentation of
Election Systems & Software Voting System
to
Anderson County Election Commission

Report to LWVOR Voting Technology Committee

V. K. Paré

February 12, 2006

A presentation of the Election Systems & Software Voting System to the Anderson County Election Commission took place on February 9 at the Commission's office in the courthouse. Besides the Commission members and Administrator of Elections Jo Ann Garrett, attendees included employees of the Election Commission; Betty Jernigan, Louise McKown, and me of the LWVOR Voting Technology Committee; Ray Garrett; and others I didn't recognize (although Louise McKown is a member of the LWVOR Voting Technology Committee, she was there primarily on behalf of an organization that advocates for the handicapped).

The E S & S representative spoke rapidly and at length; however (example below) I often found it difficult to glean specific information from his talk. Also, no product literature was made available at the presentation, and the descriptions available at the E S & S web site are less detailed than some of those I have found at other manufacturers' sites. Thus I remain uncertain about important factors such as the hardware and procedures used for collecting the vote data in a precinct and collecting and combining the precinct data at election headquarters.

The representative's main emphasis was on the E S & S iVotronic voting terminal, which is a 14-pound touch-screen device somewhat reminiscent of the Diebold AccuVote-TSX. The representative assured us that although the touch screen may require calibration, it is seldom needed and very easy to do. On its front panel the iVotronic has three distinctively-shaped navigation buttons below the display, a "Vote" button at the top, and a slot for inserting an "activation cartridge". At the rear are a memory card slot, a "DB-9" interface connector, and, at the right, an unidentified slot (which might be used in mounting the iVotronic on its easel). The voting process begins with the voter identifying herself at the precinct desk and stating the election(s) in which she wants to participate. The

voter is given an activation cartridge (or maybe activation module) and is led to the iVotronic by an election official. The voter inserts the activation cartridge; then apparently the official accesses the touch screen to set the terminal to bring up only the ballots needed by the voter [The activation cartridge is a plastic case about the size and shape of a folded wallet, and appears to communicate with the iVotronic via an interface that does not require direct (conductive) electrical contact. It didn't look obvious how to orient it to insert it into the slot].

Actually, much discussion between the representative and several attendees was required to develop the above description. If the procedure were the same as that used with the Diebold AccuVote-TSX, the activation cartridge would have been programmed at the precinct desk with the voter's choice of ballots and the official's presence would not be needed. But the activation cartridge apparently is not simply an access "key" for the individual voter; in fact its memory card contains the ballot setup data and is one of the (intentionally redundant) places in which vote data are stored. Some of the people present were surprised at the idea that an election official would have to insert himself between the voter and the terminal to enter on the touch screen the voter's choice of ballots. For example, some voters might suspect that the official was prejudicing their votes. Only after several questioners, led by Ray Garrett, asked pointedly whether this is true did the representative understand the question and give an (apparently) affirmative answer. Then someone pointed out that what has been done with Anderson County's former lever and present digital pushbutton machines is that an official, who is always present at the voting machine, receives from the voter a ticket that specifies the voter's choice of elections and uses controls on the back of the machine to set it to show only the needed ballot(s).

Still, if the procedure described above for the E S & S iVotronic is correct, it leaves other questions unanswered. It seems to mean that for each voter an election official must walk to the voting terminal and back to the election desk, a seemingly tedious routine. The status of the activation cartridge was not made clear. It contains the ballot definitions and receives and stores vote data (the election equivalent of crown jewels), yet it is apparently not associated with a particular voting terminal (it wasn't even clear that the number of cartridges is equal to the number of iVotronics), and is carried within the voting site by numerous voters as well as election officials. It would seem that constant vigilance would be needed to keep track of the cartridges.

The representative also demonstrated the Real Time Audit Log, which is a printer that can be mounted on the easel to the left of the iVotronic. As with the Diebold and Hart Intercivic voting terminals, a new model of easel/voting booth has been developed to facilitate mounting the printer, and the printer and its paper are fully enclosed and not accessible to the voter. In keeping with its role

in providing a Voter-Verifiable Paper Audit Trail, the printed record of the voter's selections is moved on to the takeup roll (and thus out of sight) when the voter has approved it. The printer also records all other actions done on the voting terminal, including all poll worker activity; thus the printout can be used in auditing the election procedures. As with the Hart eSlate (but not the Diebold) the printout is in a convenient position for viewing by the voter. However (as in the Diebold) the smallness of the font size detracts from its usability as a VVPAT [The printer used with the Hart eSlate is wider but I don't know whether the font size is larger].

The representative also demonstrated the E S & S Model 100 Precinct Ballot Counter, which is a tabletop optical scan machine intended for counting absentee ballots. Using E S & S software on a PC with an attached laser printer, election officials can print optical-scan absentee ballots as needed. Neither the representative nor the literature on the E S & S web site mentioned the capability, offered by the Hart Intercivic scanning system, of flagging doubtful ballot markings and providing magnified displays of the affected areas for review by election judges.

E S & S also sells a voting terminal called the Automark that is designed to allow handicapped people to vote independently, but its function is to fill out paper ballots that are to be counted by optical scanners, and I assume it is not available in Tennessee.

The E S & S representative didn't say much about it, but their web site offers brief descriptions of a set of software modules, running on Windows PCs, that store data on precincts, districts, candidates etc.; format ballot images; program the voting terminals (and, one supposes, the activation cartridges); and collect all the vote data and print reports. E S & S seems to assume that the election results will be transmitted from the polling places to election headquarters through modems connected by telephone.

Concerning accessibility, the touch screen is mounted on a frame which is wheel chair accessible. The recorded directions, using earphones, for visually limited voters were difficult to understand.

Diebold Presentation to Anderson County Election Commission

Report to LWVOR Voting Technology Committee

V. K. Paré

January 21, 2005

The Diebold presentation to the Anderson County Election Commission took place on January 19 at the Commission's office in the courthouse. Besides the Commission members and Administrator of Elections Jo Ann Garrett, attendees included employees of the Election Commission; Donna Smith of the Oak Ridger; Betty Jernigan, Louise McKown, and me of the LWVOR Voting Technology Committee; Ray Garrett; and a Mr. Shapira; along with some others I didn't recognize.

The Diebold representative appeared to be competent and knowledgeable. He started by implying that the many criticisms of the company are either unfounded or no longer valid. The demonstration involved two samples of the AccuVote-TSX touch-screen voting terminal, which is apparently one of those certified by the State of Tennessee. Also in the room was an AccuVote-OS optical scan terminal, which he suggested would be used for counting absentee ballots. One touch-screen machine was equipped for use by the vision-impaired and the other was equipped with a printer for generating a VVPAT, a voter-verified paper audit trail. Each terminal was mounted on an easel made of aluminum tubing and could be adjusted in both height and angle to suit standing or sitting (wheelchair) users.

A complete system would include the needed number of touch-screen terminals at each precinct's voting location and, at the Election Commission's office, a central computer and one or more optical scan terminals for reading absentee ballots. There need not be any central computer at the precinct level; any of the touch-screen terminals can, at the end of the election, accumulate the results from itself and the other touch-screen terminals. Transfer of data among them is done by "sneakernet"--hand-carrying removable memory cards from each terminal to the one specified for accumulating the precinct results. The precinct results can be transferred to the central computer by the same method or by telephone modem.

Any AccuVote-TSX touch-screen machine can be made usable by the vision-impaired simply by adding a headphone and an appropriate numeric keypad (with raised dot on the "5" key). The vision-impaired person hears an audio version of the ballot in the headphone and uses the keypad to make vote selections. The process is of course much slower than using the touch screen, and the representative recommended that the terminal for the visually impaired be set up at some distance from the others to give the visually impaired voters a feeling of privacy.

The central computer runs software called GEMS® (Global Election Management System) that tabulates and prints data obtained from the precincts and also allows election officials to set up the database that will contain the vote data and to lay out the graphical designs of the ballots. Three types of ballot design are needed for an election, (1) those that appear on the touch-screens, (2) the (absentee) paper ballots for the optical scan machine, and (3) the audio ballots to be used by visually impaired voters. The wording for the audio ballots can be submitted to Diebold's Service Bureau, where they are recorded in digital form in a studio setting and returned to the election commission.

When a voter checks in at the reception desk in the polling place, the officials, after verifying the voter's identity and finding out, if needed, in which primary and other election(s) the voter wishes to participate, use a small hand-held device to program a removable memory card that will "authenticate" the voter to the voting terminal and inform the terminal of the voter's choice of election(s). The voter carries his/her memory card to the voting terminal and inserts it into a slot; in response the terminal presents the first ballot on its touch screen. As with a lever voting machine, the terminal will prevent the voter from selecting too many candidates in a race ("overvoting"). After the voter has made the desired selections and indicated to the terminal that he/she is finished, the terminal displays a summary of the voter's selections, calling attention by color to any cases of "undervoting", and gives the voter an opportunity to make corrections and/or to cast the ballot. The terminal then either presents the next ballot or, if there is none, readies itself for the next voter. The poll officials recover the authentication memory card from the voter so that it can be reprogrammed for another voter. The terminal of course adds the voter's selections to its running totals for each candidate or issue, both in its internal flash memory and on another removable memory card held in the terminal behind a cover seal.

The Diebold representative gave a brief demonstration of the printer attachment intended to provide VVPAT capability. It has a thermal printer similar to those on adding machines, and prints on tape that is about two inches wide. No

attempt is made to print an image of the ballot; rather it simply prints a list of the candidates for whom the voter voted. The tape is under a transparent cover and the takeup roll is inside the machine. A small magnifier is provided for voters who didn't bring their reading glasses. The printer seemed quite noisy; however the Diebold representative explained that the noise was generated to call the voter's attention to the opportunity for reviewing the printout. The voter can reject the results after seeing the printout; after the voter has made revisions on the touch screen the results are printed again. If the voter approves the printout, the printer adds a bar code that contains the results, so that a recount based on the VVPAT can be done by machine (it was not clear whether Diebold offers such a machine).

The Diebold representative disparaged the need for and usefulness of the printer. He remarked that the printer attachment is not certified by the State of Tennessee and would not normally be furnished. If it were ordered it would cost \$320-\$350 for each terminal. The cost of the terminal is in the neighborhood of \$4,200.

In the question period Betty Jernigan asked for an explanation of the history of criticisms of the security features in Diebold voting machine software. I think the only specific information offered in reply was a complaint that the discovery in 2003 of an Internet-accessible computer containing the Diebold software had been made possible by a disgruntled former Diebold employee who had been fired for incompetence. Mr. Shapira asked whether the software used in the AccuVote-TSX is available for public inspection. The Diebold representative at first misunderstood the question, thinking it might refer to the database and/or ballot setups entered by the election officials. After Mr. Shapira made it clear that he was referring to the (Diebold-written) software that runs the machine, the answer was "no", followed by an assurance that the software had been certified as complying with voluntary standards of security and accuracy promulgated (several years ago) by the Federal Election Commission (FEC) and the National Association of State Election Directors (NASSED). I think it was Mr. Shapira who also asked whether the AccuVote-TSX software had been updated since 2003. The Diebold Representative assured us that the latest certified version would be furnished with the machines and, in response to my question, that the machine can display the version numbers of the software modules so that the user can verify that it contains the correct version.

The two demonstration machines contained ballots created for demonstration purposes, and after the question period several people tested the touch-screen

interface and the audio ballot for the visually impaired. I didn't test it, but the touch-screen ballot looked to be fairly easy to navigate.

I can offer the following comments on the meeting, the Diebold system, and electronic voting systems in general:

(1) I think that discussing the publicized security deficiencies of Diebold's voting system software in a meeting of this sort – where most people are clueless about computer software in general and even more so about computer security, and where the company representative is available to provide obfuscation—is very difficult; that is, I feel that it's very hard to convince people. I assume that our Voting Technology Committee will provide Ms. Garrett and the Election Commission with reports on our investigations of voting systems in time (whenever that is) for them to read them before making their purchasing decision. Presumably the report(s) will make clear our views on computer security issues in general and specifically as they relate to Diebold's products.

(2) It looked as though the ordinary voter's experience with the AccuVote-TSX machine would be mostly satisfactory. I can't speak for handicapped people.

(3) The printer for implementing VVPAT seems to me to be completely inadequate. Presumably it was chosen for minimal cost and minimal impact on the design of the voting machine, by people who were unwilling to admit to any need for a VVPAT. The "feature" of printing bar codes to make the paper printout machine-readable reflects a failure to understand the principle that what is recounted in an audit must be precisely the printout that is verified by the voter, not something that is generated by the computer and not readable by a person. Also, it has been shown that many voters tend not to take the trouble to review the VVPAT printout, and the location and small size of the Diebold implementation would tend to discourage them from looking at it. It seems to me that a desirable printer for producing a VVPAT would present the printout as a ballot image not too much smaller than the one on the touch screen, and located near the touch screen at the same height and angle. Such an arrangement would of course make the voting terminal much larger and heavier.

(4) In the packets of Diebold literature available at the meeting I was impressed by the quantity of training offered to election officials and poll workers. For the GEMS software that creates the ballots and tabulates the results there are four courses totaling 13 days of classes. For each type of voting terminal (touch screen and optical scan) there are five courses totaling 23 hours plus two days. I note this information mainly to emphasize that electronic voting technology can be complex enough that if elections are to be conducted smoothly the Election Commission must plan to provide some training for all employees and substantial training for a few.

(5) It is my understanding that (a) the old FEC/NASED standards for voting machines are considered by experts in computer security to be inadequate, and (b) the Election Assistance Commission (established by the Help America Vote Act of 2002) is working with the National Institute of Standards and Technology to create a new, more comprehensive set of standards for voting system security and accuracy, but another year or two may elapse before the new standards are available for use. However, the HAVA money for purchasing voting systems is available now. Thus many voting machines will be purchased this year but, having been certified under the old FEC/NASED standards, they may not be as secure as those that will be available in a few years.

Presentation of
Hart Intercivic eSlate Voting System
to
Anderson County Election Commission

Report to LWVOR Voting Technology Committee

V. K. Paré

January 27, 2006

A presentation of the Hart Intercivic eSlate Voting System to the Anderson County Election Commission took place on January 25 at the Commission's office in the courthouse. Besides the Commission members and Administrator of Elections Jo Ann Garrett, attendees included employees of the Election Commission; Donna Smith of the Oak Ridger; Margaret Beams, Betty Jernigan, Louise McKown, and me of the LWVOR Voting Technology Committee; Ray Garrett; and others I didn't recognize.

The system is manufactured by a Texas company, Hart Intercivic, but is sold in Tennessee and Kentucky by Harp Enterprises. In Tennessee, Harp in turn uses a Tennessee company with experience in Tennessee election law and procedures to promote the system. The Harp representative was at the meeting and provided an overview, but the main presentation was made by a representative of the Tennessee company, who seemed quite knowledgeable. Unfortunately, I didn't catch the names of the Tennessee company or either representative.

The eSlate voting system differs in configuration from other direct recording electronic systems. The voting terminals are quite compact; in a precinct installation as many as twelve of them are connected in a "daisy-chain" cable arrangement to a central device called the Judge's Booth Controller (JBC), a compact desktop computer with a built-in display about 5 inches by 3 inches and a built-in printer that uses paper 2 1/4 inches wide. Only the JBC is plugged into utility power; the eSlates receive their power from it via the cable system. Each of the units also has a battery that can last through an election day. A voter entering the polling place identifies herself, states in which election(s) she wants to vote, and then is directed to the operator of the JBC. This official enters the voter's choice of ballot(s) into the JBC, which prints a small piece of paper showing a random four-digit number and also transmits this number, along with the voter's ballot choices, to all the eSlates. The voter then takes the printed number to any available eSlate, enters the number, and is presented with the first of the needed on-screen ballot pages.

The eSlate is unique among electronic voting terminals in that it does not have either a touch screen or rows of pushbuttons. Instead, there is a horizontal wheel about 2 1/2 inches in diameter plus keys labeled ENTER, PREV, NEXT, HELP, AND CAST BALLOT. The wheel, which has radial ribs and a finger depression, turns a rotary encoder, which is a multi-position digital switch, and clicks easily from one position to the next. As the wheel is turned, the highlighting on the screen jumps from one item (typically a candidate) to the next. A typical ballot requires several screens; the PREV and NEXT keys allow navigation among them. Pressing CAST BALLOT first brings up a list of all the candidates voted for, allowing the voter to review her choices; pressing it again actually does the voting and ends the voter's session with the eSlate. The votes are recorded in the eSlate's memory and also transmitted to the Judge's Booth Controller, where they are stored in the JBC's memory (the representative said on the hard disc) and on a non-volatile memory card in a sealed external slot in the JBC. If an eSlate malfunctions it can be replaced by another with only a brief interruption of the voting process. I found the system easy to use, but I'm not a suitable judge, having used various scientific instruments that had rotary encoders. I heard no complaints from the others who tested the machine. Voting for a write-in candidate is a bit tedious. On selecting that option, the voter is presented with an alphabet and uses the rotary encoder to select each letter and the ENTER key to "type" it.

The representative pointed out that the eSlate has no need for the periodic "calibration" adjustment that is required for touch screen machines, in which the partly analog system that measures the location of the user's touch is independent of the digital system that positions the text and graphics on the screen. The rotary encoder may be of help for voters with impaired vision or motor function in that the voter's finger does not interfere with her view of the screen, and the act of voting for a candidate is separate from the act of selecting which candidate to vote for. For more severely impaired voters there is an option for the eSlate called the Disabled Access Unit that provides interfaces for a headphone, a "sip-and-puff" tube, and "jelly-bean switches".

The software in both the eSlate and the JBC is based on a "real time operating system" rather than Windows or any other personal computer operating system. [Various "real time operating systems" have been developed for dedicated applications such as aircraft flight control; the connotation of "real time" is that the computer must not only compute correct results but also must do so within specified time constraints, so that the results are available in time to be useful.] For a voting machine the advantages of such an operating system would probably be that it is compact enough to be held in nonvolatile memory and that most "hackers" would not know how to access it.

Both of the eSlates on display were installed in free-standing foldable "voting booths" that can be adjusted to accommodate either standing voters or those in wheelchairs. The booths also fold into storage cases for the eSlates. It should be noted that the backup batteries for the eSlates and JBC are non-rechargeable. Thus the Election Commission

would have to anticipate the cost of periodic battery replacement. There is, however, also a cost associated with rechargeable batteries: during the long periods of storage between elections they will deteriorate if the voting terminals are not connected continuously—or at regular intervals—to electric power. Thus the storage facility would have to have enough power connections to allow continuous or periodic recharging.

The opportunities for altering the results of an election seem quite limited. The eSlate's only connections with the outside world are its control panel and the interface with the JBC; it has no slots for memory cards. The only external connections to the JBC are the interface to the eSlates and the plug-in flash memory card (called the mobile ballot box, or MBB). During pre-election setup, as with all mechanical and electronic voting systems, the Election Commission's staff must zero out the vote data in the eSlates, the JBCs, the MBBs, and the central computer, and print verifications. Then the MBBs are reinstalled into the JBCs, physical seals bearing unique numbers are applied to the MBB slots, and a list is made that matches the seal numbers to the serial numbers of the JBCs. An MBB can be removed from a JBC only by breaking the seal with heavy wire cutters, making any intrusion by that route highly visible. After the polls close, the JBCs are taken to election headquarters where the matching of seal numbers and JBC serial numbers is verified, and the MBBs removed so that their data can be read into the central computer.

There is a VVPAT (Voter-Verified Paper Audit Trail) option for the eSlate, though it has not been certified by the State of Tennessee and none was available at the presentation. It consists of a printer that is mounted in the voting booth just to the left of the eSlate's screen. The area available for printing is about 3 inches wide and 6 inches high, and the paper moves horizontally from the supply roll to a takeup roll. Presumably, if the printing format is adequate, a voter could quite easily compare the printout with her choices.

A demonstration was also given of the system for processing absentee ballots. It consists of a PC, running Windows, with a laser printer and a heavy-duty, automatic-feed image scanner. Hart Intercivic's Ballot Now software facilitates the creation of paper ballots that can be printed by the laser printer as needed, so that they don't need to be ordered from a printing firm and everything on the printed ballot is exactly where the scanning software expects to find it. For the demonstration a number of ballots were prepared with vote selections and then fed to the scanner. One ballot was folded and unfolded and another was crumpled into a ball and flattened (more or less) by hand. When commanded, the scanner took in all the ballots and scanned them. The system (as is true, I understand, of other up-to-date ballot scanning systems) generates a digital image of the entire ballot and uses features of the image to find the areas containing boxes in which voters are expected to mark their selections. The software examines each race and records a vote if it does not detect an overvote, undervote, or ambiguity. If any anomaly is detected it does not record a vote and flags the race and ballot for manual examination.

After the ballots have been scanned an election official can sit at the computer and see a magnified image of each race that has anomalous marks, and (presumably with partisan poll watchers looking on) use her judgment to give the vote to either candidate or none. The system seemed to perform satisfactorily on a few test cases; obviously further tests would be interesting and desirable. [In tests preceding an election last November in Boulder County, Colorado, Hart scanners were faulted for recording voter selections where folds in the ballot paper passed through selection boxes. (1)]

(1) <http://www.longmontfyi.com/region-story.asp?ID=4040>